The impact of a blockchain platform on trust in established relationships: a case study of wine supply chains

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Abstract

Purpose – This paper examines the impact of a blockchain platform on the role and importance of trust in established buyer-supplier relationships.

Design/methodology/approach – A literature review provides insight into trust development in supply chains. Research uses a case study of two wine supply chains: the producers, importers, logistics companies and UK Government agencies. Semi-structured interviews determine how trust and trustworthiness develop in buyer-supplier relationships and the impact of a blockchain-based technology proof of concept on supply chain trust.

Findings – A blockchain-based platform introduces common trusted data, reducing data duplication and improving supply chain visibility. The platform supports trust building between parties but does not replace the requirements for organisations to establish a position of trust. Contrary to literature claims for blockchain trustless disintermediation, new intermediaries are introduced who need to be trusted.

Research limitations/implications – The case study presents challenges specific to UK customs borders, and research needs to be repeated in different contexts to establish if findings are generalisable.

Practical implications – A blockchain-based platform can improve supply chain efficiency and trust development but does not remove the need for trust and trust-building processes. Blockchain platform providers need to build a position of trust with all participants.

Originality/value – Case study research shows how blockchain facilitates but does not remove trust, trustworthiness and trust relationships in established supply chains. The reduction in information asymmetry and improved supply chain visibility provided by blockchain does not change the importance of trust in established buyer-supplier relationships or the trust-based policy of the UK Government at the customs border.

Keywords Visibility, Information asymmetry, Trust, Supply chain, Blockchain, Trust ecosystem

Paper type Research paper

1. Introduction

Supply chain participants have long recognised the importance of the role of trust in building business relationships, whether business-to-business or business-to-customer (Handfield and Nichols, 1999; Svensson, 2001). Literature finds customers view trust alongside risk and reputation as interrelated factors when initiating a supply chain transaction (Sekhon *et al.*, 2013). Trust is the primary reason many companies cite when supply chain relationships are not working well (Ireland and Webb, 2007).

Current supply chain friction at UK borders is replicated across the world (Holmes, 2020). The UK border strategy paper (UK Government, 2020) describes policy to move towards the creation of a single trade window (STW), a concept whereby firms submit information to a single agency rather than multiple country-specific applications for import/export permissions. This paper draws on the Reducing Friction in International Trade project (RFIT) project, detailed within the UK Border Strategy (UK Government, 2020), creating a platform for common trusted data that reduces errors and improves data visibility. This paper further considers the challenge from the perspective of the development of trust in supply chains and of trust ecosystems (UK Government, 2021).

Understanding the trust ecosystem is currently of increasing importance given changes to the UK–EU relationship and border policy (UK Government, 2020; European Commission, 2020).

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The UK is seeking to establish technology leadership in reducing friction in cross border supply chains (Holmes, 2020).

Extant literature on the role of trust in supply chains examines the overlaps, consensus and contradictions on trust building between actors in simplex, linear supply chains (Lewicki *et al.*, 2006; Poppo *et al.*, 2016; Tejpal *et al.*, 2013). However, there is limited use of trust building frameworks to determine trust relationships within case studies of complex multiparty supply chains (Chen *et al.*, 2019). This paper enhances current trust building frameworks (Akrout, 2015; Laeequddin *et al.*, 2010; Chen *et al.*, 2019) to examine multilevel and multiparty trust relationships in current cross border supply chains.

Emergent digital services and technologies such as blockchain are expected to have a disruptive impact on existing industries, markets and supply chains (Abeyratne and Monfared, 2016; Maull *et al.*, 2017). Enhancing trust is a central discourse within the digital sharing economy (Mehrwald *et al.*, 2019), with blockchain described as "trust-free technology" (Beck *et al.*, 2016; Wang *et al.*, 2019) and as an architecture for "trustless trust" (Werbach, 2019). Blockchain disrupts supply chains by removing intermediaries (Maull *et al.*, 2017), reportedly providing the source of trust and trustworthiness required by participants (Wang *et al.*, 2019).

Shin and Bianco (2020) use qualitative methods to determine the affordance of trust in blockchain media acceptance, focussing on trust in technology and transactions, not end-to-end supply chains. However, there is no case study research examining how trust within established buyer-supplier relationships is impacted by blockchain implementation as an emergent digital technology. Research has considered the strengths and opportunities blockchain technology provides operations management, supply chain and Industry 4.0 from a theoretical perspective, often as systematic literature reviews (SLRs) (Babich and Hilary, 2020; Queiroz *et al.*, 2020). Research into how broader socio-economic aspects of trust change with the introduction of blockchain in supply chains focusses on trust in blockchain as a technology (Wang *et al.*, 2019) or is limited to theory (Mehrwald *et al.*, 2019; Batwa and Norrman, 2020). This paper uses primary case research from the RFIT project (Holmes, 2020) to consider how the introduction of blockchain-based technology as a proof-of-concept implementation changes the role of trust and trust-relationships between participants in two established international wine supply chains. Focus is placed on the role of trust and examines if the blockchain-based RFIT platform and its secured data is accepted as trustworthy by participants. Work examines how increased data and supply chain visibility changes, reduces or removes the importance of trust.

The case study research seeks to answer the following research question:

RQ1. How does the introduction of blockchain technology impact the role of trust in the buyer-supplier relationships within established supply chains?

The paper proceeds as follows. Literature provides theoretical underpinning, drawing on the importance and role of trust, trustworthiness and trust building frameworks within supply chains and buyer-supplier relationships. A review of the requirements for supply chain and data visibility follows. Then, we review the technological characteristics of blockchain and how inbuilt data transparency and integrity affect trust and trustworthiness. The research methodology describes the case study approach. Findings from two use cases of wine supply chain are presented, explaining the importance and changing role of trust following the implementation of a proof-of-concept blockchain-based RFIT platform. The discussion integrates literature and findings, outlining the major contributions of the paper. Finally, conclusions give implications for theory, practice and recommendations for future research.

2. Literature

2.1 The importance of trust and trustworthiness in supply chains

Trust research is interdisciplinary as trust plays a significant role in all aspects of interpersonal and economic interactions (Corazzini, 1977). There are many perspectives on trust. Rotter's (1967) psychology-based research defines the social view of trust as a belief that other people will honour obligations (Soroka *et al.*, 2003). McAllister's (1995) paper on "affect-based trust" considers the cognitive judgements of self about another's competence or reliability as an emotional bond of an individual towards another person. Trust can refer to "the expectation that a person can have confidence in, or reliance on, some quality or attribute when undertaking a business transaction" (Small and Dickie, 1999).

Mayer *et al.* (1995) propose improved trust understanding requires consideration of its evolution within the relationship between two parties: trustor and trustee. Trust aligns with an individual (trustor's) disposition to treat a trustee with benevolence and free will. Such positive expectations are typically defined as the other party's ability or competence, benevolence, integrity and predictability (Mayer *et al.*, 1995; McKnight *et al.*, 2002). Trust is seen to evolve as a gradual, self-reinforcing phenomenon (Zand, 1972) as the trustor places themselves in vulnerable situations. The trustee is the party in whom trust is placed, who can take advantage of the trustor's vulnerability. Trust is embedded within the trustor via their feelings, emotions and cognition (Svensson, 2001). This leads to notions of trustworthiness as a measure of a trustee's ability, benevolence and integrity (Mayer *et al.*, 1995; Doney and Cannon, 1997). In reliable and dependable trust relationships, supply chain risk is minimised (Mayer *et al.*, 1995; Doney and Cannon, 1997) and trust is established. When supply chain participants collaborate (Dyer and Singh, 1998), they share knowledge and resources, establishing trust (Liedtka, 1996). In trusting relationships, information and assets can be shared, which is essential for successful strategic partnerships (Handfield and Nichols, 1999). High levels of trust enable parties to focus on the long-term benefits of relationships (Ireland and Webb, 2007). Partnership, often the ultimate objective of supply chain relationships, requires high levels of perceived value in the relationship and service (Fawcett *et al.*, 2011). Trust contributes to relational strength but is also the reason firms cite when relationships are not working (Ireland and Webb, 2007).

Within a supply chain trust and trustworthiness are loosely coupled (Kujala *et al.*, 2016). Trustworthiness is considered the key antecedent of trust, as knowing someone is trustworthy reduces

the trustor's perceived vulnerability (Tejpal *et al.*, 2013). The trustor chooses (Li, 2015) and is motivated (Bundy *et al.*, 2018 and van der Werff *et al.*, 2019) to trust based on the trustee's characteristics or institutional assurance (Bachmann and Inkpen, 2011). Institution-based trust reduces the risk to the trustor, but it is fragile, relies on extrinsic predictability and deterrence (Child and Möllering, 2003) and acts as a control mechanism. Control (Long, 2021) and repair mechanisms (Bachmann *et al.*, 2015) are required to maintain affective trust in organisations. Trust is not isomorphic within or between organisations in a supply chain (Mollering *et al.*, 2021). There are multiple trustors and trustees who adopt different roles as goods pass through their organisations (Kujala *et al.*, 2016). Adoption of a service requires trust in the direct provider and their known and unknown suppliers (Sekhon *et al.*, 2013). Supply chain trust is dynamic, progressing via a series of stages as relationships between trustee and trustor change (Fawcett *et al.*, 2011).

Literature details a number of multidimensional frameworks, which integrate different levels of trust within the supply chain (Laeequddin *et al.*, 2010; Akrout, 2015; and Chen *et al.*, 2019). These frameworks build on and are in consensus with Lewicki and Bunker's (1995) three stages: firstly, calculative trust based on an assessment of risk and reward; leads to knowledge-based trust based on others predictability and relies on information exchange; finally, identification trust draws on understanding the others wants and needs. Each stage balances trust and risk (Mayer *et al.*, 1995), analysing components (Svensson, 2001; Coulter and Coulter, 2002) and antecedents (Tejpal *et al.*, 2013; Sahay, 2003).

Laeequddin *et al.* (2010) confirm trust and risk are interlinked and are multidimensional. This framework consists of three stages that balance trust and risk: characteristic trust is assessed on the trustees' ability, benevolence, integrity and credibility; this leads to a rational stage where the economics of relationship, capabilities of partners and technology adoption develop into interpersonal trust based on calculations of professional relationships (Lewicki and Bunker,1995); finally, at the institutional stage contracts, agreements, control mechanisms and security predominate (Bachmann and Inkpen, 2011).

The Akrout (2015) and Akrout and Diallo (2017) framework defines stages of calculative, cognitive, affective and behavioural trust (Poppo *et al.*, 2016). Early in relationships, calculative trust dominates, and data integrity and information asymmetries characterise transactions (Lewicki and Bunker, 1995), where cost, benefit and reputation are core drivers (Sekhon *et al.*, 2013). As trust builds progressively, cognitive trust combines transactional and relational elements, expressed by expectations and predictions that partners will meet obligations (Johnson and Grayson, 2005). As the relationship matures, affective trust (Lewicki and Bunker, 1995; Kwon and Suh, 2005) builds on shared values, creating reciprocal durable personal attachments between buyers and sellers with behavioural trust (Mayer *et al.*, 1995). Reliance on others and disclosure of confidential information are key trusting behaviours (Lewicki *et al.*, 2006).

Chen *et al.*'s (2019) framework describe how calculative and relational trust influence the emergence of institutional-based trust (Li, 2015; Bachmann and Inkpen, 2011) and structural assurance (McKnight *et al.*, 1998).

Literature describes linear trust building frameworks, detailing the theoretical building of trust and trust relationships between two supply chain participants (Fawcett *et al.*, 2011; Akrout, 2015; Laeequddin *et al.*, 2010). Literature also includes a number of papers (Lewicki *et al.*, 2006; Poppo *et al.*, 2016; Tejpal *et al.*, 2013) that present the overlaps, consensus and contradictions of trust building between participants in linear supply chains. Case studies of supply chains using trust building frameworks are limited (Chen *et al.*, 2019). A gap in the literature appears as these frameworks do not consider complex supply chains with multiple participants; importers, producers, logistics companies and governments (customs and borders operations), with different trust relationships. This paper addresses that gap by examining trust in the context of RFIT for complex multiparty multilevel global supply chains (Holmes, 2020).

2.2 Information sharing and trust building

Theoretically, where supply chain members have access to complete mutual information, there is no risk and trust becomes irrelevant (Dasgupta, 1988). In practice, each stage of the trust development process requires a level of information sharing (Laeequddin *et al.*, 2010; Akrout, 2015). Information sharing and data integrity are pivotal to trust building (Bhattacharya *et al.*, 1998), starting from the first interaction where information is exchanged about past behaviours and promises (Doney and Cannon, 1997).

The sharing of information and assets is essential for the success of strategic partnerships (Handfield and Bechtel, 2002). Data and information exchange underpins supply chain trust development, creating a cooperative and collaborative environment (Formentini and Romano, 2016). Information sharing across supply chains is not limited to the transport mechanism (Davenport and Beers, 1995). It includes information content, quality, timeliness, accuracy and the decision-making process (Zhao *et al.*, 2002). Discrepancies combined with ineffective sharing lead to supply chain information asymmetry (Sahin and Robinson, 2002), which impacts performance (Shen *et al.*, 2019; Wiengarten *et al.*, 2016). Information and supply visibility is valuable (Fawcett *et al.*, 2011; Rogerson and Parry, 2020) as it can reduce inventory carrying costs and improve supply chain efficiencies. Technologies enabling sharing details of product orders and physical shipments, including transport and logistics activities (Prajogo and Olhager, 2012), improve supply chain information access and reduce information asymmetry (Formentini and Romano, 2016). Information sharing and supply chain visibility underpin the development of trust between participants, which is also the case with customs operations (UK Government, 2020).

2.3 Impact of blockchain as a new digital technology

Distributed ledger and blockchain technologies have potential applicability in many areas, including manufacturing and commercial supply chains (Abeyratne and Monfared, 2016). Blockchains combine several technologies: a distributed database, a decentralised consensus mechanism and cryptographic algorithms, providing four key technical features: distribution, security, immutability and trust. The combination of these features, rather than any individual element, is proposed as novel

and a disruptor for supply chains (Maull *et al.*, 2017; Abeyratne and Monfared, 2016).

There are three main forms of blockchain: public, private and consortium (Swanson, 2015), where private and consortium are typically considered as variations. Bitcoin is the best-known public blockchain implementation (Nakamoto, 2008) and uses a proof of work (PoW) algorithm to confirm transactions and produce new data blocks. PoW makes a controlling authority theoretically unnecessary (Xu *et al.*, 2017), leading to claims for "trust-less" technology. Private and consortium blockchains use permission-based access rights linked to identity (Swanson, 2015) and users must be invited and potentially screened. There are architectural differences, within a private blockchain network write permission is governed by one organisation. In contrast, within a consortium blockchain write permission is distributed to identifiable parties across multiple organisations (Zheng *et al.*, 2018).

Blockchains use cryptography to create complex, secure and immutable peer-to-peer transactions that are recorded within a common shared ledger (Mainelli and Milne, 2016). In-built consensus protocols ensure all participants have a consistent and transparent view of the ledger (Nakamoto, 2008). Blockchain supports a network of participants (Bonino and Vergori, 2017), providing a solution to the complexity of sharing data across distributed global supply chains (Abeyratne and Monfared, 2016). The common shared ledger is immutable and replicated to every node (Nakasumi, 2017), providing supply chain participants with a resilient source of trusted data (Wang *et al.*, 2019). Data is stored as a sequence of transactions in chronological blocks, broadcast to all nodes (Tian, 2018). Consensus mechanisms (Patel *et al.*, 2017; Weber *et al.*, 2016) ensure participants agree data set changes, leading to increased data security, immutability and confidence. When combined, the technical features of blockchain are claimed to help establish trust in the transactions between supply chain actors (Auinger and Riedl, 2018). A blockchain's method of establishing trust via the decentralised network (Nakasumi, 2017) presents a shift from traditional ways of organising and managing supply chains (Patel *et al.*, 2017; Wang *et al.*, 2019). Blockchains have been described as "trust-free technology" (Beck *et al.*, 2016) that decentralise trust and provide trust-by-computation representing "a shift from trusting people to trusting math" (Antonopoulos, 2014). However, the underlying assumption that trust can be so readily gained is not sufficiently tested in supply chain research.

Parties within the supply chain need to trust that information provided is accurate, complete and not unilaterally altered by another (Shen *et al.*, 2019). Blockchain can support trust building, as the data is difficult to unilaterally change, though this requires end-to-end supply chain implementation (Rogerson and Parry, 2020). Research on digital technology adoption (e.g. EDI, ERP and RFID) has been prominent in supply chain management over the past 10 years. The development of Internet of Things (IoT) devices has led to a resurgence of the topic (Feng and Shanthikumar, 2018). IoT devices can provide objective high-quality data (Kamble *et al.*, 2019), giving visibility through continuous sensor data from goods or locations across a supply chain (Parry *et al.*, 2016; Kshetri, 2018). Combining IoT devices with blockchain as an integration technology creates an immutable source of trusted data for supply chain participants (Babich and Hilary, 2020). Information becomes visible and immediate, reducing information asymmetry between parties (Morgan *et al.*, 2018). However, the technology itself needs to be trusted. van der Werff *et al.* (2021) draws a distinction between mediated trust (Bodó, 2020) and trust in technology (McKnight *et al.*, 2011). Trust in digital technology is constantly adapting (Sekhon *et al.*, 2013; van der Werff *et al.*, 2019). Trust in a supply chain is more complex than simple data exchange; it builds over time, is dynamic and multidimensional (Laeequddin *et al.*, 2010; Akrout and Diallo, 2017). A lack of trust in new technology and culture are barrier to the adoption of digital services due to uncertainty (Yousafzai *et al.*, 2009).

Current literature considers blockchain as an innovative technology as applied to operations management, supply chain and Industry 4.0 (Babich and Hilary, 2020; Olsen and Tomlin, 2020; Smith, 2020). SLR find that trust is the predominant factor driving the development of blockchain technology within supply chains (Wang *et al.*, 2019; Queiroz *et al.*, 2020; Varriale *et al.*, 2021), yet there is little empirical research to confirm this. Literature establishes data integrity and information exchange as important in the initial stages of trust building as they reduce information asymmetry (Sahin and Robinson, 2002). As trust builds the effect of information sharing reduces as psychosocial and socio-economic factors become more important (Akrout and Diallo, 2017). With the introduction of new technology and "the removal of intermediaries", established central counterparty trust developed across supply chains is distributed to multiple players (Maull, 2017). However, how or if this happens is not clear as the technology and its providers are presented as somehow integral to the supply chain and not as additional third parties. Blockchain technology changes data control from a centralised to a distributed, collaborative model (Blossey *et al.*, 2019). How trust in supply chain relationships may subsequently change has not been fully addressed.

Empirical studies of live projects examine how blockchain technology is practically deployed, focussing on asset traceability and provenance, not supply chain trust. McConaghy *et al.* (2017) implement blockchain for rights management in digital art; Kshetri (2018) examines a diverse set of IoT cases; and other work focusses on goods provenance/visibility within supply chains (Casino *et al.*, 2020; Hastig and Sodhi, 2020; Howson, 2020; Rogerson and Parry, 2020; Sternberg *et al.*, 2020; Xu *et al.*, 2021). Finally, Belu's (2020) paper describes the impact of blockchain on customs procedures and provides an exploratory case study but does not consider supply chain trust relationships. Research into broader socio-economic aspects of supply chain trust changes related to blockchain is limited to theory (Mehrwald *et al.*, 2019; Batwa and Norrman, 2020) or trust in blockchain as a technology (Auinger and Riedl, 2018; Wang *et al.*, 2019).

There is a gap in the literature as no case study considers the impact of digital technologies and blockchain on trust and trust relationships within complex supply chains with many participants; buyers, producers, logistics and government including customs/borders operations. This omission is addressed with the case of the UK Government's drive to consider how digital technologies can reduce friction at the border (Holmes, 2020), the UK border strategy (UK Government, 2020) and the EU's requirements for a STW (European Commission, 2020).

2.4 Literature summary

The literature review identifies several gaps in knowledge which this paper endeavours to address. Current literature details trust building frameworks for supply chains (Laeequddin *et al.*, 2010; Akrout, 2015; Chen *et al.*, 2019), but we found no single framework suitable to address the complex trust building relationships between multi-participant supply chains. To address this gap, the paper enhances Akrout's (2015) framework, showing where work from Laeequddin *et al.* (2010) and Chen *et al.* (2019) support calculative and institutional trust described by Rousseau *et al.* (1998), Li (2015) and Bachmann and Inkpen (2011), see Figure 1. The enhanced framework reinforces the inter-relationship between trustworthiness, trust in technology (McKnight *et al.*, 2011) and reputation (van der Werff *et al.*, 2021) as precursors for calculative trust. The framework also integrates literature on trust as a choice (Li, 2015) and trust as a motivation (van der Werff *et al.*, 2021). Trust in technology (Van der Werff *et al.*, 2019; Bodó, 2020; McKnight *et al.*, 2011) also supports calculative trust and contributes to "information sharing" alongside trust in data (Formentini and Romano, 2016), Figure 1.

The enhanced trust building framework is required to consider complex multiple participants cross-border supply chains. Recent friction(s) and the breakdown of trust in cross-border supply chains is causing trade disruption within the UK and across the globe (Holmes, 2020; UK Government, 2020). Friction in supply chains and the developing trust ecosystem (UK Government, 2020) leads to the next major omission: the literature does not consider how new digital technologies impact current trust and trust relationships established by participants within complex supply chains. With the development of the UK Government border strategy (UK Government, 2020) and the drive to a STW (European Commission, 2020), consideration of how disruptive digital technologies can change trust and develop an ecosystem of trust (UK Government, 2021) is becoming increasingly important. This paper's novelty is the case study examination of trust building and trust relationships between participants of an operational end-to-end international supply chain. Understanding is developed from the application of theory to the implementation of blockchain technology within a proof-of-concept project.

This leads to the research question:

RQ1. How does the introduction of blockchain technology impact the role of trust in the buyer-supplier relationships within established supply chains?

3. Methodology

3.1 Case based research

Case study research (Yin, 2018) draws on the RFIT project, a UK Government, Industry and Academia collaboration that commenced in March 2019 (Holmes, 2020). Understanding gained from the case study is relevant and meaningful (Farquhar, 2012) as it is the context of a current project. RFITs goal was to determine how emerging digital technology, blockchain, as a proof-of-concept implementation, can reduce friction in international trade at UK borders. The project seeks to identify if blockchain will simplify the importation process across an established end-to-end global supply chain while ensuring fiscal and regulatory compliance at the UK border (UK Government, 2020). The use cases are the movement of wine from producers in Australia to importers and consumers in the UK, providing a contemporary issue in context (Stake, 2006). Wine is either shipped in bottles in quantities of cases or pallets, or it is shipped in a bulk container to be bottled at destination. The supply chains used by two importers formed the research use cases (Yin, 2018).

The case approach used a standard protocol to increase reliability (Yin, 2018) and consisted of three phases, Figure 2. Practice focussed work is captured within "RFIT Case

Figure 1 Enhanced trust building framework. Adapted from Akrout (2015)

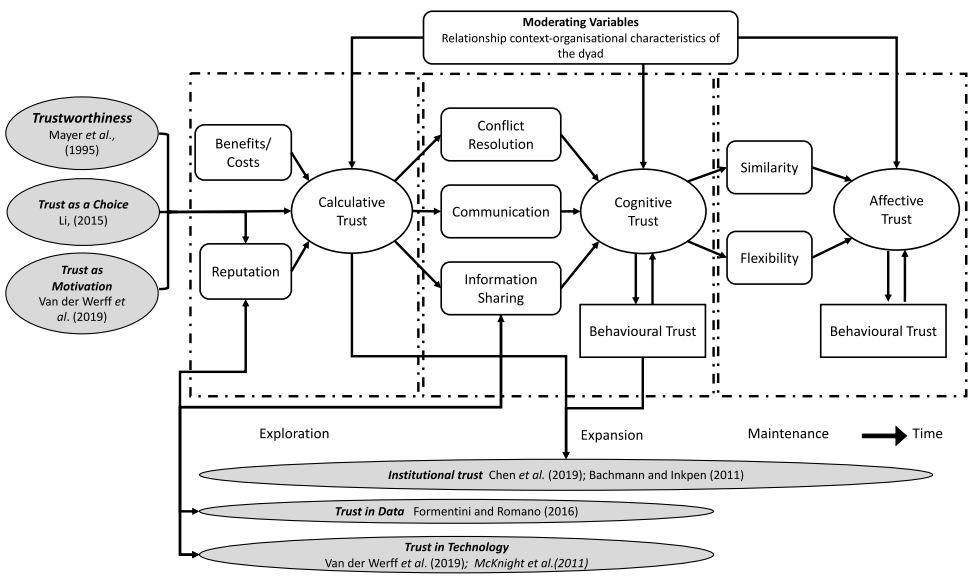
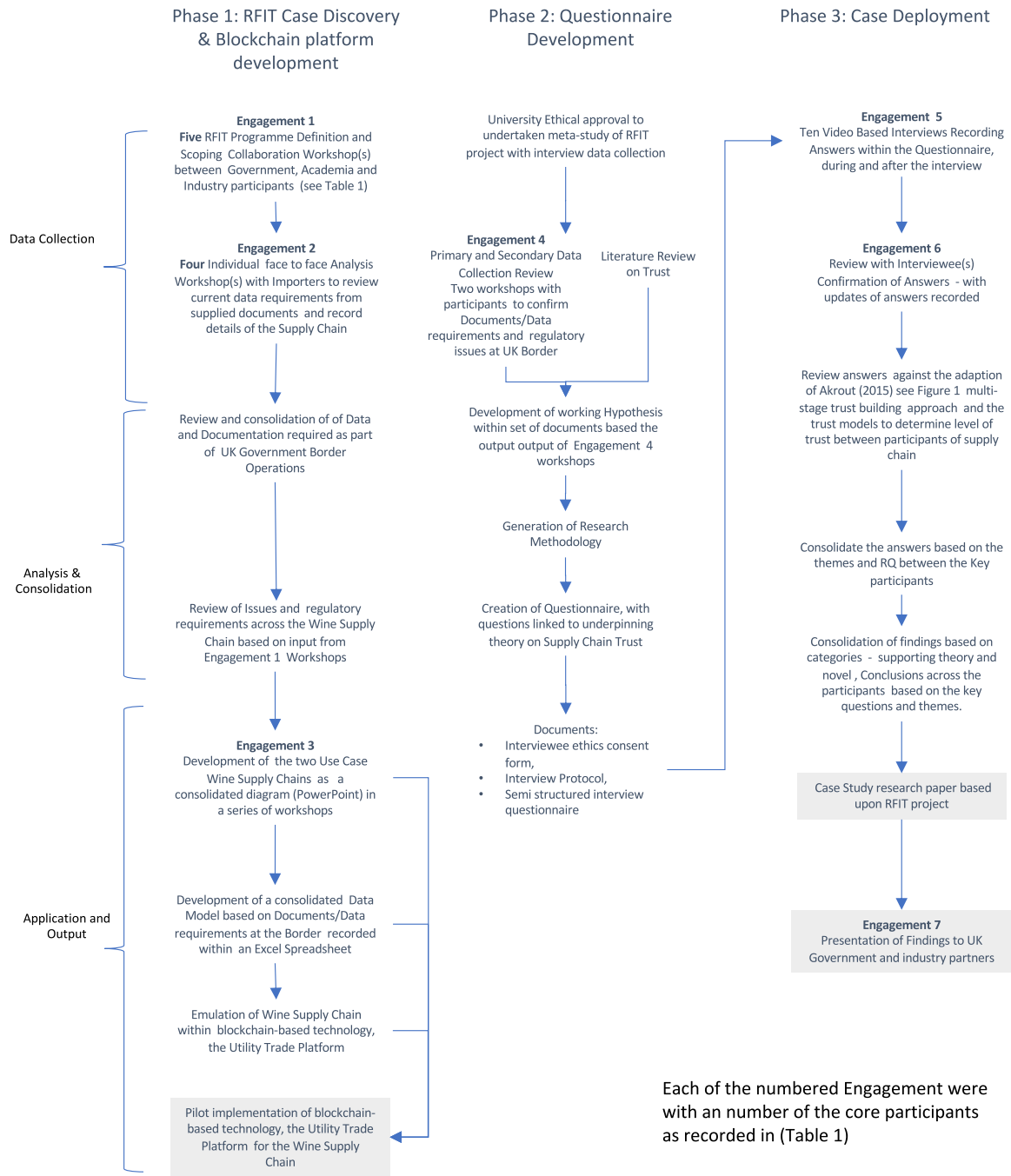


Figure 2 RFIT case study research method summary



Discovery and Blockchain platform development", then "case scope" and "case deployment" created the detailed case study. There were a series of engagements with supply chain participants, from definition and scoping to presentation of the findings and conclusions to the government, Table 1.

3.2 RFIT case discovery and blockchain platform development

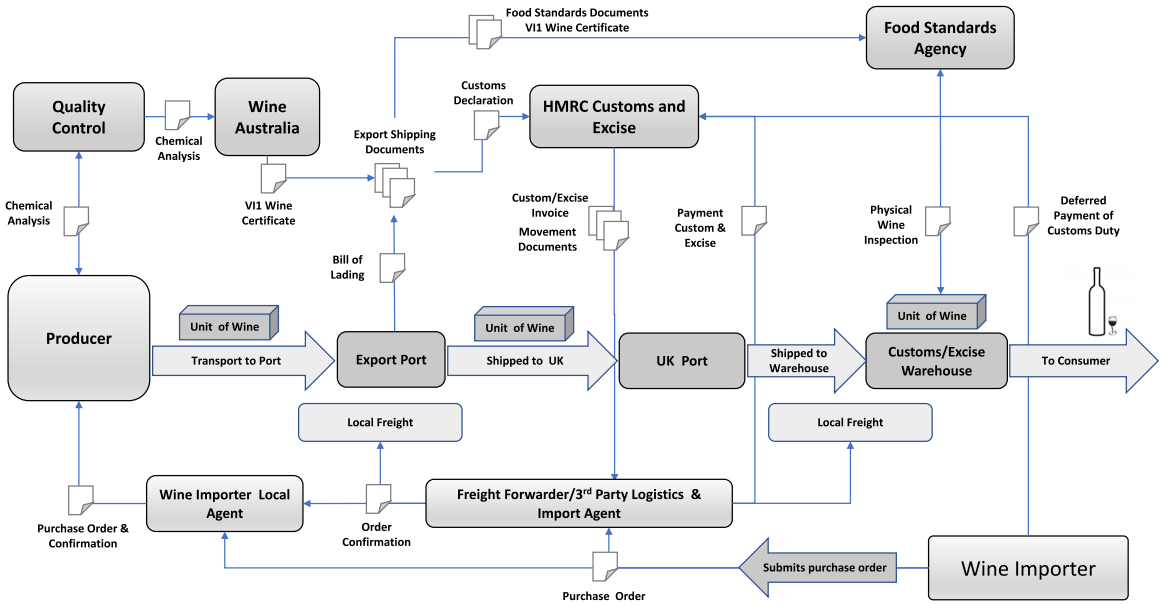
The initial engagement in the RFIT case discovery phase involved five workshops with key stakeholders, held between October 2018 and March 2019 (Figure 2 and Table 1). Workshops agreed and documented the scope, participants and terms of reference for the management and control of the RFIT project. The next participant engagement consisted of four analysis workshops with two wine importers, held between March 2019 and September 2019. Each importer provided a set of import and declaration documents, which formed the basis of detailed data capture for their wine import supply chain, captured as a flow chart diagram in PowerPoint. The diagrams, accompanied by handwritten notes, were iteratively reviewed and refined in four further workshops, with the supply chain summarised in Figure 3. Validation workshops included

Table 1 Participants of the RFIT project and the stages of the case study research

Role with supply chain	Org.	Role in organisation	Code	Sum code	Engagement 1	Engagement 2	Engagement 3	Engagement 4	Engagement 5	Engagement 6	Engagement 7
					RFIT programme definition workshop(s)	Importer analysis workshop(s)	Generation and review of supply chain process	Primary and secondary data collection	Interview(s)	Review and confirmation of findings	Confirmation of case study research
Wine importer	Alliance	Executive	Imp 1	Imp	1 h	2 h		2 h	1 h	1 h	1 h
Wine importer	Casella	Executive	Imp 2		1 h	2 h		2 h	1 h	1 h	1 h
Industry body	WSTA	Executive	Ind	Ind	1 h	2 h	3 h	2 h	1 h	1.5 h	1 h
Logistics co.	Conf	Senior Manager	Log	Log	NA			2 h	1 h	1 h	1 h
UK Government	HMRC	Senior Manager	HMRC 1	HMRC	NA		3 h	2 h	1 h	No review	1 h
UK Government	HMRC	Senior Manager	HMRC 2		NA		3 h	2 h	1 h	No review	1 h
UK Government	HMRC	Senior Manager	HMRC 3		NA			2 h	1 h	1 h	2 h
UK Government	HMRC	Senior Manager	HMRC 4		NA				1 h	1 h	1 h
UK Government	HMRC	Innovation Lead	HMRC 5		4 h	2 h	4 h	2 h	2 h	3.5 h	2 h
UK Government	FSA	Senior Manager	FSA 1	FSA	4 h		2 h	2 h	1 h	1.5 h	2 h
UK Government	FSA	Inspector	FSA 2		1 h			2 h	1 h	1 h	1 h
Aus. Government	Conf	Legal Lead	LL	LL	1 h		1 h	1 h	Not interviewed	Not interviewed	No review
Tech. provider	Chainvine	CTO	CTO	CTO	4 h		3 h	2 h	Not interviewed	Not interviewed	2 h

Notes: Key: Her majesty revenue and customs (HMRC). Food standards agency (FSA). Wine and spirit trade association (WSTA). Confidential (Conf). Code: records which person made a quote – as recorded in the Results and Discussion section of the paper. Sum code: records and defines the group of respondents to the questions as recorded in Table 2

Figure 3 RFIT wine importation supply chain



representatives from the Food Standards Agency (FSA) and Her Majesty Revenue and Customs (HMRC), confirming detail of data requirements for import and declaration documents. Specific focus was on fiscal and regulatory compliance and friction experienced by declarants at customs borders. Flipcharts documented the meeting findings and a series of excel documents detailed where data originated, where it was required and how it was used in participant's processes across the supply chain. Through a series of web-based reviews, participants validated details captured of processes and trust relationships. Information and data collected within the discovery phase helped create an emulation of the wine supply chain, the RFIT platform (RTP), as a pilot implementation.

The blockchain-based RTP proof of concept emulated the wine importation supply chain process (Figure 3). It included data requirements for all participants, including UK Government customs and border systems. The proof-of-concept implementation provided the context to determine the effect blockchain-based technology has on trust and trustworthiness in established buyer-supplier relationships within the two use cases. Research considered how increased data visibility and traceability reduce or remove the importance of trust and if data and information provided by the RTP would be acknowledged as trustworthy by all partners. The RTP helped participants explore the impact of blockchain on the trust in relationships and examine if trust could effectively be automated.

The RTP was developed by Chainvine Ltd using distributed ledger technology/blockchain technologies (Ethereum, Sawtooth and Corda), emulating processes and data requirements of the wine importation supply chain. The RTP is permission-based (Zheng *et al.*, 2018), allowing registered participants to be on-boarded. Each registered participant was given a designated user role (wine producer, logistics company, wine importer, etc.), with secured permission (Cole *et al.*, 2019) to enter data as goods move through the supply chain. The RTP provides a single source of secure, immutable trusted data that meets the process, regulatory and fiscal requirements of the UK Government agencies for importation at the UK border. RTP integrates with the UK Government customs/borders and food standards systems. Required data is entered by trusted actors throughout the supply chain: the wine producers, quality control/certification from the regulators (Vi1), financial/legal and counterparty details. The RTP is extensible, integrating with legacy systems and new technology, e.g. IoT devices. IoT devices provided tracking and sensing information, e.g. temperature and humidity of wine cases in transit, and supported UK Government food standards requirements for provenance. The RTP enables all relevant parties to become visible integrated partners in the supply chain.

3.3 Questionnaire development

Information gathered from Phase 1 (Figure 2) was consolidated with summaries of each importer's issues and the role of data in developing trust in relationships. RFIT discovery workshops findings were used to further verify the enhanced trust building framework (Figure 1) to consider the following: How has trust developed in the current supply chain? How important is supply chain visibility (traceability of goods, information transparency and provenance) in building trust? How will blockchain as an emergent digital technology change the role of trust and impact buyer-supplier relationships? Will increased visibility and traceability of information, delivered through blockchain-based technology, reduce or even remove the importance of trust? Open questions formed the semi-structured interview guide, Table 2.

3.4 Case study deployment

Ten online/video interviews were completed with wine supply chain participants (Table 1) between March and April 2020. Semi-structured interviews ensured focus on detailed questions generated from the literature review and in addressing the

Table 2 Details of the questions, relation to theory and respondent

Area of paper	High level question	Detailed question	Relation to theory/ source	Response to question				
				Imp	Ind	Log	HMRC	FSA
Background/context for the paper	How time critical is the current supply chain and what are the frictions within border operations?	How do delays in the supply chain impact you?	Discovery findings	Y	Y	Y	Y	Y
		How do frictions/delays impact you?	Discovery findings	Y	Y	Y	Y	Y
		What are the types of frictions/delays within the supply chain and their cost?	Discovery findings	Y	Y	Y	Y	Y
		How time critical is the supply chain?	Discovery findings	Y	Y	Y	Y	Y
		What is the current cost of import today?	Discovery findings	Y	Y	Y	Y	NA
		What are the high costs items today?	Discovery findings	Y	Y	Y	Y	NA
How has trust developed in the current supply chains?	How have the current trust relationships between parties have developed and what is the maturity of the relationship?	How have the current trust relationships between parties have developed?	Fawcett *et al.*, 2011; Akrout, 2015; Laeequddin *et al.*, 2010	Y	Y	Y	Y	Y
		How many of the parties do you trust/rely upon?	Sekhon *et al.*, 2013; Akrout and Diallo, 2017	Y	Y	Y	Y	Y
		How mature is the current trust relationship?	Akrout, 2015; Poppo *et al.*, 2016	Y	Y	Y	Y	Y
		What level of trust is within the relationship today?	Poppo *et al.*, 2016; Akrout, 2015	Y	Y	Y	Y	Y
		How long has the trust relationship been in place?	Akrout and Diallo, 2017	Y	Y	Y	Y	Y
How important is supply chain visibility (traceability of goods, information transparency and provenance) within the current supply chain in building trust?	How important is supply chain and information visibility and how this will change in the future?	How important is traceability information within the supply chain?	Rogerson and Parry, 2020	Y	Y	Y	Y	Y
		How would the improved visibility of traceability information help today?	Fawcett *et al.*, 2011; Rogerson and Parry, 2020	Y	Y	Y	Y	Y
	Is there trust and trustworthiness of information across the supply chain? What is the impact of data duplication?	How much do you trust the data within the system today?	Li, 2015	Y	Y	Y	Y	Y
		How much do you trust the information you receive today?	Formentini and Romano, 2016	Y	Y	Y	Y	Y
		Why do you trust the information?	Li, 2015; Zhao *et al.*, 2002; Shen *et al.*, 2019; Akrout, 2015	Y	Y	Y	Y	Y
		Why do your customers trust the information today?	Bhattacharya *et al.*, 1998	Y	Y	Y	Y	Y
	How does information asymmetry and data duplication affect the supply chain?	How does data duplication impact you?	Morgan *et al.*, 2018	Y	Y	Y	Y	Y
		How do you see information asymmetry within the supply chain?	Davenport and Beers, 1995; Li *et al.*, 2015; Formentini and Romano, 2016	Y	Y	Y	Y	Y
	How important is supply chain and information visibility and how this will change in the future?	How visible is the information across the supply chain?	Rogerson and Parry, 2020; Formentini and Romano, 2016	Y	Y	Y	Y	Y

(*continued*)

Table 2

Area of paper	High level question	Detailed question	Relation to theory/ source	Response to question Imp	Ind	Log	HMRC	FSA
		How will requirements for visibility of data/provenance change?	Babich and Hilary, 2020; Morgan *et al.*, 2018					
		How will data visibility improve the efficiency within the supply chain?	Kshetri, 2018	Y	Y	Y	Y	Y
How will blockchain as an emergent digital technology change the role of trust and impact the buyer-supplier relationships within current supply chains?	How will the blockchain-based platform change the trust and trust relationships?	How will the new blockchain-based platform change the trust and trust relationships?	Fawcett *et al.*, 2011; Akrout, 2015; Laeequddin *et al.*, 2010	Y	Y	Y	Y	Y
	How do you feel the current trust relationships between parties will change?	How do you feel the current trust relationships between parties will change?	Fawcett *et al.*, 2011; Akrout, 2015; Laeequddin *et al.*, 2010	Y	Y	Y	Y	N
		How will the role of the key "organisations" change with the new platform – and how will the relationships change		Y	Y	Y	Y	Y
	How will the current level of trust within the supply chain change?	How will the current level of trust within the supply chain change?	Fawcett et al, 2011; Akrout, 2015; Laeequddin *et al.*, 2010	Y	Y	Y	Y	N
	What level of or stage of trust will the new intermediaries need to establish themselves within the current relationship today?	What level of or stage of trust will the new intermediaries need to establish themselves within the current relationship today?	Akrout, 2015	Y	Y	Y	Y	Y
	How/Why will new intermediaries be trusted?	Why will you trust the new intermediary?	Akrout, 2015; Johnson and Grayson, 2005; Andersen and Kumar, 2006	Y	Y	Y	Y	Y
		How/Why will new intermediaries be trusted?	Akrout, 2015; Johnson and Grayson, 2005; Andersen and Kumar, 2006	Y	Y	Y	Y	Y
Will increased visibility and traceability of the information delivered through blockchain-based technology reduce or even remove the importance of trust?	How will the improved transparency of information affect your current operations? Will it be acknowledged as trustworthy by all the partners? How will this change importance of trust?	How will the improved transparency of information affect your current operations? Will it be acknowledged as trustworthy by all the partners?	Sahin and Robinson, 2002; Lewicki *et al.*, 2006	Y	Y	Y	Y	Y
	How will improved visibility and traceability of the information change (reduce or even remove) the importance of trust?	How will improved visibility and traceability of the information change (reduce or even remove) the importance of trust?	Lewicki *et al.*, 2006; Akrout, 2015;	Y	Y	Y	Y	Y
	How will improved visibility of traceability information help you trust the information you receive?	How will improved visibility of traceability information help you trust the information you receive?	Li, 2015; Zhao *et al.*, 2002; Shen *et al.*, 2019; Akrout, 2015	Y	Y	Y	Y	Y

(*continued*)

Table 2

Area of paper	High level question	Detailed question	Relation to theory/ source	Response to question Imp	Ind	Log	HMRC	FSA
	How will improved visibility of traceability information help you?	How will improved visibility of traceability information help you?	Rogerson and Parry, 2020; Formentini and Romano, 2016	Y	N	Y	Y	Y
Background/context the paper	How will the new platform reduce the frictions/delays, how will the cost change?	How will the cost change?	Follow-up on Discovery	Y	Y	Y	NA	NA
		How will the new platform reduce the frictions/delays?	Follow-up on Discovery	Y	N	Y	Y	N
	How will new trust relationships affect efficiency and costs across the supply chain?	Will blockchain allows retailers to directly tender their shipments to third-party logistics (3PLs) – remove intermediaries	Follow-up on Discovery	Y	Y	Y	Y	N
		How will new trust relationships affect efficiency and costs across the supply chain?	Li, 2015; Ireland and Webb, 2007	Y	Y	Y	Y	N

primary research question (Finley, 2018). Due to respondent requests, it was not possible to record interviews, and so handwritten notes were taken in each interview, transcribing responses. After each interview findings were analysed against the enhanced trust building framework (Figure 1), to validate this analysis the questionnaire, documented answers and findings were sent to the interviewee to review and confirm our interpretation of meaning prior to detailed analysis. Thematic analysis was then used to code results to determine common responses, plausible rival interpretations and linked themes (Braun and Clarke, 2006). Results were summarised against participant's role within the supply chain, identifying comparative responses, common themes and outliers. Findings were split into two; those that supported the enhanced trust building framework (Figure 1) and those that are novel. Within the final engagement, the findings and conclusions from the case study research were presented to target groups of participants via four Web-based conferences for validation, confirmation and feedback.

4. Results and discussion

4.1 Current state

The two use cases within the case study research are the import of sourced wine (cases of bottled wine in a container) and the import of bulk containers of wine (bladders) from Australia to the respective UK importer. The RFIT project included two importers: Alliance Wine Ltd. (Alliance), who import sourced wine and Casella Family Brands Ltd. (Casella) who import bulk wine. Analysis showed that irrespective of wine container (bottled or bladder), the overall importation process and supply chain is similar, Figure 3. The key difference is in the paperwork as each unit requires its own paperwork. A bladder unit requires less paperwork than a shipment of cases of different wines which are designated as multiple units.

Analysis of supply chain processes and data included the requirements of all participants within the supply chain: wine importer, producer, quality control, regulators and custom/ border operations. The supply chain is initiated when the UK importer (Alliance or Casella) sends a purchase order to their counterparty in Australia (the local agent). On receipt of the purchase order, the local agent and the importer arrange shipment of the unit of wine in a container from the producer/ supplier to the UK through a logistics intermediary. The logistics company manages the transport of goods from the Australian producer to the UK importer and submits the required declarations at the border as an import agent.

The local importer agent and producer allocate the required unit of wine, ensuring regulatory paperwork is in place with Wine Australia and Australian Customs and Excise. The Australian export process and UK import customs process require that a unit of wine is certified. A Vi1 certificate is created by Wine Australia, detailing the composition, chemical analysis and alcoholic content (ABV) of the wine. The current export process generates a set of paperwork linked to a container and its contents, the unit of wine for export. Documents are created at each stage of the supply chain by several information technology systems and manual processes. Data recorded in documents was analysed in the case study discovery phase, Figure 2.

The unit of wine is transported from the producer within a sealed container to the required port in Australia, e.g. Adelaide, for shipment to the UK, which typically takes five to six weeks. Simultaneously, the documents are transported (electronically and physically) to the UK. This allows the UK import agent and the logistics company time to submit data from documents into declarations within UK Government's customs, excise and food standards border systems.

4.2 Findings on the current state

Case study findings of the current wine supply chain validate theory and claims in extant literature. Trust and the development of trust-based relationships between participants are complex, iterative and the components/antecedents of trust need to be considered. Trust existed at different levels and stages within the wine supply chain, in line with the enhanced multidimensional, multilevel trust building framework, Figure 1.

4.2.1 How has trust developed in the current supply chains?

Both use cases confirmed that core business level trust relationships exist between wine producers and importers, which has developed over time. This business-level relationship has progressed through several iterations to become well-established affective level trust (Lewicki and Bunker, 1995), where parties have shared values (Akrout, 2015), Figure 1. The trust relationship between wine producers and importers is maintained through reputation, integrity and partnership, thereby achieving mutual benefits (Ireland and Webb, 2007).

> "Current trust relationships between parties have developed over a period of time." (Imp)

In contrast, the case study research found that an important trust relationship developed between the importers/producers and the logistics company is maintained at a calculative level, Figure 1. It is based on choice (Li, 2015), risk and benefit and is limited by information asymmetry (Zhou and Benton, 2007). Information asymmetry leads to trust asymmetry (Thomas and Skinner, 2010) between the importers, the logistics companies and extends to UK Government agencies. Information asymmetry led to a calculative level of trust between government agencies and the importers and logistics companies. Trust asymmetry was apparent as the importers/logistics companies expect structural assurance (McKnight *et al.*, 1998) and institutional trust (Li, 2015; Bachmann and Inkpen, 2011) with the UK Government. At the UK border, there is a policy where government agencies (customs, excise and food standards agencies) establish a calculative level of trust in the declarant based on risk, compliance and history, Figure 1. The importer and logistics companies are required to declare details are correct and meet a required level of data integrity.

> "The default position is of limited trust, trust is built up over a number of years to partnerships, shared values, based on integrity and personal reputation" (Imp)

> "The UK Government customs and excise regime is based on approving key operators in the supply chain." (HMRC)

The UK Government's trust in the declared information depends on the source, the level of compliance and reputation.

> "There is a higher level of trust in the information when it is a highly regulated product. Where there is a balance between trust, risk and reputation." (Imp)

Physical checks are used as part of an assurance/compliance process to verify the declared information and to build trust in the declarant. The UK Government's agencies trust with declarants is limited to parties within their regulatory control and, therefore, within the UK.

4.2.2 How important is supply chain visibility (traceability of goods, information transparency, provenance) within the current supply chain in building trust?

UK Government interviewees confirmed that trust in the declarants is based on a series of interactions and customs declarations. Current policy requires that a party within the control of the UK Government is accountable for data and declarations in respective customs and borders systems. The importers and logistics company confirmed the data required to support the wine export/import process is stored in multiple physical documents and IT systems across the supply chain. Each system produces a set of paper documents that are used as inputs to other systems (also found by Schmidt and Wagner, 2019; Casino *et al.*, 2020). Data is entered into Australian and UK Government systems manually from paper documentation. Data duplication and manual data entry introduce errors in declarant's submissions, which are treated with distrust by UK Government (Hui-li *et al.*, 2013), making trust relationships fragile (Bachmann and Inkpen, 2011) and causing friction at borders.

> "Information across the supply chain is not visible and the transparency is limited today" (HMRC)

Labour-intensive paper-based manual data entry processes hamper determination of data and product provenance. All parties need an understanding of the flow of goods within the supply chain (Rogerson and Parry, 2020). Research found that poor supply chain visibility does not engender trust when government agencies cannot directly identify the source of data submitted by declarants (as found by Lumineau, 2017). All interviewees identified current poor supply chain visibility and the importance of provenance and tracing bottle/bladder to the producer.

> "Traceability and visibility of goods across the supply chain is not available today." (Imp)

> "It is vitality important to be able to track back from bottles to container" (Ind)

UK Government agencies stated they need visibility of data building across the supply chain to confirm its legitimacy. The compliance process towards becoming "trusted" by the UK Government would be facilitated with improved data visibility, and product provenance and a single data source would ease customs process and declarations at the borders. All participants stated that data and information exchange underpin trust development creating a cooperative and collaborative environment, as found by Formentini and Romano (2016).

4.3 Detailed findings developed with the implementation of the blockchain-based RTP as part of the RFIT project

The following findings are from participants interviews after the blockchain-based RTP proof of concept had been implemented as part of the RFIT project.

4.3.1 How will blockchain as an emergent digital technology change the role of trust and impact the buyer-supplier relationships within current supply chains? Will increased visibility and traceability of the information reduce or even remove the importance of trust?

Case study participants found that the RTP did not change the need for trust or its role within the relationship between the importers/producers/logistics companies and the UK Government border agencies in the short-term. However, it facilitated the trust relationships between parties in the supply chain:

> "The level of trust across the supply chain will not change [. . .] just be shifted; dispersed across parties including the new intermediary" (Imp)

Blockchain and the RTP provides a supply chain with immutability, visibility and traceability of product and data (Kshetri, 2018; Rogerson and Parry, 2020). Improving these attributes does not change the importance of trust but does improve information sharing and reduces asymmetry, facilitating trust building processes and relationships across the

supply chain (Akrout, 2015; Auinger and Riedl, 2018). The blockchain technology within the RTP will facilitate the current buyer-supplier assertive trust-based relationships by reducing friction across the supply chain.

> "The RTP will change the trust and trust relationships - it may reduce the nervousness of business to become assured by UK Government" (Imp)

The permissioned RTP enhances data integrity across the supply chain as it records the identity of participants entering data, delivering a source of validated data from wine producers through local regulators and exporting customs operations to importers.

> "Improved transparency of information from the RTP will be acknowledged as trustworthy if it is clear who is accountable and responsible for data entry" (HMRC)

With RTP implementation, information and data asymmetry between parties is reduced in comparison to original state (Section 5.2). The visibility of data entrants combined with data immutability engenders additional trust across supply chain participants. The importers and logistics company confirmed that "Improved visibility and transparency of information from the RTP will lead to improved institutional trust if it is acknowledged as trustworthy by UK Government." They also stated that when these factors were combined with improved data integrity inherent in the blockchain technology, data duplication and errors in customs declarations will reduce.

> "It will reduce the amount of checking required; we will only need to check key data fields" (HMRC)

UK Government interviewees agreed that the immutable record of data entrants and details of sources of supply chain information delivered by the RTP would improve border agencies perception of trust and trustworthiness of the data declared at the customs border.

> "We can remove declaration steps with improved trust within the system, as an increasing amount of data will be trusted" (HMRC)

Current trust relationships across the supply chain would evolve with improved data sharing and reduced trust and information asymmetry. Improved data visibility, integrity and immutability reduce opportunities for fraud, and all parties can highlight and act on data discrepancies. With the reduced data risk of RTP, UK Government agencies calculative trust (Akrout, 2015) in the declarant would improve more quickly, reducing time to develop trust and changing required physical compliance checks.

> "It will not change the trust required which will still need to be established. There is the opportunity to reduce the time taken to trust parties" (Imp)

Customs operations can transition from reactive to more proactive management at borders. With required permissions, customs can observe data entered by participants as it builds across the supply chain. This reduces the complexity of the declaration as data from the RTP auto-populates required submission documents. Cognitive trust is created with the declarant as institutional trust is developed in the RTP.

> "RTP will improve confidence and trust in declarant, compliance checks will be targeted, planned and proactive". (HMRC)

RTP creates an ecosystem of trust that extends across the supply chain to the producer, outside of UK borders. Case study participants recognised that the RTP provides a common source of trusted data for all UK Government departments and externally for trusted exports. Therefore, the RTP could operate as a bi-directorial shared resource, important when participants are geographically dispersed between the UK and Australia.

Literature claims blockchain is a "trust-free technology" (Beck *et al.*, 2016; Wang *et al.*, 2019). Case study findings demonstrate that blockchain technology supports the development of trust in data and declarants by removing information and data asymmetry. However, blockchain as a technology does not remove the requirement or change the importance of trust in established supply chains. Blockchain would not replace current cognitive and assertive trust (Akrout, 2015) between parties or trust relationships developed. It will contribute to institutional trust (Bachmann and Inkpen, 2011) and structural assurance (McKnight *et al.*, 1998). Maull *et al.* (2017) suggested blockchain disintermediates supply chains. However, RTP technology providers will need to operate to UK Government common standards and be accredited, becoming new "trusted intermediaries" once they achieve a level of institutional trust. RTP implementation introduces a requirement on all supply chain participants to trust the system, technology and platform, validating findings of Sekhon *et al.* (2013) and McKnight *et al.* (2002). Trust and trustworthiness still play a critical role, especially at the customs borders and this will not change.

> "The role of organisations will change". (HMRC)

> "The platform provider will need to be accredited by UK Government and operate as a trusted intermediary and adhere government data standards to gain the required level of trust". (Log)

5. Conclusion

A gap exists in literature in how trust changes with the implementation of blockchain technology into an active supply chain. This paper uses case study analysis to examine how to trust in wine supply chains is impacted through the introduction of a blockchain-based technology, the RTP.

Within the current non-digital supply chain trust exists at different levels and maturity and is multidimensional (Akrout, 2015). Trust relationships are maintained through personal relationships, reputation, integrity and partnership, with mutually shared values (Kwon and Suh, 2005). Trust asymmetry exists because of different relationships, and information asymmetry (Thomas and Skinner, 2010). Physical compliance checks are used by UK Government agencies to confirm that customs declaration data can be trusted. Trust in the data and declarants is built up over time. Data duplication and manual data entry introduce errors in submissions from declarants, which diminishes trust (Hui-li *et al.*, 2013). Limited supply chain visibility and data asymmetry create financial cost and reputational damage (Hurley, 2006).

The RTP, using a blockchain layer, facilitated the building of trust across the supply chain through the provision of a single source of validated data and increased supply chain visibility. Data integrity and information sharing support all the stages of the trust building frameworks selected from literature (Akrout, 2015; Laeequddin *et al.*, 2010 and Chen *et al.*, 2019) and the enhanced trust building framework, see Figure 1. The RTP reduced data asymmetry, improved accuracy, timeliness and integrity, facilitating trust building. Blockchain offered structural assurance (McKnight *et al.*, 1998) through data

immutability as an integral part of the platform that also provided data visibility.

Trust remains integral to supply chain function and buyer-supplier relationships. The RTP technology may remove some intermediaries in a network, but it introduces others, complicating established trust relationships. We found no evidence to support claims that blockchain is trustless (Beck *et al.*, 2016; Wang *et al.*, 2019) or that blockchain allows people to "trust in a system without having trust in the systems actors" (Werbach, 2019). The supply chains requirement to develop trusting relationships between buyer and supplier as an end-to-end process continue with the introduction of the RTP platform, providing empirical evidence to support Sivula *et al.*'s (2021) theoretical study. The end-to-end visibility of immutable data helped create a trust ecosystem, broadening trust relationships beyond the business-to-business dyad. Creating a trust ecosystem becomes a collective endeavour. Traditional determinants of trustworthiness in dyadic relationships remain, but we found relationships and the relationship building processes was facilitated by blockchain technology.

This paper contributes to theory by developing and verifying a trust building framework, Figure 1, adapting Akrout (2015) to address the complex trust building relationships within a regulated and governed cross border supply chain. The paper demonstrates that introducing a blockchain system can affect institutional trust and structural assurance; other trust stages and trust relationships between participants within the supply chain remain constant. Blockchain supports trust building processes through information sharing and data visibility. While these contribute to institutional trust, the case study challenges current theory that blockchain is trustless (Beck *et al.*, 2016; Wang *et al.*, 2019). Contrary to theory (Maull *et al.*, 2017), blockchain changes supply chain intermediaries rather than necessarily reducing their number. Technology suppliers need to meet the participant's requirements for institutional trust and structural assurance that are currently provided by UK Government. While institutional trust develops over time, it is fragile (Child and Möllering, 2003), and mediated trust in blockchain as a technology would be quickly lost if it were used in the wrong context. An additional contribution is that this is the first case study detailing the effect a blockchain platform has on trust in an established end-to-end supply chain across a customs border.

The broader findings from the case study are influencing UK Government on how to address the current challenges with supply chains at the UK border (Holmes, 2020). This paper will also influence current work in UK Government on the trust ecosystem as part of the STW initiative (UK Government, 2021). The RTP forms the nucleation of the UK Government developing utility trade platform – broader digitisation of the border.

5.1 Implications for management practice

The research finds that the RTP blockchain platform improved the process of trust formation and maintenance in relationships between participants of the wine supply chain but did not remove the requirement for trust. From a government and regulator perspective trust will move from dyadic relationships to a state where all supply chain participants contribute to the level of trust required at the UK borders, creating a trust ecosystem. In the deployment of blockchain technology, full digitisation of the end-to-end supply chain is required (Kshetri, 2018; Rogerson and Parry, 2020).

The RTP developed introduces governance and operating model issues. Rather than disintermediate (Maull *et al.*, 2017), it introduces new intermediaries who manage access and security rights to data. Enterprise-level governance and privacy frameworks, operating models and standards need to be developed to address the changing trust and risk models between buyers and suppliers (Valentine and Stewart, 2013; Wu *et al.*, 2015).

5.2 Implications for policy

Current policies requiring physical paper records will need to adapt for the benefits of technology to be realised. UK Government policy, cultural resistance and existing business processes appear as major barriers (Patel *et al.*, 2017; Wang *et al.*, 2019). Regulator processes of certification that help identify trusted operators in the international supply chain are lengthy (1–2 years). HMRC have been partners in the research and the RFIT project is detailed within the UK border strategy (UK Government, 2020). Such co-creation may facilitate policy change as UK Government agencies can see access to such trusted supply chain data platforms will enable them to move from reactive to proactive management of declarants at the border.

To facilitate cross-border processing, UK Government needs to determine the required level of operational governance. Demarcation is required between the technology developer and all other parties to ensure the new data platforms can be trusted. A developing body of work is creating underlying standards for blockchain, ISO/TC 307, with working groups focussed on both privacy and governance. These new standards do not address the broader socio-economic issues. New digital technology governance frameworks are required to address both the distributed and collaborative governance and privacy of data required within a supply chain. Legal issues, such as the legality and enforceability of the records kept on the blockchain need to be carefully considered. Differences in countries legal frameworks must be addressed to facilitate deployment across global supply chains.

5.3 Limitations and future work

One limitation of the qualitative case study method is that findings cross several categories and may be difficult to generalise. This research needs to be repeated across a larger population with additional use cases. A longitudinal analysis (Menard, 2002) of the use cases would determine how trust between participants and technology changes over time. The case study research included analysis of the value and benefits participants reported through the introduction of the RTP, and this will be developed in longitudinal studies. Batwa and Norrman's (2020) framework can be used to examine firm expectations before future RTP deployments. Work is required into process and policy for proactive management of declarants.

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