THE ADOPTION OF BLOCKCHAIN TECHNOLOGY IN THE AUSTRALIAN AGRICULTURE SUPPLY CHAIN

A Thesis submitted by

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ABSTRACT

Agriculture supply chains have grown from independent and unsupervised local stakeholders to an interconnected global system of various actors linked by complex interactions that affect food supply, storage, processing, transportation, and delivery to end consumers. Frequent incidents of lack of traceability, slower financial transactions, and intensive manual work demonstrate a lack of transparency in the agriculture supply chains. These have generated concerns about financial losses, thereby eroding customer trust and diminishing business. Although blockchain is viewed as a solution to the agricultural sector's problems, various challenges remain regarding its adoption.

One significant barrier related to its adoption has been the lack of research into the field, primarily due to its relatively new status. The complexity of the agricultural supply chain due to various stakeholders and evolving consumer demands has created a whole new challenge. This thesis addresses the complications in the current body of knowledge by identifying and modelling the determinants of Blockchain Technology (BCT) adoption in the agriculture sector given that majority of previous research has focused on the non-agricultural sector. The study adopted a quantitative methodology to identify the determinants of BCT adoption in the Australian agriculture sector.

The finding were used to develop a practical BCT adoption scale in the supply chain. The results show that perceived behavioural control, insecurity, perceived ease of use, perceived usefulness, attitude towards use, and transparency are related to BCT adoption in the agriculture supply chain. The knowledge on blockchain adoption has three main theoretical contributions. First, it provides the basis for enhancing business process capabilities through the integration of *information systems* and for facilitating the completion of online transactions in a trustful environment. Second, it contributes to highlighting how the certainty aspect of BCT due to its transparency and traceability has transformed *digital marketing* in the

agricultural supply chain. Third, it contributes useful insights into how BCT can improve farming experience and productivity in the *agriculture* sector by creating connectivity with stakeholders.

CERTIFICATION OF THESIS

I Peter Sasitharan Gandhi Maniam declare that the DBAR Thesis entitled the adoption of blockchain technology in Australian agriculture supply chain is not more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references, and footnotes.

This Thesis is the work of Peter Sasitharan Gandhi Maniam, except where otherwise acknowledged, with the majority of the contribution to the papers presented as a Thesis by Publication undertaken by the student. The work is original and has not previously been submitted for any other award, except where acknowledged.

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STATEMENT OF CONTRIBUTION

Paper 1:

Student contributed 80% to this paper. Collectively Anne-Marie Sassenberg & Jeffrey Soar contributed the remainder.

Paper 2:

Student contributed 80% to this paper. Collectively Anne-Marie Sassenberg (10%) & Jeffrey Soar (10%) contributed the remainder.

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ABBREVIATIONS

ASCM	Agriculture Supply Chain Management
BC	Blockchain
BCT	Blockchain Technology.
DM	Digital Marketing
I4.0	Industry 4.0.
IS	Information Systems
TAM	Technology Acceptance Model.
TPB	Theory of Planned Behaviour.
UTAUT	Unified Theory of Acceptance and Use of Technology.

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CHAPTER 1: INTRODUCTION

1. Introduction

The chapter consists of eight sections, which are organised as follows: The first section describes the background of the study while the second section presents the research problem statement. The third section presents the theoretical background while the fourth section describes the thesis framework. Section five presents a summary of the research design and methodology while section six describes the theoretical contribution of thesis while section seven presents a summary of the chapter.

1.1 Background of the Study

The decentralization of transaction networks has become popular in supply chain management worldwide (Zhang, 2019). At the heart of this decentralization is Blockchain technology which is part of Industry 4.0 technologies that have been expected to make significant changes in various sectors, particularly food, manufacturing, and financial sectors (Haddud & Khare, 2020). These technologies were expected to improve the current processes and strengthen competitive positions in the market (Zhang, 2019). Originally, Blockchain technology, also known as BCT, is a mechanism that facilitated the exchange and traceability of capital assets (Yermack, 2017). It rose to prominence as a platform for managing the digital currency Bitcoin (Nakamoto, 2008). In due course, the BCT concept progressed, and it currently gives value to businesses such as manufacturing, global insurance, sales, and supply chain management (Xu et al., 2020). BCT is considered useful technology for the agro-food industry because it helps address some current supply chain challenges (Hughes et al., 2019; Queiroz et al., 2019; Kohler & Pizzol, 2020). Academic research on supply chains tend to influence industry standards, unlike in other fields (Sarkis et al., 2020). Therefore, further academic research on the application of BCT in Australian agribusiness supply chains is needed before concrete

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suggestions on how the technology can be effectively deployed in the industry is made (Sarkis et al., 2020).

Agriculture is one of the most critical areas that has a considerable impact on the world today (Sarkis et al., 2020). With many people facing hunger, mechanisms should be implemented to address issues of food shortage. Today, agriculture is supported by one of the most complicated supply chains that involves different sector players from the global economy (Ahearn et al., 2016). The agriculture supply chain is further complicated by the changing consumer demand where traceability and transparency have become part of consumer purchase preferences (Xu et al., 2020). With agricultural production mostly affected by climate change, producers face daunting tasks to meet consumer demands. Other players such as food processors, transporters, and vendors face complications in their supply chain processes to meet the evolving consumer demand (Xu et al., 2020). To ensure all stakeholders' demands are realized, there is a need to review the existing agricultural food supply chain (Bayir et al., 2022). One such way is the utilization of Blockchain technology. Blockchain is a decentralized Distributed Ledger Technology (DLT) used to securely store data from a supply chain (Caro et al., 2020). Each block is linked together by a hash and a pre-hash signature value. The transactions are managed in a distributed system with entirely decentralized servers. Because all the information is encrypted, the data in the block cannot be changed once it has been entered/committed (Kamble et al., 2021). The current body of knowledge with respect to the topic of BCT adoption in supply chain management has mostly focused on identifying the benefits and challenges of the technology. There is limited knowledge on the extent to which the identified benefits and challenges of BCT can act as determinants to its adoption. A considerable amount of current research on BCT adoption is focused on non-agricultural sectors (Li, 2020; Park, 2020) with only a few studies focusing on its adoption in the agriculture sector (Rogerson & Parry, 2020; Prashar et al., 2020; Bhusal, 2021). Besides, most of these

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studies have employed a qualitative research design approach. This research addresses this gap by identifying and modelling the determinants of BCT adoption in the agriculture sector. It also fills the current research gap by employing a quantitative research design to examine the determinants of BCT adoption in the Australian agriculture sector where there are only few studies that have focused on it.

The research phenomenon attempts to address the current concern on the low adoption of BCT in the agriculture sector. Previous research has noted that BCT adoption is most widespread in the automotive industries (Kamble et al., 2021) while in the agricultural sector, it's most common among the food processors (Xu et al., 2020). However, the existing literature has been limited to specific players in the agricultural supply chain (i.e., food processors, farm input suppliers, and food retailers) and consumers in the agro-based industry are placing considerable pressure on firms, requiring a more open and safe food supply chain (Tiscini et al., 2020). The implication is that there is a potential gap in the literature on the effectiveness of the BCT adoption for agriculture practitioners. The current thesis relies on various technology adoption theories such as TAM, UTAUT, TPB, and TRI to examine whether there are key determinants that would influence BCT adoption in the agriculture sector. The broad implication of the findings would be to model the identified determinants of BCT adoption with the aim of informing relevant stakeholders, including policy makers to adopt appropriate measures that would improve its deployment in the agriculture sector.

The review of previous studies indicates that the topic on BCT adoption in supply chain management has mostly been explored using qualitative research design approaches (Rogerson & Parry, 2020; Lin et al., 2020). As noted in the review of past studies, only Nuryyev et al. (2020) and Alazab et al. (2021) have explored this topic using a quantitative research design approach albeit focusing on non-agricultural sectors (i.e., tourism and hospitality and multiple industries respectively). The thesis addresses this gap by adopting a quantitative research

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design approach to identify the determinants of BCT adoption and then model how these determinants would influence the adoption behaviours of stakeholders in the agriculture sector. The thesis uses confirmatory factor analysis, structural equation modelling, and Rasch model to undertake this quantitative data analysis.

The findings of this thesis have both theoretical and practical contributions. There are three theoretical contributions of this thesis. First, it provides the basis for enhancing business process capabilities through the integration of *information systems* and facilitating the completion of online transactions in a trustful environment. Second, it contributes to highlighting how the certainty aspect of blockchain due to its transparency and traceability has transformed *digital marketing* in the agricultural supply chain. Third, it contributes useful insight on how blockchain can improve farming experience and productivity by creating connectivity with customers and farm input suppliers. The main practical contribution of the paper is that it highlights how agricultural stakeholders and policy makers can embrace this technology in the agriculture supply chain by leveraging its benefits and addressing its key concerns such as privacy and security aspects.

1.2 Research Problem Statement

Although Blockchain technology can help reinvent the agriculture supply chain, its adoption has been limited with only the food processors interested in it (Chen et al., 2020; Tiscini et al., 2020). Early prototype models are emerging, and globally recognized food corporations are collaborating to speed the implementation of distributed ledger technology in agro-food supply chains (Köhler & Pizzol, 2020). One of the primary aspect that has motivated the global food processors to deploy BCT is based on their desire to enhance consumer confidence with respect to safety and quality of agro-foods (Xu, Guo, Xie, & Yan, 2020). There is also an argument that these global food processors have greater financial resources to invest in Blockchain technology (Xu et al., 2020). There is currently limited insight on whether the high capital

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outlay/costs required to implement BCT has discouraged other players in the agriculture sector to invest in this technology despite its promise for food safety to address this problem in the industry, this thesis examines whether some of these challenges are likely to have influenced BCT adoption in the agriculture sector.

The existing literature has been limited to specific players in the agricultural supply chain (i.e., food processors, farm input suppliers, and food retailers) and consumers in the agro-based industry are exacting, requiring a more open and safe food supply chain (Tiscini et al., 2020). This means that a considerable amount of existing research on BCT adoption is focused on other supporting segments to the agricultural sector such as food processors, farm input suppliers, and food retailers. This creates a gap due to the limited evidence on the applicability of BCT in the Australian agricultural supply chain and specifically its benefits and challenges to farm producers. The available evidence on the determinants of BCT adoption could be applicable to other supporting segments in the agricultural sector. The implication is that there is a potential gap in the literature on the effectiveness of the BCT adoption for Australian agriculture supply chain practitioners. The potential for BCT adoption in the agro-food business is driven by changing customer requirements and consumer demand, necessitating the adoption of a long-term strategy to support the global supply chain (Saberi et al., 2019). As a result, the adoption of Blockchain in the agricultural sector is increasing, creating a good prospect for practical and theoretical advances in Blockchain-enabled agriculture supply chains (Saberi et al., 2019). There is a particular need to investigate how Blockchain technology can be integrated in the agricultural supply chain context given that the existing research on BCT adoption in the agriculture sector is limited (Tiscini et al., 2020). This thesis attempts to fill the stated research gap by examining those factors that are likely to motive stakeholders in the agricultural sector (i.e., Australian agriculture supply chain practitioners) to adopt Blockchain technology.

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The existing studies on BCT adoption have focused mostly on other sectors such as, business (Korpela, Hallikas, & Dahlberg, 2017), healthcare (Sharma & Joshi, 2021), logistics (Park, 2020), banking and financing (Malik et al., 2021), education (Kosmarski, 2020), and hospitality (Nuryyev et al., 2020) with limited research on the agricultural sector. To fill this gap, the current research will draw on existing literature and stakeholder perspectives to develop a theoretical model on the determinants of BCT adoption (Köhler & Pizzol, 2020; Tiscini et al., 2020; Chen et al., 2020).

The current study examines the determinants of BCT adoption in the Australian agricultural sector. Blockchain technology is still in its early stages of application in the agricultural industry (Xiong et al., 2020). The research was carried out in two stages. In the first stage, the study relied on the theoretical knowledge based on the review of previous studies to model the possible determinants of BCT adoption. The review included the analysis of the determinants of BCT adoption in various sectors, including the agriculture, logistics, tourism, hospitality, education, healthcare, and food retailing. The second stage involved a survey to determine the influence of BCT adoption on consumer attitudes and behavioural intentions in the agricultural sector. In this stage, the scale of the BCT adoption in the agricultural sector was also determined.

The current research on BCT adoption in the Australian agricultural sector provides three main theoretical contribution. Specifically, the thesis contributes in three was: it highlights the contribution to **1**) information system knowledge; **2**) digital marketing knowledge and; **3**) agriculture knowledge. First, it highlights the basis for improving business process capabilities through the adoption of information systems and enabling the secure completion of online transactions in an environment of trust. Second, it also depicts how the digital marketing in the agricultural sector has been transformed on the strength of the certainty, transparency, and traceability features of BCT. Third, it contributes to highlighting the

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improvement in farming experience and productivity as a result of the enhanced connectivity and trust between customers and farm input suppliers, which has been created through BCT.

1.3 Theoretical Background

1.3.1 Supply Chain Management

As a result of globalization, supply chains have become increasingly international, resulting in many geographically isolated companies collaborating. As the supply chain becomes more complicated, it becomes more challenging to manage traceability, visibility, and efficiency in supply chains (Soosay & Hyland, 2015). An extremely competitive economy, increased complexity, demand fluctuation, and response to change are just a few of the challenges businesses and individuals encounter while engaging in supply chain management (Rogerson & Parry, 2020). An excellent example is the Covid-19 global pandemic, which has caused massive disruptions and illustrated how sensitive and delicate businesses are when supply chain interruption strikes (Paul et al., 2021). During this period, global supply networks failed to provide items due to demand and supply fluctuations, and instead of acting with their usual efficiency, they caused tension, distrust, and doubts (Meyer et al., 2021). The pandemic underscored the significance of managing the supply chain in a coordinated and effective manner (Sarkis, 2020). The impacts of the Covid-19 epidemic are still being felt throughout the global supply chain today and are predicted to persist indefinitely.

To respond appropriately to this rapidly changing market and remain competitive, firms must continually seek new ways to make interactions with the supply chain more transparent, efficient, and adaptable (Paul et al., 2021). Because current technical solutions are insufficient, other techniques, such as Blockchain technology, have arisen recently. This technology has supplemented other supply chain management technologies such as the enterprise resource planning (ERP) systems, which lack the transparency and traceability features of BCT (Quzmar et al., 2021).

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1.3.2 Blockchain Technology

Blockchain is a distributed database system that keeps track of a broader array of data items verified by all network nodes (Demestichas et al., 2020). The data is stored in blocks, which are linked together in the form of a chain. The data in a Blockchain network are unchangeable and all network nodes have access to the whole distributed database, preventing the chance of a single node obtaining control of the data records (Lee & Yeon, 2021). Rather than routing information through a central node, each participating node keeps a copy of the data records and sends it to all other nodes in the network, increasing trust and openness. BCT functional mechanism may be described in phases as follows: First, the transaction is requested and the block is produced. The freshly formed partnership is then broadcast to all nodes in the network. Once all nodes in the network concur on the proposed transaction, it is validated. In the last phase, the transaction is authorized, and the block is appended to the existing partnerships with a new block of data (Xu et al., 2020; Torky & Hassanein, 2020). Blockchain is gaining traction in various industries, including agriculture, due to its unique properties of traceability, immutability, and transparency (Prashar et al., 2020). The figure below shows an example of how Blockchain technology works, in this case, buying or selling bitcoins (Rees, 2020).

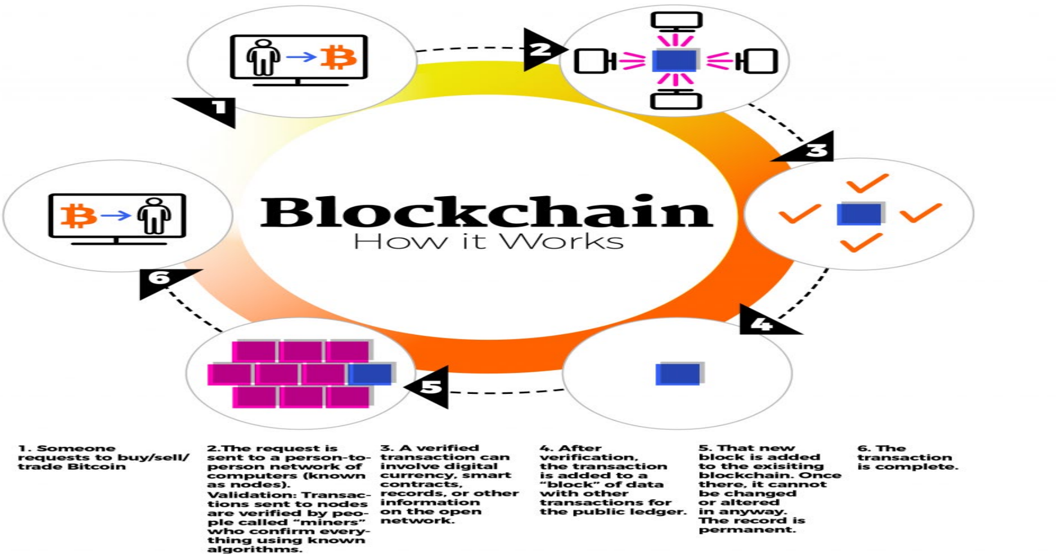

Figure 1: A model depicting a Blockchain transaction process.
Source: Rees (2020).

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1.3.3 Agriculture and BCT Adoption

a) Agriculture

Agriculture is one of the key sectors for enhancing inclusive growth and eradicating abject poverty. The current target is to feed an estimated 9.8 billion people by 2050 (Boult & Chancellor, 2019). Agricultural production is two to four times more effective than the growth in other sectors of the economy. BCT adoption is expected to improve further its effectiveness and efficiency in this respect (Rogerson & Parry, 2020). As a result of the changing consumer needs, efficient supply chain management has become a critical component of the strategic plan for the agricultural sector.

Agriculture plays a critical role in sustaining the world economy. Although the sector is expected to play a crucial role in the growth of the world's gross domestic product, especially in developing countries, many challenges threaten its sustainability (Bhusal, 2021). The continued adverse effects of climate change pose one of the greatest threats to agricultural production, with shifting weather patterns creating uncertainty in agricultural output (Lin et al., 2020). For example, the recent wildfires in Australia are expected to affect the global food supply chain due to the disruption in the ecosystems. Besides climate change, pollution significantly affects food safety, with governments putting stringent measures regarding the need to maintain food quality (Kamble et al., 2020). The rising toxicity level in farm inputs and water sources have created a whole new challenge for this sector. Finally, food wastage is primarily due to bottlenecks in the supply chain (Kamble et al., 2020). The complexity of the supply chain from farms to consumers is creating a risk of food shortage, especially in developing countries where food hygiene while in transit is not a common practice. The perishable nature of agricultural farm produce also creates a risk of food shortage due to wastage and inefficiencies (Prashar et al., 2020).

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b) Justification for the Investigation of BCT in the Agricultural Industry

Agribusiness customers are increasingly demanding a more transparent and secure food supply chain (Feng, 2016). The sector involves various stakeholders, including farmers, food processors, farm input suppliers, shipping businesses, wholesalers, retailers, distributors, and grocery stores. It is exceptionally multi-stakeholder and diffused (Lin et al., 2020). Most information in existing agribusiness is stored on paper or private servers and databases of trusted third parties (Bhusal, 2021). As a result of this information management structure, the cost of data access tends to rise while data becomes vulnerable to fraud, corruption, or inaccuracy, resulting in financial losses and the possibility of product counterfeiting (Azzi et al., 2019; Lee & Yeon, 2021). The current agricultural system lacks (1) product provenance, (2) product safety, (3) credibility among suppliers, and (4) customer confidence and trust in terms of the quality of its products (Motta et al., 2020). Today, agriculture is considered a less digitized sector, missing out on the advantages of technological innovation due to lack of connectivity (Shepherd et al., 2020). To address the issues of tracing food safety and building trust among stakeholders, the sector has adopted technological changes such as BCT. The application of BCT in agriculture improves the efficiency of data collection, storage, analysis, and usage (Bhusal, 2021). This allows all stakeholders to readily obtain current information and make more effective decisions in their everyday agricultural operations (Lin et al., 2020).

BCT adoption in agribusiness has been accelerated by several factors, such as the changing consumer demand, need for accountability, traceability, sustainability and the need to address the challenge of farm produce perishability (Bumblauskas et al., 2020). Customers' expectations are rising, but so are stakeholders' expectations for a better future due to global concerns (Saberi et al., 2019). The United Nations' Sustainable Development Goals, particularly Goal 2: Zero Hunger and Goal 12: Responsible Production and Consumption, are pushing for transparency and accountability in the global food supply chains (Sharma et al.,

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2020). Studies indicate that the agro-food business plays a crucial role in achieving these goals (Sharma et al., 2020).

Many agro-food supply chain concerns, such as accountability and traceability have been identified as possible aspects and solutions that can be addressed through BCT adoption (Kohler & Pizzol, 2020). This technology can bridge the trust gap between producers and consumers where the former can inform customers on the source and processing journey of the food they consume. Even though BCT is still a relatively new technology that is in its early implementation phase, the successful trial of other stakeholders in the agribusiness sector has attracted considerable attention and interest (Chen et al., 2020).

Technology-driven disruptions have impacted various sectors such as service delivery, customer care, hospitality, and supply chain management. The agricultural sector has also experienced substantial disruptions due to new technology such as farming apps, e-commerce, and digital marketing apps (Krishnan et al., 2020). These disruptive technologies have the potential to lower the production costs and improve efficiency in the agricultural value chain (Prashar et al., 2020). In conjunction with the increasing usage of information technology, globalization has intensified worldwide market competitiveness, pushing the agricultural stakeholders to develop more effective tactics to stay competitive. The agricultural sector in Australia needs BCT in order to enhance its strategic competitiveness in the face of global competition. Specifically, there is a potential for farmers and other players in the agribusiness sector to mitigate the losses and inefficiencies that occur due to product perishability and delays (Bhusal, 2021). Moreover, the transparency, security, and immutability aspects of BCT would also benefit the agricultural sector in the form of secure payments, which would allow stakeholders such as farmers and farm input suppliers to effectively manage their working capital needs (Lin et al., 2020). Technology has played a critical role in improving the supply chain and corporate efficiency.

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The agriculture sector needs Blockchain technology in order to strengthen its supply chain and value chain efficiency to achieve its production targets (Bhusal, 2021). In addition, through the BCT, the agribusiness sector will also be in a better position to address the supply chain complexity issues that occur due to coordinating entities in multiple geographical locations, diverse product portfolios, and issues of increasing technology size (Lin et al., 2020). The BCT adoption in the agriculture industry will also have a favourable impact, such as lowering supply chain costs, shortening lead times, and increasing customer satisfaction.

To resolve issues associated with the agricultural supply chain, Blockchain technology is viewed as an effective solution if adequately implemented (Kamble et al., 2020). Consumers and food producers must be adequately equipped with new technologies, including BCT in this digital age. Farmers, farm input suppliers, and food processors have faced numerous transparency issues, especially during the delivery of farm produce and inputs across the agricultural supply chain (Bhusal, 2021). There is also a lack of trust and connection between them. On the other hand, consumers lack access to reliable food data/labels and have limited faith in the sourcing of the food they consume (Montes de Oca Munguia, 2021). From the cultivation and harvesting of data through transportation and storage, Blockchain-based solutions provide a critical trust layer to the agriculture business, ensuring that supply chain stakeholders' claims and data cannot be tampered with.

c. The Gap in the Studies Focusing on Agriculture and BCT

The insight based on the research on technology acceptance indicate that Scandinavian countries have a high level of industry 4.0 technology adoption (Castelo-Branco et al., 2019). However, there is a scarcity of studies on BCT adoption in the Australian agribusiness sector. This thesis seeks to address the stated research gap by focusing on the determinants of Blockchain adoption in the Australian agriculture industry.

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Previous studies on the adoption of BCT in the agricultural sector have shown that the technology provides capability for improvement in productivity and public health safety (Lin et al., 2020; Prashar et al., 2020). However, there is limited research on how BCT implementation affects agricultural supply chain management especially in terms of its impact on efficiency and cost mitigation. Prior research studies focusing on the BCT adoption in the non-agricultural sectors have also noted the benefits of Blockchain technology in enhancing product visibility and creating efficient supply chain processes (Korpela et al., 2017; Nathani & Singh, 2020). Based on the stated insight, there is an existing literature gap on how the stated efficacious aspects of BCT adoption (i.e., efficiency, effectiveness, and cost mitigation) would influence the agricultural sector players to integrate the technology in the supply chain. Most studies based on current publications have concentrated on other industries such as food retailing (Rogerson & Parry, 2020), health (Sharma & Joshi, 2021), education (Kosmarski, 2020), logistics (Park, 2020), hospitality (Nuryyev et al., 2020), manufacturing (Li, 2020), and infrastructure (Malik et al., 2021), outlining the benefits (Prashar et al., 2020), barriers (Lin et al., 2020), and other notable effects in the respective sectors, with limited research in agriculture.

The studies that focus on BCT adoption and agriculture identify the benefits of the technology in the sector as increased traceability, efficiency, safety, visibility, and privacy (Rogerson & Parry, 2020; Lin et al., 2020; Prashar et al., 2020; Bhusal, 2021). The other important research gap is that there is limited knowledge on whether the stakeholders in the agricultural sector appreciate the important role of BCT in the supply chain and value chain. There are few studies, which have examined the extent to which the trust, transparency, connection, and accountability aspects of BCT might motivate stakeholders in the agricultural sector to embrace the BCT adoption (Bhusal, 2021). These studies focused on how the benefits of BCT (i.e., transparency, efficiency, and traceability) could create an incentive for its

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widespread adoption in the respective sectors (Prashar et al., 2020; Bhusal, 2021). The thesis fills this gap by examining the extent to which the stated benefits and barriers of Blockchain technology could influence its adoption in the agriculture sector.

Most studies on BCT adoption have focused on the benefits and challenges of BCT adoption for stakeholders (Rogerson & Parry, 2020; Lin et al., 2020). However, there are limited studies, which have sought to examine how these potential benefits and limitations of BCT could influence behavioural intention and attitudes towards its adoption. The thesis addresses this gap by identifying the determinants of BCT adoption in the Australian agriculture sector.

Table 1 and 2 present a summary of the gap in the existing theoretical and empirical literature with respect to the benefits and challenges of BCT adoption to the agricultural sector and in other sectors.

Table 1: Summary of the Literature Gap on BCT Adoption: Studies on Agricultural Sector

Study	Country	Method	Industry	BCT Theme	Research Gap
Rogerson & Parry (2020)	Worldwide (Australia, Europe, China, and Fiji)	Qualitative	Agriculture and Food	BCT improves the visibility and traceability of agricultural food products.	There is a missing insight on how the customers' preference for BCT influences the farmers' intention for its adoption.
Lin et al. (2020)	Worldwide	Qualitative	Agriculture	BCT improves agricultural supply chain efficiency while enhancing integrity and privacy of data. It also highlights the scalability, privacy, and integration challenges of BCT.	The study highlights both the benefits and challenges of BCT in agriculture supply chain. However, it fails to establish how these aspects of BCT influence its adoption.
Prashar et al. (2020)	India	Qualitative	Agriculture	BCT improves traceability in the	There is limited knowledge how the

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				agro-food sector and therefore, guarantees public safety.	efficacious traceability aspect of BCT influences its adoption by policymakers and agricultural stakeholders.
Bhusal (2021)	Worldwide	Qualitative	Agriculture	BCT can revolutionise the agricultural sector by mitigating fraud, price manipulation, and lack of customer trust while enhancing the traceability of agricultural products.	There is missing insight on why these factors do not influence BCT adoption in the agricultural sector.

The review of previous research from the table 1 indicates that all four studies focusing on the agricultural sector and seven out of nine of the studies from the table 2 focusing on other sectors have relied on the qualitative research method. This is an important research gap, which the thesis seeks to address by using a quantitative research design. In terms of the country of study, the review indicates that most studies were conducted worldwide with only one of them focusing on BCT adoption in multiple industries across Australia (Malik et al., 2021). The thesis fills this gap by focusing the research on the determinants of BCT adoption in the Australian agriculture sector.

The previous studies on BCT, which focused on the agricultural sector have mostly highlighted its benefits and challenges. Using the qualitative research method, Rogerson and Parry (2020) found that BCT played an important role in enhancing the traceability and visibility of the agricultural food supply chain. Similarly, using the qualitative research method, Prashar et al. (2020) also highlighted the importance of BCT in strengthening the traceability of the agricultural supply chain, which in turn enhanced the safety of food products. The same insight on the traceability feature of BCT and its importance on the agricultural supply chain

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was also noted based on the qualitative study by Bhusal (2021). However, using the qualitative research design, Lin et al. (2020) noted that despite its ability to enhance efficiency of the agri-business supply chain, there are scalability, privacy, and integration concerns (challenges) associated with the BCT adoption in the agricultural sector. There is a clear research gap based on the insight from previous studies given that none of them explored the implication of the stated benefits and challenges of BCT on its deployment in the agricultural sector. This study attempts to fill this gap by arguing that the BCT benefits and challenges could act as key drivers and, or impediments to its adoption in the agricultural sector. Further, to fill the stated research gap, the study develops an integrated theoretical research model based on the identified BCT drivers and challenges to investigate those factors that would influence the stakeholders' behavioural intention and attitudes to deploy the technology, especially in the agricultural sector.

Based on previous studies, there is an important research gap with respect to the study design/method. All the four studies focusing on the agricultural sector relied on the qualitative research method to explore the drivers and challenges associated with BCT adoption. This study fills the identified research gap by using a quantitative research design approach. The quantitative research design is expected to improve the reliability and validity of the findings.

Table 2: Summary of the Literature Gap on BCT Adoption: Studies on Other Sectors

Study	**Country**	**Design**	**Industry**	**BCT Theme**	**Gap**
Korpela et al. (2017)	Worldwide	Qualitative	Business	The integration of BCT in SCM can enhance security and time stamping of transactions.	There is limited knowledge how these aspects of BCT can improve the agricultural value chain.
Kosmarski (2020)	Europe, U.S., Russia, and Belarus	Qualitative	Education	Despite its benefits, the challenges of BCT adoption include its security concerns, legal	There is limited information on how these challenges influence the scale of BCT adoption.

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				issues as well as governance aspects.	
Li (2020)	Worldwide	Qualitative	Multiple Industries	The benefits and usability of BCT influence its adoption and implementation.	The study identifies the drivers of BCT adoption but fails to focus on a specific country or sector.
Park (2020)	Worldwide	Qualitative	Logistics	Performance expectations, social influence and attitudes are the main drivers of BCT adoption.	The findings are relevant to this study. However, there is limited knowledge on how these factors would be applicable in the Australian agricultural sector.
Nathani & Singh (2020)	Malaysia	Qualitative	Supply Chain	BCT can be an effective technology to manage risk. However, there is need to enhance its awareness among stakeholders.	The study acknowledges the limited scale of BCT adoption. However, it fails to identify the factors that have contributed to its limited adoption.
Nuryyev et al. (2020)	Taiwan	Quantitative	Tourism and hospitality	The drivers of BCT adoption include the organizations' strategic direction, attributes of its leaders, and social influences.	There is limited insight on whether these factors are applicable to the Australian agricultural sector.
Alazab et al. (2021)	Worldwide	Quantitative	Multiple Industries	Data integrity concerns and security issues have adversely affected the adoption of BCT.	The study fails to focus on specific sectors. Therefore, there is limited knowledge on the applicability of these factors in the agribusiness sector.
Sharma & Joshi (2021)	India	Qualitative	Healthcare	Lack of awareness, legal challenges, and limited support are the main barriers to BCT adoption.	There is limited knowledge whether these factors have adversely influenced BCT adoption in the Australian agribusiness sector.
Malik et al. (2021)	Australia	Qualitative	Multiple Industries	Organizational readiness, the need	There is no evidence on whether the

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				to lower cost, and customer pressures are the main factors that influence BCT adoption in Australia.	stated drivers/factors of BCT adoption are applicable in the country's agricultural sector.

The summary of studies on BCT adoption in other non-agricultural sectors also reveals that most prior studies have focused on the benefits and challenges of Blockchain technology. For instance, one study that focused on the business sector indicates that BCT has a potential to enhance security of transactions, improve traceability, and visibility of agricultural products (Korpela et al., 2017). There are other studies in the non-agricultural sector, which attempted to examine the factors that influence BCT adoption. For instance, one study in Australia noted that organizational readiness, customer pressure and the need to enhance efficiency of the agricultural supply chain are the main factors that influence BCT adoption in various sectors (Malik et al., 2021). Another study conducted in Taiwan found that organizational strategic direction, leadership attributes, and social influences are the main factors that drive BCT adoption in the tourism and hospitality industry (Nuryyev et al., 2020). However, based on the stated insight, there is an important research gap, which will be addressed by this study. It relates to the fact that there is limited knowledge on which specific factors influence BCT adoption in the Australian agricultural sector. That is why this study seeks to fill the current research gap by exploring the factors that influence behavioural intention and attitudes towards BCT adoption in the Australian agricultural sector.

1.4 Thesis Flow

The research presented in this thesis can be broadly divided into two stages. These are: 1) Analysing previous studies to identify the determinants of Blockchain technology adoption; and 2) modelling factors that affect Blockchain adoption behaviours and to determine their influence on consumer attitudes and behavioural intentions in the Australian agriculture sector.

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The two stages of this study capture the thesis structure and provide a foundation to the reader on how the concept of the study emerged through the thesis. Figure 2 illustrates that the systematic literature review (Chapter 2) will identify the determinants of BCT adoption while Chapter 3 will model the factors affecting BCT adoption behaviour. Figure 2 also indicates that Chapter 4 will highlight how the BCT adoption factors influence consumer attitudes and behavioural intentions in the agricultural sector.

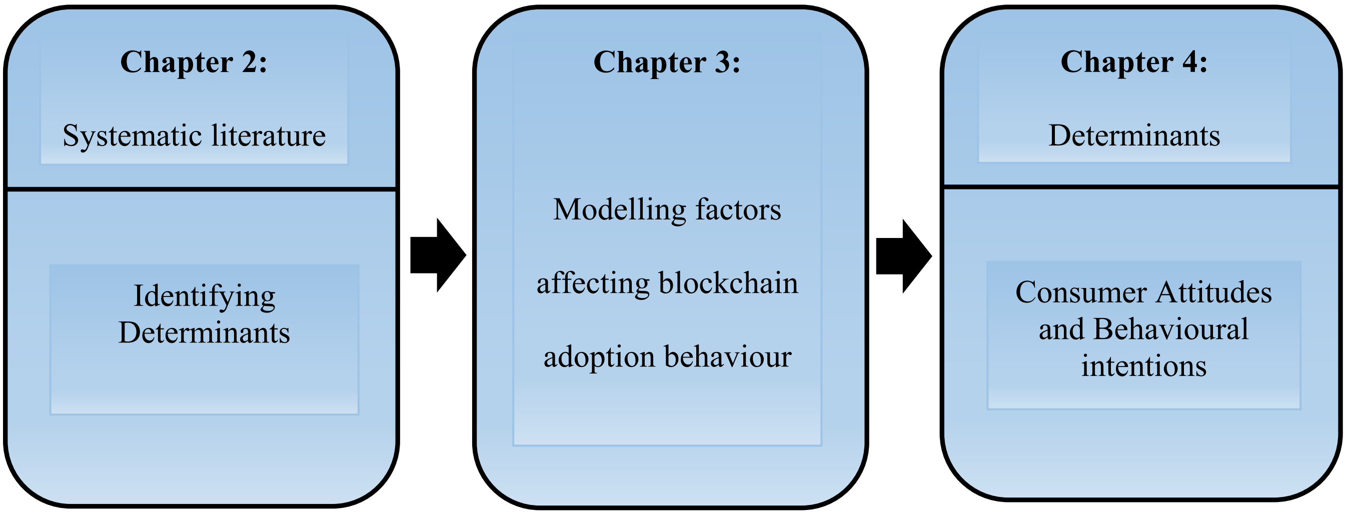

Figure 2: The Thesis Framework

This thesis consists of 4 chapters which seek to identify and determine the factors affecting BCT adoption in the Australian agricultural sector. Many of the themes included in these papers were developed, refined and subsequently prepared ready for publications throughout my candidacy. For this reason, many of the chapters include unavoidable repetition as readers from different journals are introduced or reintroduced to important themes. A synopsis of each chapter of this thesis is outlined below:

Chapter 1

The first chapter lays the groundwork for the research, including the thesis background, research questions, theoretical framework, research technique, and data collection. The introduction outlines BCT in the supply chain. As part of I4.0 technologies, BCT is expected to revolutionize the different supply chain sectors. The chapter discusses BCT and how its

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decentralized systems enable cross-platform transactions. It also provides an overview of each chapter in the thesis.

Chapter 2

The aim of chapter 2 is to identify and determine the possible factors that affect BCT adoption. In the introduction, the chapter outlines the BCT in the supply chain by highlighting all the sectors where it has been utilised to form background knowledge that would facilitate research on the determinants of BCT adoption. The paper is titled "The Adoption of BCT in Australia Agriculture Supply Chain" and was written in response to the call for more research in BCT and agriculture.

The analysis of previous studies provides an overall view of the current research on the determinants of BCT adoption in general (Xiong et al., 2021). The chapter concludes with a proposed theoretical framework. The chapter identifies an important gap on the research design where most of the previous studies on BCT adoption in the agricultural sector were qualitative. This thesis addresses the stated research gap by using a quantitative research design approach to examine the determinants of BCT adoption in the Australian agricultural sector.

The review of previous studies indicated the following themes that may influence BCT adoption in the agriculture industry as follows:

- Transparency.
- Traceability.
- Contract exchange.
- Transaction efficiency.
- Trade finance management.
- Quality control.
- Real-time information to involved parties.
- Security

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- Trust
- Legislation

Chapter 3

Chapter 3 presents an empirical paper that addresses the determinants of BCT adoption through application of the following theoretical models: the Technology Acceptance Model, the Unified Theory of Acceptance and Technology Use Model, and Theory of Planned Behaviour (Hazen et al., 2012). These models were applied to offer a better understanding of BCT adoption especially in regards to the agricultural stakeholders' behavioural intentions and attitudes to embracing the technology (Chod et al., 2020).

The findings indicated the following determinants of BCT adoption ranked from the most important. These include, transparency, traceability, quality control, smart contracts, transaction efficiency, trade finance management, security, legislation, and real time information to involved parties (Kamble et al., 2021).

Chapter 4

Chapter 4 consolidates the findings from the research and provides a critical analysis of the literature to draw comparisons and provide recommendations for further research. It specifically outlines the contributions and implications of the thesis findings for research on BCT management and for practitioners.

1.5 Research Design and Methodology

Supply chain management (SCM) is facing various challenges in the contemporary world. These issues may be addressed by using a number of industry 4.0 (I4.0) technologies, with past research indicating a strong link between I4.0, BCT, and SCM (Haddud & Khare, 2020). I4.0 is considered the fourth industrial revolution technology representing a new stage in the organization and control of the industrial supply chain. Industry 4.0 is a collection of cutting-edge production technology enabling organizations to achieve their strategic goals more

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quickly (Ghobakhloo, 2020). Blockchain is one of those technologies that create an innovative, flexible, and highly variable cyber-physical network due to its unique qualities. Many technologies can be deployed to tackle supply chain constraints based on the research findings in the subject of I4.0 (Chauhan & Singh, 2019). However, these concepts are complex and lack a standard definition, posing a challenge regarding their implementation. Academics recommend that businesses need to plan and change their operations at both the organizational and managerial levels to overcome technology adoption obstacles (Shao et al., 2021). This is justified by the insight that managerial attributes or leadership qualities bring to strong determining the BCT adoption (Nuryyev et al., 2020). The implication is that organizations with the right strategic direction, values, and calibre of leaders are more likely to identify and implement BCT, which is part of the I4.0 technologies. In this respect, there is limited research on the extent to which leadership attributes and organizational strategic plans influence BCT adoption in the agricultural sector.

Nevertheless, there is a lack of research on the various organizational aspects of I4.0 and how the I4.0 technology can be deployed (Liao et al., 2017). As a result, there is also a limit to how sound suggestions from the study may be implemented. This is a significant problem to overcome since more research is needed to facilitate the adoption of I4.0 technologies and identify solutions for their deployment in specific industries and supply chains. As a result, I4.0 can help with supply chain concerns, but their implementation is complex and needs further research.

BCT is an example of a new I4.0 technology that can help boost agricultural supply chains. Several benefits and motivations for BCT implementation in agricultural supply chains have been discovered via research. Increased accountability and transparency, food quality, improved food safety, trust and efficiency, and benefits resulting from its dis-intermediation and immutability are some of the BCT benefits (Zhao et al., 2019; Chen et al., 2020; Kohler &

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Pizzol, 2020; Tiscini et al., 2020). Most scholars believe that BCT can also assist businesses in attaining a more efficient supply chain (Zhao et al., 2019; Tiscini et al., 2020; Kohler & Pizzol, 2020; Chen et al., 2020). As a result, BCT adoption in agricultural enterprises might be viewed as an economic advantage. However, existing research on factors affecting BCT adoption in agriculture is limited. This issue must be addressed since researchers have identified the need for additional study on BCT adoption, its acceptance and the focus on specific nations, sectors, and enterprises (Dutta et al., 2020). Kamble et al. (2020) also underline the need to identify the BCT adoption determinants in different countries. Many factors and perceived benefits influence the implementation of BCT in agricultural supply chains. However, additional study is required on the uptake of BCT in various circumstances and contexts.

1.5.1 Purpose

The purpose of this research is twofold. First, it identifies the determinants of BCT adoption in the agricultural sector. Second, it seeks to establish how the determinants of BCT adoption influence the behavioural intention and attitudes of stakeholders in the agricultural sector. Thus, the research will investigate the underlying benefits, causes, challenges, and roadblocks that influence how firms make decisions on BCT adoption. Furthermore, by focusing on Blockchain adoption in the context of the Australian agricultural sector, the research is poised to design a conceptual framework by advancing existing BCT adoption information and expertise. It also seeks to provide a new mapping of drivers, benefits, causes, and barriers to BCT adoption in Australia's agricultural supply chains. As a result, the agriculture industry in Australia will obtain crucial insights and recommendations.

1.5.2 Research Paradigm

A research paradigm is a philosophical framework that guides the research structure by drawing on people's ideas and opinions about the reality and nature of knowledge (Collis & Hussey, 2014). This study is guided by the positivist paradigm, which assumes that one can gain an

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understanding of human behaviour through observation and reason in an objective manner (Creswell, 2017). The study will rely on the objective analysis of the experiences of stakeholders in the Australia's agriculture sector to identify and examine the determinants of BCT adoption. Figure 3 below shows that the positivist epistemology lies at the one end of the spectrum before the post-positivism and the interpretivism paradigms. It is based on the assumption that effective understanding of the reality depends on the objective analysis of a research phenomenon (Saunders et al., 2012). Because the purpose of this thesis is to examine the rationale for the Australian agricultural sector's policy choices to adopt or reject BCT and their strategy for incorporating the technology in their supply chains, it will delve into the scope and beliefs of individuals to better understand the adoption process. As a result, when doing this thesis, it was critical to comprehend the responsibilities of humans as social actors with a view to observe how people perceive the research phenomena's intricacy (Saunders et al., 2012; Saunders & Lewis, 2016).

This research uses a positivist approach, which is suitable in facilitating the objective analysis of human perceptions and experiences (Saunders et al., 2016). The research was able to collect rich quantitative data from small samples using this paradigm to acquire objective knowledge of the BCT adoption phenomena in the context of the Australian agriculture industry, thereby resulting in greater reliability. Furthermore, a positivist method is particularly significant for doing management and business research on organizational behaviour, such as this thesis, due to their need for objectivity.

Positivism	Post-Positivism	Interpretivism
	Epistemology	

Figure 3: Epistemological Position of the Thesis

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1.5.3 Research Questions

This thesis contributes to the growing conversation and research on the adoption of BCT. In particular, the overall objective of this research is to address the determinants of BCT adoption in agricultural supply chains in Australia. The research seeks to identify the determinants of BCT adoption in the agricultural sector and determine whether these determinants influence the stakeholders' behavioural intentions and attitudes towards its adoption.

1.5.4 Research Method

This section explores the philosophical framework to identify a suitable approach for the research. A suitable research method is identified to address the identified concerns based on the identified framework. Under the research paradigm, the thesis explores the philosophical underpinnings behind adopting certain research methodologies. Based on the research framework and design analysis, a quantitative research design was identified as the best method to examine and analyse the research problem. The implication is that this thesis used a quantitative research method to identify the determinants of BCT adoption in the Australian agricultural sector. The quantitative research method was also effectively used by Nuryyev et al. (2020) to examine the drivers of BCT adoption in the tourism and hospitality industry. The strength of this research design approach is based on its objectivity and ability to generate findings that can be reliable and accurate (Nuryyev et al., 2020). There are two studies, which were carried out sequentially to answer the research inquiry as part of the quantitative research design.

Chapter 3

This chapter discusses how the BCT adoption factors influence the behavioural intention and attitudes of stakeholders to deploy the technology in the agriculture supply chain. In study two, the chapter briefly examines BCT and the key factors driving its adoption. Study two seeks to answer the following research question:

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RQ2: What is the influence of the determinants of BCT adoption on the behavioural intentions and attitudes of stakeholders in the agricultural sector?

The chapter also explores the business environment driving BCT adoption such as the existing supply chain management structures. Furthermore, the section discusses the data collection process. It also outlines and describes the participants, their demographic profile and the recruitment process. The data collection process is also outlined to provide a clear picture of the steps involved, which would facilitate its future replication.

Chapter 3 involved two stages (processes) for collecting data based on the quantitative research design. In the first stage, a pilot study was employed with a sample of eight participants to evaluate the reliability of the measurement instrument. Specifically, the pilot participants included 3 Blockchain experts from the IT industry, 2 agriculture supply chain and logistics experts, and 3 university professors with expertise in Blockchain and supply chain management. In the second stage, data collection involved the use of an online survey. In this stage, data was collected from a sample of 358 participants using online surveys.

Chapter 4

The chapter employed grounded theory methodology to review the collected data and analyse it through the lens of value creation. The methodology was chosen to compare the result with the findings of the critical literature review in order to draw conclusion and recommendations. Table 3 below presents a summary of the research methodology applied in this thesis.

Table 3: Applicable Methodology for the Research Thesis

Context	Chapter 2: The Drivers and Challenges for the adoption of Blockchain Technology in the Australian Agricultural sector: A Systematic Literature Review Research aim: To identify the determinants of BCT adoption in the Australian agricultural sector. Research Questions: RQ1 and RQ2.

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	Study design: Quantitative method.
Stage 1	Chapter 3: Developing a BCT Adoption Identity Scale Using the Rasch Model/Analysis. Research Aim: To identify the determinants of BCT adoption in the agriculture sector. Research hypothesis: H1 and H12. Theoretical underpinnings: Motivation model, social cognitive theory, model of personal computer utilization, and the diffusion of innovation theory. Study design: Quantitative Data collection: Pilot study based on a sample of 8 participants (n = 8). Data analysis: Confirmatory Factor Analysis, Structural Equation Modelling, and Rasch Model
Process 2	Chapter 3: BCT Congruence as a Measure to Study Drivers and Challenges of BCT Adoption. Research Hypothesis: H1 to H13. Theoretical Underpinnings: Theory of Planned Behaviour, The Unified Theory of Acceptance and Use of Technology, Technology Acceptance Model. Study design: Quantitative. Data collection: Online surveys, n = 385. Data analysis: Confirmatory Factor Analysis, Structural Equation Modelling, and Rasch Model
Outcome	Chapter 4: The overall results of this study are offered in the broader discussion as a synthesis and interpretation of the combined findings based on the three included studies.

As an explanation of Table 4, it presents an overview of the four chapters in the thesis that will be used to come up with the research outcome. The table illustrates how Chapter 2 provides a context to the research by outlining its aims, research questions, and the quantitative research design approach. It also describes study one, which used a pilot study (n = 8) to evaluate the reliability of the measurement instruments. Study two describes how the online survey (n = 385) was used to collect data on the determinants of BCT adoption. Finally, the table describes

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how the outcome of the study will be reported and subjected to discussion in Chapter 4 to address the research gap.

1.5.5 Research Objectives

This review seeks to answer the following questions:

RO1: What are the perceived determinants (i.e., drivers and challenges) of BCT adoption in the agriculture supply chain?

RO2: What is the influence of the determinants of BCT adoption on the behavioural intentions and attitudes of stakeholders in the agricultural sector?

1.6 Theoretical Contributions

The thesis contributes to the theoretical understanding on information systems, digital marketing and agriculture industry. First, the study contributes to the body of knowledge on information systems by highlighting the basis for enhancing business process capabilities through the integration of ***information systems***. It also contributes to the improvement in business process capabilities by facilitating the completion of online e-commerce transactions in a secure environment of trust. Second, the thesis contributes to theory on ***digital marketing*** by determining the influence of determinant factors, such as transparency, certainty, and traceability of BCT on consumer attitudes and behavioural intentions. Third, this thesis adds to the body of knowledge on agriculture by highlighting how the enhanced connectivity and trust between BCT consumers can enhance the overall consumer experience in the ***agriculture industry***.

1.6.1 Theoretical Underpinning

The following theoretical models are used in this study: Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB) as well as the Unified Theory of Acceptance and Use of Technology (UTAUT). These models were chosen for inclusion in the current study because they address individual attitudes and behaviours that contribute to a person/s

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embracing, adopting, and finally utilising an innovation/technology. Each theory was evaluated and analysed to assess how it relates to the adoption of BCT in the agriculture sector.

1.7 Conclusion

This chapter briefly introduces all of the key areas of the thesis and an overview of Blockchain technology. The chapter presented a brief introduction and background to the study. It also outlined its synopsis and an overview of the research design and methodology. The study aim, objectives, and research questions were also outlined in this chapter. Its main objective is to identify and examine the determinants of BCT adoption in the Australian agriculture sector. There are two main research questions, which are aligned to the stated research objective. The first research inquiry seeks to identify the determinants of the BCT adoption in the Australia's agriculture sector. The second research inquiry seeks to examine how the BCT adoption factors influence the stakeholders' behavioural intention and attitudes towards its deployment. The thesis is divided into four main chapters. This chapter presented the background, outlined the research aims/questions and provided a brief description of the research topic's design and methods. The synopsis of *chapter 2* presented an overview of the systematic literature review on BCT adoption in the agricultural supply chain. The outcome on the review of prior studies is expected to facilitate the design of the theoretical model that identifies the BCT adoption determinants.

The synopsis of *chapter 3* describes how the quantitative research design was employed to answer the research questions on the determinants of BCT adoption. The methodology described in chapter 3 involved two stages/processes. In stage 1, a pilot study (n = 8) was undertaken to evaluate the reliability of the measurement instrument. In stage 2, an online survey (n = 385) was organized to collect relevant data on the determinants of BCT adoption in the Australian agriculture sector. Process 1 sought to test hypotheses 1 to 12 while process 2 sought to test and confirm the validity of hypotheses 1-13. Finally, *chapter 4* presents the

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findings and offers a broader discussion on the BCT adoption in the agriculture sector. Suggestions for future research are also presented in the final chapter.

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CHAPTER 2: SYSTEMATIC LITERATURE REVIEW

CHALLENGES OF BLOCKCHAIN TECHNOLOGY ADOPTION IN AUSTRALIAN AGRICULTURE SUPPLY CHAIN: A SYSTEMATIC LITERATURE REVIEW

ABSTRACT

The aim of this study is to examine the determinants of Blockchain Technology (BCT) adoption in the Australian agriculture sector. The study is organised into two stages. In the first stage, it seeks to develop a theoretical model of the determinants of BCT adoption in the agricultural sector. In the second stage, it examines whether the stated BCT adoption factors influence the behavioural intention and attitudes of stakeholders in the agricultural sector. BCT is a new and emerging technology allowing effective management of supply chains in the agricultural sector. The adoption of BCT has resulted in the transparency of business processes, increased visibility, and reputation, reduced business costs, reduced business risks, increased public trust, and reduced incidences of production delays. In this paper, the author presents a systematic literature review to collect and analyse recent literature on the adoption of BCT in the agricultural supply chain. Twenty studies published between 2015 and 2021 were extracted from relevant scientific databases, indicating that BCT is a new and growing research area. The findings from this systematic literature review identified 10 themes that influence BCT adoption, including: transparency, traceability, contract exchange, transaction efficiency, trade finance management, quality control, real-time information to involved parties, security, trust, and legislation. Organizations adopt BCT to attain product traceability, quality control, trust, transaction efficiency, security, contract exchange, real-time data, and trade finance management in agricultural supply chains. The study provides three theoretical contributions. 1) It highlights how BCT can enhance business process capabilities through the integration of information systems, 2) describes how BCT has transformed digital marketing, and 3) highlights how BCT has improved farming experience (i.e., agriculture).

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Keywords: Blockchain, supply chain, Australian agriculture, Blockchain technology, BCT, agriculture supply chains.

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2.1 Synthesis and Identification

The aim of this thesis is to examine the determinants of BCT adoption factors in the agriculture sector. The first stage develops a theoretical model based on the systematic literature review on the determinants of BCT adoption in the agriculture sector. The second stage examines whether the stated BCT adoption factors influence behavioural intention and attitudes in the agricultural sector. This paper reports on a review of the literature on BCT from 2015 to 2021 to provide an understanding of the generalized approach to implementing the technology in the management of supply chain. Organizations in the manufacturing and production industry rely on BCT to revolutionize supply chain processes in order to attain competitive advantages and improve their overall business success (Farooq & O'Brien, 2012; Francisco & Swanson, 2018). The need for BCTs and other technologies stems from the changing business environment characterized by diversity in customer preferences, diversification of product portfolios, business scale expansion, geographically dispersed production locations, complex supply chain, and distribution systems (Ghadge, Karantoni, Chaudhuri, & Srinivasan, 2018). Effective supply chain systems can assist manufacturing firms to attain timely delivery of products to physical and online retailing points (Foerstl, Schleper, & Henke, 2017; Sheel & Nath, 2019). The integration of BCTs in business models has saved over $400 billion in Europe (Issa & Hamm, 2017; Morkunas, Paschen, & Boon, 2019). Issa and Hamm (2017) attribute the reduction of fraud and increase in product quality to the incorporation of BCT in supply chain management thus saving companies costs related to litigations and reputational damage. In the United States, Australia, and other developed countries, BCT is estimated to reduce logistics and supply chain costs by around 0.7% (Morkunas, Paschen, & Boon, 2019). BCT adoption is becoming a significant research area that will allow businesses to better understand its effective integration into core business processes such as supply chain management.

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There is extensive research on the effectiveness of BCT in supply chain management (Craighead et al., 2017; Davcev et al., 2017; Foerstl, Schleper & Henke, 2017; Queiroz, Telles, & Bonilla, 2019; Prashar et al., 2020). Most studies have focused on how the integration of BCT in the supply chain management (SCM) has provided better platforms for businesses to leverage the available technologies and eliminate bottlenecks in the acquisition, storage, inventorying, warehousing, and distribution of products (Davcev et al., 2017; Craighead et al., 2017; Nathani & Singh, 2020; Alazab et al., 2021). However, there is limited insight on what motivates stakeholders to adopt BCT in the agricultural sector. In addition, there are few such studies on the determinants of BCT adoption in the agricultural sector, which have been conducted in Australia. This study attempts to address the stated gap (on limited studies related to BCT adoption in the Australian agriculture industry) by identifying the determinants of BCT adoption with a specific focus on the Australian agricultural sector. The empirical studies reviewed in this chapter focus on agriculture, tourism and hospitality, healthcare, supply chain, logistics, and related industries. The broad knowledge gained from the review of BCT adoption factors in the non-agricultural sectors will provide a basis for their application in the Australian agricultural sector (Lin et al., 2020; Prashar et al., 2020; Rogerson & Parry, 2020).

Agriculture plays an important role in sustaining the world economy. Based on the current target, the sector is expected to feed an estimated 9.8 billion people by 2050 (Bout & Chancellor, 2019).The agricultural sector's sustainability remains one of the most essential strategies for enhancing growth and eradicating poverty globally. The importance of the agriculture sector has been emphasised by the fact that it is considered two to four times effective compared to the growth in other sectors of the economy (Bout & Chancellor, 2019). The adoption of BCT is projected to enhance further its overall efficiency and effectiveness. The deployment of BCT in the agriculture sector is expected to help in addressing issues of food safety and low trust among stakeholders. The application of BCT in agriculture is also

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expected to improve the efficacy and efficiency of data collection, storage, analysis, and usage (Bhusal, 2021). This would allow all stakeholders to readily obtain current information and make more effective decisions in their everyday agricultural operations (Lin et al., 2020). Other essential benefits such as reducing paperwork, real-time information accessibility and sharing, lower administrative costs, improved efficiency in decision-making, transparency, and traceability can also be associated with BCT (Crosby, Pattanayak, Verma, & Kalyanaraman, 2016; Cuthbertson, 2015).

Studies by Gökalp et al. (2020) and Kamble et al. (2019) explored BCT adoption in the agricultural sector through the analysis of trends in adoption, the technology requirements, its challenges, and the expectations. The study by Gökalp et al. (2020), which used the systematic literature review (SLR) method found that the environment-related determinants were more critical in influencing BCT adoption compared to the technology-related and the organization-related factors. The Gökalp et al. (2020) study differs from this research thesis, which employs a quantitative research design approach to examine the determinants of BCT adoption in the Australian agriculture sector. The quantitative design used in this thesis addresses the gap from the Gökalp et al. (2020) study, which relied on the systematic literature review to identify the environmental, technology, and organizational factors that influence BCT adoption. The study by Kamble et al. (2019) undertook a statistical validation of three models (i.e., TAM, TRI, and TPB) to evaluate the user perceptions on BCT adoption in the agricultural supply chain. According to Kamble et al. (2019), the perceived usefulness, attitude and behavioural control of the BCT had a significant effect in influencing the stakeholders' behavioural intention to adopt it. The Kamble et al. (2019) study differs from this thesis, which focuses on two stages: the first stage is to develop a theoretical model on the determinants of BCT adoption factors and the second is to validate the statistical models of BCT adoption, including the three (i.e., TAM, TRI, and TPB) validated by Kamble et al. (2019). Therefore, while Kamble et al. (2019)

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focuses on stage 2, this thesis addresses the gap by first developing a theoretical framework model on the determinants of BCT adoption before attempting to validate statistical models on the factors influencing behavioural intentions and attitudes towards its adoption.

However, Agustina (2019) asserts that it is not clear whether the adoption of new technology in the agricultural sector will lead to positive impacts such as the reduction in supply chain costs, reduced lead time, and improved client satisfaction. This study, however, limits its research on the antecedents (trialability) of new technology such as BCT and the accompanying challenges creating a research gap, which necessitated the current study. The stated study differed in terms of how it restricted its research focus on the antecedents (i.e., trialability) and challenges (i.e., complexity) of BCT adoption. However, as a research gap, the study failed to examine how these antecedents and challenges of BCT adoption would influence the behavioural intention of stakeholders to integrate the technology in their supply chain networks. There are research studies, which borrow from existing publications while focusing on other sectors such as the food industry, health, education, logistics, hospitality, manufacturing, and infrastructure (Korpela et al., 2017; Nuryyev et al., 2020; Kosmarski, 2020; Park, 2020; Rogerson & Parry, 2020;; Alazab et al., 2021;). There are significant market pressures that force businesses to adopt new technologies instead of implementing technologies to solve known supply chain challenges (Nakasumi, 2017). Therefore, it is vital for organizations to understand the determinants related to the adoption of BCT. There is limited evidence on how these factors, drivers, and challenges affect the adoption of BCT in the agricultural supply chains.

Using a systematic literature review (SLR) method this study aims to analyse the determinant factors influencing BCT adoption based on the review of previous studies on the research topic. The review examines 20 current and credible research studies across different industries. The studies were found on online databases: Google Scholar, Science Direct, and

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Elsevier. The systematic literature review findings indicate that the ten themes, which influence BCT adoption include: transparency, traceability, contract exchange, transaction efficiency, trade finance management, quality control, real-time information to involved parties, security, trust, and legislations. The three theoretical contributions of the study include: 1) It highlights how BCT can enhance business process capabilities through the integration of information systems, 2) describes how BCT has transformed digital marketing, and 3) highlights how BCT has improved farming experience (i.e., agriculture).

2.2 Theoretical Background and Key Studies

2.2.1 Blockchain Technology

Blockchain technology collates digital information that includes identifiers of a transaction such as time, amount, and date (Cole, Stevenson, & Aitken, 2019). The technology stores information derived from entities participating in a transaction by creating a block for every transaction that is subsequently added to a chain of similar transactions. A unique code called the ‘hash’ is used to identify each block of information (Cole et al., 2019). Blockchain is publicly available but the encryption prevents any alteration or deletion of the blocks. BCT operates on specific principles where a transaction must occur, be verified, stored in a block, and allocated a hash code (Lee, Fiedler, & Mautz, 2018). It constitutes a decentralized ledger that allows storing information and data in blocks to create an incorruptible chain for all relevant processes and entities (Kamble, Gunasekaran, & Arha, 2019). The use of Blockchain technology in supply chain management (SCM) might have important ramifications such as increased transparency and transaction visibility (Chen, Xu, Lu, & Chen, 2018). Organizations that have been able to address transparency concerns due to the adoption of BCT are able to enjoy improved governance, consumption, and traceability of corporate information based on the available data (Tönnissen & Teuteberg, 2020).

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The supply chain management system incorporates processes and resources that allow the movement and distribution of products among stakeholders in a given sector (Mirabelli & Solina, 2020). In a typical agricultural supply chain, the key components include the procurement process, collation of correct and complete information, and product distribution. The agriculture supply chain management (ASCM) in Australia is gradually seeking new and innovative technologies to improve the accuracy and efficiency of processes (Agustina, 2019).

The Australian ASCM favours the adoption of information-driven systems that will allow the sector to minimize inventory costs, extend resources, add product value, retain clients, and accelerate time to market (Gunasekera & Valenzuela, 2020). Blockchain technology is already providing the expected outcomes in a few organizations that have incorporated the technology in their supply chain processes (Folkinshteyn & Lennon, 2016). The ultimate decision on whether to adopt or not adopt the BCT in the SCM will influence the eventual outcomes of the technology in the Australian agricultural sector (Kamble et al., 2019). Understanding the influence of BCT in a supply chain is pivotal to improving business processes and reducing unnecessary manufacturing, warehousing, and logistics costs (Abeyratne & Monfared, 2016).

The BCT creates opportunities for the collection and storage of pertinent information such as product location, date, price, certification, and quality (Kshetri & Loukoianova, 2019). BCT has the capability to store information related to the production plans, the distribution channel, the sell-by date, storage locations, and recall information such as batch numbers (Frizzo-Barker et al., 2020). The technology's feature that allows the selection of the people to share information gives the organization the ability to control and protect its sensitive information (Prashar et al., 2020).

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2.2.2 BCT Adoption

BCT adoption is a deliberate strategy that ultimately leads to the integration of Blockchain technology in an organization's supply chain (Kamble et al., 2019). BCT adoption is influenced by the behavioural intention and attitudes towards the technology. Their attitudes and intention to adopt BCT tends to be influenced by its ease of use and usefulness (Kamble et al., 2019). The available studies on BCT adoption in supply chain management focus on its five main advantages in the sector, including: collection and control of information; transparency, traceability, reduction of business cost, and elimination of production delays (Queiroz et al., 2020).

BCT adoption also results in transparency and the building of trust in organizations (Kamble et al., 2019). The perennial transparency and visibility problems in supply chains require new technologies that improve the process of recording business transactions (Godoe & Johansen, 2012; Frizzo-Barker et al., 2020). BCT creates trusts and allows the sharing of personal details/information between two parties that do not know each other. Its transparency also entails the need to verify the history of transactions and guarantee non-manipulation of such transactions (Queiroz et al., 2020). This is achievable with BCT because it acts as a repository of all relevant information used in the supply chain.

BCT adoption is also associated with traceability benefits in the supply chain and payment transactions (Kamble et al., 2019). This is achieved through the implementation of ledger systems that keep track of products at different stages of the production process. The adoption of BCT not only improves products' traceability but also reduces cases of counterfeit products and improves manufacturing and distribution processes. With such potential benefits of BCT, many organizations that rely extensively on supply chain management are considering adopting this technology to streamline their production, warehousing, and logistics processes

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(Kshetri & Loukoianova, 2019). BCT is considered among the leading disruptive technologies in supply chain management (Frizzo-Barker et al., 2020).

The adoption of BCT in the supply chain is also expected to result in the reduction of business costs. The reduction in business process cost occurs due to the efficiency of BCT (Kamble et al., 2019). The technology automates business and supply chain processes, thereby enhancing their efficiency. It also makes auditing and reporting processes much easier (Härting et al. 2020; Durach et al. 2020). Generally, the technology minimizes business costs by eliminating middlemen such as third-party service providers and vendors (Tse, Zhang, Yang, Cheng, & Mu, 2017). Business experts also agree that BCT has helped their institutions save on business costs because of its capacity to streamline operations.

BCT adoption is also expected to eliminate production delays. This is because, the technology eliminates middlemen and automates key business and supply chain processes. The implication is that BCT tends to complete transactions faster although the speed may vary depending on factors such as network traffic and the size of data. Nevertheless, experts still conclude that the technology is faster and efficient. The U.S. retail giant, Walmart adopted the technology and was able to trace the origin of its fruits and vegetables throughout its supply chain (Sharma & Kumar, 2021). Therefore, the focus on BCT in the agriculture will be good in highlighting the determinants of its adoption and how the sector can benefit from the technology. The agriculture sector is one of the industries that have benefited considerably from the adoption of BCT (Lin et al., 2020; Prashar et al., 2020; Rogerson & Parry; 2020).

2.2.3 Agriculture

Agriculture is defined as an activity that involves farming, cultivation, animal rearing, and fish harvesting (Harris & Fuller, 2014). The agricultural sector comprises establishments that are engaged in crop farming, raising animals, and harvesting fish in order to provide food for human sustenance. The advancement in technology and globalization have expanded the types

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of establishments that operate within the agricultural sector. Today, the sector comprises organizations that operate as large scale farms, food processors, farm input suppliers, and groceries that benefit from BCT adoption in the supply chain. The few studies, which have examined the impact of BCT in the agricultural supply chain provide evidence of its positive contribution to the sector (Lin et al., 2020; Prashar et al., 2020; Rogerson & Parry; 2020).

The study by Prashar et al. (2020) presented findings that highlighted how the adoption of BCT in the sector has improved traceability and productivity in the agro-food industry. The incorporation of BCT also provided noticeable improvement in public health safety due to its transparency and traceability features. Lin et al. (2020) also found that BCT is able to build efficient agricultural supply chains, thereby enabling farmers and other entities to lower their production costs. The technology has become a key enabler of product visibility in the agricultural supply chain. Rogerson and Parry (2020) found that due to customers' preference for product visibility across the agricultural value chain, organizations that operate in the agricultural sector have begun to embrace the technology. These studies are important in highlighting the benefits of BCT adoption in the agricultural sector. However, they differ from this thesis because, there is none, which has examined how the identified efficacies/benefits of BCT influence the behavioural intention and attitudes towards its adoption. This thesis fills the stated gap by validating a statistical model that determines whether the ease of use and perceived usefulness of BCT influences the behavioural intention and attitudes of stakeholders to adopt the technology.

2. Methods

Systematic literature reviews (SLRs) are considered the most accurate secondary data source and provide ideal platforms for inquiries that do not require primary data (Queiroz, Telles, & Bonilla, 2019). The basic principle of systematic reviews is the synthesis and summarization of recent and exhaustive evidence regarding a particular phenomenon (Koberg & Longoni,

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2019). *PRISMA Guidelines* and checklist were also used in the selection of relevant evidence from the reviews (Li, 2020; Nathani & Singh, 2020).

2.1 Literature Search

Google Scholar, Science Direct, and Elsevier are the primary databases used in this review. The literature search topics included the adoption of BCT, drivers of BCT in the agriculture supply chain, and challenges in the adoption of BCT. While the study focuses on the Australian supply chain, studies from other regions were considered to provide diversity and comparative capability to the review. The abstracts for the chosen articles were used to determine their relevancy and suitability for this study. The reference lists for these articles also provided another source for relevant articles. Search terms used included:

- "Blockchain Technology"
- "Supply Chain"
- "Supply Chain Management"
- "Australian Agriculture Supply Chain"
- "Impact of Blockchain technology."
- "Effects of Blockchain technology."
- "Considerations for Blockchain technology adoption."
- "Influence of Blockchain technology."
- "Factors for the adoption of Blockchain technology."
- "Benefits of Blockchain Technology "

Boolean operators, "AND," "OR" were used to combine the above search terms to yield the desired search outcomes. A detailed search stagey is provided in the appendices section (see appendix 2).

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2.2 Eligibility Criteria

Journal articles included in this review mentioned the adoption or use of BCT in the supply chain. The articles met the following inclusion criteria: 1) the article was published in the English language, 2) the articles were published between 2015 and 2021, 3) the study showed extensive utilization of Blockchain technologies in supply chain management, 4) empirical studies including qualitative, quantitative, and mixed studies were included. The exclusion criteria were based on factors such as 1) the article was older than 2015, and 2) the article does not contain any relevant information related to BCT and agricultural supply chain.

2.3 Selection of Studies and Data Extraction

The researcher was involved in the evaluation of all studies. Inquiries identified from the investigation were independently evaluated by two investigators, AS and JS. The abstract guided the researcher in establishing the eligibility of each study. The entire article was screened before including or excluding such study where the abstract did not provide adequate information. Data extracted from each article included the name of the author(s), publication dates, the title of study, the title and name of the journal, methodology, study population and sample, processes using Blockchain technology, the impact of BCT, and critical findings.

2.4 Quality of Studies

STROBE checklist was used to evaluate the quality of all 20 studies (Cuschieri, 2019). This checklist's fifteen key items were used: objectives, background, and rationale, abstract, study design, variables, setting, quantitative variables, data sources/measurement, statistical method, main results, generalizability, key results, interpretation, limitations, and funding. Appendix 3 presents the quality assessment of each study using the STROBE checklist.

2.5 Data Synthesis

The identified studies showed significant diversity in methodologies, study designs, outcomes, and findings. Most studies relied on document analysis as data sources due to focus on

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processes and institutions instead of human participants. The lack of uniformity in the study problems and findings indicates that meta-analysis and other reporting evaluations cannot be used for this project. Analysis of study characteristics was used to build a comparable pool of conclusions around the challenges and drivers of BCT in agricultural supply chains.

2.6 Data Analysis

The determinants of BCT adoption used in the studies were further analysed and grouped into homogenous themes. Table 4 provides a summary of the proposed themes based on the determinants of BCT adoption. The analysis is presented according to two dimensions 1) BCT drivers; and 2) BCT challenges. The BCT drivers include the need for product visibility and traceability, integrity and privacy of data, business trust, health safety, security of confidential data, reduction of business risks, as well as partner and customer pressure. These determinants were grouped into the following themes: transparency, traceability, contract exchange efficiency, and finance management.

The BCT challenges include low organizational-level awareness, foreseeable scalability, integration, security problems, social influences, inadequate support from relevant stakeholders, legal consequences and concerns, costs, organizational readiness, as well as the intentions and attitudes towards BCT. The BCT challenges were grouped into the following themes: quality control, real-time information, security, and legislation.

Table 4: Grouping Factors into Themes

Sources	**Dimensions**	**Factors used in studies**	**Themes**
Rogerson & Parry, 2020; Lin et al. , 2020; Prashar et al., 2020	BCT drivers	Low trust in the technology Fear of human error in implementation and use. Need to trace produce Possible fraud cases Governance issues	Transparency Traceability Contract exchange

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		Threat to consumer data Need for smart contracts	
		Need for quick transactions Need to monitor and manage trade finances	Transaction's efficiency Trade finance management
	BCT challenges	Need for quality food Need for timely collection and communication of data	Quality control Real-time information to involved parties
		Need for security of private information Regulation of BCTs	Security Legislation

Table 5 below summarizes these themes.

Table 5: Themes Developed in the Study

Source	All factors (drivers and challenges)	Homogenous Themes
Rogerson & Parry (2020).	▪ Low trust in this technology ▪ Fear of human error in implementation and use ▪ Possible fraud cases ▪ Governance issues ▪ The threat to consumer data	▪ Transparency ▪ Quality control
Lin et al. (2020)	▪ Transparency ▪ Quality control, ▪ Contract exchanges ▪ Transaction's efficiency ▪ Food safety ▪ Traceability ▪ Trade finance in supply chain management ▪ Provenance ▪ Security and privacy ▪ Real-time accurate information for parties involved	▪ Traceability ▪ Contract exchange ▪ Transaction's efficiency ▪ Trade finance in supply chain ▪ Security ▪ Real-time information for parties involved ▪ Trust ▪ Legislation
Prashar et al. (2020)	▪ Encryption ▪ Secret information. ▪ Monitoring ▪ Quality ▪ Safety ▪ Accountability	

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3. Systematic Literature Review Outcome

3.1 Identification of Studies

A total of 1,641 peer-reviewed articles were accessed. Elsevier had 580, Science Direct 533 Google Scholar 327, and other databases had 116 articles. The sources were scaled down to 412 sources after screening all the studies to remove the duplicates. From the shortlist of 445 studies, 380 sources were excluded from the review because they were published earlier than 2015, not published in English, or did not focus on SCM. The remaining articles were evaluated for eligibility, including checking for discussion on the utilization of Blockchain technology in supply chain, drivers, advantages, and challenges of BCT. After this screening, a further 45 articles were excluded. A total of 20 articles were deemed fit for the analysis and review after assessment for eligibility. At the final evaluation, the researcher ensured the shortlisted studies reflected different countries and regions worldwide.

3.2 Study Characteristics

The selected studies had their research setting in different regions across the world. One study was also set in more than one country or region. Eleven studies were set in Asia, seven in Europe, two in the United States, one study in South America, and one study in Australia (Malik et al., 2021). The methodology and research processes used in the studies included qualitative (n = 4), quantitative (n = 13), and mixed methods (n = 3). Three studies focused on agriculture and the food industry, four on business, four on health, two on education, five on logistics and supply chain, and the other two focused on the tourism and hospitality sector.

The four studies that focused on BCT adoption in the agricultural setting were all qualitative. This thesis addresses the identified research gap by adopting a quantitative research design approach to examine the determinants of BCT adoption in the Australian agriculture sector. The studies relied on common theories to explain the organizational and individual behaviours regarding change and new technologies. These theories and models included the

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technology acceptance model (seven studies), technology readiness index (three studies), TPB (five studies), unified theory of acceptance and use of technology (three studies), competitive performance model (one study), grounded theory (one study), and technology-organization-environment (three studies).

3.3. Summary of Literature Review Findings

This section summarizes the key themes that emerged from the systematic review of identified studies. Based on this review, 12 studies provided more relevance to the topic, including factors that influence and challenge the adoption of BCT in different sectors. The table below summarizes the findings from the selected studies:

Table 6: Summary of Literature Review Findings

Source	Type of Industry	Type of Research	Findings
Rogerson & Parry (2020).	Agriculture and Food	Qualitative	Blockchain technology is the leading enabler of product visibility in the food supply chains. Customers are ready to pay more to facilitate the adoption of BCT and improve the visibility and traceability of products
Lin et al. (2020)	Agriculture	Qualitative	Blockchain technology ensures integrity and privacy of data, which in turn improves productivity. BCT also builds efficient supply chains, based on the trust among all stakeholders. The study also identifies challenges in scalability, integration, privacy, and security associated with BCT.
Prashar et al. (2020)	Agriculture	Qualitative	BCT led to better product traceability in the agro-food industry. There is a noticeable improvement in public health safety due to the deployment of BCT.
Korpela, Hallikas, & Dahlberg (2017)	Business	Qualitative	Business is missing many functionalities in efforts to reap benefits from new technologies. BCT provides opportunities for the inclusion of tracking and monitoring

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			capabilities, security, and time stamping of transactions.
Nathani & Singh (2020)	Supply Chain	Qualitative	BCT is an ideal technology that help companies reduce business risks. Most organizations are not ready for BCT, which means that there is need for organizational-level awareness.
Alazab et al. (2021)	Multiple Industries	Quantitative (cross-sectional survey)	Complex challenges related to integrity, confidentiality of data, and the unavailability of secure systems affect the BCT adoption.
Nuryyev et al. (2020)	Tourism And Hospitality	Quantitative (survey)	The adoption of any new technology is affected by the organizational strategic direction and the characteristics of individual managers/leaders. BCT adoption is also affected by innovativeness, self-efficacy, and social influences.
Sharma & Joshi (2021).	Healthcare	Qualitative (15 interviews)	Barriers to the adoption of BCT result from lack of awareness, presence of legal issues, and inadequate support from top management.
Kosmarski (2020).	Education	Qualitative (24 interviews; 4 focus groups)	The significant challenges facing BCT adoption include security issues, usability, legal concerns, governance, and organizational conflicts.
Li (2020)	Multiple Industries	Qualitative	Understanding the driving factors for new technology adoption is essential to help the organization develop effective implementation plans for BCT.
Malik, Chadhar & Chetty (2021)	Multiple Industries	Qualitative (23 interviews)	Adoption of BCT in Australian organizations is affected by customer pressure, cost, leadership and government support, organizational readiness, perceived lack of awareness and perceived complexity of BCT.
Park (2020)	Logistics	Qualitative	Factors affecting the adoption of BCT include performance and effort expectations, social influence, intentions, and attitudes

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Table 6 shows that three studies focused on BCT adoption in the agriculture sector, one study each focused in the area of business, logistics, tourism, healthcare, and supply chain industries, while three studies focus on other (multiple) sectors. The studies identify different factors or drivers related to BCT adoption and challenges facing the adoption of this technology.

This study identified ten themes that may influence BCT adoption in the Australian agricultural sector, including: transparency, quality control, contract exchange, transactions efficiency, trade finance management, security, and real-time information for involved parties, trust, and legislation.

Transparency

Nathani and Singh (2020) define transparency as the capability of a technology that allows each participant or stakeholder to see the changes in a transaction or data in the system. Transparency also enables participants to see any individual who makes changes to a transaction or data. The theme of transparency emerged from three studies by Kosmarski (2020), Lin et al. (2020), and Nathani and Singh (2020). The factors included in this theme include the need for food safety and management of sensitive business information. However, these were qualitative investigations that did not test empirically the statistical significance of these factors. According to these studies, there is a need for transparency in agriculture supply chains, leading to food safety and increased trust in business processes. Nathani and Singh (2020) found out that there is minimal support on transparency and visibility values in organizations trying to adopt new technologies, which undermine the perceived usefulness and ease of using such technologies. These studies were conducted in the retail sector, with limited focus on the agricultural sector. Further empirical investigation into the importance of

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transparency in the agricultural industry is thus needed and may provide additional benefits such as enhanced food safety and increased trust in the SCM relationships.

Quality Control

Quality control refers to processes and mechanisms that recognize and remedy defects in finished goods (Prashar et al., 2020). Studies by Lin et al. (2020) and Prashar et al. (2020) found out that organizations seeking to adopt BCT are driven by the need to attain and guarantee the quality of products. Two main factors that determined this theme include the need for food quality management throughout the supply chain process and provenance that guides organizations to verify their food products (Rana, Tricase & De Cesare, 2021). In the agriculture sector, quality control has become vital for businesses in their endeavour to build customer confidence and meet regulatory requirements. According to Lin et al. (2020), organizations depend on BCT to trace the movement of food products from their source, processing, to the customer point. The analysed studies focused on food safety, which can be categorised as quality control, but the study focused on finished agricultural products failing to account for the supply chain. Furthermore, there is need for empirical research to assess how quality control can help the farmers.

Traceability

Prashar et al. (2020) defines product traceability as the ability of a technology to instantly track food products at every point of contact throughout the supply chain. Three studies by Nathani and Singh (2020), Prashar et al. (2020), and Rogerson and Parry (2020) captured the theme of traceability as a driver of BCT adoption in supply chain, agriculture, and food industries respectively. Rogerson and Parry (2020) found out that customers are willing to be charged extra for their food products to ensure that human errors are eliminated when sourcing such products. The additional resources have allowed businesses to consider the adoption of BCT to improve traceability and visibility of food products. Prashar et al. (2020)

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and Nathani and Singh (2020) supported these findings by suggesting that the adoption of BCT in the agro-food supply chain brings traceability, provenance, and visibility of products. Flores, Sanchez, Ramos, Sotelo and Hamoud (2020) conclude that the traceability aspect is gaining momentum in the agriculture sector due to its ability to reinforce products' efficiency, safety, and credibility. The two studies were conducted in the agro-food industries, focusing on the food processing supply chain. Furthermore, empirical research is required to understand the importance of traceability not only to the farmer but to the ultimate consumer.

Contract Exchange

Rogerson and Parry (2020) have a clear definition of smart contract exchanges in agricultural supply chains. They refer to the execution of agreements between partners that have automated systems such that all parties reach an outcome simultaneously without time loss or the involvement of an intermediary. Two studies by Lin et al. (2020) and Rogerson and Parry (2020) investigated the contract exchange theme in the agricultural sector. According to Chang, Chen and Lu (2019), the adoption of BCT is expected to facilitate the introduction of smart contracts and also improve contract exchange, thus ensuring employees, owners of the business, and stakeholders, are legally protected. Therefore, BCT is expected to popularize smart contracts in several industries, including programs that only run when specific conditions are present (Chang, Chen, & Lu, 2019). However, the current investigations on smart contracts in the agricultural sector mostly focus on legal and financial processes. There are no empirical studies, which have focused on the utilization of contract exchanges in agricultural supply chain management.

Transactions Efficiency

Lin et al. (2020) introduces transaction efficiency as the capability of BCT to eliminate the requirement for intermediaries in critical business processes within the supply chain, thus leading to faster and safer transactions. This theme emerged from studies by Korpela, Hallikas,

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and Dahlberg (2017) as well as Lin et al. (2020). According to these studies, organizations incur huge costs when outsourcing third-party experts to run, monitor, and verify transactions. The need for digital signatures and timestamps for each transaction has necessitated the adoption of BCT to protect the transaction from modification and unnecessary denial (Lin et al., 2020). Similarly, Korpela et al. (2017) ascertained that businesses seek technologies that guarantee the security of transactions through time stamping and other forms of authentication. The cost-effectiveness, flexibility, and integration guaranteed by BCT contribute to transaction efficiency (Korpela et al., 2017). However, these studies do not establish a relationship between transaction efficiency, the need for BCT, and the improvement of supply chains in the agricultural sector. While the two studies hypothesize the impact of BCT on transaction efficiency, there is need for empirical studies that show how the technology affects or influences transaction efficiency.

Trade Finance Management

Trade finance in supply chain management refers to the use of new technologies such as BCT to manage financial transactions with a view to increase the profits of farmers (Pufahl, Ohlsson, Weber, Harper, & Weston, 2021). Farmers and small traders in the agricultural industry may face huge losses from different business risks, increased transaction costs, or expenses from accidental losses (Perboli, Musso, & Rosano, 2018). In most instances, these costs negate any returns from such businesses. Therefore, the adoption of BCT is geared towards helping these businesses become profitable. The adoption of BCT enables organizations to automatically predict risks and raise claims when such risks occur (Lin et al., 2020). They are able to eliminate fraud risks, while improving the efficiency of claim processing. Because trade finance management in the agricultural sector differs from other industries, there is a need for a technology that can facilitate automated payments, provide instant evidence of product delivery, and offer a platform to identify and manage disputes.

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Ultimately, businesses can control their trade finances through the tracking of production and sales to balance risks and returns. Lin et al. (2020) found that the comprehension of trade finance management in the agricultural supply chain was very critical in the use of BCT. However, there are no case studies from the Australian agricultural sector to support these viewpoints. Thus, there is need for empirical research on importance of BCT in financial management in the Australian agricultural sector and how it can help farmers manage their finances with the ultimate aim of attaining profit.

Security

The adoption of BCT in the agriculture sector seeks to address the incidences of security gaps in business processes by improving data privacy, encryption, and protection of confidential information (Tse, Zhang, Yang, Cheng, & Mu, 2017). Kosmarski (2020) explained that data security in supply chain management is concerned with protecting information systems, networks, and other platforms that cybercrime may threaten. This premise emerged from three studies that focus on the agriculture sector by Rogerson and Parry (2020), Lin et al. (2020), and Prashar et al. (2020). The premise resulted from the investigation of different factors, including information privacy, encryption of data, and the need for safety of both information and business processes. The findings from these studies indicate that the increasing adoption of new technologies in agricultural supply chain management may lead to a rise in insecurity concerns, vulnerabilities, and risks (Rogerson and Parry, 2020; Lin et al.., 2020; Prashar et al., 2020). Organizations without adequate and effective security systems may experience breaches of data privacy and confidentiality.

The use of smart contracts, e-certificates, and other records that hold confidential information can open avenues for exploitation. Lin et al. (2020) ascertained that many organizations turn to automated BCT tools to identify, reduce, and, if possible, prevent security risks by using enhanced security and privacy components. Rogerson and Parry (2020) and

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Prashar et al. (2020) also found that the use of multiple nodes in BCT guarantees higher security levels in managing data and in the authentication of business processes. Therefore, BCT ensures businesses achieve expected levels of data integrity that gradually influence the levels of trust and productivity. The adoption of BCT in other sectors such as the financial and data management may help to understand the impact of security gaps in agricultural supply chain management. However, while such findings from the three studies are useful in understanding how BCT improves security in the agriculture supply chain, they are not sufficiently focused. The implication is that there is need for studies that concentrate solely on security in the supply chains within the Australian agriculture sector.

Real-Time Information for Parties Involved

Lin et al. (2020) found out that there is increasing reliance on real-time data in agricultural processes and decisions. Availability of real-time information is facilitated by a digital token embedded in every product to enable instantaneous tracking. BCT seeks to create a balance between the need for correct real-time data and the maximization of transaction throughputs. Further, Lin et al. (2020) found out that reliance on real-time information improves stakeholders' decision-making and eliminates unnecessary bureaucratic procedures. The increasing reliance on real-time data forces many organizations to adopt new technologies that allow the generation, management, and dissemination of such data. However, few studies have focused on the importance and utilization of real-time information in the agriculture supply chain as observed in the systematic literature review where only one study focused on data. Also, the analysed qualitative study was not based on the Australian sector and thus lacked empirical evidence on how BCT adoption can help with real-time information management in the country's agricultural sector.

Trust

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Lin et al. (2020) define trust in the agricultural supply chain as the levels of reliability and dependence that stakeholders build around a process, product, or technology. The theme of lack of business trustworthiness emerged from three studies by Rogerson and Parry (2020), Lin et al. (2020), and Alazab et al. (2021). Rogerson and Parry (2020) included lack of trust in new technologies among the significant challenges that affect data access for both management and customer. Lin et al. (2020) identified BCT as the most suitable technology to address business trust issues by integrating cryptographic and computational techniques in processes that rely entirely on computer technology. Building a trustworthy platform is a win for all stakeholders in the agricultural supply chain, including farmers, producers, distributors, and customers (Lin et al., 2020). Further, Alazab et al. (2021) found that organizational trust is a critical consideration that influences the intention to adopt BCT. Lin et al. (2020) concluded that the adoption of BCT for agricultural supply chain management sought to solve many trust issues arising from the relationship among customers, businesses, partners, and regulators. However, there are still gaps in the understanding of how BCT can resolve the increasing cases of fraud and business malpractices in the Australian agriculture supply chain. Furthermore, the three studies, which were analysed lacked empirical evidence on the importance of trust to the Australian agricultural industry.

Legislation

The challenge of legislation in BCT adoption emerged from two studies: Kosmarski (2020) and Sharma and Joshi (2021). According to Kosmarski (2020), there are no clear legal and regulatory procedures for adoption and use of technologies that rely on BCT. Sharma and Joshi (2021) found that there is minimal awareness of the legal issues involved in organizations seeking to use BCT to improve business processes. The above studies only mention legislation as a challenge related to the adoption of new technologies in supply chain management.

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Therefore, it is essential to investigate how legislation requirements affect the adoption and implementation of BCT in the agricultural sector.

3.4. Gaps in Literature

The analysis of the above themes provides a foundation on the drivers and challenges affecting the adoption of BCT in the agricultural sector. Based on the above findings, at least one gap was identified for each theme on the determinants of BCT. From the perspective of BCT determinants related to transparency, it was established that the accuracy of information put by sensors or people is not guaranteed, which meant that transparency may not be achieved completely. The procedure of developing, verifying, adopting, and implementing smart contracts is limited by the availability of frameworks that could support smart contracts efficiently.

Despite the increasing number of inquiries on traceability in the agriculture sector, a limited number of empirical studies focus on traceability and visibility in the Australian agriculture supply chains. In terms of achieving transaction efficiency and trade finance management, it is still not clear whether if the use of BCT and its alternatives could provide greater efficiency benefits compared to other centralized systems.

From the perspective of challenges, previous studies failed to identify how third-party activities could be detected using BCT. This means that future innovators should be committed to address this gap otherwise trust and security of the technology may be compromised. From the aspects of achieving real-time information and legislation, a lot still needs to be done to protect key stakeholders from the risk of false information and other technological risks. Where possible, new studies should focus on organizations and businesses that have adopted BCT in their agricultural supply chains to understand the suitability, benefits, and drawbacks of this technological innovation.

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3.5. Systematic Review Discussion

This systematic review emerged with ten themes related to the adoption of BCT in the agricultural sector and other industries. The themes relate to the drivers of BCT and the challenges in the adoption of this technology. The key drivers of BCT identified in this study are the need for transparency, quality control, traceability, contract exchange, transaction efficiency, security, trade finance management, and the need for real-time data. The challenges related to the adoption of this technology include legislation and legal issues, lack of trust, awareness, and minimal support from relevant stakeholders. Figure 4 below shows the proposed theoretical framework on the determinants of BCT adoption.

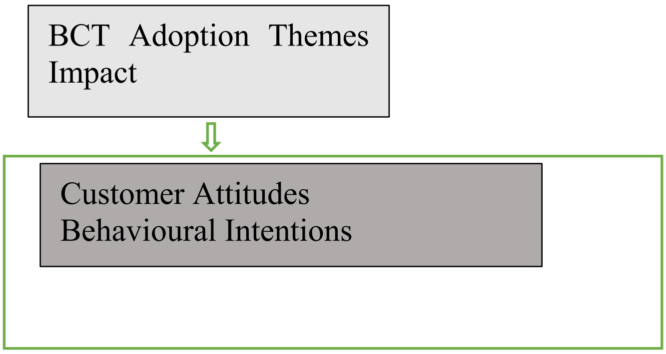

Figure 4: Potential Impact of Themes on BCT Adoption

According to the figure, the successful adoption of Blockchain may depend on different factors, including transparency, traceability, quality control, transaction efficiency, security, finance management, and real time data. These determinants may have a direct influence on the adoption of BCT in the agricultural sector, as it influences the consumer attitudes towards the technology. This may further influence the behavioural intentions, which can act as drivers and obstacles (challenges) to BCT adoption. Organizations must balance the need for this technology and its potential challenges to guarantee any value to related business processes. Failure to manage obstacles in the adoption of BCT can adversely impact specific business processes (Lin et al., 2020).

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The findings stress the importance of transparency and traceability in decisions regarding the adoption of BCT. Organizations are also looking for technologies that can guarantee the required product quality and transaction efficiency (Lin et al., 2020). An increase in business losses is attributed to the ineffectiveness of systems supporting business transactions and the inability to manage trade finances compels institutions to consider the adoption of BCT to guarantee efficiency and eventual business returns (Korpela et al., 2017; Lin et al., 2020). The need to incorporate smart contracts through contract exchanges as well as the desire for real-time data has also influenced decisions to adopt BCT.

Moreover, the need for technologies that can guarantee secure systems and processes is becoming a vital consideration for business functions such as supply chains that use considerable volumes and require numerous approvals. Rogerson and Parry (2020) and Prashar et al. (2020) note that the adoption of BCT is driven by the need for secure systems and platforms that can guarantee customer and organizational data protection. However, lack of trust in new technologies and legal obstacles has been linked to lack of BCT and related technologies. According to Kosmarski (2020) and Sharma and Joshi (2021), the legal requirements for adopting BCT and subsequent governance issues prevent many organizations from considering the adoption of new technologies despite the projected benefits associated with such technologies. Since BCT is still a developing technology with limited adoption, decisions on governance and legislation have not been universally incorporated in the use of this technology (Kosmarski, 2020). Further, attempts to integrate BCT with a view to improve specific business processes have received substantial opposition from stakeholders who do not understand the immediate and future value of these new technologies and developments.

3.6 Theoretical Implications of the Findings

The study contributes to the theory on agriculture. The theory of change in agriculture is concerned with the statement of mini steps which will result in the desired goal. Having

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identified the determinants of BCT adoption in the agricultural supply chain, mini steps that will be undertaken include understanding of the needs, identification of relevant framework needed, developing legislation framework, and selection of the best technology that will provide the desired solution. For instance, research has established the need for transparency in the supply chain, therefore, a new technology (BCT) is needed to address the problem. The BCT requires supporting frameworks such as systems of compiling quality data.

This study contributes to the body of knowledge on BCT by investigating the adoption process. The findings have also impacted the food security theory of change. This theory is concerned with ensuring sustained and healthy meals for children from vulnerable families particularly the most susceptible communities. The study finding on the potential benefits associated with the usage of BCT especially the achievement of efficient agriculture will contribute considerably to the achievement of the theory's goal. The traceability of agricultural produce will enable experts to reach out to the farmers with a view to train them on good farming practices. Ultimately, the production of healthy agricultural produce will lead to the supply of healthy products to consumers. This will ensure that the customers are able to consume healthy agricultural products.

3.7. Conclusion

This study has established the critical determinants that influence the adoption of BCT, including assessing transparency, traceability, contract exchange, transaction efficiency, trade finance management, quality control, real-time information, security, and legislation. This study concludes that the need for product traceability drives the adoption of BCT. Process transparency, the need for quality controls, and the necessity for smart contracts in business engagements also motivate businesses to implement BCT. Further, the study concludes that the need for transaction efficiency, business trusts, real-time data, security, and trade finance management are critical drivers that influence BCT adoption. On the other hand, challenges

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such as legal uncertainties, low readiness and awareness levels, lack of trust, and inadequate support prevent or slow down decisions on BCT adoption.

The analysis finds that when it comes to determining whether or not to adopt BCT in business processes, firms tend to consider certain aspects. The agricultural supply chain is being pushed to embrace BCT due to a loss in production and performance, as well as issues in ensuring product quality. BCT adoption is also necessitated by the need to eliminate fraud and security concerns in supply chain management. However, the sustained use of this technology in the Australian agricultural supply chains is projected to have greater success.

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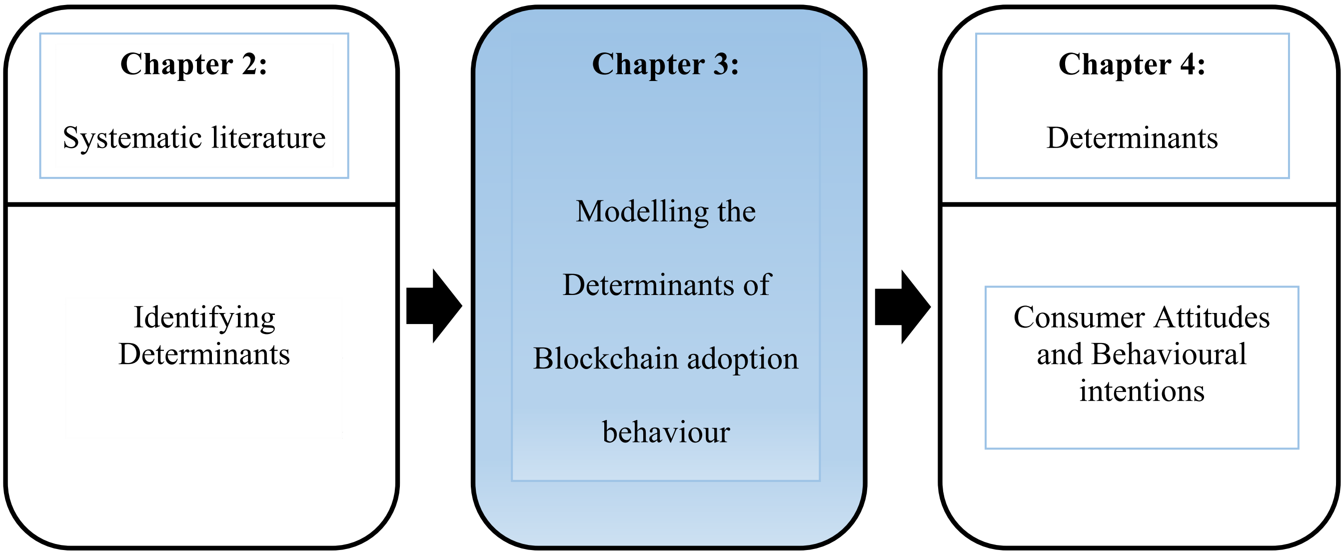
CHAPTER 3: RESEARCH DESIGN AND FACTOR MODELLING

Structure



Modelling the Determinants of BCT Adoption Behaviour

The chapter first briefly explores BCT and key factors driving its adoption. The chapter explores the business environment driving BCT adoption in the introduction, such as supply chain management. The chapter also discusses the technology adoption models, TAM, UTAUT, TPB, and TRI. These models play a vital role in the research by analyzing factors that influence people to adopt technology, BCT. The section discusses the obtained results concerning BCT adoption or rejection drivers. The technology adoption models play a critical role in analysing the results to measure the adoption of BCT or the barriers facing its adoption. The paper will be presented at the International Journal of Information Management in March 2022.

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PERCEIVED DRIVERS AND CHALLENGES FOR THE ADOPTION OF BLOCKCHAIN TECHNOLOGY IN AGRICULTURAL SUPPLY CHAINS IN AUSTRALIA

ABSTRACT

Blockchain is a distributed ledger of transactions and accounts offering a more reliable source of truth about transactions that could be applied to the state of farms, inventories, and contracts in agriculture. The aim of this study is to determine the factors influencing Blockchain adoption in the Australian agricultural supply chain and how it can improve the agricultural sector. A pilot test involving 10 experts was conducted to improve the survey instrument before collecting data from 358 agricultural supply chain experts in Australia. The study methods integrated four technology adoption theories including the technology acceptance model (TAM), the unified theory of acceptance and use of technology (UTAUT), the theory of planned behaviour (TPB), and the technology readiness index (TRI). Structural equation modelling was used to test the proposed model. Results indicated that subjective norms positively affected perceived usefulness, while behaviour control positively affected intentions. Insecurity negatively affected perceived usefulness and perceived ease of use, while discomfort also negatively affected perceived usefulness Managers may address the slow uptake of BCT by addressing hurdles such as discomfort and insecurity in order to discourage successful adoption of BCT in their organisations. The study aims to make an important theoretical contribution to the agriculture supply chain, and logistics literature by indicating the importance of such disparate issues as discomfort, transparency, insecurity, and culture

Keywords: Blockchain adoption; Australian agriculture; supply chain management; technology acceptance model (TAM); unified theory of acceptance and use of technology (UTAUT); the theory of planned behaviour (TPB); the technology readiness index (TRI)

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1. Introduction

Technology-driven disruptions have greatly impacted organizational operations in various aspects including service delivery, customer care, and operations management (Chod et al., 2020; Wamba & Queiroz, 2020). Associated with the growing adoption of information technology, globalization has increased global market competition necessitating organizations to adopt more effective strategies to remain competitive (Longo et al., 2019). Supply chains have become among the more disrupted business segments, necessitating technological adoption to reduce costs, manage increasingly complex global markets, and ensure business sustainability (Longo et al., 2019). Technology has been central to enhancing supply chain and business efficiency (Duan et al., 2020). Efficient, healthy, and inclusive food supply chain systems are critical to achieve global development goals.

Over the centuries, agricultural development has remained one of the most essential tools to boost shared prosperity and end extreme poverty. The current goal is to feed an estimated 9.8 billion people by the year 2050 (Boult & Chancellor, 2019). Growth in the agribusiness sector is two to four times more effective in raising family incomes among the poorest compared to other economic sectors (Chod et al., 2020). In 2020, 65% of poor working adults across the world made a living through agriculture (Duan et al., 2020; Awan et al., 2021). Agriculture is crucial to economic growth for many countries and in 2020, agribusiness accounted for 5.1% of global gross domestic product (GDP), while in some developing countries it accounted for more than 25% of their national GDP (Boult & Chancellor, 2019; Awan et al., 2021).

As consumer demands have changed rapidly, effective supply chain management has become a fundamental component of business efficiency and customer responsiveness (Saurabh & Dey, 2021). Modern technologies may provide essential solutions to enable companies to improve their supply chain efficiency. Technologies could enable companies to

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overcome growing supply chain complexities such as diverse geographical locations, different product portfolios, and increasing business scales (Duan et al., 2020). Technology adoption may be a solution for organizations that are increasingly faced with the challenge of customizing products and raw materials to maintain a competitive edge (Chod et al., 2020; Fosso Wamba et al., 2020; Tipmontian et al., 2020).

As a result of the dynamic business environment, companies continue to experience uncertainty in predicting supply demand, planning, and coordinating customer orders (Kamble et al., 2020; Yadav et al., 2020). Mitigating such challenges requires companies to adopt and implement lean supply chain practices. Lean approaches can offer the potential to assist to reduce waste, increase productivity, lower inventory costs, improve quality, and provide greater logistic flexibility (Yadav et al., 2020). Blockchain technology (BCT) has emerged as one of the potential solutions to enhance coordination, collaboration, and traceability of supply chain transactions (Duan et al., 2020; Kamble et al., 2020; Yadav et al., 2020). Blockchain architecture offers greater transparency and traceability of supply chain transactions, effectively reducing any trust problems among various parties (Saurabh & Dey, 2021). BCT has several potential advantages over traditional supply chain management as it reduces costs and losses, enhances trust, is tamper-fee, and offers decentralised information (Kamble et al., 2020).

BCT has some challenges to overcome such as developing a universal platform for scaling up its adoption and application (Chod et al., 2020; Fosso Wamba et al., 2020). Potential concerns about BCT have resulted in some companies becoming concerned about the high cost of implementing BCT (Collart & Canales, 2021; Kouhizadeh et al., 2021). Due to the perceived risks, some agricultural organisations show hesitancy to adopt BCT in their logistics and supply chain operations (Chod et al., 2020; Wamba & Queiroz, 2020; Yadav et al., 2020). Managers

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in the agricultural sectors may not understand Blockchain and remain hesitant to promote its uptake in their organisations (Duan et al., 2020).

While much remains to be known about supply chain adoption in organizations, there is also a paucity of research on the factors influencing critical drivers and challenges for the adoption of BCT in agricultural supply chains (Yadav et al., 2020), presenting a potential knowledge gap in the literature. Research in BCT adoption focuses on supply chain management. These studies found factors such as transparency reduce costs in food supply chain management (Duan et al, 2020) but failed to examine factors like discomfort, insecurity, and culture regarding their impact on BCT adoption. Limited research on the topic necessitates the need for this study to identify the factors influencing BCT adoption in the agricultural industry.

The lack of a universal implementation model hinders BCT uptake in organizations (Duan et al, 2020). The current study seeks to provide a comprehensive understanding of the factors influencing BCT adoption, with a specific research focus on agricultural supply chains. To identify important BCT adoption factors, the research uses four theoretical models including the technology acceptance model (TAM), the theory of planned behavior (TPB), the technology readiness index (TRI), and the unified theory of acceptance and use of technology (UTAUT). The contribution of this study is to recommend future managerial interventions to enhance the adoption of BCT especially in agricultural companies that are still skeptical about BCT adoption in their supply chains. The study further contributes to theory by identifying key factors that organizations and managers need to take into consideration for successful implementation of BCT adoption in the agricultural supply chain management. Findings from the study contribute to theory on supply chains and agriculture by indicating discomfort, transparency, and insecurity influence use adoption of BCT in agricultural chains.

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The study is guided by the following hypotheses:

H1: Subjective norms have a significant influence on the perceived usefulness (PU) of BCT.

H2: Subjective norms have a significant influence on intention to use BCT.

H3: Perceived behavioural controls have a significant influence on intention to use BCT.

H4: Discomfort as a TRI construct has a significant influence on perceived usefulness of BCT.

H5: Technology discomfort has a significant influence on the perceived ease of use of BCT.

H6: Insecurity as a TRI construct has a significant influence on perceived usefulness of BCT.

H7: Technology insecurity has a significant influence on the perceived ease of use of BCT.

H8: Perceived ease of use of BCT has a significant influence on its perceived usefulness.

H9: Perceived ease of use of BCT has a significant influence on the attitude towards its use.

H10: Perceived usefulness of BCT has a significant influence on the attitude towards its use.

H11: Perceived usefulness of BCT has a significant influence on the intention to use it.

H12: Attitudes towards BCT has a significant influence on the intention to use it.

H13: Transparency has a significant influence on the intention to use BCT.

2. Blockchain Technology

BCT is a decentralized and distributed ledger that records digital assets (Wamba & Queiroz, 2020) and information in a way that makes it difficult to hack or alter (Long et al., 2019). BCT has also been defined as a network of computers that operate without the need for a central authority (Jabbar et al., 2020; Bischoff & Seuring, 2021). BCT is decentralized, difficult to maliciously manipulate, and can therefore help to ensure the trustworthiness of multiple entities in a transaction.

Being a peer-to-peer transaction platform, BCT does not require third parties as different entities involved in a transaction serve as nodes with all transactions varied using cryptography (Collart & Canales, 2021). Records from BCT transactions are shared and decentralised across multiple entities (Collart & Canales, 2021). BCT can help to eliminate

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trust-related problems in business transactions, thereby reducing the friction of business authentication (Rana et al., 2021), contribute to transparency in financing transactions and enhance the traceability of supply chains (Chod et al, 2020; Collart & Canales, 2021). BCT is further considered to be a digital revolution considering its potential benefits like making transactions cheaper and instantaneous (Bischoff & Seuring, 2021)

2.1. Blockchain Technology in Agricultural Supply Chains

BCT adoption in agriculture supply chain is critical in supply chain traceability (Bischoff & Seuring, 2021), supply chain transparency, financial returns (Chod et al., 2020), fresh produce supplies (Collart & Canales, 2021), and food supply and logistics management (Duan et al., 2021). BCT has been found to contribute to improved food supply chain effectiveness (Fosso Wamba et al., 2020) and enhanced traceability of food produce distribution (Jabbar et al., 2020; Kamble et al., 2020). Implementing BCT in agricultural supply chains may contribute to reduced redundancy, shorter lead times, a leaner supply chain, and fewer delays (Collart & Canales, 2021). BCT adoption in supply chains may help to ensure high-quality standards, giving stakeholders more control of the production and distribution of agricultural produce across the supply chain (Chod et al., 2020). Research on BCT in agriculture also indicates that it contributes to improved safety, privacy, and individual control of data in the food processing supply chain industries (Long et al., 2020; Collart & Canales, 2021). The potential benefits for supply chain and sustainability issues in the horticultural sector include improving traceability, transparency, and efficiency in addition to substantial cost savings (Kouhizadeh et al., 2021). Despite these reported advantages, the adoption of BCT has not seen rapid acceptance and implementation (Collart & Canales, 2021).

2.1.1. BCT Impact on Order Placement and Procurement

BCT adoption would potentially contribute to trust and authenticity in procurement and order placement (Bischoff & Seuring, 2021; Jabbar et al., 2020). BCT has been found to

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improve the transparency of placed and procured products from customers and manufacturers (Kouhizadeh et al, 2021). The BCT models address limitations of analogue contracts that largely define traditional supply chains when there are issues of product delivery and actual payment (Kim & Shin, 2019). BCT is reported to eliminate issues of delayed payment settlement and generation of invoices that have characterized traditional order placement and goods procurement (Longo et al., 2019). BCT provides smart contracts that help companies end or significantly reduce order placement delays, product delivery, and payment (Kouhizadeh et al., 2021).

BCT could contribute to more seamless connections among logistic partners, manufacturers, suppliers, and banks through integrated networks (Wamba & Queiroz, 2020). Such an integration could result in reduced operating capital and simplified financial operations resulting in effective procurement and ordering processes (Wamba & Queiroz, 2020; Wu et al., 2021). As a result, there is a generation of smart contracts where payments are automated with the origins of goods traced back to their roots (Saurabh & Dey, 2021). These processes can ensure more efficient and cost-effective procurement processes, with enhanced accuracy of ordered goods and delivered products (Longo et al., 2019; Kouhizadeh et al., 2021).

2.1.2. BCT Impact in Processing, Manufacturing, and Value Addition

Agricultural processes entail multiple activities throughout the supply chain. There is a need to better align operations from raw material outsourcing, processing, or manufacturing, and value addition (Tipmontian et al., 2020). A systematic literature review of past studies on BCT adoption in agribusiness found 43 studies indicating that the use of BCT in agribusiness is a new topic, with the initial publications reported in the year 2016 (Rocha et al., 2021). Although most of the BCT uptake has been limited to computer science and finance, there is increased utilisation of Blockchain in other fields like livestock, agricultural, environmental,

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and agribusiness logistics (Rocha et al., 2021). Key interests in BCT uptake in agricultural fields include efficiency in processing, manufacturing, and supply chain management.

There is an increase in BCT uptake in the food and agriculture supply chain (Kamilaris et al., 2019). Findings from interviews with 17 managers indicated that BCT is emerging as a promising technology that focuses on creating transparency and trust within processing and manufacturing (Kamilaris et al., 2019). BCT has been noted to reduce the cost of operations in manufacturing although some challenges exist that hinder Blockchain adoption among farmers and agricultural systems like value addition and manufacturing (Kamilaris et al., 2019). Some of the potential challenges include lack of policies, inadequate regulatory framework, education, and technical aspects (Kamilaris et al., 2019; Tipmontian et al., 2020). Despite these challenges, BCT can promote greater reliability and agility in manufacturing and processing with reduced costs (Wu et al., 2021).

2.1.3. BCT Impact on Transparency and Traceability in Logistics and Distribution

BCT enhances the ability to trace and track information, goods, and products during transit and distribution (Yadav et al., 2020). Through traceability, BCT not only improves transparency in logistics but also improves trust among various entities in a supply chain (Hu et al., 2021). Traditionally, traceable solutions were largely centralized and not suitable for modern highly dynamic supply chains since they are exposed to data manipulations and potential single-point failures (Yadav et al., 2020). BCT may be a suitable alternative in addressing transparency and traceability problems in centralized systems.

An overview of different BCT solutions has also been examined in past studies. For example, researchers have examined a proof of concept using Microsoft Azure Blockchain Workbench (Sunny et al., 2020). Results indicate that the use of BCT in logistics and supply chains improves transparency and creates better tracking of customer orders during delivery (Sunny et al., 2020). As a supply chain becomes complex and widely distributed, centrally

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located solutions can become difficult to manage, resulting in challenges for information sharing, tracing the location of products, and assuring product quality (Sunny et al., 2020). Improved transparency and traceability can contribute to customer satisfaction in an increasingly competitive agricultural sector (Ronaghi, 2020).

In ensuring efficient company operations and competitiveness, BCT may be useful in ensuring that companies maintain their market share (Ali et al., 2021). For example, resources used in supply chain distribution and logistics including personnel, vehicles, and capital would easily be incorporated with GPS technologies and serve as a unit data block (Patel & Shrimali, 2021; Rana et al., 2021). Such integration has been reported in a study by Dietrich et al. (2021) regarding a new effective BCT framework for the halal food supply chain in Malaysia. The halal supply chain includes five dimensions that address the complexity of ensuring transparency. The dimensions include regulatory capability, efficient production, change management, cost reduction, and logistic efficiency (Dietrich et al., 2021). These indicate that BCT continues to show a promising impact in agricultural supply chains in terms of preventing data forgery, thereby improving operational efficiency of supply chains.

2.2. Technology Adoption Models

Key among the widely used technology adoption models to help understand how users adopt and use innovative concepts include motivation model, social cognitive theory, a model of personal computer utilization, and diffusion of innovation theory. These technology models have few constructs to help managers understand key factors influencing BCT adoption and subsequent implementation of new technology (Dietrich et al., 2021). Alternative models include the theory of reasoned action (TRA), the theory of planned behaviour (TPB), and the technology readiness index (TRI) that are more comprehensive in examining the process of technology adoption. The current section briefly presents the major constructs of TAM, UTAUT, TPB, and TRI and their application to this study.

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2.2.1. Technology Acceptance Model (TAM)

The TAM framework was proposed by Davis in 1989 to explain how individuals accept and use technology. Two primary factors influence the use of technology by potential users: perceived usefulness (PU) and perceived ease of use (PEU) (Davis, 1989). The primary feature under the TAM is an emphasis on user perceptions. Davis first used the TAM in 1989 to explain key determinants of technology acceptance. Figure 5 shows the two constructs of perceived usefulness and perceived ease of use initially proposed by Davis in 1989. Perceived usefulness refers to a users' subjective likelihood that using technology will improve their actions. Perceived ease of use refers to the likelihood that using a system will be effortless (Davis, 1989).

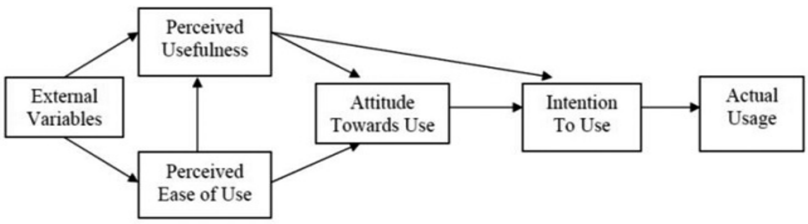

Figure 3: First Modified Technology Acceptance Model (TAM) (Davis, 1989)

In 1996, Venkatesh and Davis improved on the initial TAM after finding both PU and PEU directly influenced behaviour intention (Venkatesh & Davis, 1996). The new TAM model eliminated the need for the attitude construct. Figure 6 shows the final version of the TAM model.

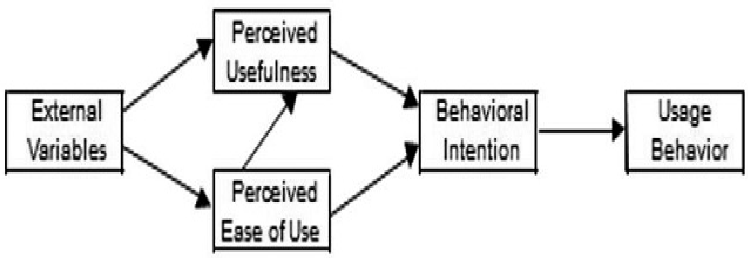

Figure 4: The Final version of the TAM model by Venkatesh and Davis (1996)

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The TAM model has been widely used in recent studies to assess how perceived usefulness and perceived ease of use inform BCT uptake in agricultural supply chains. The TAM model has been used to examine user behaviour and acceptance of BCT in agricultural supply chains (Saurabh & Dey, 2021). Further, TAM has been applied to assess BCT impact in facilitating an accurate, secure, real-time, and cost-effective coffee supply chain in Burundi with implications on the need for further research on its application on agricultural supply chains. Recent studies have found TAM effective in explaining managers' intentions to use Blockchain technology in the agricultural industry (Queiroz & Fosso Wamba, 2019; Jain et al., 2020; Saurabh & Dey, 2021; Giri & Manohar, 2021). Table 7 presents examples of some past empirical studies that have used the TAM adoption model to understand the acceptance of BCT in supply chains.

Table 7 shows that studies investigating perceived usefulness and perceived ease of use focus on the private and public supply chains (Giri 2021) logistics (Jain et al., 2020; Queiroz & Fosso Wamba, 2019) and grape wine supply chain (Saurab 2021). Limited studies have determined the impact of perceived usefulness and ease of use in the agricultural industry. Blockchain is an emerging technology that has largely been limited to the information technology and financial sectors (Saurab 2021). Being a novel technology and considering the diversity of the agricultural sector, factors that may influence its uptake in this industry may differ from other sectors.

Table 3: Past Empirical Studies that have used TAM Adoption Models to Explore Blockchain Acceptance in Supply Chains

References	Country	Objectives	Findings
Giri & Manohar, 2021	India	To examine the acceptance of private and public BCT-based collaboration among supply chain practitioners	Collaboration strongly mediated the relationship between both perceived usefulness and perceived ease of use and their influence behavioural intention to use

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Jain et al., 2020	India	To understand Blockchain uptake and acceptance in logistics	Perceived usefulness, perceived ease of use, and attitude influence BCT uptake and implementation in logistic supply chains.
Queiroz & Fosso Wamba, 2019	United States & India	To understand BCT adoption behaviour in the logistics and supply chain fields in India and the USA	Supply chain and logistic transactions executed using Blockchain were deemed to be safer, more traceable, and transparent
Saurabh & Dey, 2021	India	To identify potential factors of BCT adoption in the grape wine supply chain	Trust, compliance, traceability, dis-intermediation, control, and coordination informs BCT adoption.
Shrestha & Vassileva, 2019	Canada	To uncover how the PEU, perceived enjoyment, system quality, and perceived usability influence the intention to use the BCT-based systems.	Behaviour influences intention to use BCT in the supply chain with the quality of the system having a strong influence on perceived usefulness and perceived ease of using the technology.

2.2.2. The Unified Theory of Acceptance and Use of Technology (UTAUT)

In 2003, Venkatesh further expounded on the previous theories related to the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). The UTAUT contains four predictors of individuals' behavioural intentions including facilitating conditions, social influence, efforts expectancy, and performance expectancy. In the UTAUT model, performance expectancy is influenced by outcome expectations, relative advantage, job fit, extrinsic motivation, and perceived usefulness. Effort expectancy is focused on capturing user-perceived complexity and perceived ease of use. Social influence has been found not to be significant, especially in voluntary settings (Venkatesh et al., 2003). Table 8 presents some studies that have used the UTAUT model to examine BCT adoption in agricultural supply chains (Subramanian et al., 2020). Figure 7 presents the UTAUT conceptual framework.

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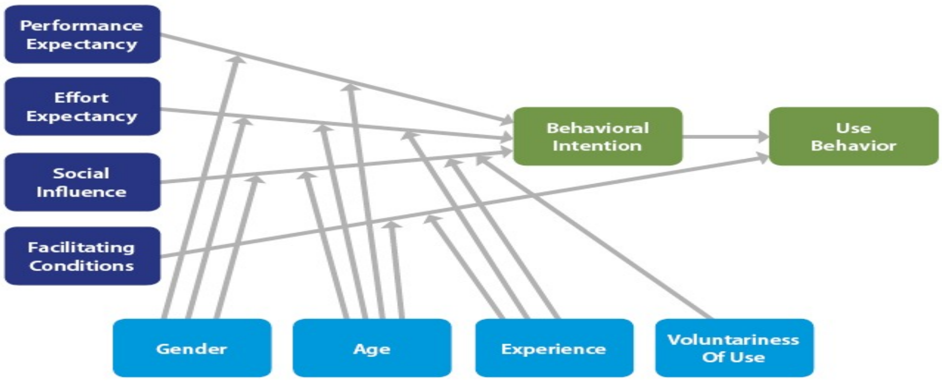

Figure 5: The UTAUT Conceptual Model by Venkatesh et al. (2003)

Through the UTAUT, Venkatesh et al. (2003) combined the most relevant features of the past technology acceptance theories. The UTAUT model is one of the most widely cited conceptual frameworks used to explain how users accept and adopt new technologies (Cordeiro & Olsen, 2021; Tran & Nguyen, 2021). Besides the four attributes associated with the UTAUT (i.e., facilitating conditions, social influence, effort expectancy, and performance expectancy), the model has four moderating factors. These moderators include experience, voluntariness, age, and gender (Batwa & Norrman, 2021). Since its publication, the UTAUT conceptual framework has been widely applied to understand BCT adoption in supply chain management (Dietrich et al., 2021). The model and its survey instrument have proved robust, reliable, and valid when used to assess how organisations accept Blockchain in their supply chain and logistics processes, as further shown by recent studies presented in Table 8. Past studies have not examined the application of the UTAUT model in agricultural supply chains. Undertaking this study would fill this knowledge gap and help examine the model's application to the agricultural sector.

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Table 4: Past Empirical Studies that have used UTAUT Adoption Models to Explore Blockchain Acceptance in Supply Chains

References	Countries	Objectives	Findings
Francisco & Swanson, 2018	United States	To examine user technology acceptance for Blockchain traceability applications	social influence, performance expectance, social expectancy, organizational support, user behavior, and trust impact on BCT adoption in supply chains
Khazaei et al., 2020	Malaysia	To study possible factors affecting the adoption of BCT in Malaysian SME supply chains	Effort expectancy, performance expectancy, trust, security, social influence, and personal innovativeness influence intention to use BCT in Malaysian supply chains
Sheel & Nath, 2020	India	To study BCT adoption intentions in Indian supply chains	Behavioral intention to use BCT are influenced by price value aspects, hedonic motivation, social influence, and performance expectancy.
Subramanian et al., 2020	Turkey	To examine Blockchain acceptance and application in the food supply chain in Turkey	Traceability, transparency, and efficiency inform organizational uptake of BCT uptake in food supply chains
Cordeiro & Olsen, 2021	Europe & China	Identify BCT use as traceability and anti-counterfeit instrument in wine supply chains between Europe and China	The uptake of BCT in wine supply chains are influenced by facilitating conditions, user behavior, behavioural intention, social influence, effort expectancy, and performance expectancy.

2.2.3. Theory of Planned Behaviour (TPB)

Ajzen (1985) proposed the TPB to help understand and explain behaviours (Ajzen, 1985). The TPB postulates that behaviours are influenced by intentions. The intentions are subsequently determined by three factors: perceived behavioural control, subjective norms, and attitude towards behaviour. Figure 8 presents the TPB theory. The first two constructs (i.e., attitude and subjective norms) are like the Theory of Reasonable Action proposed by Fishbein and Ajzen in 1975 (Ajzen & Fishbein, 1975). The third construct (i.e., perceived behaviour control) is the limit that users consider may hinder their behaviour. The TPB is important when modelling the acceptance of various new information technology products and assessing levels of usage (Cheng, 2018). Insights from past studies in the agricultural supply chains have not

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investigated how TPB may be used to understand BCT adoption. Findings from this study will be key to identifying important TPB constructs that would help understand BCT uptake in agricultural supply chains.

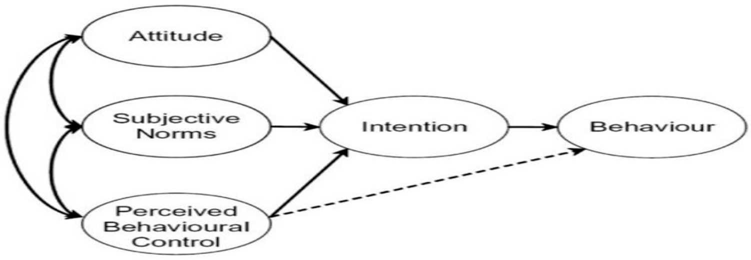

Figure 6: The Theory of Planned Behaviour (Ajzen, 1991)

2.2.4. Technology Readiness Index (TRI)

The TRI measures individual readiness to use technology. TRI is defined as “people's propensity to embrace and use new technologies for accomplishing goals in home life and at work” (Parasuraman, 2000, p. 308). TRI is used to understand peoples’ beliefs and it contains four sub-constructs: insecurity, discomfort, innovativeness, and optimism (Lin et al., 2020; Paliwal et al., 2020). Optimism defines the positive perception a user has towards technology and is a belief that using it will contribute to improved efficiency, flexible operations, and control (Dutta et al., 2020; Parasuraman, 2000). Innovativeness means a sense of inclination and a belief that a person has been a pioneer with a newly introduced technology (Parasuraman, 2000). Discomfort refers to a sense of being overwhelmed and lacking control when using new technology (Parasuraman, 2000; Park, & Li, 2021). Finally, insecurity refers to distrusts and worries about using new technology, and potential users largely remain suspicious of its capabilities to be helpful in their work or at home (Parasuraman, 2000).

Over the years, researchers have used the TRI to understand technology use where innovativeness and optimism are considered motives of use, while discomfort and insecurity are considered inhibitors (Curry et al., 2021; Montes et al., 2021; Saurabh & Dey, 2021). TRI

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has been used in combination with TAM to assess Blockchain use in enhancing horticulture traceability (Kosgei & Moturi, 2021). Further research has confirmed the use of TRI as an effective model to understand expert attitudes towards BCT used to establish fair agricultural trade (Kamble et al., 2020).

Past studies did not assess the application of TRI in agricultural supply chains. Undertaking this study will be key to examining issues like insecurity, discomfort, innovativeness, and optimism in terms of their influence on BCT uptake in the agricultural sector. Survey results will be key to determining factors central to influencing managers in agricultural sectors to implement BCT uptake in supply chains. Table 9 presents a review of literature on the use of BCT in the agriculture supply chain management from various countries showing that there is a paucity of research on the topic as applies to the Australian context.

Table 5: Past Empirical Studies on Blockchain Use in Agricultural Supply Chain Management

References	Country	Objectives	Findings
Ali et al., 2021	Malaysia	To propose an effective Blockchain framework to enhance the integrity of the halal food supply chain	BCT uptake in the halal supply chain is influenced by regulatory capability, efficient production, change management, cost reduction, and logistic efficiency
Bischoff & Seuring, 2021	Germany	To identify limitations and opportunities that influence the adoption of BCT in supply chain management	Blockchain adoption acceptance is influenced by information confidentiality, the privacy of entities in a supply chain, and vulnerability towards third parties
Collart & Canales, 2021	United States	To assess the adoption of BCT and its potential impact in addressing the challenges of the fresh produce industry.	BCT adoption enhances the resilience of supply chains by reducing food fraud, loss, wastage, and ensuring safety.
Hu et al., 2021	China	To formulate a blockchain framework to enhance efficiency and reduce cost in the organic supply chain	BCT use in supply chains may contribute to enhanced efficiency, cost-effectiveness, transparency, tamper-resistance, trust-free, and immutable constructs
Kamble et al., 2020	India	To identify and establish the relationship between the enablers of BCT	Traceability, auditability, provenance, and immutability largely informs the uptake and use of BCT in Indian agricultural supply chains

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	adoption in agricultural supply chains	

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3. Research Model

3.1. Theoretical Framework of the Model

The previous section details key models central to understanding technology acceptance among users. The current section presents a theoretical framework to explain potential hurdles and enablers of BCT adoption in agricultural supply chains. The model combines TAM, TPB, TRI and UTAUT because they present comprehensive constructs that influence perceptions and attitudes towards technology acceptance (Dietrich et al., 2021). TRI helps to understand individual inclination towards technology, while TAM focuses on attitudes towards system perceptions (Bischoff & Seuring, 2021).

The TAM, TPB, TRI and UTAUT models offer a comprehensive understanding of the factors influencing BCT adoption by agricultural supply chains (Curry et al., 2021). Both PEU and PU are cognitive dimensions that predict individual technology acceptance, and they mediate between TRI constructs based on behavioural intentions and individual psychological differences (Cordeiro & Olsen, 2021; Tran & Nguyen, 2021). Finally, through the TPB model, perceived behaviour and subjective norms are used to understand how control influences users to adopt technology when combined with TAM constructs (Cordeiro & Olsen, 2021).

3.2. Hypothesis Development

Figure 9 presents the proposed theoretical model for this study. The conceptual framework summarises the 13 hypotheses formulated for this study.

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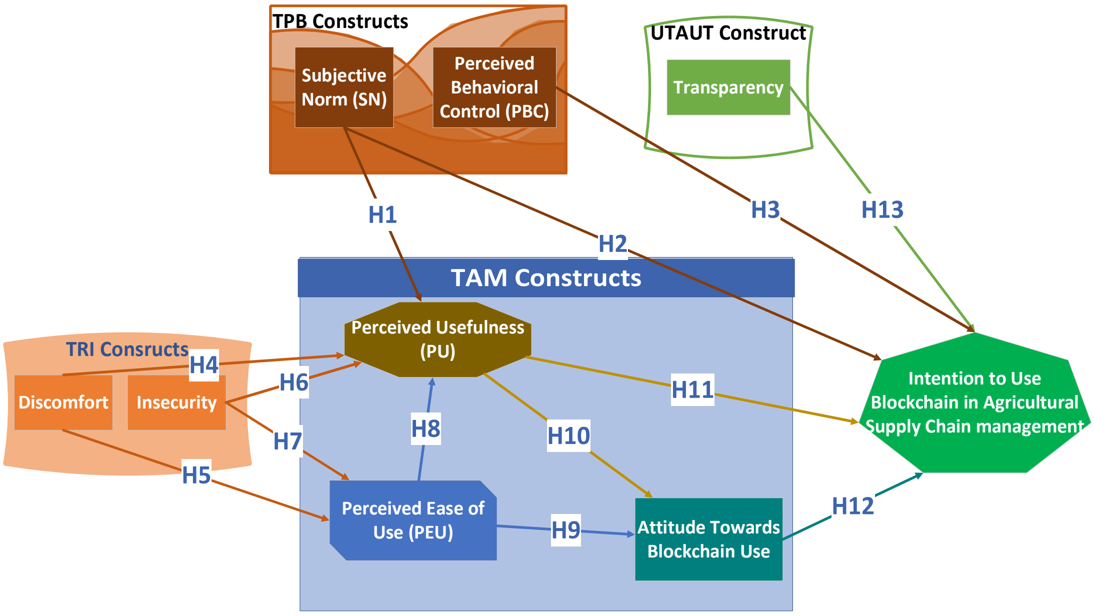

Figure 7: Proposed Theoretical Framework

3.2.1. TPB Constructs

The TPB includes subjective norms and perceived behavioural control. Subjective norms include a person's perception that people important to them think they should consider when adopting new technology (Wamba & Queiroz, 2020). Subjective norm influences behavioural intention among organisational leaders, while other researchers have observed that subjective norms influence perceived usefulness among managers to use BCT (Duan et al., 2020; Kamble et al., 2020). Further research was undertaken to improve the TRA to form TPB by adding perceived behaviour control which measures users' behavioural intentions (Ajzen & Madden, 1986; Ajzen, 1991). Perceived behavioural control is an individual perception about personal abilities to perform a specific activity (Kamble et al., 2020). Limited research has determined the impact of subjective norms and observed behaviour on perceived usefulness of BCT in the agricultural industry. Past research was largely a theoretical investigation (Rocha) focusing on supply chain in agriculture (Kamble et al., 2020; Rocha et al., 2021). Because of the perishable nature of farm products, the agriculture supply chain differs from other supply chains, demanding the need for effective and efficient logistics to fulfil consumer expectations.

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The current study differs from past research as it will empirically examine how subjective norms and perceived behavioural intentions influence BCT uptake of agricultural supply chains. To address this gap in the literature, it may be postulated that:

H_1: *Subjective norms positively affect the perceived usefulness of BCT*

H_2: *Subjective norms positively affect behavioural intentions to use BCT*

H_3: *Perceived behaviour control positively affects behavioural intentions to use BCT*

3.2.2. TRI Constructs

TRI constructs include discomfort and insecurity. Users who have high discomfort levels towards a new technology find it less easy to use (Ali et al., 2021). The current study differs from previous research by undertaking an empirical assessment to determine the effect of discomfort on perceived usefulness and perceived ease of use when adopting BCT in agricultural supply chains. Discomfort has been found to negatively influence the perceived usefulness of BCT as it inhibits its use as a new technology among agricultural supply chain managers (Longo et al., 2019; Kouhizadeh et al., 2021). These studies did not empirically evaluate how discomfort influences individual anxiety and fear with the new technology. Therefore, the motivation to undertake this study derives from the need to investigate how discomfort impacts perceived ease of use of BCT. Considering these observations, it may be postulated that:

H_4: *Discomfort while using Blockchain negatively affects the PU of BCT*

H_5: *Discomfort while using Blockchain negatively affects the PEU of BCT*

By contrast, insecurity may contribute to the low utilisation of BCT in agricultural sectors in addition to ambiguity (Kouhizadeh et al., 2021). Insecurity inhibits individual uptake of BCT in agricultural supply chains (Jabbar et al., 2020). Insecure managers are less likely to embrace BCT uptake as they express less support on whether its use will be beneficial in facilitating efficient supply chains (Jabbar et al., 2020). Insecurity may contribute to low

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perceived usefulness and perceived ease of use potentially hindering its uptake within organizations (Duan et al., 2020; Fosso Wamba et al., 2020; Hu et al., 2021). These studies differ from the current research since they were based on theoretical evaluation of insecurity and its impact on BCT uptake, mediated by perceived ease of use and perceived usefulness. The studies did not empirically examine the impact of insecurity on BCT adoption in Australian supply chains, thereby the need for this study. In light of these considerations, it may be postulated that:

H_6: *Insecurity negatively affects the perceived usefulness of BCT*

H_7: *Insecurity negatively affects the perceived ease of use of BCT*

3.2.3. TAM

The TAM model includes perceived usefulness, perceived ease of use, and attitude towards use. A growing body of research has shown that PEU substantially impacts managers' usage intention when considering BCT technology in agricultural supply chains (Collart & Canales, 2021; Dietrich et al., 2021). PEU denotes the degree to which managers in agricultural organisations believe that using BCT would improve their supply chain management and transparency (Chod et al., 2020). The studies did not empirically determine whether PEU is an important determinant that influences managers' attitudes towards BCT uptake and implementation in agricultural supply chains. The focus of this study is to fill this knowledge gap. It may be postulated that:

H_8: *Perceived ease of use positively affects the perceived usefulness of BCT*

H_9: *Perceived ease of use positively affects attitudes towards using the BCT*

Perceived usefulness refers to the degree to which managers in agricultural organisations believe that using BCT would improve their logistics and supply chain process performance (Bischoff & Seuring, 2021). For example, corporations that find BCT reliable in ensuring effective supply and delivery of halal food are likely to associate it with high usefulness (Ali et al., 2021). Recent studies show that perceived usefulness influences managers' attitudes towards using BCT in supply chains (Kamble et al., 2020; Wu et al., 2021). Despite these findings, these studies used a small sample size, and their findings may not be generalised to the Australian supply chains. There is need for further research to determine whether perceived usefulness is likely to influence the managers' behavioural intention to use BCT technology in the Australian agricultural supply chains. It may be concluded that:

H_{10}: *Perceived usefulness positively affects attitudes towards using the BCT*

H_{11}: *Perceived usefulness positively affects the behavioural intention to use BCT*

Attitude largely captures an emotional aspect of managers' intention to use BCT in their organisations when seeking to improve their supply chain management (Wamba & Queiroz, 2020; Yadav et al., 2021). In addition, researchers report that attitude largely captures the emotional aspect of users' intention to use new technology. Attitude defines the level to which users show a favourable or unfavourable assessment of technology (Kouhizadeh et al, 2021). In the Australian agricultural supply chains, there is a paucity of research on whether attitudes towards BCT would influence managers' intention to adopt and use it in their supply chains. This study intends to answer this knowledge gap. It may be hypothesized that:

H_{12}: *Attitude positively affects behavioural intention to use BCT*

Transparency refers to the extent to which information is readily accessible to both entities in a supply chain and external observers (Tipmontian et al., 2020). In the agricultural supply chain, transparency denotes the information accessible to companies and customers along with the logistics and distribution network (Saurabh & Dey, 2021). Studies show that supply chain traceability influences transparency in terms of raw material origin, processing, and end product delivery (Chod et al., 2020; Wamba & Queiroz, 2020; Yadav et al., 2020). Insights from past literature show mixed findings regarding the impact of BCT on the improvement of supply chain transparency. There is a need for further research to determine whether supply chain managers who find that BCT enhances transparency across the supply chain are likely to show a high intention of use in their organisations. It may be postulated that:

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H13: *Blockchain transparency positively affects behavioural intentions to use BCT*

3.2.4. UTAUT Construct

Transparency refers to the extent to which information is readily accessible to both entities in a supply chain and external observers (Tipmontian et al., 2020). In the agricultural supply chain, transparency denotes the information accessible to companies and customers along with the logistics and distribution network (Saurabh & Dey, 2021). Studies did not investigate and identify whether supply chain traceability influences transparency in terms of raw material origin, processing, and end product delivery within agricultural supply chains (Chod et al., 2020; Wamba & Queiroz, 2020; Yadav et al., 2020). The current study seeks to address this knowledge gap by assessing whether BCT improves supply chain transparency and creates immutable records of all transactions, making them easily traceable. Supply chain managers who find that BCT enhances transparency across the supply chain are likely to show a high intention to use in their organisations. It may be postulated that:

H13: *Blockchain transparency positively affects behavioural intentions to use BCT*

3.3. Discomfort and Blockchain Adoption

BCT adoption may be impacted by inhibitors, key among them being discomfort (Godoe, 2012; Parasuraman, 2000). Inhibitors potentially affect the technology readiness of managers in organisations. Discomfort is defined as a perceived lack of control over technology and a feeling of being overwhelmed by innovations (Parasuraman, 2000). Based on perceived behavioural control, it may be anticipated that the relationship between discomfort and BCT would be negative. The TPB suggests that perceived behavioural control is a direct determinant of both actual behaviour and behavioural intention (Ajzen & Fishbein, 2005). Studies have also reported that users' control beliefs positively influence their adoption of technology (Duan et al., 2020; Kamble et al., 2020). These findings show that discomfort (a users' general feeling of lack of control) should have a negative effect on BCT uptake. The current study differs from

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past studies by presenting empirical research on how discomfort affects BCT uptake. The study fills the paucity of knowledge where limited research has examined the impact of discomfort on BCT use in the agricultural industry.

3.4. Insecurity and Blockchain Adoption

Insecurity denotes an individual's level of distrust in a new technology. Distrust may stem from scepticism regarding its capacity to work properly or personal concerns about possible harmful consequences (Parasuraman, 1999; Parasuraman, 2000). Insecurity combines with general safety issues, worries about negative consequences, and desire for assurance (Wamba & Queiroz, 2020; Wu et al., 2021). In organisations, if managers are naturally distrustful of, and sceptical about, technology they are likely to expect risks instead of technology benefits (Kamble et al., 2020). As a result, individuals are likely to avoid its uptake. In line with the TPB, one would expect a negative relationship between the insecurity trait and technology usage. Past studies have not examined how insecurity might influence individual behaviour towards BCT adoption, thereby the need for this study. Results of this study will create new knowledge regarding insecurity as a potential technology readiness inhibitor hindering usage intention and usage behaviour of BCT in agricultural supply chains.

3.5. Transparency and Blockchain Adoption

Transparency relates to the provision and access of clear, accurate, and timely information about technology. Lack of transparency would negatively impact BCT adoption. Transparent technology is likely to accelerate acceptance and its subsequent uptake among individuals (Morgan et al., 2018). If users think Blockchain enabled-supply chain processes are transparent they are more likely to adopt it in their business operations (Van Donk et al., 2010). Access to relevant insights from stakeholders regarding how blockchain enabled applications work also increases transparency which positively affects behavioural intentions to adopt technology (Morgan et al., 2018). Past studies have not examined transparency and its

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effect on individual behaviour to use BCT in agricultural supply chains. This study serves to fill this knowledge gap to understand how blockchain transparency affects behavioural intentions to use BCT in agricultural supply chains.

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4. Methods

The aim of the study was to identify the factors considered to influence blockchain adoption in the agricultural supply chain in Australia. Quantitative research was used to examine this issue. Survey questionnaires were used to collect data from employees and managers from different agricultural sectors across Australia. The current section details the participants, instrument development, and data collection.

4.1. Participants

Quantitative data was collected through an online survey of 385 professionals drawn from the Australian agricultural industry using online surveys. The choice of the 385 participants was intended to collect data from a representative sample of agricultural supply chain stakeholders in Australia. The criteria for selection is that they must be employees or managers of firms that operate in the Australian agriculture sector. The other criteria for selection is that their respective firms must have deployed BCT in their supply chains. The selected stakeholders also need to have experience in how BCT operates in their supply chains. Purposive sampling, a nonprobability sampling technique, was used to recruit participants to the study. The focus on purposive sampling was informed by the need to recruit a sample with expertise and relevant information on blockchain adoption in agricultural supply chains (Creswell, 2017). There are multiple entities in the Australian supply chain including vendors, producers, warehouses, transportation companies, retailers, and distribution centres (Boult & Chancellor, 2019).

4.1.1. Participant Recruitment

The population of research interest for this study was limited to stakeholders within the Australian agricultural industry. Agriculture remains a vital economic sector employing over 385,000 people including 136,000 farmers, who provide 93% of the domestic food supply (Boult & Chancellor, 2019). Since it is difficult to survey all stakeholders in the agricultural

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sector, a suitable representative sample was identified using G*Power analysis. Assuming a population size of 385,000, at a 95% confidence level, and with a margin of error of 5% a suitable representative sample for the study was 385 participants.

To recruit participants, the data collection process was outsourced to Zoho, a web-based survey tool to conduct survey research, evaluations, and other data collection initiatives (https://www.zoho.com/survey/). An online advertisement was posted on Facebook targeting stakeholders across various agricultural sectors in Australia. The advertisement contained details of the study including the aim and objectives of the study, as well as a consent form from the university to conduct the study. Alongside the advertisement, detailed information about the study was included, together with a formal request to invite participants to participate in the study. Participants who expressed interest in participating in the study accessed a provided URL link where the online survey was hosted. The first page of the online survey contained the consent information with an option to click on "Continue" or "Exit" the study. Participants who clicked on "Continue", filled, and submitted their survey responses were considered to have consented to voluntary participation in the study. Completed surveys were returned anonymously to conceal the identity of the participants. Upon completing and submitting their survey, a prompt appeared on their computer screen respectively thanking the participants for participating in the study.

4.1.2. Participant Demographics

Table 10 presents the demographic characteristics of the participants who participated in the study. After cleaning the data and removing 27 incomplete surveys, a total of 358 participants remained for further analysis. Out of the remaining complete surveys, 69.3% were male and 30.7% were female. Most participants (39.1%) were aged 26-35 years, followed by 33.8% of the participants who fell within the 36-45 age bracket, and 17.3% in the 20-25 age bracket. In

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terms of work experience, 29.3% had worked for between 4-7 years, 29.3% between 8-12 years, 20.7% between 1-3 years, and 5.9% for more than 13-17 years.

Table 6: Participants' Demographic Characteristics by Age, Gender, and Work Experience

	N = 358	Frequency (%)	Mean	SD	p-value
Gender					
Male	248	69.3	33.61	9.48	.127
Female	110	30.7			
Age					
≤19	7	2.0			
20-25	62	17.3	32.09	9.85	.078
26-35	140	39.1			
36-45	121	33.8			
≥46	28	7.8			
Work Experience					
1-3	74	20.7			
4-7	105	29.3	38.96	9.63	.092
8-12	105	29.3			
13-17	21	5.9			

In line with Table 11, there was no statistically significant mean group difference by gender (M = 33.61, SD = 9.48, p = 0.127), age (M= 32.09, SD = 9.85, p = 0.078), or by work experience (M= 38.96, SD = 9.63; p = 0.092). Table 11 summarizes participants' demographic characteristics by country of primary business operations and level of education. Results indicated that 95.3% of the participants primarily based their operations in Australia, compared to 3.1% who based their operations in the United States (US), 1.1% in the United Kingdom (UK) and 0.6% in China. In terms of the level of education, 46.1% had a college degree, 23.7% had completed study at college, 12.8% had an associate degree, 7.0% had a doctorate, and 3.6% had completed some postgraduate studies.

Table 7: Participants' Demographic Characteristics by Age, Gender, and Work Experience

	N = 358	Frequency (%)	Mean	SD	p-value
Country of Business Operation					
Australia	341	95.3	32.21	11.62	.412
China	2	.6			
UK	4	1.1			

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US	11	3.1			
Level of Education					
College Degree	165	46.1	34.11	8.27	.212
Completed some college	85	23.7			
Associates Degree	25	7.0			
Doctorate Degree	46	12.8			
Completed postgraduate	13	3.6			

Figure 10 shows participants' demographic characteristics by marital status. Results show 62.8% of the participants were married, 32.1% were single, 2.5% were divorced, and 1.1% were widowed. The remaining 1.2% were partnered, were in active relationships, or de facto relationships.

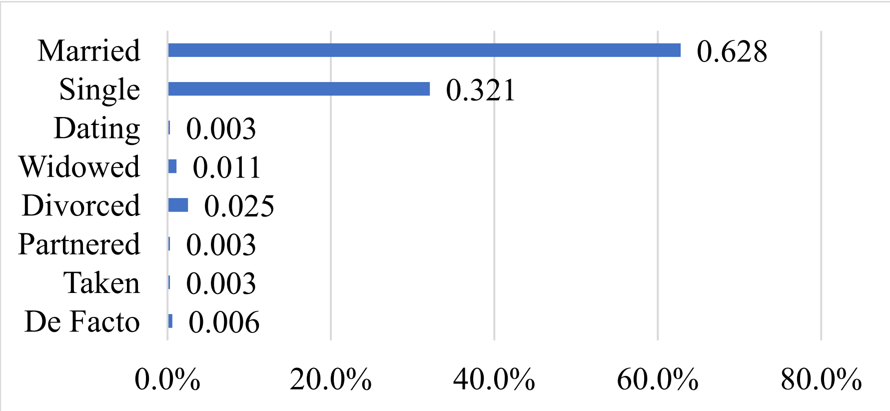

Figure 8: Participant Demographic Characteristics by Marital Status

Figure 11 shows the demographic characteristics of the participants by their state. Most of the participants (49.4) were from New South Wales, followed by 21.2% from Victoria, 12.6% from Queensland, and 9.2% from Western Australia. A further, 3.9% of the participants were from South Australia, 3.4% from the Australian Capital Territory, and 0.3% from Tasmania. These demographics show that participants were drawn from a nationally representative sample covering most regions with agricultural activities across Australia. Survey insights drawn from the selected sample would potentially help understand the critical factors influencing BCT adoption in agricultural supply chains.

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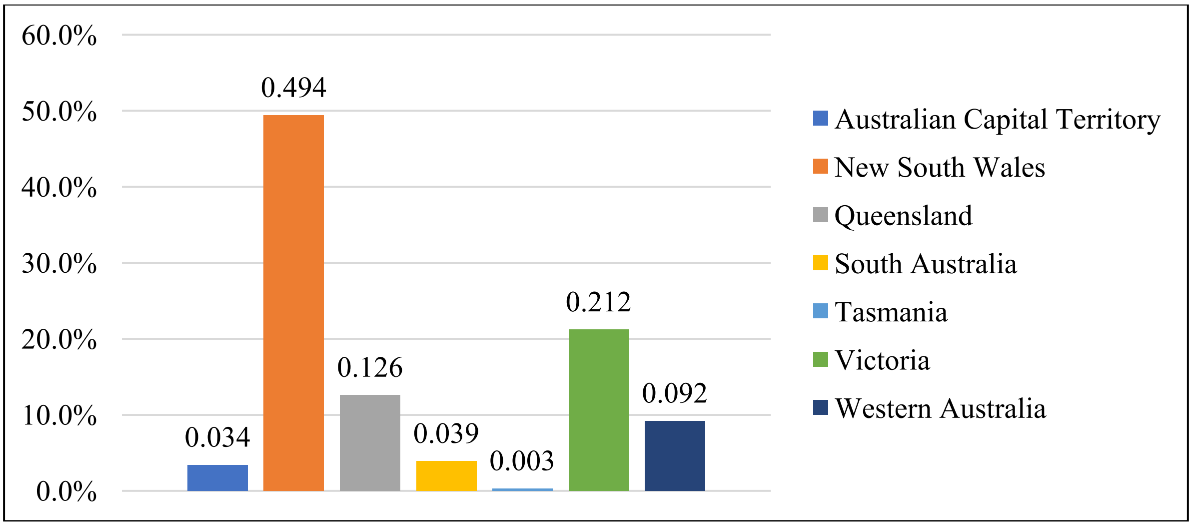

Figure 9: Participants' Demographics by Australian State

Table 12 further shows the nature of diversity among the participants who participated in this study. Survey responses showed that 17.9% of the participants were chief executive officers, followed by 11.7% who were managers, and another 11.7% who were retailers. A further 5.0% of the participants worked in supply chain IT, followed by 4.7% who worked as warehouse directors, professionals, logistic managers, or executives. Manufacturers, supply chain managers, and or executive professionals accounted for 3.6% of the participants, 2.0% accounted for chief financial officers, and 2.8% were office coordinators and procurement service providers. The remaining 30% of the participants (not shown in Table 12) included buyers, chief commodity officers, manufacturers, call centres, crypto traders, customer service officers, drivers, maintenance workers, planning or scheduling officers, project engineers, sales managers, and students in agricultural supply chains. Based on the participants' demographic characteristics, the sample recruited into this study possessed diverse knowledge to help understand the formulated study problem. The diverse nature of participants who participated in the study further indicates the representative nature of the participants who were drawn to participate in the study.

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Table 8: Participants' Demographic Characteristics by Role in their Organization

	n = 358	Frequency (%)	Mean	SD	p-value
Role in Organization					
Chief Executive Officer	64	17.9			
Management	42	11.7			
Retailers	42	11.7			
Supply chain IT	18	5.0			
Warehouse Director /Executive/ Professionals	17	4.7	38.43	9.32	.082
Logistics Manger/ Executive /Professionals	17	4.7			
Chief Financial officer	7	2.0			
Manufacturers	13	3.6			
Supply chain Manager /Executive /Professionals	11	3.1			
Office Coordinator	10	2.8			
Procurement Solutions	10	2.8			

4.2. Instrument Development

The constructs that were used to collect data from participants were developed from previous literature. Table 13 presents details of the data measurement items used to collect data from the participants from different agricultural sectors across Australia. The items and scales for TAM, UTAUT, TPB, and TRI were identified from past studies with responses measured on a 5-point Likert scale, based on an interval ranging from 1 = "Strongly Disagree" to 5 = "Strongly Agree".

Table 9: Data Measurement Constructs Used to Collect Data from the Participants from Different Agricultural Sectors from Across Australia

No.	Construct	Measurement items	Adapted from
1	Discomfort	DISC1: It will be difficult to understand and apply the concept of BCT in SCM. DISC2: At times, BCT is thought to be designed for complex supply chain usage only. DISC3: I feel that a service provider or an integrator who is more knowledgeable than we are may take advantage of our SCM.	Godoe, 2012; Parasuraman, 2000

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		DISC4: Technology seems to fail at the worst possible time.	
2	Insecurity	INSC1: I do not consider it to be safe in our firm to adopt BCT INSC2: I worry that other people will get the information sent over the BCT. INSC3: I do not feel confident doing business on a portal that can only be reached online. INSC4: Any business transaction done electronically should be confirmed later with writing or manually. INSC5: Whenever something gets automated, you need to check to ensure the system is not making any errors. INSC6: When you call a business, you prefer talking to a person rather than a machine.	(A. Parasuraman, 1999; Ananthanarayanan Parasuraman, 2000)
3	Perceived usefulness	PU1: Using BCT will help minimize transaction delays. PU2: Using BCT would improve SCM performance. PU3: Using BCT would improve SCM productivity. PU4: Using BCT would improve SCM effectiveness.	(Davis, Bagozzi, & Warshaw, 1989; Godoe, 2012)
4	Perceived ease of use	PEU1: The features of BCT will be easy to use PUE2: BCT is clear and understandable. PEU3: It will be easy to remember and perform tasks using BCT. PEU4: BCT will be much easier to use compared to the conventional practices of managing SCM.	(Aboelmaged & Gebba, 2013; Davis et al., 1989; Godoe, 2012)
5	Attitude	ATTI1: In my opinion, it is desirable to use BCT in SCM. ATTI2: It will be good for SCM to use BCT. ATTI3: I guess using BCT is a good idea. ATTI4: Overall, I am favorable towards BCT. ATTI5: I will be happy if my company implements BCT.	(Aboelmaged & Gebba, 2013; Davis et al., 1989; Taylor & Todd, 1995)
6	Subjective Norms	SN1: Most of my colleagues and SCM partners expect my firm to use BCT. SN2: Most of my colleagues and SCM partners believe using BCT is a wise decision. SN3: People whose opinion I value prefer my firm to use BCT. SN4: The fact that my competitors are exploring the use of BCT puts pressure on my firm to use BCT.	(Taylor & Todd, 1995; Wu & Chen, 2005)
7	Perceived behavioral control	BC1: Our firm would be able to use BCT well. BC2: Using BT is entirely within our firm's control. BC3: Our firm has the resources, knowledge, and ability to use BCT.	(Aboelmaged & Gebba, 2013; Ho & Ko, 2008; Wu & Chen, 2005)
8	Behavioral intention	BI1: I foresee that our firm will use BCT regularly in the future. BI2: Our firm will use BCT in future. BI3: I expect my firm to use BCT or a similar type of system for SCM transactions.	(Ho & Ko, 2008; Hsu Meng, Chiu Chao, & Ju Teresa, 2004; Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh & Zhang, 2010)

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9	Transparency	Trans 1 - I believe Blockchain enabled-supply chain processes would be transparent Trans2 - I believe supply chain stakeholders will provide me with deep access to how Blockchain enabled-supply chain applications work Trans3- I believe supply chain stakeholders will provide me with in-depth knowledge about applications of Blockchain in the supply chain Trans4- I believe I will have opportunities to provide feedback on Blockchain enabled-supply chain applications	(Morgan, Richey Jr, & Ellinger, 2018; van Donk, van der Vaart, Awaysheh, & Klassen, 2010)

4.3. Data Collection

The first stage of data collection consisted of an initial pilot test conducted with 10 professionals from across the agricultural supply chain to evaluate the reliability of the measurement items. The experts who participated in the pilot study were recruited based on pre-established contacts. The pilot participants included 3 Blockchain experts in the IT industry, 2 agriculture supply chain and logistics experts, and 3 university professors who are also experts in Blockchain and supply chain management. All measurement items during the pilot study had Cronbach's alpha (α) values more than 0.70 which is the recommended level for high internal consistency (Creswell, 2017).

The second stage of data collection consisted of a survey. The first section of the survey included informed consent with an option to "Exit" or "Continue". Participants who clicked "Continue" were considered to have voluntarily consented to participate in the study. The email also detailed the purpose and objectives of the study. The emails were sent between 1st March 2021 and 30th April 2021. Two follow-up reminders were performed on 20th March and 11th April 2021. At the end of the eight-week duration, a total of 385 responses were received. In total, 27 surveys were incomplete, partially filled, or not filled and subsequently excluded from the final data analysis, as discussed in section 4.1, only 358 survey responses were used in the final data analysis.

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Normality tests were performed to assess whether the data was drawn from a normally distributed population, based on Kolmogorov-Smirnov and Shapiro-Wilk Normality tests. T-test and analysis of variance (ANOVA) are based on the normally distributed sample population. Failure to meet the assumption of normality may contribute to unreliable and biased outcomes (Hair, 2015; Ghasemi & Zahediasl, 2017). Parametric tests are important to address potential statistical errors in tests such as regression, correlation, ANOVA, and *t*-test (Hair, 2015). Table 14 presents the obtained normality tests based on Kolmogorov-Smirnova and Shapiro-Wilk Normality tests.

In line with the obtained results (Table 14), the p-values for both normality tests have large alpha values than the 0.05 level of significance. The collected data from the Australian agricultural sectors were normally distributed and did not deviate significantly from a normal distribution. The skewness of the collected data by age, gender, and year of work experience ranged between 0.09, -1.39, and -0.47 which align with the cut off values of -1 and +1. As such, the results indicated that the data distribution fell with the normal range, meeting the assumption of parametric tests (Hair, 2015). By contrast, Kurtosis values ranged between -0.24, 0.18, and 0.33 by age, gender, and years of experience, respectively. The Kurtosis values ranged between -0.5 and 0.5, showing that obtained data were symmetrically distributed (Hair, 2015).

Table 10: Kolmogorov-Smirnova and Shapiro-Wilk Normality Tests for participants by Age, Gender, and Years of Experience

Tests of Normality							
		Kolmogorov-Smirnov			Shapiro-Wilk		
	Gender	Statistic	df	Sig.	Statistic	df	Sig.
Age	Male	.225	9	.146	.920	9	.219
	Female	.326	7	.158	.754	7	.154
Gender	Male	.153	9	.230*	.843	9	.202
	Female	.193	7	.211*	.884	7	.141
Years of experience	Male	.168	9	.170*	.898	9	.243
	Female	.223	7	.168*	.943	7	.261

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Mauchly's sphericity test was further used to ensure that repeated measures analysis of variance (ANOVA) during hypotheses tests were validated (Ali et al., 2018). Table 15 presents normality results based on Mauchly's W test. Based on the obtained results, it may be concluded that the alpha significant value by age, gender, years of experience, and type of agricultural organisation was larger than the 0.05 level. These observations imply that the survey data from the 358 respondents did not violate the assumption of Sphericity and was adequate for hypothesis testing through repeated ANOVA.

Table 11: Mauchly's Assumption Test for Sphericity

Mauchly's Test of Sphericity							
Measure: MEASURE_1							
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Age	.733	4.581	2	.121	.792	.864	.500
Gender	.622	6.738	2	.084	.829	.938	.638
Experience (years)	.787	5.744	2	.092	.773	.583	.367
Organisation	.757	4.822	2	.179	.893	.637	.463

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5. Results

The model was tested using a two-step method. Initially, the validity and reliability of the measurement items were examined using convergent, composite, and discriminant validity. Subsequently, the second step examined the structural model using structural equation modelling. Subsequent sections present the obtained results from the survey responses.

5.1. Measurement Model

Validity tests were run on the measurement model before testing the hypotheses. Validity denotes the accuracy of survey items used in the data collection measure variables they are designed to measure. As further discussed below, three validity and reliability tests were performed in this study including convergent validity, composite reliability, and discriminant validity.

5.1.1. Convergent Validity

Convergent validity is the degree to which a scale is related to other measures and variables of the same construct (Ali et al., 2018). The 9 constructs in Table 16 were examined for their convergent validity using three key guidelines: (i) the factor loading should be above 0.50; (ii) composite reliability must be above 0.70; and (iii) the average variance extracted of each construct must be above 0.50 (Fornell et al., 1981; Hair, 2015; Danks et al., 2020). Factor loadings were performed using Smart PLS (Partial least squares). Smart PLS software was used because it has a detailed graphical user interface for variance-based structural equation modelling using the partial least squares path modelling method and is easy to use for beginners as well as experts (Ringle et al., 2015; Ali et al., 2018). Table 16 presents the obtained results for convergent validity using the summed scales.

All factor loadings were found to be above the recommended 0.70 level showing high internal consistency of the used items (Ringle et al., 2015). Further, the composite reliability

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(CR) for all the survey constructs exceeded the 0.60 recommended limit (Ali et al., 2018). Similarly, the average variance extracted (AVE) values were more than the acceptable level of 0.50 (Ali et al., 2018). Finally, the Cronbach's alpha values for all constructs were greater than the recommended value of 0.70 indicating an acceptable levels of scale reliability and internal consistency (Creswell, 2017). All the factors were used in subsequent data analysis.

Table 12: Factor Loadings and Reliability Assessments for the Summed Scales

No.	Variables	Cronbach's Alpha	Rho A (λ)	Composite Reliability	Average Variance Extracted (AVE)
1	Attitude Towards Blockchain Use	0.803	0.804	0.802	0.549
2	Discomfort	0.717	0.786	0.783	0.551
3	Insecurity	0.763	0.792	0.774	0.537
4	Intention to Use Blockchain	0.755	0.754	0.753	0.505
5	Perceived Behavioral Control (PBC)	0.720	0.724	0.719	0.562
6	Perceived Ease of Use (PEU)	0.789	0.792	0.789	0.684
7	Perceived Usefulness (PU)	0.732	0.741	0.732	0.609
8	Subjective Norm (SN)	0.770	0.777	0.772	0.561
9	Transparency	0.702	0.717	0.709	0.581

5.1.2. Discriminant Validity

Discriminant validity was used to assess the extent to which the constructs in the model were distant from each other (Fornell et al., 1981; Hair, 2015). The aim is achieved using the square roots of the AVE's and comparing them with the correlation for every construct. In the model, discriminant validity is confirmed when the square root AVE of the examined constructs are higher than the correlation between a specific construct and other constructs in the tested model (Fornell et al., 1981; Danks et al., 2020). Table 17 shows the obtained results for discriminant validity. The off-diagonal items show correlations between constructs, while the diagonal items show the square root of AVE, which is higher compared to correlations of the constructs. These observations show that the constructs satisfied discriminant validity and may be used to test the structural model.

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Table 13: Discriminant Validity and Tests of Differences between Correlations

	DISC	INSC	PU	PEU	ATTI	SN	BC	BI	Trans
DISC	0.670								
INSC	0.223	0.593							
PU	0.175	0.816	0.609						
PEU	0.892	0.280	0.217	0.710					
ATTI	0.814	0.375	0.351	0.748	0.679				
SN	0.834	0.160	0.356	0.780	0.724	0.696			
BC	0.875	0.213	0.225	0.797	0.574	0.759	0.639		
BI	0.854	0.278	0.360	0.763	0.815	0.888	0.692	0.679	
Trans	0.941	0.260	0.249	0.816	0.865	0.796	0.756	0.955	0.617

Note: DISC = Discomfort; INSC= Insecurity; PU = Perceived Usefulness; PEU = Perceived ease of use; ATTI= Attitude; SN = Subjective norms; BC= Perceived behavioural control; BI = Behavioural intention; Trans = Transparency

5.2. Results of SEM

Figure 12 presents the research model in the form of a PLS-SEM path model showing the interrelationship among variables indicating path coefficients, p-values, and t-values. As discussed in Section 5.11, PLS was used because it allows researchers to analyse the relationships simultaneously. PLS-SEM analysis provides fewer contradictory results than regression analysis in terms of detecting mediation effects (Ramli et al., 2018). The structural model has 9 unobserved latent factors and 37 observed variables. The 37 variables were indicators of their respective underlying latent constructs (i.e., DISC, INSC, PU, PEU, ATTI, SN, BC, BI, and Trans). The SEM analysis was conducted using Smart-PLS version 3.3.3 to test the 13 hypotheses as shown in Figure 12.

Results indicated that a subjective norm influences perceived usefulness but does not influence the intention to use BCT in agricultural supply chain management. Discomfort influences both PU and PEU, while insecurity also influences PU and PEU. Perceived ease of use influences attitudes to use BCT and PU. By contrast, attitude is influenced by PEU and PU, which in turn informs the intention to use BCT in agricultural supply chains. Transparency also influences the intention to use BCT in the agricultural supply chain. Of the tested 13 relationships, 12 were statistically significant ($p < 0.05$), with the independent constructs explaining 72.1% of the variation ($R^2 = 0.721$), with a strong correlation ($r = .832$).

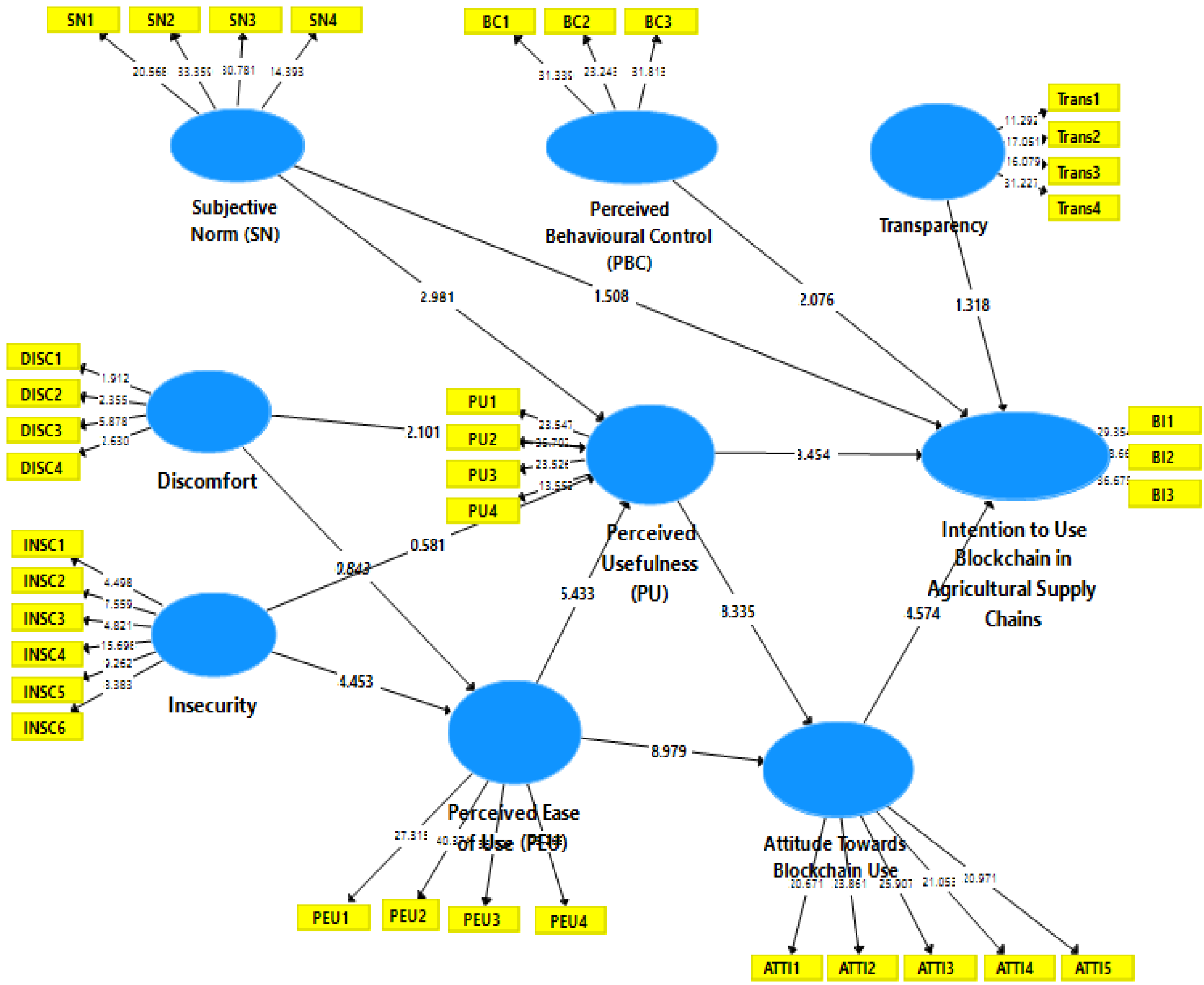

Figure 10: PLS-SEM Path Model showing Interrelationship among Variables Indicating Path Coefficients, P-values, and T-values.

Table 18 shows results from the hypotheses testing. In summary, the obtained results suggest that blockchain technologies positively affect people's intention to use Blockchain in the agricultural supply chain. Subjective norm ($p = 0.037$) and discomfort ($p = 0.404$) does not influence the intention to use blockchain in the agricultural supply chain. In line with Hypothesis 1, results show that subjective norm ($\beta = 3.030$, t (356) = 4.4, p = 0.003) significantly influences perceived usefulness of BCT. Since the p-value is less than the alpha

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significance level of 0.05, the results lead to the rejection of the null hypothesis. As such, it may be concluded that:

H_{A1}: *Subjective norms positively affects the perceived usefulness of BCT*

Table 14: Hypothesis test results

Hypotheses		**Mean (M)**	**Standard Deviation (SD)**	**β-coefficients**	**t-stat**	***p* Values**
H1	Subjective Norm -> Perceived Usefulness	0.221	0.071	3.030	4.400	0.003
H2	Subjective Norm -> Intention to Use Blockchain	0.106	0.067	-0.489	3.030	0.057
H3	Perceived behavioral control -> Intention to Use	0.142	0.067	2.081	1.276	0.038
H4	Discomfort -> Perceived Usefulness	0.147	0.059	-2.341	0.891	0.020
H5	Discomfort -> Perceived Ease of Use	0.082	0.073	-0.891	2.341	0.404
H6	Insecurity -> Perceived Usefulness	0.053	0.081	-0.544	4.405	0.027
H7	Insecurity -> Perceived Ease of Use	0.309	0.068	-3.405	0.544	0.000
H8	Perceived Ease of Use -> Perceived Usefulness	0.384	0.072	5.503	3.091	0.000
H9	Perceived Ease of Use -> Attitude towards use	0.670	0.029	23.091	5.503	0.000
H10	Perceived usefulness -> attitudes using the BCT	0.242	0.086	2.054	3.435	0.002
H11	Perceived Usefulness -> Intention to Use Blockchain	0.220	0.062	3.435	2.081	0.001
H12	Attitude towards use -> Intention to Use Blockchain	0.316	0.074	4.400	1.489	0.000
H13	Transparency -> Intention to Use Blockchain	0.096	0.078	1.276	4.400	0.002

In line with Hypothesis 2, results show that subjective norm (β= -0.489, t (356) = 3.030, p = 0.057) does not positively influence perceived usefulness of BCT. Since the p-value is larger than the alpha significance level of 0.05, the results confirm the null hypothesis. As such, it may be concluded that:

H_{02}: *Subjective norm negatively affects behavioural intentions to use BCT.*

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Hypothesis 3 was formulated to examine whether perceived behavioural control affects intention to use BCT in agricultural supply chain management. Results indicated that discomfort (β= 2.081, *t* (356) = 0. 1.276, *p* = 0.038) influences intention to use BCT. Since the p-value is less than the Alpha significance level of 0.05, the null hypothesis is rejected. It may be concluded that:

H_3: *Perceived behaviour control positively affects behavioural intentions to use BCT*

Hypothesis 4 is set to examine whether discomfort while using Blockchain negatively affects the perceived usefulness of BCT. Results show that discomfort (β= -2.341, *t* (356) = 0.891, *p* = 0.020) negatively influences people's perceived usefulness of BCT. Since the p-value is less than the Alpha significance level of 0.05, the null hypothesis is rejected. It may be concluded that:

H_{A4}: *Discomfort while using Blockchain negatively affects the perceived usefulness of BCT*

Hypothesis 5 was formulated to assess whether discomfort while using Blockchain negatively affects the perceived ease of use of BCT. Results show that discomfort (β= -0.891, *t* (356) = 2.341, *p* = 0.404) does not significantly influence people's perceived ease of use of BCT. The β coefficient is negative (-0.891) showing the negative impact discomfort causes in informing low ease of use of BCT, but this negative impact does not have any significant impact ($p > 0.05$, $p = 0.404$), thereby confirming the null hypothesis is confirmed. Based on these test results, it may be concluded that:

H_{05}: *Discomfort while using Blockchain does not negatively affect the perceived ease of use of BCT*

Hypothesis 6 was postulated to examine whether insecurity negatively affects the perceived usefulness of BCT. Results show that insecurity (β= -0.544, *t* (356) = 4.405, *p* =

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0.027) significantly influences perceived usefulness of BCT. The beta coefficient is negative and since the p-value is less than 0.05, the null hypothesis is rejected; implying that:

H_{A6}: *Insecurity negatively affects the perceived usefulness of BCT*

Hypothesis 7 was postulated to examine whether insecurity negatively affects the perceived ease of use of BCT. Results show that insecurity (β= -3.405, t (356) = 0.544, p = 0.000) significantly affects the perceived ease of use of BCT. Since the p-value is less than 0.05, the null hypothesis is rejected. As such, it may be concluded that:

H_{A7}: *Insecurity negatively affects the perceived ease of use of BCT*

Hypothesis 8 was created to examine whether perceived ease of use positively affects attitudes towards using BCT. Results show that perceived usefulness (β= 5.503, t (356) = 3.091, p = 0.000) significantly influences perceived usefulness. Since the p-value is less than 0.05, the null hypothesis is rejected. It may be concluded that:

H_{A8}: *Perceived ease of use positively affects perceived usefulness of BCT*

Hypothesis 9 was created to understand whether perceived ease of use positively affects behavioural intention to use BCT. Results show that intention to use Blockchain in the agricultural supply chain (β= 23.091, t (356) = 5.503, p = 0.000) positively influences Blockchain use. Since the p-value is less than 0.05, the null hypothesis is rejected. It may be concluded that:

H_{A9}: *Perceived ease of use positively affects attitudes towards using BCT*

Hypothesis 10 was created to test whether PU positively affects attitudes towards using the BCT. Results show that perceived usefulness (β= 2.054, t (356) = 3.435, p = 0.002) positively influences attitudes towards using the BCT. Since the p-value is less than 0.05, the null hypothesis is rejected. It may be concluded that:

H_{10}: *Perceived usefulness positively affects attitudes towards using the BCT*

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Hypothesis 11 was created to test whether PU positively affects behavioural intention to use BCT. Results show that perceived usefulness (β= 3.435, t (356) = 1.489, p = 0.000) positively influences behavioural intention to use BCT. Since the p-value is less than 0.05, the null hypothesis is rejected. It may be concluded that:

H_{11}: *Perceived usefulness positively affects behavioural intention to use BCT*

Hypothesis 12 was created to examine whether attitude positively affects behavioural intention to use BCT. Results show that attitude (β= 4.400, t (356) = 2.081, p = 0.001) positively influences behavioural intention to use BCT. Since the p-value is less than 0.05, the null hypothesis is rejected. It may be concluded that:

H_{12}: *Attitude positively affects behavioural intention to use BCT*

Hypothesis 13 was postulated to examine whether transparency positively affects behavioural intention to use BCT. Results show that transparency (β= 1.276, t (356) = 4.400, p = 0.002) positively influences behavioural intention to use BCT. Since the p-value is less than 0.05, the null hypothesis is rejected. It may be concluded that:

H13: *Blockchain transparency positively affects behavioural intentions to use BCT*

5.3. Variance, Predictive Relevance, and Effect size

Table 19 shows that 67% of the variation in individual intention to use BCT in agricultural supply chains is explained by the constructs of perceived usefulness, perceived ease of use, transparency, attitude towards use, discomfort, and insecurity. Results show that 73% of the perceived usefulness of BCT is explained by the constructs of insecurity, discomfort, and PEU. Further, 77.7% of the PEU is explained by the constructs of insecurity and discomfort. Transparency explains 61.8% of the intention to use BCT in agricultural supply chain management, while individual attitudes towards use explains 42.7% of BCT adoption in supply chains. Discomfort and insecurity may explain 36.3% and 38.9% of the variation in PU and PEU during BCT adoption in supply chain management, respectively.

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In line with the literature, the predictive power of a model is explained by the R^2 values. R^2 values of 0.25, 0.50, or 0.75 are described as weak, moderate, and substantial, respectively (Davies, 2020). The obtained results (Table 19) show that the constructs had a moderate to substantial impact on BCT adoption in agricultural supply chains. That is, the R^2 values ranged from 0.363 to 0.777. Based on these assumptions, it may be concluded that the constructs PU and PEU substantially explain BCT adoption, while the constructs of transparency, attitude, discomfort, and insecurity moderately explain the variation in people's intention to use BCT in agricultural supply chain management. All the five constructs in Table 19 have large effect sizes (Cohen's d) above the recommended 0.80 level. Cohen (1988) suggested that $d = 0.2$ is considered a small effect size, 0.5 is a 'medium' effect size, while 0.8 is a large effect size.

Table 15: Variance, Predictive Size, and Effect Sizes

	R Square	**R Square Adjusted**	**Effect Size (*d*)**
Perceived usefulness	0.730	0.613	.83
Perceived Ease of Use	0.777	0.574	.83
Transparency	0.618	0.400	.84
Attitude towards use	0.427	0.458	.82
Discomfort	0.363	0.583	.82
Insecurity	0.389	0.473	.81

Cross-validated redundancy measures of Q^2 were used to evaluate the predictive power of the constructs' impact on Australian companies' intention to use Blockchain in agricultural supply chain management. Table 20 shows the obtained results with Q^2 values greater than 0.35 for all the variables except for the subjective norm. Since the productive power is more than 0.35 (Ali et al., 2018), it may be noted that except for subjective norm and discomfort, all other constructs show high predictive relevance in understanding how the new technology impacts Australian companies' intentions to adopt blockchain in their agricultural supply chain management.

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Table 16: Evaluating the Predictive Power of the Survey Constructs' Impact Australian Companies' Intention to use BCT in their Agricultural Supply Chain Management

	SSO	**SSE**	**Q^2 (=1-SSE/SSO)**
Subjective Norm	1694.00	845.73	.291
Perceived behavioral control	2388.00	2378.08	.412
Insecurity	1753.00	1422.57	.491
Perceived Ease of Use	741.00	736.03	.432
Perceived usefulness	2231.00	1841.01	.422
Attitude towards use	744.00	743.04	.377
Transparency	934.00	956.06	.521
Discomfort	1243.00	742.03	.314

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6. Discussion

The aim of the study is to identify the factors considered to be determinants of blockchain adoption in the agricultural supply chain. Obtained results show that perceived behavioural control, insecurity, perceived ease of use, perceived usefulness, attitude towards use, and transparency are related to blockchain technology adoption in agricultural supply chain management. Discomfort and subjective norms were insignificant in terms of influencing blockchain technology adoption among agricultural supply chains. On the one hand, subjective norms did not positively affect behavioural intentions to use blockchain technology among agricultural supply chains, thereby rejecting H_2. On the other hand, discomfort while using blockchain did not negatively affect the perceived ease of use of blockchain technology adoption, further rejecting H_5.

These findings echo observations from past studies, which have reported that subjective norms have negligible influence on behavioural intentions to adopt blockchain technology in Indian supply chain management (Kamble et al., 2020; Mishra & Maheshwari, 2021). The findings conflict with observations from the Iranian and Malaysian supply chains that discomfort negatively impacts the behavioural intention to adopt Blockchain technology (Mousaei & Khoshoei, 2020; Ng & Lee, 2021). The variation in results may be due to different sample populations used in the studies that included Iranian and Malaysian farmers, while the current study recruited professionals from the Australian agricultural supply chain. This may indicate that ethnicity or culture may influence the adoption of BCT technology in the agricultural industry.

6.1 TRA Constructs H_1-H_3: Perceived Behavioural Control and Subjective Norm

Results indicated that subjective norms positively affect the perceived usefulness of blockchain technology (confirming H_1). The findings echo past studies that have shown subjective norms to influence the perceived usefulness of blockchain technology among

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organisational leaders in their logistics management (Duan et al., 2020; Kamble et al., 2020). The construct of perceived behaviour control was found to positively affect behavioural intentions to use blockchain technology in the agricultural industry (confirming H_3). Similarly, the study confirmed past study findings that perceived behavioural control influenced organisational managers' intention to use blockchain technology in their supply chain management (Wamba & Queiroz, 2020; Rocha et al., 2021).

6.2 TRI Constructs H_4-H_7: Discomfort and Insecurity

Discomfort was found to negatively influence perceived usefulness (confirming H_4), while discomfort did not negatively affect the PEU of BCT (rejecting hypothesis 5). By contrast, insecurity had negative effects on both perceived usefulness and perceived ease of use when adopting BCT in agricultural supply chains (confirming H_6 and H_7). These survey results confirm past findings that organisation managers who express extreme discomfort towards blockchain technology are less likely to adopt it in their supply chain management (Ali et al., 2021). Similar observations have also been reported in the United States and Italian food supply chains where discomfort has been documented to negatively influence the perceived usefulness of Blockchain technology, subsequently inhibiting its adoption among managers (Kouhizadeh et al., 2021; Longo et al., 2019). Further, the results indicated that insecurity negatively affects blockchain technology uptake as organisational leaders become anxious and uncertain regarding its perceived usefulness and perceived ease of use (Jabbar et al., 2020; Kouhizadeh et al., 2021). As such, the current observations align with past studies showing that discomfort negatively affects PU, while insecurity negatively affects both perceived usefulness and perceived ease of use of Blockchain technology (Duan et al., 2020; Fosso Wamba et al., 2020; Hu et al., 2021).

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6.3 TAM Constructs H_8-H_{12}: Perceived Ease of Use and Perceived Usefulness

Insights from past studies showed that when assessing the TAM constructs, perceived ease of use positively affects both perceived usefulness and attitudes towards blockchain technology adoption in agricultural supply chains (thereby confirming H_8 and H_9). The observations align with a growing body of literature that shows perceived ease of use to substantially impact managers' support and intentions to implement Blockchain technology in agricultural supply chain management (Collart & Canales, 2021; Dietrich et al., 2021). A primary impact of perceived ease of use on blockchain technology adoption aligns with the extent that managers in agricultural organisations believe that using blockchain technology would improve aspects such as trust, transparency, and traceability in the supply chain process (Chod et al., 2020). In this case, survey findings confirm that perceived ease of use is a major technology acceptance model determinant that informs blockchain technology adoption in Australian agricultural supply chains.

Like perceived ease of use, the other technology acceptance model constructs of perceived usefulness were found to positively affect attitudes towards using Blockchain technology. These findings confirmed hypotheses H_{10} and H_{11} and align with observations from past studies in Germany and Malaysia where managers are likely to adopt blockchain technology if they believe that using it would improve the performance of their logistics and distribution services (Ali et al., 2021; Bischoff & Seuring, 2021). Further, perceived usefulness has been noted to influence blockchain technology adoption due to important attributes of blockchain such as being fast, effort saving, timesaving, overall usefulness, and cost-saving (Wu et al., 2021). The obtained results from the Australian agricultural supply chain confirm insights from the extant body of literature that perceived usefulness is a precursor that influences managers' attitudes towards using blockchain technology in supply chains (Jabbar et al., 2020; Kamble et al., 2020; Long et al., 2020). As such, it may be concluded that perceived

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usefulness is a key determinant that positively affects attitudes towards using the blockchain technology in Australian supply chains.

The attitude towards blockchain technology adoption was also observed to positively affect behavioural intentions to use blockchain technology in agricultural supply chains. The results further confirm H12 in that there is a positive impact between individual attitudes and intention to use blockchain. These observations echo findings from the literature on potential enablers of blockchain technology adoption in supply chain management. For example, Wamba and Queiroz (2020) reported that attitude defines an emotional aspect of managers' intention to use blockchain technology. Positive emotions, beliefs, and behaviours about Blockchain technology largely contribute to support for the adoption of the technology in supply chain systems (Wamba & Queiroz, 2020; Yadav et al., 2021). In the Australian agricultural supply chains, attitudes towards blockchain technology were found to be a determinant in the adoption of blockchain in logistics management (Kouhizadeh et al, 2021).

6.4 UTAUT Construct H_{13}: Transparency

Finally, survey results indicated that the unified theory of acceptance and use of technology construct transparency positively influence behavioural intention to adopt blockchain technology in agricultural supply chain management. The results confirm H_{13} indicating that transparency concerns are a key determinant for blockchain adoption in Australia. The findings further align with past observations that managers are more willing to embrace blockchain technology in their supply chain management (Tipmontian et al., 2020; Saurabh & Dey, 2021). The perception that blockchain technology contributes to transparency, traceability, and decentralised information substantially contributes to a positive approach towards its uptake in Australian supply chains, potentially explaining why it is considered a key determinant in supply chain management (Chod et al., 2020; Wamba & Queiroz, 2020; Yadav et al., 2020). These findings further align with past studies that postulate the potential

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impact that blockchain technology adoption has on improving supply chain transparency and creating immutable records of all logistics transactions, making them easily traceable (Tipmontian et al., 2020; Wamba & Queiroz, 2020). As such, it may be noted that managers who find that blockchain technology enhances transparency are likely to show a strong intention of adopting blockchain in their supply chain management.

7. Implications

7.1 Theoretical Implications

Results of this study have potential theoretical implications when considering the technology acceptance model, theory of planned behaviour, and unified theory of acceptance and use of technology constructs. This study contributes to theory on supply chains by indicating how discomfort, transparency, and insecurity influence the adoption of BCT in supply chains. Important constructs added to theory include discomfort, transparency, and insecurity as presented in the measurement items. Results showed that both discomfort and insecurity positively affect perceived usefulness and perceived ease of use, while transparency positively influences intention to use blockchain in agricultural supply chains. A growing body of literature shows that blockchain is gaining growth in research and practitioner interest across regional and global supply chains. Unlike the technology and financial sectors, blockchain adoption in the agricultural sector is still at its nascent stages thereby necessitating the need for further research on the topic.

This study contributes to the body of knowledge on agriculture. Specifically, there is a paucity of studies that have examined this problem within agricultural supply chains. Insights from this study that indicated that differences in culture, country, and ethnicity may influence the adoption of BCT. Managers in agricultural sectors need to evaluate the central role that transparency, discomfort, and insecurity may play in informing uptake of BCT in the agricultural sectors. The current study identifies important theoretical constructs that may be

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used to identify the drivers for the adoption of blockchain technologies in agricultural supply chains. Insights from this study identify key technology constructs that may help understand motivators likely to inform blockchain technology adoption.

Key among the important theories of planned behaviour constructs that may influence the theory of planned behaviour adoption include subjective norms and their impact on perceived usefulness and perceived behaviour control. By contrast, the theory of planned behaviour constructs that impact blockchain technology adoption include discomfort and insecurity that impact perceived ease of use and perceived usefulness. Technology acceptance model constructs perceived ease of use and perceived usefulness largely impact on perceived usefulness and attitude towards blockchain technology adoption. Attitude also positively affects behavioural intention to use blockchain technology. The unified theory of acceptance and use of technology constructs related to transparency also positively affects blockchain technology adoption. The study indicated that potential challenges to blockchain technology adoption may be attributed to subjective norms in terms of negatively affecting behavioural intentions to use blockchain technology. Discomfort while using blockchain would negatively affect the perceived ease of use of blockchain technology, further hindering its adoption in supply chain management. The study empirically validates the theory of planned behaviour, theory of planned behaviour, technology acceptance model, and unified theory of acceptance and use of technology constructs that may play a key role in understanding blockchain adoption in Australian supply chain management and serves as the foundation for future studies to corroborate the study results.

7.2 Managerial Implications

Insights from this study have important theoretical implications for managerial practice within agricultural supply chain management. First, the study identified essential constructs for the successful adoption of blockchain technology in Australian supply chain management. The

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study also showed how supply chain managers' behavioural intentions on adopting blockchain technology emerge based on behavioural control, individual attitudes, transparency, perceived usefulness, and perceived ease of use. Second, the study indicated that the theory of planned behaviour, technology acceptance model, and unified theory of acceptance and use of technology constructs were key to understanding managerial decisions when adopting and implementing blockchain technology in the agricultural supply chains. Specifically, more focus on the successful adoption of blockchain should be anchored on addressing hurdles such as discomfort and insecurity since they might discourage managers from adopting blockchain technology in their organisations.

Third, while more managerial efforts should be taken to address potential negative impacts of insecurity and discomfort on blockchain technology adoption, managers may optimize on constructs including transparency, positive attitude, perceived usefulness, and perceived ease of use (Duan et al., 2020). Past findings indicate that having positive perceptions of technology uptake and use potentially encourages organisations to implement blockchain technology in their logistics management systems (Duan et al., 2020). These findings show that perceived usefulness and perceived ease of use, in addition to a positive attitude about BCT transparency would enable stakeholders in the agricultural supply chain to perceive blockchain as free of effort. As a result, organisations consider blockchain technology to enable them to derive maximum returns for their supply chain management.

8. Conclusion

The aim of the study was to determine the factors influencing blockchain adoption in the agricultural supply chain. Results indicated that the theory of planned behaviour constructs subjective norm positively influences perceived usefulness but has negligible impact on the intention to use blockchain. These findings show that participants may be overwhelmed by the usefulness of blockchain technology but see a lack of control on the intention to use Blockchain technology in their supply chains (Ali et al., 2021). Further, findings indicated that perceived behavioural control positively influences the intention to use blockchain technology in supply chain management (Cheng, 2018).

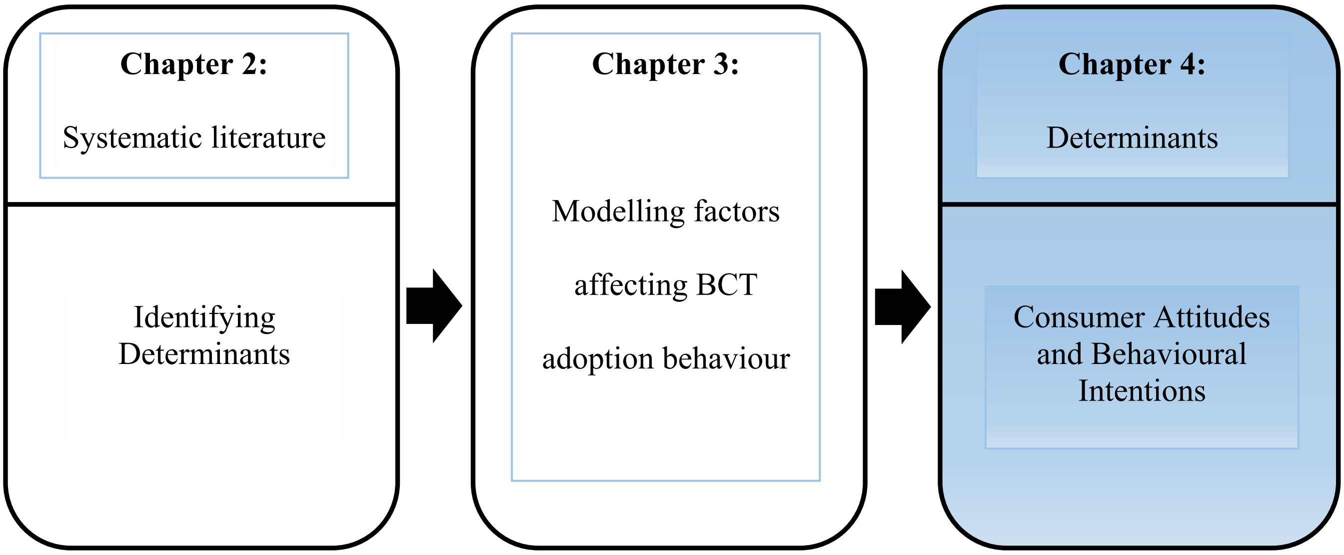
Further insights indicated that discomfort negatively affects the perceived usefulness of blockchain technology adoption, although discomfort does not have any negative impact on perceived ease of use. In contrast, insecurity negatively affects perceived usefulness and perceived ease of use. These observations show that Australian supply chain specialists are likely to consider insecurity and discomfort as potential inhibiting factors in the blockchain technology adoption process. Concerns about discomfort and insecurity may be attributed to uncertainties such as the lack of a universal ecosystem and platform for scaling up blockchain technology adoption and application (Chod et al., 2018; Collart & Canales, 2021).

The technology acceptance model construct of perceived ease of use was found to positively influence perceived usefulness and attitudes towards blockchain technology use. These insights may imply that Australian agricultural practitioners are likely to express optimism that using blockchain technology in the supply chain is free of effort and enables them to realize its positive impacts such as reduced cost, effectiveness, transparency, and trust (Danks et al., 2020; Curry et al., 2021). As a result, supply chain managers in the Australian agricultural sector would be more likely to show higher intentions and positive attitudes to blockchain technology adoption. It may be concluded that agricultural companies in Australia may consider embracing blockchain technology that is easy to use and provides value to supply chain management in terms of security, comfort, and transparency.

Attitude towards use was also found to influence agricultural specialists' intentions to use blockchain. The survey results show that having appropriate beliefs and emotions would impact practitioner support for blockchain technology adoption, while a negative attitude would have a counterproductive impact on its uptake in supply chain management (Fosso Wamba et al., 2020). Findings also indicate that the unified theory of acceptance and use of the technology construct of transparency has a positive impact on the intention to use blockchain. Practitioners in the agricultural supply chain may be cautious of the trust issues resulting from logistic and distribution processes, in addition to limitations of centralised data management (Ghasemi & Zahediasl, 2017). Considering blockchain technology's immutability, enhanced security, distributed ledger, decentralised data, traceability, and faster settlement, more managers may show increased interest in its adoption in enhancing the transparency of their supply chain operations.

A key limitation of this study was that most information was based on numerical data collected using surveys. Future studies should be undertaken using field observations, interviews, and focus group discussions to collect participant feelings, lived experiences, and personal attitudes towards blockchain technology. In addition, company data such as archival information and minutes of board meetings among various agricultural organizations may help understand the commitment that managers and other stakeholders have towards blockchain adoption in their supply chain management.

CHAPTER 4: DISCUSSION AND CONCLUSION



Discussion and Conclusion of the Research Project

Preface

The chapter marks the end of the dissertation. In the introduction, a brief discussion of the BCT based on previous studies is undertaken to guide the discussion and examines the drivers of BCT adoption concerning the findings of the current study. Through a discussion of these drivers in relation to the BCT adoption models, the research considers why these factors are critical in enhancing its adoption. The chapter also discusses the identified barriers and explores how the current study contributes to existing research.

4.1 Introduction

The research explores the customer attitudes and behavioural intentions as influenced by the drivers or barriers to BCT adoption. The systematic literature review developed a frame of reference that served as the thesis's foundation. Following that, a survey of Australia's agriculture industry stakeholders was done. The two specified research questions and hypotheses that were specified in chapter will be answered and evaluated to fulfil the thesis's goal. The first research question sought to identify the drivers and challenges of BCT adoption in the Australian agricultural sector. The second research question sought to examine how the drivers and challenges related to BCT adoption influences the stakeholders' behavioural intention and attitude to adopt the technology.

According to the findings of the study, perceived behavioural control, insecurity, perceived ease of use, perceived usefulness, attitude toward usage, and transparency are the main drivers or barriers towards BCT adoption in the agricultural supply chain management. The stated view is consistent with the insight from the systematic literature review. Previous studies showed that the automation of intelligent contracts and payments was the main factor that influenced the BCT adoption in the agriculture supply chain (Sharma et al., 2021). In this regard, BCT adoption is attributed to factors that promote agricultural production and improve the food supply chain from the farm to the consumers. Thus, when exploring BCT in the Australian agriculture sector, it is critical to look at the issue from the perspective of supply chain management. Today, consumers have become more aware of what they consume hence the need for transparency and traceability in the agriculture supply chain.

4.2 Drivers of BCT Adoption in the Agriculture Supply Chain

4.2.1 Transparency

Transparency was identified in the systematic literature review as a critical factor in enhancing agricultural supply chain. Participants showed confidence in the ability of BCT technology to promote stakeholder accountability. They also exhibited considerable confidence in the ability of BCT to visibly depict all the business processes and transactions that are involved in the agricultural value chain and supply chain. This view is supported by the survey findings where 61.8% of the participants indicated their intention to use BCT. Previous cases of poor food supply chain have necessitated the need for a transparent supply chain. For example, an E.coli outbreak in the United States in 2015 not only caused considerable adverse effects on human health and businesses, but it also took a long time to resolve due to lack of supply chain transparency (Kshetri 2019; George et al. 2019). BCT can transmit real-time information regarding product movement and storage along the supply chain (Mondal et al., 2019; Kumar et al., 2020). This represents an important technological advancement in food quality and safety management, especially for product lines such as processed beef or soya beans (Pearson et al. 2019).

Behavioural control was found to positively influence the adoption of BCT in the agricultural sector. The research findings support the outcome of previous studies where behavioural intention was noted to be driven by perceived usefulness. In this case, transparency, and traceability influenced the perceived usefulness of BCT in agricultural supply chain. This view affirms the need for supply chain managers to adopt BCT. According to the TAM, individuals accept to use technology based on two factors: perceived usefulness and perceived ease of use (Cordeiro & Olsen, 2021). In terms of perceived service, the consumer's need for openness in the supply chain further compels the adoption of BCT.

In the current supply chain, agricultural sector stakeholders, primarily farm input suppliers, typically choose to restrict certain information to the public in order to benefit themselves. This practice can lead to customers lacking sufficient knowledge of products and the supply chain operations (Lin et al., 2020). According to Reyna et al. (2018), inadequate information might also contribute to food security issues, mainly due to the marketing of uncertified seeds and other farm inputs. Transparency of the supply chain is critical for specific products in order to assure product quality and maintain consumer confidence (Tieman & Darun, 2017). Even though the Australian government has established laws and regulations with frequent inspections in many circumstances, the efficacy of such measures can be adversely affected by incidences of bribery. For example, the Sanlu milk crisis remained hidden for a long time because corporate executives and municipal officials failed to disclose it (Barboza, 2008). Even though corporations can share information based on certain criteria, it is easy to modify such information or delete the logs to conceal the truth (Biswas et al., 2017; Tian, 2017). As a result, centralized supply chains struggle to establish information credibility and confidence since openness and visibility remain inadequate (Hua et al., 2018). The agricultural sector can be disadvantaged when consumers avoid certain products.

Decentralization is one of the main features of BCT, allowing consumers to access the history of a product without the intervention of a third party. Each validly registered user has the same ability to analyse a transaction and obtain a copy of its records (Queiroz et al., 2019). This functionality can help alleviate information imbalance among stakeholders and provide transparency across the supply chain. The BCT mining process may be used to achieve immutability. Once the transaction is complete, its associated data is saved and cannot be altered without alerting other users (Tian, 2017). As a result, the history of product movements in a supply chain can be accessed and reviewed at any moment with minimal risks that it can be tampered (Queiroz et al., 2019).

Furthermore, product information and key details may be digitalized and updated, allowing only authorized people to view it at any time. Authentication would be required to initiate trade in agricultural products within the supply chain. The digitization of records and documents saves time by eliminating manual paper checks and the risk of data manipulation or inaccuracies (Kamble et al., 2019). In 2016, Walmart and Tsinghua University were able to trace the movement of pork from farms to consumers (fork) in China (Yiannas, 2018). The findings demonstrated the capacity of BCT to improve data integrity, authenticity, reduce mistakes, and build consumer confidence. Given the benefits associated with the transparency aspect of BCT, there is need for organizations to adopt BCT.

4.2.2 Traceability

The findings noted that perceived usefulness is one of the major drivers of BCT adoption. The findings were consistent with previous studies, which indicated that perceived usefulness has a significant influence on behavioural intentions (Prashar et al., 2020). Therefore, based on the findings, traceability can be viewed as perceived usefulness of BCT adoption in the Australian agriculture sector. The traceability of agricultural produce has become a critical aspect of the modern consumers due to their concern on environmental and production sustainability (Kamble et al., 2019). Several agricultural crises in recent years have heightened consumer demand for high-quality food as well as access to food labels, including the ingredients. With the growing concerns on food quality and sustainability issues, the necessity for agricultural traceability has increased considerably. As such, perceived usefulness of BCT in terms of traceability can influence behavioural intentions. Other studies such as Rogerson and Parry (2020) found that due to their preference for food safety and concerns on environmental sustainability, consumers were willing to pay a premium price to enjoy the traceability benefits associated with BCT. The implication is that the traceability feature of BCT was considered an important aspect of the agriculture supply chain to the extent that consumers indicated preference for firms who had invested in the technology (Rogerson & Parry, 2020). The findings based on the study by Prashar et al. (2020) indicate that traceability feature of BCT resulted in noticeable improvement in the public health safety of agricultural products.

Furthermore, as the food ecosystem is globalized, agricultural produce tend to move long distances from farmers to consumers ("Farm to Fork") (Lehtinen, 2017). For a food quality control system, the capacity to track commodities from their primary source is now more vital than ever. Similarly, the ability to trace products from the suppliers to ultimate consumers is critical for enhancing accountability when safety and quality requirements are violated (Prashar et al., 2020).

The issue of food traceability is especially critical in the contemporary society where preferences for agricultural produce such as organic food supply has declined due to health concerns. The traceability feature of BCT can indicate whether the agricultural produce used pesticides, genetically modified organisms (GMOs) or had adverse environmental impact such as carbon footprint. According to World Health Organization, the effects of pesticide exposure on health and the environment are a growing concern. Nutritionists have also supported the intake of healthy foods, which are sourced from farms that employ environmental sustainable production techniques. As a result of these incidents, consumers are becoming increasingly worried about the origins of their food. Such concerns have created the need for the adoption of BCT despite its challenges and problems to farmers. Based on the technology acceptance model, external factors are essential in facilitating the adoption of a new technology. In this case, the agricultural sector is greatly influenced by external factors such as consumer demands.

BCT improves the capacity to trace and monitor information, commodities, and products as they move from the suppliers to consumers. BCT promotes logistical clarity and confidence among multiple actors in the supply chain through its traceability benefits. Supply chain systems have traditionally been centralized, making them unsuitable for modern, highly dynamic business environment due to the risk of data tampering (Westerlund et al., 2021). BCT is a viable option for resolving transparency and traceability issues in centralized systems.

According to previous research, BCT is associated with the desired properties such as transparency, traceability, fraud prevention and improved data management (Swan, 2015).

The present agriculture is more knowledge-intensive and data-driven than ever before. Given the worsening trade conditions affecting the agricultural sector more than other sectors, technology breakthroughs are required to lower transactional costs and facilitate the creation of reliable supply chains that would fulfil customer expectations. Farmers, manufacturers, retailers, transporters, consumers, governments, and the public at large all have a stake in the global agriculture supply chain's safety and cost-effectiveness. Technological advancements in product identification, process, and environmental characterization, information collection, analysis, storage and transmission, and overall system integration are necessary to attain a traceable agricultural supply chain. Hardware (i.e., measurement equipment, identifying tags, and labels) and software are examples of such technologies (i.e., computer programs and information systems). Food security and withdrawal, regulatory compliance, societal challenges, and customer awareness are issues that can be addressed through traceability feature of BCT. In the long term, tracing and monitoring objects can increase asset value and profit for businesses through cost reductions.

Some of the traceability technologies include:

Environment monitoring technology: Temperature and relative humidity, as well as the air's composition, which includes pollutants, have an impact on food quality, sustainability, and safety. Environmental recording devices (i.e., gas analysers and biosensors) are able to monitor these characteristics and may be integrated with control systems.

Quality and safety measurement technology: The capacity to establish the location of each product unit for effective recall in the case of a quality or safety violation, as well as the consistency with which products are supplied to fulfil the expectations of consumers and other stakeholders determine the effectiveness of traceability. This demands accurate data on the product's maturity, quality features, and safety status. All of these must be evaluated and analysed using appropriate equipment and methodologies.

The relevant data collected from such technologies provide an avenue for consumers to trace the product from suppliers to consumers. Agricultural produce traceability requires a considerable volume of data collection across the supply chain. Such data requirements might cause bottlenecks in tracing agricultural goods, particularly in a centralised system. As a result, buyers can readily trace the origin of agricultural goods through a BCT-enabled supply chain.

4.2.3 Agricultural Produce Safety and Quality Monitoring

The empirical findings indicated that BCT insecurity and discomfort have a significant influence on the perceived ease of use and perceived usefulness of the technology. Therefore, the expectation that BCT would enhance the safety of agricultural produce was an important factor that influenced the intention on its adoption. Agricultural production traceability systems based on BCT provide a platform that allows all supply chain members to retrieve all data related to a specific farm produce, giving agricultural supply chains accountability, openness, impartiality, dependability, and safety (Tian, 2017). The data linked to create safety and quality that may be monitored by BCT is summarized in either external or internal factors.

The insight on agricultural produce safety and quality control is supported by the research finding where transparency and traceability are viewed as key factors influencing the adoption of BCT. Based on the systematic literature review, traceability and transparency are critical in ensuring food safety and quality control. Thus, based on the perceived usefulness of the BCT adoption, traceability and transparency act as behavioural changes in the usefulness of the technology.

Internal factors include initial bacterial activity, environmental toxins, artificial colorants, food pathogen contaminants, food allergy, toxicity, accumulation of heavy metals, sick poultry and cattle, as well as the misuse of additives and chemicals. Surface flaws include (bruise, worm), texture, maturity, nutrition (sugar, water content, etc.), taste, volatile, origin, falsification, inferior, etc.) (Lin et al., 2018). Temperature, relative humidity, sanitation technique, CIP, shelf-life, and other aspects are examples of external variables (Gao et al., 2020).

To avoid cross-contamination and the outbreak of agricultural diseases, which can be initiated by global transportation and have a multi-national impact, agricultural produce quality is critical for global supply chains. Faulty sanitation practices, lack of processing to remove pathogens, improper handling and storage, and worker cross-contamination are additional food safety issues (Sokoowska & Nasiowska, 2020). The threats mentioned above would be significantly reduced or eliminated if BCT could monitor and regulate all information concerning the origin and processing of food produce, thereby increasing agricultural production safety.

BCT has been implemented in several areas within the agricultural sector. BCT has been used in a pilot study in the mango industry in the United States to monitor the quality or ripeness of mango slices during international shipping from Mexico using the technology (Kamath, 2018). The experience may be used for other fresh fruits and vegetables during manufacturing and shipping. Environmental elements (i.e., temperature, moisture), as well as quality-related features like appearance (i.e., colour, size, etc.), physical damages (i.e., bruise), or biological damages (i.e., worms) are likely to be crucial for monitoring or evaluating the quality of supply chains.

The use of BCT in agriculture is still in its early stages; the stated features and traits are among those that are now being monitored by Blockchain, albeit in a limited way. The most common use of BCT in supply chain is tracking the origin of agricultural produce, although other food safety and quality areas are becoming increasingly popular (Feng et al., 2020). Quality control has become critical for organizations in the agriculture industry to create public confidence and meet regulatory obligations/requirements. Organizations rely on BCT to track the movement of food produce from their source to the point of sale. Additional systematic exploration and advancement of BCT are required to facilitate the tracking of other food safety aspects.

4.2.4 Agriculture Finance

The findings illustrated that the perceived usefulness of BCT had a significant bearing on the stakeholders' attitudes and their intention to use the technology. Specifically, the agricultural finance benefits attributed to BCT was a key factor that influenced the stakeholders' intentions and attitudes to adopt the technology. Finance in supply chain management refers to the application of emerging blockchain platforms to manage financial processes with a view to boost farmers' earnings (Tripoli & Schmidhuber, 2018). In agricultural financing, cross-border transactions involving many jurisdictions and players, such as farmers, vendors, consumers, and traders are prevalent. The traditional payment process is inconvenient and involves numerous paper-intensive settlement procedures, significantly reducing transaction efficiency. In most cases, the sophistication of the old payment method has mitigated the financial gain that farmers have reaped due to delayed payments.

Agricultural financial services can benefit from blockchain-based technologies that allow quick and real-time transactions, thereby cutting transaction costs and risks while increasing income and cash flow (Tripoli & Schmidhuber, 2018). Ripple, a blockchain-based payment network, can be used to tackle the challenge of cross-border payments. Because it uses virtual currencies like Bitcoin and Ethereum for financial transactions, Ripple has drawn tremendous interest from financiers and other industry stakeholders over the last decade. The usage of bitcoin as a global currency on a blockchain platform in the agricultural supply chain can significantly save transaction costs and time (Tripoli & Schmidhuber, 2018). BCT allows low-cost, rapid, and secure payments. The standard payment process takes 3-5 days, with some of that time spent passing through many banks as middlemen, resulting in high transaction fees that put significant financial pressure on agricultural stakeholders, particularly farmers. These expenditures outweigh any profits generated by such enterprises. Consequently, BCT adoption aims to assist these businesses in becoming profitable (Tripoli & Schmidhuber, 2018).

4.2.5 Smart Contracts

The importance of smart contracts was consistent with the thesis's findings that the perceived usefulness of BCT influenced the stakeholders' attitudes and behavioural intentions to use it. Smart contracts offer an opportunity to improve the efficiency, transparency, and traceability of value and information exchange in the agriculture industry (Chang et al., 2020). Blockchain can make it easier to implement smart contracts and therefore, enhance contract exchange, guaranteeing that employees, company owners, and stakeholders will be legally protected. As a result, smart contracts, such as programs that only execute when specific criteria are met, are predicted to gain popularity due to BCT (Chang et al., 2020).

4.3 Barriers to BCT Adoption

There are several challenges that hamper BCT adoption, including user acceptability issues, supported business requirements, technologies and applications, labour and talent shortages, and lack of knowledge, which contribute to misconceptions about BCT. Some of the problems associated with BCT implementation in the agricultural sector relate to the shortage of skill, trust issues, and limited understanding among early adopters due to its newness. Besides, there are several additional challenges, some of which are technological.

The introduction of BCT in the agricultural sector creates technological obstacles due to certain aspects of the technology (Chen et al., 2020; Feng et al., 2020). For example, BCT tends to have a lag problem, which is connected to its transaction capacity (Zhao et al., 2019). BCT-enabled technologies tend to take time to process transactions. In addition, their capacity is inadequate to handle financial transactions in real-time (Zhao et al., 2019). The scalability problem is attributed to the fact that BCT can only complete a few transactions per second. This challenge has yet to be rectified due to the novelty of the technology and other issues, such as data storage capacity. Although the literature review only identified security as a significant challenge, the technological obstacles such as slow transaction speed can create barriers to the adoption of BCT.

The findings based on the hypothesis testing indicated that discomfort and insecurity concerns of the BCT had a significant negative effect on its perceived usefulness. The stated findings identified these factors (i.e., discomfort and insecurity) as key barriers related to the BCT adoption. The security requirement is another identifiable technical obstacle related to data security. Security is a two-edged sword: on the one hand, it promotes transparency, but it also raises the possibility of privacy leaks (Zhao et al., 2019). According to the research conclusions reviewed, the growing use of new technologies in the agricultural supply chain may increase insecurity, vulnerabilities, and risks. Immutability, like transparency, has two sides. In addition to being advantageous, immutability creates error intolerance because data cannot be modified. This issue can be problematic because there is no assurance that the initial information processed is accurate or reliable (Chen et al., 2020). Based on TRI constructs, discomfort and insecurity negatively influenced the perceived usefulness of BCT. When using BCT in agricultural supply chains, insecurity has a particularly detrimental impact on both perceived utility and perceived simplicity of use. This is because security breaches can create some form of insecurity at personal levels resulting in a negative perception of BCT. Lin et al. (2020) demonstrated that businesses use BCT to detect, mitigate, and, if feasible, prevent security threats. The use of numerous nodes in BCT guarantees that there is improved security in data management and process authentication. As a result, when data breaches result in losses, it can become a barrier, especially in a new field with many misconceptions.

Lack of stakeholder support provides a challenge in the adoption of BCT. Many organizations are concerned that their bottom line puts BCT at a disadvantage due to initial investment cost and the capital required to maintain it. Furthermore, BCT is an energy-intensive technology that requires greater use of computer processing power and a high-speed internet connection (Feng et al., 2020). The substantial energy expenditure required, among other considerations, is a strong indication of the expenses associated with BCT adoption (Zhao et al., 2019; Tiscini et al., 2020). For example, employee training expenditures are incurred due to a lack of expertise on BCT implementation in the organization.

As Chen et al. (2020) point out, implementing BCT involves institutional impediments, which primarily include legal and regulatory issues (Kamble et al., 2020). There are currently few norms and guidelines for BCT implementation on a national and international basis (Feng et al., 2020; Chen et al., 2020). Because BCT is a unique technology involving many different stakeholders from several countries (Zhao et al., 2019; Kamilaris et al., 2019), it necessitates the establishment of universal rules and standards. Furthermore, BCT design lacks standardization and flexibility, which hinders technical compatibility (Feng et al., 2020; Rana et al., 2021). Because all stakeholders must engage to achieve interoperability (Feng et al., 2020), the attainment of significant benefits from BCT is reliant on supplier involvement, which can be difficult where suppliers are small in size and lack the financial resources to invest in BCT (Tiscini et al., 2020). This can be the case for small-scale farmers and urban farmers. Urban farming is becoming increasingly common in Australia, where 90% of the population lives in urban areas. Thus, implementing BCT can become a problem for such farmers where the existing legal obligations to implement BCT can lead to individuals quitting farming, thereby creating a food crisis in the country.

4.4 BCT Adoption in the Australian Supply Chain

When it comes to increasing transparency in the agricultural supply chains, BCT can help by providing an immutable record from origin to the end of the sale transaction. This can boost customer confidence in the items they buy, which would allow farmers to cultivate their crops using excellent agricultural techniques. Australia has set a road map to implement BCT across various supply chains. The Australian government has formed two new National Blockchain Roadmap Working Groups: The Supply Chains Working Group and the Credentialing Working Group. These groups will work together to help the Steering Committee to create measures that would advance/support the application of BCT in Australia (Potts, 2019).

Blockchain technology has already been deployed in several projects in Australia. AgriChain, a blockchain supply chain management platform promises to link producers, traders, and logistics providers to enable end-to-end insight into the agricultural supply chain. Citrus Australia, a non-profit organization, implemented a blockchain-based traceability system for citrus fruit exports with the help of Agriculture Victoria. Australia's most prominent family-owned meat processor, Thomas Foods International, joined IBM's Food Trust, demonstrating the growing popularity of blockchain solutions for beef farmers (Ledger Insights, 2020).

4.5 Theoretical Contributions to BCT Adoption

This thesis offers fresh perspectives on the strategy and rationale for BCT implementation in the Australian industry. Consequently, the view adds to the subject of BCT adoption in the Australian agriculture sector, which has yet to be researched. First, the findings of this thesis contribute to the research on BCT adoption in the agricultural supply chain management and the application perspective of the I4.0 technology, which includes BCT.

4.5.1 Contribution to Information Systems Knowledge

This research adds to supply chain theory by demonstrating how discomfort, transparency, and insecurity impact BCT adoption in supply chains. Discomfort, transparency, and insecurity are important constructs that have been introduced to the theory. According to a growing literature, BCT increases scholarly and practitioner attention throughout regional and global supply chains. In contrast to the technological and financial industries, the use of BCT in agriculture is still in its early stages, needing more research on the subject. This is accomplished by conducting research focusing specifically on the Australian agriculture sector, thereby contributing to the current scarcity of research focusing on a single country and industry as well as the apparent need for more research on BCT adoption in industrialized economies.

Information system is related to the provision of enhanced administration features for numerous internet-based applications. The management information system (MIS) primarily handles data security, transaction auditing, reporting, centralized policy, and application connection. It is connected to the provision of additional administration capability for numerous internet applications. MIS is a set of tools, processes, and software used to complete various business activities at different organizational levels. Recently, there has been a growth in automation across a variety of industries, with the use of management information systems revolutionizing the decision-making process.

Blockchain can revolutionize information systems especially when it relates to online transactions. As previously observed in the literature review, blockchain enable payment to be completed without the need of an intermediary. This process is facilitated by the capacity of BCT to enable communication between two different software that make part of the BCT network. Thus, based on the research findings, understanding the factors behind the adoption of BCT can help information systems become more integrated thus enhancing its business capabilities.

4.5.2 Contribution to Digital Marketing Knowledge

The most crucial part of creating and promoting commerce is marketing. By reducing uncertainty, BCT can transform the nature of internet firms and hence boost the amount of commerce done online. Customers are hesitant to alter who they do business with due to uncertainties surrounding many organizations in the internet marketplace. Well-established companies must build trust over time, obtaining greater credibility from more and more customers through comments, ratings, and other forms of feedback. As a result, customers are less inclined to switch vendors. Thus, based on the research findings, BCT offers transparency and traceability benefits, which can help businesses and customers feel secure when conducting online transactions. Traceability can help businesses track and consolidate data on product and consumer preferences while creating a marketing strategy that targets those preferences. Transparency and traceability can help customers identify certain brands by tracking the source of advertised products. Thus, this research adds to the knowledge of digital marketing by exploring the importance of BCT in the agriculture supply chain and the factors influencing its adoption.

4.5.3 Contribution to Agriculture Knowledge

This thesis adds to the findings based on past academic studies by giving fresh insights and mapping of variables that impact companies' decisions to embrace or reject BCT. It also outlines two methods to BCT adoption in the Australian agriculture industry. In this sense, the study looked at both the drivers and the constraints to BCT implementation in the agriculture sector. Together, these contributions created a framework that serves as the thesis's core theoretical contribution, defining the BCT adoption process in the Australian agriculture industry, thereby allowing for additional research in this area.

Farmers today are experiencing supply chain challenges from getting their products to the market and farm inputs. The existence of intermediaries has created bottle necks in the supply chain resulting in most of the farm produce not reaching the market in time. The issue of intermediaries is prevalent in developing countries where farmers are left at the mercy of greedy traders who supply substandard farm inputs.

BCT can greatly improve the farming experience by creating seamless connectivity with customers and farm input suppliers. The study looked at both barriers and drivers towards BCT adoption in Australian agricultural sectors. The findings from this research can provide a theoretical foundation for future research by offering insights into progress made towards human perception of the technology. BCT promotes openness among all parties involved and makes it easier to obtain trustworthy data. BCT can record every stage in a product's value chain, from conception to conclusion. Reliable data from the agricultural process is extremely important for establishing data-driven facilities and insurance solutions that will make farming smarter and less susceptible to the current risks and challenges.

4.5.4 Contribution to Theory

The study also added to the theory of planned behaviour construct. In this regard, the study focused on insecurity and discomfort and how each affects the adoption of BCT. Based on the research findings, although discomfort negatively influences the adoption of BCT, the negative effect is minimal. On the other hand, insecurity has a negative impact on perceived utility and simplicity of use. These findings suggest that insecurity and discomfort are likely to be important limiting factors to the adoption of Blockchain technology in Australia. Uncertainties such as the lack of a uniform ecosystem and platform for scaling up blockchain technology adoption and implementation may be blamed for the perceptions of uneasiness.

4.6 Practical Implications

The findings of this thesis provide new insights into BCT implementation in Australian agricultural firms. They may, therefore, help these businesses determine their phase and the manner of its adoption. Consequently, the thesis provides a foundation for companies to assess their BCT adoption policies by providing a framework for determining which factors may help or impede their adoption process. As observed throughout the systematic literature review and the survey of participants, several factors influence the pace of BCT adoption. These factors can be classified as internal and external. Although these factors have a critical role in facilitating the adoption of BCT, theories regarding the technology also show that personal perspectives such as discomfort and insecurity play an important role. For example, the rising cases of data insecurities as observed from the recent claims regarding Google and Facebook related to breach of privacy can create a form of discomfort and insecurity hence hindering the adoption of BCT. Because the findings suggest that BCT adoption can be one approach to promote trustworthiness, the results might benefit people who are already enthusiastic about the technology. Consumers' desire to track the origins of their agricultural produce and the requirement for openness in pesticide usage are two main factors that push the adoption of BCT in the Australian agriculture sector. The stated insight coupled with the Australian government's desire to implement BCT in the agricultural sector emphasizes the value of this study in offering practical guidance on factors that influence BCT adoption.

4.7 Limitations and Delimitations of the Research

4.7.1 Limitations

BCT in the agricultural sector is still in its initial phases, which led to the challenges encountered in accessing Australian players in the agriculture industry who have expertise and experience in the field. As a result, one of the limitations of this thesis is that participants have varying knowledge and understanding of BCT adoption, which forces the researcher to interact extensively with participants in order to obtain accurate data/information from them.

The other limitation of the study is that there are few Australian studies, which were included in the systematic literature review. This was attributed to their limited availability. A consequence of this is that it was expected to limit the Australian context in the review of past literature. An additional limitation of the study is that the systematic literature review was conducted using only 20 studies, which were used to generate the themes related to the two dimensions (i.e., drivers and challenges of BCT adoption and their influence on behavioural intention and attitude). Furthermore, the qualitative design component of the phenomenological research captures the everyday experiences of human beings (Creswell, 2017). This could adversely affect the reliability of the findings due to the subjectivity element associated with the qualitative findings. These findings depends on the views of experts during the interview, which are likely to be subjective (Saunders et al., 2016).

4.7.2 Delimitations

There are three main limitations of this thesis. First, although, there are many I4.0 technologies involved, the thesis focused only the determinants of BCT adoption in the agricultural sector (Kamble et al., 2020; Prashar et al., 2020). This means that the thesis does not examine the contribution of other I4.0 technologies such as big data analytics and robotics in enhancing the efficiency of the agricultural supply chain. Secondly, there is considerable evidence that the deployment of BCT has the potential to enhance the sustainability of the agriculture supply chain (Li, 2020). However, another limitation is that this thesis only focuses on sustainability as a determinant (i.e., driver/benefit) of its adoption in the agricultural sector. This is because, the thesis only focuses on the BCT adoption perspective while failing to examine how it is related to sustainability in the agricultural supply chain. The other limitation is that given the Australian context of the study, there were few academic literature on BCT adoption that focus on the Australian agricultural sector. This aspect restricted the systematic review to studies that focus on the determinants of BCT adoption in other countries (Korpela et al., 2017; Kosmarski, 2020; Li, 2020; Park, 2020; Alazab et al., 2021).

4.8 Future Research

Several potential study directions for BCT adoption were indicated based on the research findings and limitations of the present literature. To begin, more research should be conducted on BCT adoption in a particular supply chain network within the Australian agriculture industry. This recommendation is based on data demonstrating that product features and other supply chain circumstances influence businesses' adoption decisions. As a result, this study would provide much more specific information about the adoption process. The existing research sheds light on the causes and barriers to BCT adoption. However, to attain the intended results, in-depth insights from the agriculture and food industries are required to establish solid and specialized frameworks for BCT deployment.

Second, the study should concentrate on addressing primary barriers to BCT adoption. Specifically, how to strike a balance between openness and privacy and how to address the problem of Oracle, a gateway between Blockchain and the actual world (Caldarelli et al., 2020). When it comes to BCT for supply chain management, these difficulties have been highlighted as significant concerns (Zhao et al., 2019; Öztürk & Yildizbaşi, 2020). In the case of the former, a case study can show how the transparency and privacy problem is resolved in a well-established BCT system. Even though incorrect inputs are a crucial risk with BCT, there is limited work, which has been done to investigate the accuracy of information. More research in this area can help validate BCT usage in supply chains.

Future studies should also concentrate on the policies that govern the Blockchain network. The decentralized feature of BCT can provide some benefits in terms of reliability and transparency; yet it might be a constraint for corporate use cases where total control must be maintained (Pearson et al., 2019). The present corpus of literature on BCT and SCM provides only a limited range of such topics. Several kinds of governance exist, including network participants, smart contracts, and the consortium that began the Blockchain initiative (Chong et al., 2019; Caldarelli et al., 2020). More research is needed to shed light on this critical issue.

While few initiatives have sustainability as a primary goal, most Blockchain applications provide supply chain management operational improvements. Nonetheless, the technology can improve agriculture supply chain sustainability (Saberi et al., 2019; Li et al., 2020). Consequently, future research needs to investigate how BCT might be utilized for effective development. In-depth case studies, for example, might investigate how BCT can be used to monitor waste or ensure that upstream farmers receive a fair share of profits.

Finally, future studies need to analyse and expand the paradigm provided in this thesis. For example, future research can explore the same research problem through a multiple case study, which allows for a more in-depth investigation of the reasoning behind BCT adoption in various organizations.

4.9 Conclusion

The study summarized the factors and constraints to BCT adoption and presented its applications in the agricultural supply chain environment. The study demonstrated how BCT adoption might improve transparency and traceability in the agriculture sector. Furthermore, enhancing transparency and efficiency were highlighted as two significant internal motivations for BCT adoption while external drivers included pressure from customers, rivals, and regulatory agencies. According to the findings from the study based on the unified theory of adoption of technology construct, transparency has a favourable impact on behavioural intention to use BCT in agricultural supply chain management. The impression that BCT contributes to transparency, traceability, and decentralized information significantly contributes to a favourable attitude toward its adoption in Australian supply chains, which might explain why it is seen as a crucial factor in supply chain management.

The thesis uniquely addresses the area of supply chains in general and agriculture supply chains in particular. The research presents academically sound conclusions on BCT deployment in the supply chain and a conceptual model for its implementation. According to a descriptive analysis of the reviewed literature, its development has been rapid, and it is likely to accelerate in the near future.

This thesis has inevitable consequences for businesses and government entities. First, stakeholders may acquire insight into the SC's BCT development and essential understandings on the technology's implementation processes and possibilities as well as its obstacles. Furthermore, while the approach is abstract, it may assist stakeholders in planning their adoption process by applying the insights presented. Policymakers can help leverage BCT in the supply chain by removing regulatory barriers such as a lack of legal frameworks for recognizing intelligent contracts, allowing businesses to conform to other standards like food traceability and food safety.

Future scientific research can help develop the conceptual framework by testing it in a real-world scenario. Because the evaluation was restricted to the agriculture supply chain in Australia, generalizing the findings to other SCM domains may be difficult. Even though the data search terms were carefully crafted, it is possible that numerous relevant research studies were ignored. Nonetheless, this research gives a new conceptual framework for applying BCT in the agriculture supply chain and proposing evidence-based long-term prospects.

REFERENCES

Abeyratne, S. A., & Monfared, R. P. (2016). Blockchain-ready manufacturing supply chain using a distributed ledger. *International Journal of Research in Engineering and Technology*, *5*(9), 1-10.

Aboelmaged, M., & Gebba, T. (2013). Mobile banking adoption: An examination of technology acceptance model and theory of planned behaviour. *International Journal of Business Research and Development*, *2*(1). https://doi.org/10.24102/ijbrd.v2i1.263

Abou Maroun, E., Daniel, J., Zowghi, D., & Talaei-Khoei, A. (2019). Blockchain in supply chain management: Australian manufacturer case study. *ASSRI and Springer*, 367, 93-107.

Agustina, D. (2019). Extension of Technology Acceptance Model (Etam): Adoption of Cryptocurrency Online Trading Technology. *Jurnal Ekonomi, 24*, 272.

Ahearn, M. C., Armbruster, W., & Young, R. (2016). Big data's potential to improve food supply chain environmental sustainability and food safety. *International Food and Agribusiness Management Review*, *19*(1030-2016-83146), 155-171.

Ahmad, N., & Vignesh, R. (2021). A Literature review on blockchain technology for food supply chain management. *International Journal of Computing*, 7(5), 17-29. https://doi.org/10.33590/ijerph17051784.x

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978 (91)90020-T

Ajzen, I.; Fishbein, M. (1975). A Bayesian analysis of attribution processes. *Psychological Bulletin. 82* (2): 261. https://doi.org/10.1037/h0076477

Alazab, M., Alhyari, S., Awajan, A., & Abdallah, A. (2020). Blockchain technology in supply chain management: an empirical study of the factors affecting user adoption/acceptance. *Cluster Computing*, *24*(1), 83-101. https://doi.org/10.1007/s10586-020-03200-4

Alazab, M., Alhyari, S., Awajan, A., & Abdallah, A. B. (2021). Blockchain technology in supply chain management: an empirical study of the factors affecting user adoption/acceptance. *Cluster Computing*, *24*(1), 83-101.

Ali, F., Rasoolimanesh, S., Sarstedt, M., Ringle, C., & Ryu, K. (2018). An assessment of the use of partial least squares structural equation modelling (PLS-SEM) in hospitality research. *International Journal of Contemporary Hospitality Management*, *30*(1), 514-538. https://doi.org/10.1108/ijchm-10-2016-0568

Ali, M., Chung, L., Kumar, A., Zailani, S., & Tan, K. (2021). A sustainable Blockchain framework for the halal food supply chain: Lessons from Malaysia. *Technological Forecasting and Social Change*, *170*, 120870. https://doi.org/10.1016/j.techfore.2021.120870

Allen, D., Berg, C., Davidson, S., Novak, M., & Potts, J. (2019). International policy coordination for blockchain supply chains. *Asia & The Pacific Policy Studies*, *6*(3), 367-380. https://doi.org/10.1002/app5.281

Awan, S., Ahmed, S., Ullah, F., Nawaz, A., Khan, A., & Uddin, M. et al. (2021). IoT with blockchain: A futuristic approach in agriculture and food supply chain. *Wireless Communications and Mobile Computing*, *2021*, 1-14. https://doi.org/10.1155/2021/5580179

Azzi, R., Chamoun, R. K., & Sokhn, M. (2019). The power of a blockchain-based supply chain. *Computers & industrial engineering*, *135*, 582-592.

Baralla, G., Pinna, A., & Corrias, G. (2019). Ensure traceability in the European food supply chain by using a blockchain system. *2019 IEEE/ACM 2Nd International Workshop on*

Emerging Trends in Software Engineering for Blockchain (WETSEB). https://doi.org/10.1109/wetseb.2019.00012

Barboza, D. (2008, September 23). *China Milk Cover-up Started Last Year (Published 2008).* China's milk cover-up started last year (Published 2008). https://www.nytimes.com/2008/09/23/world/asia/23iht-24milk-new.16423573.html.

Batwa, A., & Norrman, A. (2021). Blockchain technology and trust in supply chain management: a literature review and research agenda. *Operations and Supply Chain Management: An International Journal*, 203-220. https://doi.org/10.31387/oscm0450297

Bayir, B., Charles, A., Sekhari, A., & Ouzrout, Y. (2022). Issues and challenges in short food supply chains: A systematic literature review. *Sustainability*, *14*(1), 1-20. https://doi.org/10.3390/su14053029

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.

Bhusal, C.S. (2021). Blockchain technology in agriculture: A case study of blockchain start-up companies. *International Journal of Computer Science & Information Technology*, *13*(5), 31-48. https://deliverypdf.ssrn.com/delivery.php?

Bischoff, O., & Seuring, S. (2021). Opportunities and limitations of public blockchain-based supply chain traceability. *Modern Supply Chain Research and Applications*, *ahead-of-print* (ahead-of-print). https://doi.org/10.1108/mscra-07-2021-0014

Biswas, K., Muthukkumarasamy, V., & Tan, W. (2017). Blockchain-based wine supply chain traceability system. *Future Technologies Conference (FTC)*, 56-62. https://saiconference.com/Downloads/FTC2017/Proceedings/6_Paper_425-Blockchain_based_Wine_Supply_Chain_Traceability.pdf

Boult, C. & Chancellor, W. (2019), Agricultural Commodities March Edition 2019, Australian Bureau of Agricultural and Resources Economics and Sciences, accessed from http://www.agriculture.gov.au/abares/research-topics/productivity/agriculturalproductivity-estimates, accessed on 25 September 2021.

Boult, C., & Chancellor, W. (2019). Productivity of Australian broadacre and dairy industries, 2017-18. *Agricultural Commodities*, *9*(1), 155-168.

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

Cai, Y., & Zhu, D. (2016). Fraud detections for online businesses: a perspective from blockchain technology. *Financial Innovation*, *2*(1), 1-10.

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

Caro, M. P., Ali, M. S., Vecchio, M., & Giaffreda, R. (2018, May). Blockchain-based traceability in Agri-Food supply chain management: A practical implementation. In *2018 IoT Vertical and Topical Summit on Agriculture-Tuscany (IOT Tuscany)* (pp. 1-4). IEEE.

Castelo-Branco, I., Cruz-Jesus, F., & Oliveira, T. (2019). Assessing Industry 4.0 readiness in manufacturing: Evidence for the European Union. *Computers in Industry*, *107*, 22-32.

CBH Group. (2019). AgriDigital. Pilot Report: Solving for Supply Chain Inefficiencies and Risks with Blockchain in Agriculture. 5af2a0068f5865bb84d047ff_AgriDigital CBH Blockchain White Paper Final.pdf (website-files.com)

Chang, S. E., Chen, Y. C., & Lu, M. F. (2019). Supply chain re-engineering using blockchain technology: A case of smart contract-based tracking process. *Technological Forecasting and Social Change*, *144*, 1-11.

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.

Chauhan, C., & Singh, A. (2019). A review of Industry 4.0 in supply chain management studies. *Journal of Manufacturing Technology Management*, *31*(5), 525-836. https://doi.org/10.1108/JMTM-07-2020-0284

Chen, G., Xu, B., Lu, M., & Chen, N.-S. (2018). Exploring blockchain technology and its potential applications for education. *Smart Learning Environments, 5*(1), 1.

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*, *19*(1), 909-935. https://link.springer.com/article/10.1007/s10257-020-00467-3

Cheng, E. (2018). Choosing between the theory of planned behaviour (TPB) and the technology acceptance model (TAM). *Educational Technology Research and Development*, *67*(1), 21-37. https://doi.org/10.1007/s11423-018-9598-6

Chiarello, F., Trivelli, L., Bonaccorsi, A., & Fantoni, G. (2018). Extracting and mapping industry 4.0 technologies using Wikipedia. *Computers in Industry*, *100*, 244-257.

Chod, J., Trichakis, N., Tsoukalas, G., Aspegren, H., & Weber, M. (2020). On the financing benefits of supply chain transparency and blockchain adoption. *Management Science*, *66*(10), 4378-4396. https://doi.org/10.1287/mnsc.2019.3434

Cole, R., Stevenson, M., & Aitken, J. (2019). Blockchain technology: implications for operations and supply chain management. *Supply Chain Management: An International Journal*, 24(4), 469-483.

Collart, A., & Canales, E. (2021). How might the broad adoption of blockchain-based traceability impact the U.S. fresh produce supply chain? *Applied Economic Perspectives and Policy, 44*(1), 219-236. https://doi.org/10.1002/aepp.13134

Collis, J., & Hussey, R. (2013). *Business research: A practical guide for undergraduate and postgraduate students*. London: Macmillan International Higher Education.

Cordeiro, C., & Olsen, P. (2021). Blockchain-based traceability system adoption in the wine global value chain: A unified theory of acceptance and use of technology framework of analysis, the example of the Chinese market for Bordeaux wine. *European Review of Service Economics and Management*, (11), 17-54.

Craighead, C. W., Ketchen, D. J., Jenkins, M. T., & Holcomb, M. C. (2017). A supply chain perspective on strategic foothold moves in emerging markets. *Journal of Supply Chain Management, 53*(4), 3-12.

Creswell, J. (2017). R*esearch design: Qualitative, quantitative, and mixed methods approach (5th Ed.)*. Thousand Oaks, CA: Sage Publications.

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

Curry, G., Nake, S., Koczberski, G., Oswald, M., Rafflegeau, S., & Lummani, J. et al. (2021). Disruptive innovation in agriculture: Socio-cultural factors in technology adoption in the developing world. *Journal of Rural Studies*, *6*(1), 45-61. https://doi.org/10.1016/j.jrurstud.2021.07.022

Cuschieri, S. (2019). The STROBE guidelines. *Saudi Journal of Anesthesia*, *13*(1), 31-34. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6398292/

Cuthbertson, A. (2015). Bitcoin now accepted by 100,000 merchants worldwide. *International Business Times*, *4*, 1-23.

Dania, W. A. P., Xing, K., & Amer, Y. (2018). Collaboration behavioural factors for sustainable agri-food supply chains: A systematic review. *Journal of cleaner production*, *186*, 851-864.

Danks, N., Sharma, P., & Sarstedt, M. (2020). Model selection uncertainty and multi-model inference in partial least squares structural equation modelling (PLS-SEM). *Journal of Business Research*, *113*, 13-24.

Davcev, D., Kocarev, L., Carbone, A., Stankovski, V., & Mitresk, K. (2017). Blockchain-based distributed cloud/fog platform for IoT supply chain management. *Management Science*, *8*(2), 53-68. https://doi.org/10.1287/yuss.35.8.982

Davies, P. (2020). *A Quick Guide to Quantitative Research in the Social Sciences*. Oxford: Oxford University Press.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. J. M. s. (1989). User acceptance of computer technology: a comparison of two theoretical models. *35*(8), 982-1003.

Davis, F., Bagozzi, R., & Warshaw, P. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, *35*(8), 982-1003. https://doi.org/10.1287/mnsc.35.8.982

Demestichas, K., Peppes, N., Alexakis, T., & Adamopoulou, E. (2020). Blockchain in agriculture traceability systems: a review. *Applied Sciences*, *10*(12), 4113.

Dietrich, F., Ge, Y., Turgut, A., Louw, L., & Palm, D. (2021). Review and analysis of blockchain projects in supply chain management. *Procedia Computer Science*, *180*, 724-733. https://doi.org/10.1016/j.procs.2021.01.295

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

Durach, C. F., Blesik, T., von Düring, M., & Bick, M. (2020). Blockchain Applications in Supply Chain Transactions. *Journal of Business Logistics,* 42(1), 7-24.

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.

Dutta, P., Choi, T., 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. https://doi.org/10.1016/j.tre.2020.102067

Easterby-Smith, M., Thorpe, R., Jackson, P. and Jaspersen, L. (2018). *Management and Business Research*. 5th Ed. New York: SAGE.

Eluubek, I., Song, H., Vajdi, A., Wang, Y., & Zhou, J. (2021). Blockchain for consortium: A practical paradigm in an agricultural supply chain system. *Expert Systems with Applications*, *184*, 115425. https://doi.org/10.1016/j.eswa.2021.115425

Farooq, S., & O'Brien, C. (2012). A technology selection framework for integrating manufacturing within a supply chain. *International Journal of Production Research, 50*(11), 2987-3010.

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.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention, and behaviour: An introduction to theory and research. Reading, Mass; Don Mills, Ontario: Addison-Wesley Pub. Co.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behaviour: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Flores, L., Sanchez, Y., Ramos, E., Sotelo, F., & Hamoud, N. (2020, July). Blockchain in Agribusiness Supply Chain Management: A Traceability Perspective. In *International Conference on Applied Human Factors and Ergonomics* (pp. 465-472). Springer, Cham.

Foerstl, K., Schleper, M. C., & Henke, M. (2017). Purchasing and supply management: From efficiency to effectiveness in an integrated supply chain. *Journal of Purchasing and Supply Management, 23*(4).

Folkinshteyn, D., & Lennon, M. (2016). Braving Bitcoin: A technology acceptance model (TAM) analysis. *Journal of Information Technology Case and Application Research, 18*(4), 220-249.

Fornell, C., & Larcker, D.F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, *18* (1), 39-50.

Fosso Wamba, S., Queiroz, 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/10.1016/j.ijpe.2020.107791

Francisco, K., & Swanson, D. (2018). The supply chain has no clothes: Technology adoption of Blockchain for supply chain transparency. *Logistics*, *2*(1), 2-5.

Francisco, K., & Swanson, D. (2018). The supply chain has no clothes: technology adoption of blockchain for supply chain transparency. *Logistics*, *2*(1), 2. https://doi.org/10.3390/logistics2010002

Frizzo-Barker, J., Chow-White, P. A., Adams, P. R., Mentanko, J., Ha, D., & Green, S. (2020). Blockchain as a disruptive technology for business: A systematic review. *International Journal of Information Management*, 51, 102029.

Gao, Z., Shao, Y., Xuan, G., Wang, Y., Liu, Y., & Han, X. (2020). Real-time hyperspectral imaging for the in-field estimation of strawberry ripeness with deep learning. *Artificial Intelligence in Agriculture*, *4*, 31-38.

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.

Ghadge, A., Karantoni, G., Chaudhuri, A., & Srinivasan, A. (2018). Impact of additive manufacturing on aircraft supply chain performance. *Journal of Manufacturing Technology Management*, *29*(5), 846-865

Ghasemi, A., & Zahediasl, S. (2017). Normality tests for statistical analysis: a guide for non-statisticians. *International journal of endocrinology and metabolism*, *10*(2), 486-489. https://doi.org/10.5812/ijeesm.3505

Ghobakhloo, M. (2020). Industry 4.0, digitization, and opportunities for sustainability. *Journal of cleaner production*, *252*, 119869.

Ghode, D. J., Yadav, V., Jain, R., & Soni, G. (2020). Blockchain adoption in the supply chain: an appraisal on challenges. *Journal of Manufacturing Technology Management*, *32*(1), 42-62. https://doi.org/10.1108/JMTM-11-2019-0395

Giri, G., & Manohar, H. (2021). Factors influencing the acceptance of private and public blockchain-based collaboration among supply chain practitioners: a parallel mediation model. *Supply Chain Management: An International Journal*, *ahead-of-print* (ahead-of-print). https://doi.org/10.1108/scm-02-2021-0057

Godoe, P. & Johansen, T. (2012). Understanding adoption of new technologies: Technology readiness and technology acceptance as an integrated concept. *Journal of European Psychology Students, 3*(1), pp.38–52. http://doi.org/10.5334/jeps.aq

Godoe, P., & Johansen, T. S. (2012). Understanding the adoption of new technologies: Technology readiness and technology acceptance as an integrated concept. *Journal of European Psychology Students, 3*, 38-52. http://doi.org/10.5334/jeps.aq

Gökalp, E., Gökalp, M. O., & Çoban, S. (2020). Blockchain-based supply chain management: understanding the determinants of adoption in the context of organizations. *Information Systems Management*, 1-22.

Government Offices of Sweden (2021, September 16). *Sweden's pathway for sustainable food systems*. https://summitdialogues.org/wp-content/uploads/2021/09/Swedish-National-Pathway-for-Sustainable-Food-Systems-Final.pdf

Govindan, K., & Hasanagic, M. (2018). A systematic review on drivers, barriers, and practices towards a circular economy: a supply chain perspective. *International Journal of Production Research*, *56*(1-2), 278-311.

Gunasekera, D., & Valenzuela, E. (2020). Adoption of Blockchain Technology in the Australian Grains Trade: An Assessment of Potential Economic Effects. *Economic Papers: A journal of applied economics and policy*, *39* (2), 152-161

Gurtu, A., & Johny, J. (2019). Potential of blockchain technology in supply chain management: a literature review. *International Journal of Physical Distribution & Logistics Management*, *49*(9), 881-900. https://doi.org/10.1108/IJPDLM-11-2018-0371

Haddud, A., & Khare, A. (2020). Digitalizing supply chains potential benefits and impact on lean operations. *International Journal of Lean Six Sigma*.

Hair, J. (2015). *Essentials of Business Research Methods*. New Delhi: Pearson Prentice Hall.

Härting, R. C., Sprengel, A., Wottle, K., & Rettenmaier, J. (2020). Potentials of Blockchain Technologies in Supply Chain Management - A Conceptual Model. *Procedia Computer Science*, *176*, 1950-1959.

Hazen, B.T., Overstreet, R.E., & Cegielski, C. (2012). Supply chain innovation diffusion: Going beyond adoption. *The International Journal of Logistics Management*, *23*(1), 119-134. http://dx.doi.org/10.1108/09574091211226957

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

Ho, S., & Ko, Y. (2008). Effects of self-service technology on customer value and customer readiness. *Internet Research*, *18*(4), 427-446. https://doi.org/10.1108/10662240810897826

Hox, J. J., & Boeije, H. R. (2005). Data collection, primary vs. secondary. *Encyclopedia of social measurement*, *1*(1), 593-599.

Hsu Meng, H., Chiu Chao, M., & Ju Teresa, L. (2004). Determinants of continued use of the WWW: integration of two theoretical models. *Industrial Management & Data Systems, 104*(9), 766-775. https://doi.org/10.1108/02635570410567757.

Hu, S., Huang, S., Huang, J., & Su, J. (2021). Blockchain and edge computing technology enabling organic agricultural supply chain: A framework solution to trust crisis. *Computers & Industrial Engineering*, *153*, 107079. https://doi.org/10.1016/j.cie.2020.107079

Hua, J., Wang, X., Kang, M., Wang, H., & Wang, F. Y. (2018, June). Blockchain based provenance for agricultural products: A distributed platform with duplicated and shared bookkeeping. In *2018 IEEE Intelligent Vehicles Symposium (IV)* (pp. 97-101). IEEE.

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.

Issa, I., & Hamm, U. J. S. (2017). Adopting organic farming as an opportunity for Syrian farmers of fresh fruit and vegetables: Applying the theory of planned behavior and structural equation modeling. *Sustainability*, *9*(11), 2024. https://doi.org/10.3390/su9112024

Jabbar, S., Lloyd, H., Hammoudeh, M., Adebisi, B., & Raza, U. (2020). Blockchain-enabled supply chain: analysis, challenges, and future directions. *Multimedia Systems*, *27*(4), 787-806. https://doi.org/10.1007/s00530-020-00687-0

Jain, G., Singh, H., Chaturvedi, K., & Rakesh, S. (2020). Blockchain in the logistics industry: in fizz customer trust or not. *Journal of Enterprise Information Management*, *33*(3), 541-558. https://doi.org/10.1108/jeim-06-2018-0142

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. S., Gunasekaran, A., & Sharma, R. (2020). Modeling the Blockchain enabled traceability in agriculture supply chain. *International Journal of Information Management*, *52*, 101967.

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., Gunasekaran, A., & Sharma, R. (2020). Modelling the blockchain-enabled traceability in the agriculture supply chain. *International Journal of Information Management*, *52*, 101967. https://doi.org/10.1016/j.ijinfomgt.2019.05.023

Kamble, S.S., Gunasekeran, A., Subramanian, N., & Ghadge, A., et al. (2021). Blockchain technology's impact on supply chain integration and sustainable supply chain performance: Evidence from the automotive industry. *Annals of Operations Research*, 1-27. https://doi.org/10.1007/s10479-021-04129-6

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.

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

Khazaei, H. (2020). Integrating cognitive antecedents to the UTAUT model to explain the adoption of blockchain technology among Malaysian SMEs. *JOIV: International Journal on Informatics Visualization*, *4*(2). https://doi.org/10.30630/joiv.4.2.362

Kim, J.-S., & Shin, N. (2019). The impact of blockchain technology application on supply chain partnership and performance. *Sustainability, 11*(21), 6181. https://doi.org/10.3390/su11216181

Koberg, E., & Longoni, A. (2019). A systematic review of sustainable supply chain management in global supply chains. *Journal of cleaner production*, *207*, 1084-1098.

Köhler, S., & Pizzol, M. (2020). Technology assessment of blockchain-based technologies in the food supply chain. *Journal of Cleaner Production*, *269*, 122193.

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

Kosgei, A. Moturi, C. A (2021). Is Kenya ready to Leverage Blockchain Technology in Horticulture Traceability? *Kenya Policy Briefs, 2*(1), 59–60. http://erepository.uonbi.ac.ke/handle/11295/154880

Kosmarski, A. (2020). Blockchain adoption in academia promises and challenges. *Journal of Open Innovation: Technology, Market, and Complexity*, *6*(4), 117.

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.

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. https://doi.org/10.1016/j.ijpe.2020.107831

Krishnan, A., Banga, K., & Mendez-Parra, M. (2020). Disruptive technologies in agricultural value chains. *Enhanced Integrated Framework*, Working Paper, no. 576, 1-60. https://cdn.odi.org/media/documents/disruptive_agritech_-_5_mar_2020_-_final_draft.pdf

Kshetri, N. (2019). Blockchain and the economics of food safety. *IT Professional*, *21*(3), 63-66.

Kshetri, N., & Loukoianova, E. (2019). Blockchain Adoption in Supply Chain Networks in Asia. *IT Professional, 21*(1), 11-15. doi:10.1109/MITP.2018.2881307

Kumar, A., Liu, R., & Shan, Z. (2020). Is Blockchain a silver bullet for supply chain management? Technical challenges and research opportunities. *Decision Sciences*, *51*(1), 8-37.

Ledger Insights (2020, August 31). *Australia Creates Supply Chain, Credentialing Working Groups for National Blockchain Strategy - Ledger Insights - Enterprise Blockchain.* Ledger Insights - enterprise blockchain. https://www.ledgerinsights.com/australia-creates-supply-chain-credentialing-working-groups-for-national-blockchain-strategy/.

Lee, L., Fiedler, K., & Mautz, R. J. I. A. (2018). Internal Audit and the BLOCKCHAIN: There is more to Blockchain than bitcoin, and auditors have much to learn about how it works. *Internal Auditor*, *75*(4), 41-46.

Lee, H., & Yeon, C. (2021). Blockchain-Based Traceability for Anti-Counterfeit in Cross-Border E-Commerce Transactions. *Sustainability*, *13*(1), 1-20. https://doi.org/10.3390/su131911057

Leema, R., Kiruba, K., Hemalatha, P., Manikandan, J., Madhin, M., & Mohan, R. (2021). Revolutionizing secure commercialization in agriculture using blockchain technology. *Journal of Production Research,* *5*(2), 87-103. https://doi.org/10.1109/icscan53069.2021.9526452

Lehtinen, U. (2017). Sustainable supply chain management in agri-food chains: A competitive factor for food exporters. *Sustainability challenges in the agro food sector*, *150*.

Li, J. (2020). Blockchain technology adoption: examining the fundamental drivers. In *Proceedings of the 2020 2nd International Conference on Management Science and Industrial Engineering* (pp. 253-260).

Li, X., Wang, D., & Li, M. (2020). Convenience analysis of sustainable E-agriculture based on blockchain technology. *Journal of Cleaner Production*, *271*, 122503.

Liao, Y., Deschamps, F., Loures, E., & Ramos, L. (2017). Past, present, and future of Industry 4.0 - a systematic literature review and research agenda proposal. *International Journal of Production Research*, *55*(12), 3609-3629. https://doi.org/10.1080/00207543.2017.1308576

Lin, J., Shen, Z., Zhang, A., & Chai, Y. (2018, July). Blockchain and IoT based food traceability for smart agriculture. In *Proceedings of the 3rd International Conference on Crowd Science and Engineering* (pp. 1-7). https://hdl.handle.net/10356/137329

Lin, W., Huang, X., Fang, H., Wang, V., Hua, Y., & Wang, J. (2020). Blockchain Technology in Current Agricultural Systems: From Techniques to Applications. *IEEE Access*, 8, 143920-143937. doi: 10.1109/access.2020.3014522

Lin, W., Huang, X., Fang, H., Wang, V., Hua, Y., Wang, J., & Yau, L. (2020). Blockchain technology in current agricultural systems: from techniques to applications. *IEEE Access*, *8*, 143920-143937.

Lin, W., Ortega, D., Ufer, D., Caputo, V., & Awokuse, T. (2020). Blockchain-based traceability and demand for U.S. beef in China. *Applied Economic Perspectives and Policy*, 6(3), 12-27. https://doi.org/10.1002/aepp.13135

Lin, Y., Petway, J., Anthony, J., Mukhtar, H., Liao, S., Chou, C., & Ho, Y. (2017). Blockchain: The Evolutionary Next Step for ICT E-Agriculture. *Environments*, *4*(3), 50. https://doi.org/10.3390/environments4030050

Linsner, S., Kuntke, F., Schmidbauer-Wolf, G. M., & Reuter, C. (2019). Blockchain in Agriculture 4.0-An Empirical Study on Farmers Expectations towards Distributed Services based on Distributed Ledger Technology. In *Proceedings of Mensch und Computer 2019* (pp. 103-113).

Longo, F., Nicoletti, L., & Padovano, A. (2019). Estimating the impact of blockchain adoption in the food processing industry and supply chain. *International Journal of Food Engineering*, *9*(8), 89-111. https://doi.org/10.1515/ijfe-2019-0109

Maestrini, V., Luzzini, D., Maccarrone, P., & Caniato, F. (2017). Supply chain performance measurement systems: A systematic review and research agenda. *International Journal of Production Economics*, *183*, 299-315.

Malik, M. S., Chadhar, M., & Chetty, M. (2021). Factors affecting the organizational adoption of blockchain technology: an Australian perspective. In *Proceedings of the 54th Hawaii International Conference on System Sciences*, 5597-5606

Mangla, S., Kazancoglu, Y., Ekinci, E., Liu, M., Özbiltekin, M., & Sezer, M. (2021). Using system dynamics to analyze the societal impacts of blockchain technology in milk supply chains refer. *Transportation Research Part E: Logistics and Transportation Review*, *149*, 102289. https://doi.org/10.1016/j.tre.2021.102289

Meyer, A., Walter, W., & Seuring, S. (2021). The impact of the coronavirus pandemic on supply chains and their sustainability: A text mining approach. *Frontiers in Sustainability*, 1-5. https://www.frontiersin.org/articles/10.3389/frsus.2021.631182/

Mirabelli, G., & Solina, V. (2020). Blockchain and agricultural supply chains traceability: research trends and future challenges. *Procedia Manufacturing*, *42*(1), 414-421. doi: 10.1016/j.promfg.2020.02.054

Mishra, H., & Maheshwari, P. (2021). Blockchain in Indian Public Distribution System: a conceptual framework to prevent leakage of the supplies and its enablers and disablers. *Journal of Global Operations and Strategic Sourcing, 14*(2), 312-335. https://doi.org/10.1108/jgoss-07-2020-0044

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L. A., & PRISMA-P Group (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic reviews*, *4*(1), 1-5.

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.

Montes de Oca Munguia, O., Pannell, D., & Llewellyn, R. (2021). Understanding the Adoption of Innovations in Agriculture: A Review of Selected Conceptual Models. *Agronomy, 11*(1), 139. https://doi.org/10.3390/agronomy11010139

Morgan, T. R., Richey Jr, R. G., & Ellinger, A. E. (2018). Supplier transparency: scale development and validation. *The International Journal of Logistics Management*, *29*(3), 959-984. https://doi.org/10.1108/IJLM-01-2017-0018

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

Motta, G. A., Tekinerdogan, B., & Athanasiadis, I. N. (2020). Blockchain applications in the agri-food domain: The first wave. *Frontiers in Blockchain*, *3*, 6.

Mousaei, M., & Khoshoei, L. (2020). Factors affecting behavioural intention to use information and communication technology (Case study: Farmers in Behbahan, Iran). *Global Journal of Agricultural Economics, Extension and Rural Development, 8* (1), 1-3.

Mukherjee, A., Singh, R., Mishra, R., & Bag, S. (2021). Application of blockchain technology for sustainable development in the agricultural supply chain: justification framework. *Operations Management Research*, *2*(1), 67-89. https://doi.org/10.1007/s12063-021-00180-5.

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. *Decentralized Business Review*, 21260.

Nakasumi, M. (2017). *Information sharing for supply chain management based on blockchain technology.* Paper presented at the 2017 IEEE 19th conference on business informatics (CBI).

Nathani, M. U., & Singh, J. S. K. (2020). Using Blockchain for effective risk management in the supply chain: a qualitative study. *Global Business & Management Research*, *12*(3).

Ng, C., & Siew Hoong Lee, A. (2021). Factors influencing the acceptance of blockchain technology: Real estate industry. *The 4Th International Conference on Software Engineering and Information Management*, *8*(1), 212-237. https://doi.org/10.1145/3451471.3451482

Nuryyev, G., Wang, Y. P., Achyldurdyyeva, J., Jaw, B. S., Yeh, Y. S., Lin, H. T., & Wu, L. F. (2020). Blockchain technology adoption behavior and sustainability of the business in tourism and hospitality SMEs: An empirical study. *Sustainability*, *12*(3), 1256.

Öztürk, C., & Yildizbaşi, A. (2020). Barriers to implementation of Blockchain into supply chain management using an integrated multi-criteria decision-making method: a numerical example. *Soft Computing*, *24*(19), 14771-14789.

Paliwal, V., Chandra, S., & Sharma, S. (2020). Blockchain Technology for Sustainable Supply Chain Management: A Systematic Literature Review and a Classification Framework. *Sustainability*, *12*(18), 7638. https://doi.org/10.3390/su12187638

Parasuraman, A. (1999). Technology Readiness Index: Instructions for Use in a Survey. *Rockbridge Associates Inc. Washington, DC*.

Parasuraman, A. (2000). Technology Readiness Index (Tri). *Journal of Service Research*, *2*(4), 307-320. https://doi.org/10.1177/109467050024001.

Park, A., & Li, H. (2021). The Effect of Blockchain Technology on Supply Chain Sustainability Performances. *Sustainability*, *13*(4), 1726. https://doi.org/10.3390/su13041726

Park, K. O. (2020). A study on sustainable usage intention of blockchain in the big data era: logistics and supply chain management companies. *Sustainability*, *12*(24), 10670.

Patel, H., & Shrimali, B. (2021). AgriOnBlock: Secured data harvesting for the agriculture sector using blockchain technology. *ICT Express*, *5*(3), 78-88. https://doi.org/10.1016/j.icte.2021.07.003

Paul, S.K., Chowdhury, P., Moktadir, M.A., & Lau, K.H. (2021). Supply chain recovery challenges in the wake of COVID-19 pandemic. *Journal of Business Research*, *136* (1), 316-329. https://www.sciencedirect.com/science/article/pii/S0148296321005464

Perboli, G., Musso, S., & Rosano, M. (2018). Blockchain in logistics and supply chain: A lean approach for designing real-world use cases. *IEEE Access*, *6*, 62018-62028.

Prashar, D., Jha, N., Jha, S., Lee, Y., & Joshi, G. (2020). Blockchain-based traceability and visibility for agricultural products: A decentralized way of ensuring food safety in india. *Sustainability*, *12*(8), 3497. doi: 10.3390/su12083497

Pufahl, L., Ohlsson, B., Weber, I., Harper, G., & Weston, E. (2021). Enabling financing in agricultural supply chains through blockchain. In *Business Process Management Cases Vol. 2* (pp. 41-56). Springer, Berlin, Heidelberg.

Queiroz, M. M., Fosso Wamba, S., De Bourmont, M., & Telles, R. (2020). Blockchain adoption in operations and supply chain management: empirical evidence from an emerging economy. *International Journal of Production Research*, 1-17.

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*, *25*(2), 241-254.

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

Quzmar, A., Qatawneh, M., & Al-Maliah, S. (2021). Reducing counterfeit drugs with blockchains: A survey. *International Conference on Information Technology*, 143-148. https://www.researchgate.net/publication/353488444

Ramli, N.A., Latan H., & Nartea G.V. (2018). *Why should PLS-SEM be used rather than regression? Evidence from the capital structure perspective*. In: Avkiran N., Ringle C. (Eds) Partial least squares structural equation modelling. *International Series in Operations Research & Management Science, 267*. Springer, Cham. https://doi.org/10.1007/978-3-319-71691-6_6

Rana, R. L., Tricase, C., & De Cesare, L. (2021). Blockchain technology for a sustainable agri-food supply chain. *British Food Journal*, *123*(11), 3471-3485. https://doi.org/10.1108/BFJ-09-2020-0832

Rana, R., Tricase, C., & De Cesare, L. (2021). Blockchain technology for a sustainable agri-food supply chain. *British Food Journal*, *ahead-of-print* (ahead-of-print). https://doi.org/10.1108/bfj-09-2020-0832

Rees, J. (2020, February 10). *How Blockchain Is Revolutionizing The Supply Chain Industry? ReadWrite*. https://readwrite.com/2020/02/10/how-blockchain-is-revolutionizing-the-supply-chain-industry/.

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.

Reyna, A., Martín, C., Chen, J., Soler, E., & Díaz, M. (2018). On Blockchain and its integration with IoT. Challenges and opportunities. *Future generation computer systems*, *88*, 173-190.

Ringle, C. M., Wende, S., and Becker, J.-M. (2015). *SmartPLS 3. Boenningstedt: SmartPLS GmbH*. Newbury Park, Calif.: Sage Publications.

Rocha, G., de Oliveira, L., & Talamini, E. (2021). Blockchain Applications in Agribusiness: A Systematic Review. *Future Internet*, *13*(4), 95. https://doi.org/10.3390/fi13040095

Rogerson, M., & Parry, G. C. (2020). Blockchain: case studies in food supply chain visibility. *Supply Chain Management: An International Journal*, *25*(5), 601-614.

Ronaghi, M. (2020). A blockchain maturity model in the agricultural supply chain. *Information Processing in Agriculture*, *7*(3), 231-256. https://doi.org/10.1016/j.inpa.2020.10.004

Ruoti, S., Kaiser, B., Yerukhimovich, A., Clark, J., & Cunningham, R. (2019). Blockchain technology: what is it good for? *Communications of the ACM*, *63*(1), 46-53.

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.

Sajja, G., Rane, K., Phasinam, K., Kassanuk, T., Okoronkwo, E., & Prabhu, P. (2021). Towards applicability of blockchain in the agriculture sector. *Materials Today: Proceedings, 5*(2), 45-61. https://doi.org/10.1016/j.matpr.2021.07.366

Salah, K., Nizamuddin, N., Jayaraman, R., & Omar, M. (2019). Blockchain-based soybean traceability in agricultural supply chain. *IEEE Access*, *7*, 73295-73305.

Saunders, M., & Lewis, P. (2012). *Doing research in business and management: an essential guide to planning your project*. Harlow, England: Financial Times Prentice Hall.

Saunders, M., Lewis, P., & Thornhill, A. (2016). *Research methods for business students* (7. Ed.). Harlow, England: Pearson Education Limited.

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

Sharma, M., & Joshi, S. (2021). Barriers to blockchain adoption in the healthcare industry: An Indian perspective. *Journal of Global Operations and Strategic Sourcing*, *14*(1), 1-5.

Sharma, M., & Kumar, P. (2021). Adoption of blockchain technology: A case study of Walmart. In book: *Blockchain Technology and Applications for Digital Marketing* (pp.210-225). http://dx.doi.org/10.4018/978-1-7998-8081-3.ch013

Sharma, R., Samad, T. A., Jabbour, C. J. C., & de Queiroz, M. J. (2021). Leveraging blockchain technology for circularity in agricultural supply chains: Evidence from a fast-growing economy. *Journal of Enterprise Information Management*, 1-5. https://doi.org/10.1108/JEIM-02-2021-0094

Sheel, A., & Nath, V. (2019). Effect of blockchain technology adoption on supply chain adaptability, agility, alignment, and performance. *Management Research Review*, *42*(12), 1353-1374.

Sheel, A., & Nath, V. (2020). Blockchain technology adoption in the supply chain (UTAUT2) with risk)-evidence from Indian supply chains. *International Journal of Applied Management Science*, *12*(4), 324. https://doi.org/10.1504/ijams.2020.110344

Shepherd, M., Turner, J. A., Small, B., & Wheeler, D. (2020). Priorities for science to overcome hurdles thwarting the full promise of the 'digital agriculture' revolution. *Journal of the Science of Food and Agriculture*, *100*(14), 5083-5092.

Shrestha, A., & Vassileva, J. (2019). User acceptance of usable blockchain-based research data sharing system: an extended TAM-Based Study. *Sustainability*, *13*(4), 1801- 1817. https://doi.org/10.1109/tps-isa48467.2019.00033

Soosay, C. A., & Hyland, P. (2015). A decade of supply chain collaboration and directions for future research. *Supply Chain Management, 20*(6), 613-630. https://doi.org/10.1108/SCM-06-2015-0217

Subramanian, N., Chaudhuri, A., & Kayikci, Y. (2020). Blockchain applications in the food supply chain. *Blockchain and Supply Chain Logistics*, 21-29. https://doi.org/10.1007/978-3-030-47531-4_3

Sunny, J., Undralla, N., & Madhusudanan Pillai, V. (2020). Supply chain transparency through blockchain-based traceability: An overview with demonstration. *Computers & Industrial Engineering*, *150*, 106895. https://doi.org/10.1016/j.cie.2020.106895

Swan, M. (2015). Blockchain thinking: The brain as a decentralized autonomous corporation [commentary]. *IEEE Technology and Society Magazine*, *34*(4), 41-52.

Taylor, S., & Todd, P. A. (1995). Understanding Information Technology Usage: A Test of Competing Models. *Information Systems Research,* *6*(2), 144-176. https://doi.org/10.1287/isre.6.2.144

The World Bank (2022). *Agriculture and food: Overview*. https://www.worldbank.org/en/topic/agriculture/overview#1

Thiruchelvam, V., Mughisha, A. S., Shahpasand, M., & Bamiah, M. (2018). Blockchain-based technology in the coffee supply chain trade: Case of Burundi coffee. *Journal of Telecommunication, Electronic and Computer Engineering (JTEC)*, *10*(3-2), 121-125.

Tian, F. (2017, June). A supply chain traceability system for food safety based on HACCP, Blockchain & internet of things. In *2017 International conference on service systems and service management* (pp. 1-6). IEEE.

Tian, F. (2017, June). A supply chain traceability system for food safety based on HACCP, Blockchain & internet of things. In *2017 International conference on service systems and service management* (pp. 1-6). IEEE.

Tieman, M., & Darun, M. R. (2017). Leveraging blockchain technology for halal supply chains. *ICR Journal*, *8*(4), 547-550.

Tipmontian, J., Alcover, J., & Rajmohan, M. (2020). Impact of Blockchain Adoption for Safe Food Supply Chain Management through System Dynamics Approach from Management Perspectives in Thailand. *Blockchain and Supply Chain Logistics*, *39*(1), 14. https://doi.org/10.3390/proceedings2019039014

Tiscini, R., Testarmata, S., & Ciaburri, M. (2020). The blockchain as a sustainable business model innovation. *Management Decision*, *58*(8), 1621-1642. http://dx.doi.org/10.1108/MD-09-2019-1281

Tliche, Y., Taghipour, A., & Canel-Depitre, B. (2019). Downstream Demand Inference in decentralized supply chains. *European Journal of Operational Research*, *274*(1), 65-77. https://doi.org/10.1016/j.ejor.2018.09.034

Todd, P., & Model, T. A. (1995). Assessing IT usage: The role of prior experience the influence of prior experience. *Journal of Research in Marketing, 19*(4), 561–570.

Tönnissen, S., & Teuteberg, F. (2020). Analyzing blockchain-technology impact for operations and supply chain management: An explanatory model drawn from multiple case studies. *International Journal of Information Management*, *52*, 101953.

Toptanci, A. (2021). Adoption of blockchain technology in the agricultural sector and food supply chain. *Journal of Information Management*, *42(3)*, 70-82. https://doi.org/10.13616/j.ijinfomgt.2018.11.021y

Tran, L., & Nguyen, P. (2021). Co-creating blockchain adoption: theory, practice, and impact on user behaviour. *Asia Pacific Journal of Marketing and Logistics*, *33*(7), 1667-1684. https://doi.org/10.1108/apjml-08-2020-0609

Tripoli, M., & Schmidhuber, J. (2018). Emerging Opportunities for the Application of Blockchain in the Agri-food Industry. *FAO and ICTSD: Rome and Geneva. Licence: CC BY-NC-SA*, *3*.

Tsang, Y. P., Choy, K. L., Wu, C. H., Ho, G. T. S., & Lam, H. Y. (2019). Blockchain-driven IoT for food traceability with an integrated consensus mechanism. *IEEE access*, *7*, 129000-129017.

Tse, D., Zhang, B., Yang, Y., Cheng, C., & Mu, H. (2017, December). Blockchain application in food supply information security. In *2017 IEEE international conference on industrial engineering and engineering management (IEEM)* (pp. 1357-1361). IEEE.

Ullah, N. (2020). Integrating TAM/TRI/TPB frameworks and expanding their characteristic constructs for DLT adoption by Service and Manufacturing Industries-Pakistan

Context. In 2020 International Conference on Technology and Entrepreneurship (ICTE) (pp. 1-5). IEEE.

Underwood, S. (2016). Blockchain beyond bitcoin. *Communications of the ACM*, *59*(11), 15-17.

Van Donk, T., van der Vaart., A. Awaysheh, & R. D. Klassen. (2010). The impact of supply chain structure on the use of supplier socially responsible practices. *International Journal of Operations & Production Management, 30*(9), 1246-1268.

Venkatesh, V., & Zhang, X. (2010). Unified Theory of Acceptance and Use of Technology: U.S. Vs. China. *Journal of Global Information Technology Management*, *13*(1), 5-27. https://doi.org/10.1080/1097198x.2010.10856507

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly, 27*(3), 425-478. https://doi.org/10.2307/30036540

Verma, M. (2021). Smart contract model for trust-based agriculture using blockchain technology. *International Journal of Research and Analytical Reviews, 8*(2), 343-345

Vinesh T., Mughisha, S., Shahpasand, M., Mervat, B. Blockchain-based Technology in the Coffee Supply Chain Trade: Case of Burundi Coffee. *Journal of Information Management, 10*(3), 121-135. https://www.academia.edu/37503428/

Wamba, S., & Queiroz, M. (2020). Blockchain in the operations and supply chain management: Benefits, challenges, and future research opportunities. *International Journal of Information Management*, *52*(1), 102064-10265. https://doi.org/10.1016/j.ijinfomgt.2019.102064

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.

Westerlund, M., Nene, S., Leminen, S., & Rajahonka, M. (2021). An Exploration of Blockchain-based Traceability in Food Supply Chains: On the Benefits of Distributed Digital Records from Farm to Fork. *Technology Innovation Management Review*, *11*(6).

Wu, I., & Chen, J. (2005). An extension of trust and TAM model with TPB in the initial adoption of online tax: An empirical study. *International Journal of Human-Computer Studies*, *62*(6), 784-808. https://doi.org/10.1016/j.ijhcs.2005.03.003

Wu, X., Fan, Z., & Cao, B. (2021). An analysis of strategies for adopting blockchain technology in the fresh produce supply chain. *International Journal of Production Research*, 1-18. https://doi.org/10.1080/00207543.2021.1894497

Xiong, H., Dalhaus, T., Wang, P., & Huang, J. (2020). Blockchain technology for agriculture: Applications and rationale. *Frontiers in Blockchain*, 1-10. https://www.frontiersin.org/articles/10.3389/fbloc.2020.00007/full

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

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.

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

Yermack, D. (2017). Corporate governance and blockchain. *Review of finance*, *21*(1), 7-31.

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

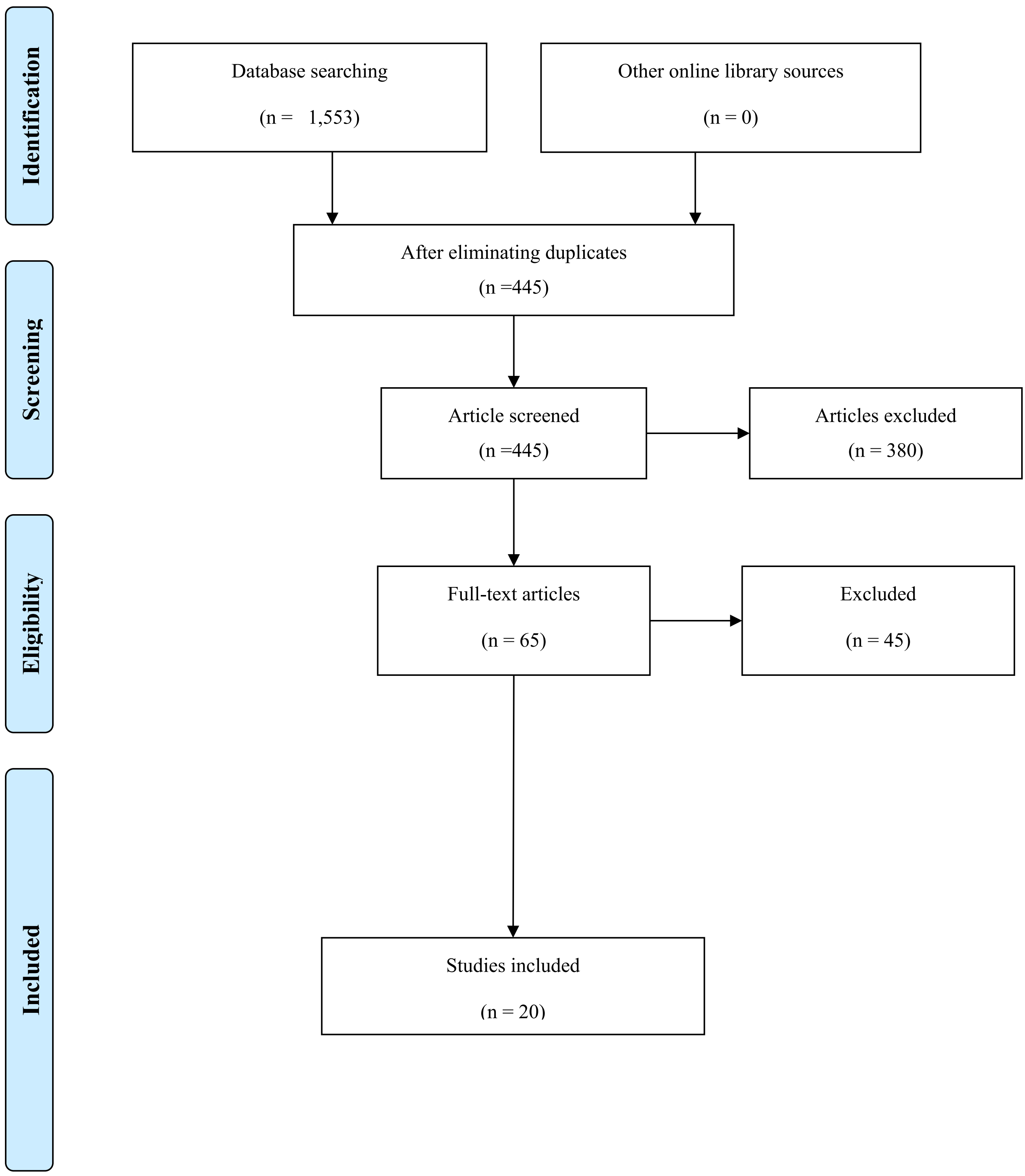
Zelbst, P. J., Green, K. W., Sower, V. E., & Bond, P. L. (2019). The impact of RFID, IIoT, and Blockchain technologies on supply chain transparency. *Journal of Manufacturing Technology Management*, *33*(3), 1-5.

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.

Zhang, J. (2019). *Deploying blockchain technology in the supply chain*. IntechOpen. https://www.intechopen.com/chapters/67390

APPENDICES

Appendix 1: PRISMA Flowchart



Appendix 2: Search Log

Date	**Search Strategy**	**Database**	**Results**	**Fields searched**	**Notes**
9/30/2020	"Blockchain Technology" AND "Supply Chain" AND "Australian Agriculture Supply Chain"	Google Scholar	412	All	Search narrowed down to new studies (2019 to present) due to a high number of hits
9/30/2020	"Blockchain Technology" AND "Australian Agriculture Supply Chain"	Science Direct	533	All	Limited studies specific to Australia
9/30/2020	("Considerations" OR "Factors") AND (Blockchain* OR Blockchain technology*) AND "Australian agriculture supply chain."	Elsevier	580	All	Good articles on factors and considerations for the adoption of Blockchain technology
9/30/2020	("Benefits" OR "Effects" OR "Advantages") AND "Block Chain Technology" AND "Australian Agriculture Supply Chain"	Others	116	All	Random search from all databases to find studies that focus on the advantages/impacts/benefits of Blockchain technology
		Total	**1,641**		

Appendix 3: Methodological Quality Assessment and Depth of Reporting

STUDIE	STROBE ITEMS															
	1	2	3	4	5	7	8	11	12(	12(	12(	16(	1	1	2	2	2
Queiroz,	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	P	N
Kamble,	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	P	Y	Y	N
Kumpaja	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	P	N
Queiroz	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	P	N
Yadav,	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	P
Linsner	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	P	Y	P	P
Lin, et	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	P	Y	P	P
Awa, et	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y
Rogerso	Y	Y	Y	Y	Y	N/	Y	N/	N/A	N	N	Y	Y	P	Y	P	N
Lin et al.	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	P	N
Prashar	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	P	Y	Y	N
Korpela	Y	Y	Y	Y	Y	N/	Y	N/	N/A	N	N	Y	Y	P	Y	P	N
Nathani	Y	Y	Y	Y	Y	N/	Y	N/	N/A	N	N	Y	Y	P	Y	P	N
Alazab et	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	P	N
Nuryyev	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	N
Sharma	Y	Y	Y	Y	Y	N/	Y	N/	N/A	Y	N	Y	Y	N	Y	P	N
Kosmars	Y	Y	Y	Y	Y	N/	Y	N/	N/A	N	N	Y	Y	Y	Y	P	Y
Li (2020)	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	Y
Malik et	Y	Y	Y	Y	Y	N/	Y	N/	N/A	N	N	Y	Y	N	Y	Y	N
Park	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	P	Y	P	N

Key: 1(b): Abstract, 2: Background/rationale, 3: Objective, 4. Study design, 5: Setting, 7: Variables, 8: Data sources/measurement, 11: Quantitative variables, 12(a): Statistical methods with control variables, 12(c): Addressing missing data, 12(e): Sensitivity analysis, 16(a): Main results, 18: Key results, 19: limitations, 20: Interpretation, 21: Generalisability, 22: Funding.

Items 6, 9, 10, 12b, 12d, 13, 14, 15, 16b, 16c, and 17 were not applicable for assessing the papers included in this study.
Y = present, N = not present, P = partially present, N/A = not applicable. **% Positive judgments =** total +/total paper