Master Thesis

Strengthening the chain

Assessment of reliable tokenization of indistinguishable assets on a blockchain within the food industry

M.Sc. Business Administration and E-Business

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Abstract

This study attempts to understand the issue which occurs when indistinguishable assets are tokenized on a blockchain. The study then attempt to solve how such assets can be accurately tokenized, within a supply chain context. This is done through a qualitative approach where two case companies in the food industry are investigated. Data is gathered through the use of both unstructured and semi-structured interviews with six different representatives, spread across the two cases.

The researcher attempts a grounded-theory approach in the hopes of generating new theory about the researched phenomena. The researcher then leverages agency theory as a lens from which to view the phenomena through and as a means to help ground the research in existing theory. The result is an initial understanding for the phenomena and some generated insight into its resolution through leveraging complimentary validation services. Firstly, the issue seems to stem from how anyone can make any claim and upload any data onto the blockchain. This creates an issue when an indistinguishable asset in the real world is claimed to be something on the blockchain ledger, which in reality it is not. To combat this the two cases made use of various validation technologies. The key insight, however, was how there was no one technology which provided a solution. Rather, validation was best done through leveraging multiple validation services in tandem with one another. This way misconduct or error in one validation stage can be seen in another. This effectively creates a web of security, where made claims become reliably verified as they move through the supply chain across the different validation stages. Finally, the researcher attempts to improve this process and reduce agency costs of spent time and resources used by increasing the use of behavior-oriented contracts. The gathered insights seem to suggest increasing information sharing between validation service providers and tightening their relationship to one another reduces agency costs while still allowing for the use of a security web.

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1 Introduction

1.1 Background

An article in Forbes magazine from 2018 claimed blockchain would change the world (Spatz, 2018). According to the article blockchain is capable of forever changing banking, cybersecurity, healthcare and many other industries to the extent where it will affect our working and personal lives. While grand, the claims could be argued were speculatative. However, researchers have since begun to make more founded claims surrounding the technology. Wladawsky-Berger (2019) argues blockchain is the next step in the internet's evolution and our path to a more equal future. Hall (2018) makes an even bolder claim suggesting blockchain has the potential to reshape the world as we know it. The reason for this could perhaps be the multifaceted nature of blockchain technology where it can be adapted to fit an industry and desired need. A PWC study in 2018 revealed as many as 65 existing and emerging use cases where blockchain technology could be leveraged in both business and government. One of the presented cases mentions the use of blockchain to create "see-through" supply chains. The technology supposedly makes it possible to create an immutable record of a product, from origin to destination. The same study then argues blockchain could be a vital weapon in the fight for transparency in global supply chains where all corporate action is made available for public viewing. This argument is also supported by a study from Medaglia and Damsgaard (2020), who claim blockchain provides a pathway to complete visibility over responsible operations in not only a transparent, but also a cost-efficient manner.

From a technical standpoint, blockchain is a growing list of records defined as blocks which link using cryptography. Each block holds a timestamp, transactional data, and cryptographic serial number known as a "hash" (Nofer et.al, 2017). A key functionality of blockchain technology is how anything added to it cannot be modified or removed unless the whole chain is modified too, creating a fully transparent and increasingly secure chain over time. Its relevance extends into the business world and beyond; 84% of surveyed business executives claim to be actively involved with blockchain technology (PWC, 2019), and in a study by Deloitte (2019), 53% of respondent business leaders placed blockchain as a critical priority within their organizations. Even start-ups have seen a massive increase in equity funding when they are centered around blockchain technology. Growing at a steady pace since 2013, funding skyrocketed in 2018, during which annual funding for the technology increased to $4.3 billion (Liu, 2019). Looking at all the evidence, it could be argued that blockchain does hold the potential to at least change the way business is conducted globally (Rajput & Singh, 2019).

1.2 Problem discussion

The buzz surrounding blockchain is seemingly warranted. Even in academia, many theoretical studies provide supporting evidence for using the technology in areas such as agri-food, manufacturing, pharmaceutical, and supply chain management (Wang et.al., 2018).

However, most research focuses on the positive applications of blockchain, with criticism being regularly overlooked. Kouhizadeh and Sarkis (2018) describe the issue as a mudslide where practitioners and researchers scramble on the hype surrounding this new technology and its disruptive potential. Saberi et al. (2018) suggest expectations on blockchain are inflated and that practical assessments need to be conducted. While blockchain's value is clear, its implementation is what could prove difficult. This includes general issues of cost and stakeholder mobilization.

Specifically, the issue of *data entry* has recently received extensive attention in the practitioner community. The original purpose of blockchain was dedicated towards the creation of a cryptocurrency, where transfers of digital tokens which held monetary value much like real world currencies could be traded via the internet (Nakamoto, 2008). The value of the token was and is decided by the market. Ownership and transfer of ownership is then very easy to assess as whoever holds the tokens is specified in the blockchain ledger and their value is constantly appraised by supply and demand. The issue of data entry then only came to existence when blockchain technology started to evolve and take presence in industries beyond online banking. Five years after blockchains creation a researcher by the name of Vitalik Buterin (2013) discovered how to create digital contracts which would represent real world physical assets on a blockchain. This made it possible to "tokenize" anything from shoes to apples and thereby prove or transfer ownership of real world assets via the blockchain. While this was a major development for blockchain technology it also came with many security risks (Tikhomirov, 2018).

Compared to cryptocurrency, this new change merged the digital and physical world. One of the new risks is then when information about the real world is added onto the blockchain, a process known as *tokenization*. Because while it can be stated that all information on the blockchain is transparent, secure, and immutable, the same cannot be said about how it is uploaded in the first place. The 2018 PWC study which brings forth 65 use cases for blockchain technology in business and government also cautions the challenge of information entry. The report finds the issue of tokenization is a particularly critical issue of implementing blockchains, as it might challenge the whole foundation of the blockchain and its potential use. This is especially the case when the tokenized object was a commodity where one asset is *indistinguishable* from another. To illustrate this, the report uses an example of tracking a fish through the supply chain and gives the following statement: "while blockchain applications can track fish all the way from the boat to the plate, they cannot guarantee they were caught how and where the data claims" (PWC, 2018). A similar argument is brought forth by Oberhauser (2019), who questions the trust which can be placed on a blockchain system where the most critical points, where information is uploaded, commonly occurs in parts of the world most vulnerable to corruption.

1.3 Purpose

The purpose of this paper is twofold:

(1) To create an understanding of the tokenization issue regarding indistinguishable assets when applying blockchain technology to supply chain management.

(2) To draw on the refined understanding of the issue and begin to articulate practices that can help mitigate the issues, ensuring validity and security throughout the chain.

The report is written from an organizational context looking at the addressed issue through a corporate lens. The researcher aims to study companies which have implemented and leveraged blockchain technology within their supply chains to assess what considerations and measures were taken to ensure data input validity. Specifically the report looks at organizations centered around creating food products, such as chocolate, coffee, or wheat.

To address the given issue, the researcher takes an exploratory approach in the hopes gaining new insights over a persisting issue (Robson, 2002). The research hopes to create an initial understanding for issues centered around the input stage of blockchain technology and connect it to existing literature. The goal is then to create an understanding for what causes the issue and subsequently how to solve it on a technological, legal, or sociological level. To this extent, the research will be malleable and adapt to the provided insights through the research. While this could arguably affect the guided course of the study, flexibility in exploratory research does not necessarily imply absence of direction if treated adequately (Adams and Schvaneveldt, 1991).

1.4 Research questions

1. What mechanisms impede the reliable tokenization of indistinguishable assets on a blockchain?

2. How can reliable tokenization of indistinguishable assets be validated to ensure uploading accuracy within supply chains?

1.5 Delimitations

The paper looks into the use of blockchain technology within supply chain management. Specifically, the research focuses on the phenomena of data entry and the concept of tokenization. For the purpose of this paper, tokenization refers to creating a digital representation of a physical asset for the purpose of ownership claim and ownership transfer. This paper is also limited to tokenization of indistinguishable assets, where the tokenized asset is replicable and indistinguishable. The research seeks to understand the issue of tokenization of such assets and also look for potential solutions to the described issue. For this purpose, the term validation is used. Validation in this case describes the process of assessing validity or accuracy, to ensure an asset is what it is claimed to be.

The paper is also limited in its scope of supply chain management. While multiple use cases for blockchain has been identified, this study solely focuses on the applicability of the research within supply chain management. Furthermore this research investigates tokenization validation within the food industry. While findings can be generalized to some extent, the gathered data comes solely from the food industry and should not be assumed will apply within other industries.

Finally the paper investigates the phenomena with qualitative research through the lens of agency theory. This research then takes on assumptions given in agency theory as a means to ground this study in existing research. The qualitative nature of the research allows for a deep dive into the investigated phenomena but also limits the research to a smaller data sample size, and as such, the generalizability of the study is limited.

2 Theoretical background

2.1 Blockchain

Created in 2008 as an electronic and decentralized monetary system, blockchain has now branched out and been applied to other industries, such as healthcare (Mettler, 2016), real estate (Spielman, 2016), supply chain management (Burger et.al, 2016), and has even been suggested for use within government (Ølnes et.al, 2017). According to Gustavo et.al (2020) blockchain can be described as a chronological database of transactions which is maintained across nodes (blockchain members) that engage in a peer-to-peer network. All transactions are then packaged into blocks and stored together as one long chronological chain. A similar description is given by Nofer et.al (2017) who adds how each block in the chain contains multiple transaction records (TX) along with the hash (serial number) of the previous block, a timestamp and a nonce (randomized number used for hash verification) (see Fig. 1). Any attempt at altering a previous transaction also alters the hash value of the block it is in. Moreover, since every added block must be validated by a "consensus mechanism" where the majority of all participants of the chain agree to accept it, any altered hash value would then be detected and denied access to the chain (Swanson, 2015).

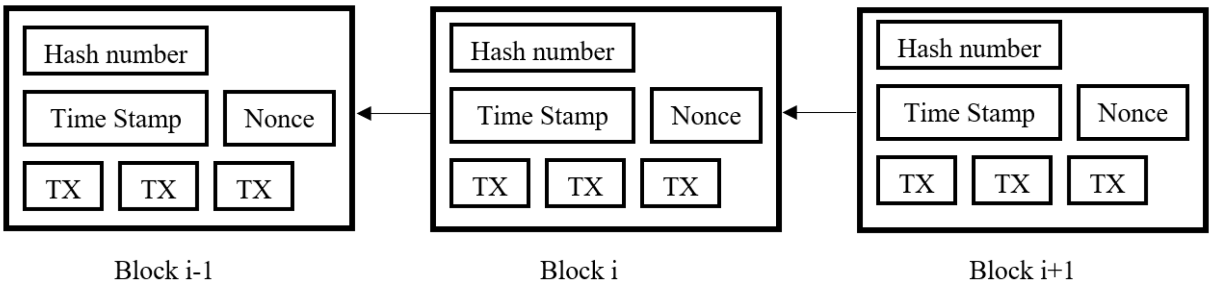

Fig. 1 Example of a blockchain (Zheng et al., 2016)

Bracamonte and Okada (2017) add how the consensus mechanism is a key feature of the technology. It is proposed how this not only provides security but also disperses power among all users equally, effectively democratizing validation of transactions. This is also suggested by researchers Kouhizadeh and Sarkis (2018) who argue it is one of the key reasons for the multifaceted nature of blockchain which has led to its penetration in multiple industries. Other key features brought forth are the transparency over what is stored and the information immutability where anything uploaded to a blockchain cannot be removed or edited. Together this creates a supposedly impenetrable system for transaction and storage that can be used for varying purposes across multiple industries. Considering all the features of blockchain and its potential to disrupt various markets, researcher Vitalik Buterin (2015) in one of his early studies on the technology described it among other things as a“(…)magic computer than anyone can (use)(…).”

2.1.1 Smart contracts

A key reason why blockchain technology was able to branch out from its original purpose of cryptocurrency was the creation if Ethereum (Kouhizadeh & Sarkis, 2018). Ethereum introduces the idea and solution for smart contracts, encoded scripts which can be put into distributed ledgers (Adams & Tomko, 2018). The idea originated from Vitalik Buterin in 2013, the same researcher who later would describe blockchain as a “magic computer”. His vision has expand the possibility of what a blockchain can put into one of its blocks. Through the use of smart contracts, any arbitrary combination of computable rules can be defined to test if a list of specified criteria are met. Once the defined criteria is met, the contract will execute the desired transaction automatically. Today multiple blockchains have been created taking inspiration from Ethereum and enabling use of smart contracts, such as Rootstock, Qtum, Corda, and Hyperledger (Tikhomirov, 2018) . Sergei Tikhomirov (2018) argues smart contracts theoretically opens up the possibility to convey all practical computations into a smart contract. Tikhomirov also suggests this increased functionality is unfortunately not strictly positive, as it also opens up for new security threats. According to Adams & Tomko (2018), the only limitation for creating a smart contract “(…)is that whatever is being transferred must be tokenizable in digital form.” Transfers of money and other digital assets are then well within the scope of a smart contract. However, this also means blockchain technology can transcribe transfer of a physical asset. This especially becomes an issue if the asset is not easily identifiable and distinguishable as there is no structure in place to validate authenticity of the physical asset.

In spite of this there is a growing interest to affix smart contracts to a digital representation of a physical asset. Recent examples include registration of land ownership (Aanchal, et.al.,2017), transportation systems (Yuan & Wang, 2016), and tracking of legally sourced timber through a supply chain (Düdder & Ross, 2017). Following this trend, it is believed blockchain technology using the smart contract system will help bring “trust, security and decentralization into current business systems” (Chen et.al., 2018). However, Chen et.al. (2018) also argue the technology is limited in its high requirement for processing power and slow performance compared to relational databases, limiting its application in some industries. Herian (2018) argues there is an increasing issue whereby blockchain technology is pushed onto individuals that do not have the means to accommodate it. In the case brought forth by Aanchal et.al. (2017) following blockchain in transportation systems, a goods transport driver has little means to understand

and control the blockchain technology which is increasingly controlling his work. Professor Jannice Käll (2018) at Halmstad University is under the interpretation how we may see an even larger number of layers placed onto physical assets to increase traceability and make them more tangible in our globalized and digital world. An article on Forbes from 2017 critiquing the hype around blockchain technology, Jason Bloomberg argues many end-users are struggling with adopting the technology, detailing how its primary uses to bring transparency and legitimacy do not translate well when put to the test in real world scenarios.

2.2 Supply chain

A review on Supply Chain Management research identified people, process, and technology to be the three keys to success (Bala, 2014). It was argued leveraging technology to create a process which helps connect people in various stages of a supply chain should be the underlying goal for managing any successful supply chain. According to Khanna et.al (2020) blockchain holds the potential to meet such a goal with its ability to create an open and even playing field throughout a supply chain by increasing transparency between different actors. It is argued this increases trust, and in doing so improves overall efficiency by removing the need for lengthy verification procedures. A study by Adams & Tolko (2018) also argues how trust can be especially hard to obtain in less developed parts of the world. In such areas it can also be hard to acquire a trusted third party to help verify claims made in a supply chain. Dobrovnik et al., (2018) claims the use of blockchain in supply chain management can then give an edge over conventional systems. Dobrovnik et al. (2018) argue the immutable and decentralized system blockchain is built upon helps substitute any lacking trust for people with trust for the system itself. It has also been observed that implementation of blockchain technology in supply chains helps geographically distanced participants feel closer to one another thanks to a shared system of reporting (Lee, and Pilkington, 2017). Furthermore, as corporate managers begin to see the potential of blockchain technology in supply chain management there is strong potential to increase transparency across industries (Francisco & Swanson, 2018). At the same time, pressure from consumers who want to ensure ethical standards are met to create the products they purchase is also an increasing issue. Concern for human rights, food integrity, and our environment have been growing issues for consumers on a global scale (PWC, 2018). Consumers are today asking questions about not only what they are buying but how it was made. Providing such information has in many cases been found to be too costly or challenging to execute (Francisco & Swanson, 2018). Additionally Ghode et.al. (2020) state commonly used supply chain management systems with a centralized authority are exposed to dishonestly, deception, and tampering. Blockchain technology, however, is argued holds the potential to address all these challenges (Francisco & Swanson, 2018). This claim is supported by findings from Rahmadika et.al. (2018) who present a case where blockchain was used in supply chain management resulting in reduced administration costs and also removed multiple administrative procedures, simplifying the tracking process. Ghode et.al (2020) further state inter-organizational trust is the main factor which is affected when implementing a blockchain solution into a supply chain. Khanna et.al. (2020) argue for the malleable impact of blockchain across industries, stating it unlocks the possibility to securely track any product through its entire lifecycle. This is argued to be especially true in combination with other tracking technologies which leverage IoT technology such as RFID or QR codes. An argument supported by a study on blockchain adoption which similarly argues for increased traceability when blockchain technology is combined with RFID or an NFC tag (Francisco & Swanson, 2018).

On the other hand, a study about reviewing blockchain expectation claims technology cannot substitute for trusting relationships (Pisa, 2018). It is argued trusting the system does not remove the need to be sceptic about what is uploaded to it. While it could be stated there is full transparency over what is on a blockchain and how all information is immutable once uploaded, it does not address reliability of what is uploaded. This argument is seconded by Potdar at.al (2018) who state that there is not necessarily any guarantee that uploaded information is accurate, only that a made claim cannot be edited at a later stage. This is suggested to be a bigger issue in the absence of adequate legal regulations. Any information about a product with origins in an area lacking sufficient regulatory system is then arguably not transparent and secure at all. Adams and Tomko (2018) also bring up how the areas where security is low are also those most in need of a complete blockchain system. However, these are also commonly areas which lack the digital infrastructure to support them. A statement which is seconded by Potdar et.al (2018) stating IT infrastructure is a major barrier to blockchain technology adoption.

2.3 Agency theory

Agency theory is a concept used to detail and resolve issues within partnerships where one party delegates work to another (Eisenhardt, 1989). Specifically agency theory attempts to describe the varying desires and approach to risk of a work delegator (*principal*) and work performer (*agent*). According to Eisenheardt (1989) agency theory deals with problems which arise from varying goals between the principal and her agent in situations where the principal struggles to verify what the agent is doing and if she has behaved appropriately. In such cases the agent has been given a *task*, defined as by Eisenhardt (1989) as a piece of work the agent is to perform on behalf of the principal, in exchange for some form of reward. The main assumption of agency theory is how individuals always set out to maximize their own self-interest, even at the cost of anothers (Perrow, 1986). Agency theory therefore focuses on minimizing what is known as agency costs. This term refers to the costs in time and resources a principal bears to ensure agents act in a favorable manor, which advances the principals agenda while completing the given task (Eisenhardt, 1989). The costs are typically incurred due to a lack of trust in the good faith of an agent to act appropriately, as their own self-interest will always take precedence.

Shapiro (2005) states agency theory details two alternate ways to ensure an agent acts in an appropriate manner. Firstly a principal can take steps to increase monitoring and transparency giving the agent less room act freely, this however would increase agency costs. Alternatively the principal can seek to align their own benefit with benefit for the agent. This in turn is stated to have two approaches. Firstly a principal can make use of a behavior-oriented contract where reward is given for time spent completing a task (Perrow, 1986; Shapiro, 2005). A common example here is providing an agent with an hourly or monthly salary, thereby binding the agent to a set contract to complete the task in exchange for a predetermined monetary reward. The second path is to leverage outcome-oriented contracts where reward is given based on the end result of the sought task. Common examples include commission schemes in sales, or stock options for higher management. The difference here is then reward for pursuit of, or completion of the given task. Research indicated both options help align the self-interest of the principal with that of the agent, thereby supposedly reducing the need for monitoring and by extension reducing agency costs (Shapiro, 2005).

2.3.1 Agency theory in supply chain

Agency theory has been used throughout academia since the early 1970s and seen use in accounting, finance, marketing, sociology, and behavioral studies (Eisenhardt, 1989). Agency Theory has also more recently seen use in Supply Chain Management. A 2012 study identified 86 research cases where agency theory was used to explain relationships between buyers and suppliers (Fayezi el.al., 2012). When applying agency theory to supply chain management a purchasing organization becomes the principal and the supplier the agent (Zsidisin & Ellram, 2003). In such a case the factors which influence the contract between them would consist of outcome uncertainty, risk aversion, conflicting goals, relationship length, and information systems. In 2003 researchers Zsidisin and Ellram conducted a literature review covering cases of agency theory within supply chain management. From the compiled findings, it was indicated how purchasing organizations typically manage agency issues though the use of behavior-oriented contracts. Common examples included systems to increase information sharing and initiatives to create tighter relationships with suppliers. However Zu and Kaynak (2012) argue firms need to adapt management mechanisms to best fit each individual supplier. The study suggests a mix of behavior-oriented and outcome-oriented techniques to maximize outcome and minimize agency costs.

2.3.2 Assessment of agency theory

On the other hand, Bendickson et.al. (2015) argue agency theory is outdated in its understanding of business relationships. In what was called the new era of business, it is suggested a larger interest for social entrepreneurship, the sharing economy, and family businesses has taken rise. In such cases, the playing field between agent and principal is shifted, and it is argued the assumption of self-interest should be put to question. Additional criticism from Cuevas-Rodriguez et.al. (2012) also argues against the assumption an agent will always exhibit selfish behaviors that reduce the principal's wealth. Cuevas-Rodriguez et.al. (2012) states literature on trust and the herd mentality of humans, argues this assumption does not hold, and that an agent might self-regulate and act in a truthful way without the need for any contract or control mechanism. Supposedly, the agents primarily seek socioemotional rewards such as a feeling of accomplishment and cooperation.

However, within a supply chain there are typically multiple touch point that represent various agents to the buying organization. Additionally, in contrast to other principal agent relationships, a supplier is often an external partner with little social or emotional benefit to gain from the buying organization. Moreover, the argument of promoting trust, while it is well-founded could lack strength within supply chain management and other forms of corporate reporting. The need for transparent control-mechanisms is fueled by the repeated breach in trust between buyer and supplier. Repeated scandals concerning child-labor and corruption have hit many global organization such as Apple, Carrefour, Coca-Cola, General Electric, H&M, McDonalds, Nestlé, Nike, Samsung, Siemens, Tesco, Disney, Wal-Mart, Starbucks, and more (International Trade Union Confederation, 2016). It could then be stated that while trust in an agent can be a great tool, it arguably falls short when applied to global business reporting and within supply chain management.

2.4 Agency theory within a blockchain and supply chain context

This study leverages agency theory as a lens from which to study the use of blockchain technology within supply chains, specifically to assess the vulnerable point where indistinguishable assets are tokenized. As agency theory has been selected to help create an understanding for the researched phenomena and its potential solutions, the areas of supply chain, blockchain, and agency theory all hold importance in this study. However, it is important to note how the purpose of this research is not to test agency theory, but to use its principles and assumptions to help interpret the gathered data through the lens of agency theory. For this reason, the study follows certain assumptions made in agency theory. The research also applies those assumptions to the studied concepts of supply chain and blockchain so they fit better into the agency theory framework.

This research then fundamentally follows the underlying agency theory assumption that each individual will always act in a manner to promote their own self-interest, even at the expense of another's. The research therefor assumes an inherent tension between different people's agendas, specifically between a principal and an agent. This is believed to create an issue when an agent is employed to act in the principal's stead, as the agent is assumed to place their own interests above those of the principal. The research then follows the approach by Zsidisin and Ellram (2003) who applied agency theory into a supply chain context, where a buying organization is assumed the role of principal and suppliers are viewed as the agents. Following this assumption, the two case companies from this research who seek assistance in performing the task of claims verification are viewed as the principals. Furthermore, the research follows the description of an agency theory task given by Eisenhardt (1989), where it is the work assignment given to an agent by the principal. In this study, the task revolves around claims verification. Specifically, the agent is tasked with verifying that any data added on indistinguishable tokenized assets on the blockchain is accurate. Following these assumptions, the agents are assumed to be the party tasked by the principal to verify claims on their behalf.

Furthermore, the study will also seek to investigate the common relationship features detailed by Zsidisin and Ellram (2003) when assessing a supply chain with agency theory. Specifically, the research will look for how the agents address outcome uncertainty, provide risk aversion, conflicting goals, the length of the relationship, and how the agent makes use of information systems to minimize agency costs for the principal. As a result of the made assumptions, Table 1a was created to serve as a simple guide.

Agency theory concept	Study association
Task	Verify that indistinguishable asset data added on the blockchain is accurate
Principal	Company seeking claims verification assistance
Agent	Individual or organization tasked with verifying blockchain data entry
Sought relationship features	How agents address outcome uncertainty, provide risk aversion, and leverage information systems to minimize agency costs.

Table. 1a

Finally the research is built following the assumption of a divide between our physical world and the digital one. When blockchain was originally created as a cryptocurrency, it only held a place in the digital world (Nakamoto, 2008). However the creation of smart-contracts by Vitalik Buterin (2013) allowed for blockchain to cross into our physical world, where digital tokens could be created to represent physical assets. The research then follows the assumption of a created tension when a digital representation is created of an asset from the physical world. While the digital element of blockchain allows for immutability and full transparency, a tension is assumed when claims can be made on the blockchain regarding a supposed physical asset that has been tokenized. The researcher follows the assumption that this is the key element of the research and therefore seeks to assess the relationship between the digital and physical world.

3 Methodology

3.1 Research philosophy

This study attempts to gather a comprehensive understanding for the researched phenomena surrounding tokenization of indistinguishable assets on the blockchain. Specifically, what varying factors impede the reliability of uploaded tangible assets which have been tokenized. The research also attempts to assess what validation actions or processes can be leveraged to ensure entered data is reliable. The researcher is under the initial assumption the researched phenomena will not hold one definitive solution and believes situational factors play a large role in determining how an organization resolves the issue of reliable asset tokenization. The researcher would then argue the interpretivist philosophy is most suitable for this study as it seeks to understand behavior and gather deep insights over the researcher phenomena and its resolution (Saunders et al., 2012). In line with the interpretivist paradigm, gathered insights will come from observations and shared meanings from in-depth interviews which has been stated to be a favorable approach when researching a complex phenomenon (Eliot at.al, 2016)

Gathering data through in-depth interviews is suggested to assist in bringing forth more relevant comparative factors between the gathered data during the analysis phase (Collis and Hussey, 2014). Moreover, following a grounded theory approach in the attempt to generate theory through constant comparison the researcher argues the use of in-depth interviews is beneficial as it brings more elements of data for comparison (Corbin & Strauss, 2015). The researcher then hopes to pursue constant comparison both within and between cases during this study as a means to build theory around the researched phenomena (Corbin & Strauss, 1990).

On the other hand, gathering data through in-depth interviews greatly reduces the sample size, a measure that has been suggested to limit the replicability of a study (Avgousti, 2013). The researcher will then leverage the aforementioned constant comparison between data points in combination with triangulation to help ensure all given insights hold merit and allow for some degree of replicability (Benbasat et al., 1987). Finally, the limited sample size has been stated to help create an understanding for human tendencies and behavior, factors which are assumed to be of critical importance within this study (Bryman & Bell, 2011).

3.2 Research approach

Initially, this research has its roots in a deductive research approach. A gap was initially found in literature through assessment of existing literature and theory surrounding blockchain technology and supply chain management. The researcher therefore leveraged theory to help create an understanding for what insights had been made and where research had been overlooked, an approach stated to be consistent with deductive research (Saunders et al., 2012).

However, as a grounded theory approach has been attempted, the researcher aims to analyze data to extend and develop new theory (Corbin & Strauss, 2015). This approach, according to Saunders et al. (2012) aligns with inductive reasoning. The researcher would argue the analytical process focuses on deriving theory as the outcome of research, rather than using existing theory as a springboard to conduct research. This, according to Bell & Bryman (2011) constitutes use of inductive reasoning.

The research could even be suggested to have some elements of an abductive approach. Following descriptions given by Mantere and Ketokivi (2013), an abductive approach, much like an inductive approach, leverages presumptive results. As this research to some extent attempts to translate unanticipated findings into a logical consequence, it could be suggested abductive elements can be found within the analytical process. However, looking back to grounded theory the researcher ultimately attempts to create theory through combining and comparing gathered data, rather than to explain identified insights (Corbin & Strauss, 1990). Following logic by Mantere and Ketokivi (2013) the researcher would argue the analytical process then primarily follows an inductive approach.

3.3 Research strategy

In an attempt to reveal multiple dimensions of the phenomenon of tokenization of indistinguishable assets, the researcher makes use of case study research. This study follows the definition given by Baxter and Jack (2008), stating a case study is a research strategy which explores a phenomenon in a particular context through various lenses of information. According to Yin (2009), case study research addresses questions of how and why, where a researcher has little control over present events. An additional description comes from Benbasat et al. (1987) who compile a list of case study research characteristics. According to Benbasat et al. (1987), a case study research is where a contemporary phenomenon is examined in a real-life context, through examination of one or few entities. It is added how the researcher focuses on the complexity of the studied phenomenon, making sure not to isolate it from its context.

In a business context Halinen and Tornroos (2005) argue a case study is an intensive study into one or a few business networks, where network relates to the connection a set of companies share for the purpose of doing business. A later study by Järvensivu and Törnroos (2010) on the applicability of case study research within business states they are highly appropriate for investigation of business-to-business relationships and networks.

Furthermore, to increase generalizability, the study looks into two separate cases which address the same phenomenon. This is done through investigating two case companies. In line with Dubé and Paré’s research, (2003), this classifies the study as a multiple case study. This is done to create the possibility of comparison between the two cases and increase the accuracy of the data by seeing if what is observed in one case can also be seen within another (Saunders et al., 2012). Study of a single case was stated to leave some readers wondering about a study’s representativeness of the phenomenon (Weick, 1984). On the other hand, the depth of the research is limited when time is allocated between multiple cases, meaning the study moves closer to being quantitative compared to a single case which is perhaps strictly more qualitative (Gustafsson, 2017).

3.4 Method for theoretical background search

Literature for a theoretical background was derived from research databases Google Scholar and PRIMO, accessed through the Copenhagen Business School online library. Initial searches focused on combining the term "blockchain" with various terms such as "transparency" and"reporting." The initial search helped identify a gap in literature relating to data input for blockchain leveraged supply chains. The gap was then verified though found literature relating to the terms "blockchain" in combination with "supply chain," as well as "blockchain data input" and "tokenization." This also helped narrow the topic to solely focus on tokenization of indistinguishable assets.

Throughout the search, almost all results were narrowed to only include peer reviewed articles published within the previous ten years. This was only overlooked to include highly sighted sources commonly used in research of the stated topics. Finally, after an initial research question had been formulated, a search was conducted for a relevant model to view the findings though. As the studied phenomena was previously unresearched, finding a theoretical model proved challenging. Ultimately a fit was found with agency theory, due it the model's broad applicability and focus on the dynamics between multiple actors where one dictates work to another.

3.5 Context of the participant organizations

The research centers around two case companies in the supply chain management industry. Both companies provide a service leveraged by blockchain technology to create transparent and secure supply chains for partnering organizations. As such, both cases allow for tokenization of indistinguishable assets onto a blockchain. Both cases also focus on the agricultural industry and providing a complete farm to table solution. To provide their solutions, both companies partner with various monitoring service providers. The two cases differ in terms of the size of land they assess and use for food production. While Case 1 solely works on small areas often around one hectare and no larger than 10 (Representative A, 2021), Case 2 primarily works with larger organizations where assessed farmland can be as large as 100 hectares (Representative D, 2021). Moreover, for Case 1 the validation service providers are in the satellite imagery and on-sight geotagging industries. In Case 2, validation comes from an optical sensor company along with a blockchain implementation consultant.

As the investigated phenomena concerns detailed data which touches sensitive supply chain information, and as the research takes a critical approach, the researcher decided to provide all participant organization with anonymity. This is believed to help the interviewees give honest answers to the complete line of questioning and not have them worry about revealing sensitive information.

The participating organizations did not receive any financial compensation for their involvement in the study. However, following the conclusion of the research, both case companies were sent the final report and given a presentation of the resulting findings and analysis, along with recommendations for how to improve their blockchain data entry and validation processes.

3.6 Data collection

For the purpose of this research, data is primarily collected through individual interviews. For each of the two cases, one preliminary interview was conducted where the researcher explained the purpose of the research and gathered initial insights over the two cases. This helped assess fit of the study and collect some initial insights before conducting more thorough interviews. Following this, three interviews were conducted per case, one with the case company and two separate interviews with partnering organizations which offer validation services. This was done to help verify and triangulate any made claims. Ultimately, a follow-up interview was conducted for Case 2 as information was given by a partnering organization that did not align with what had been stated by the Case 2 company. This helped clarify statements and ensure collected insights could be triangulated (see Table 2).

The purpose of the interviews is to gather insight into how the chosen participants think and feel about the researched phenomena (Collis and Hussey, 2014). Following the interpretivist paradigm, the researcher aims to create an understanding for the researched phenomena and how to address it in a business context (King, 2004). The researcher then hopes to acquire high level comparable data from all sources within both cases, while still allowing for improvised follow-up into specific areas during the interviews. For this purpose, a semi-structure approach was chosen where the primary interviews follow a of preconceived list of questions but allow for new lines of inquiry which develop over the course of an interview (Young et al., 2018). Finally, due to the ongoing pandemic during the time this report is written, all interviews were conducted online via digital call services. Collected data was then be stored and saved via audio-recording following recommendations from researchers Collis and Hussey (2014). To help visualize the data collection process the following tables were made. Table 2 displays all conducted interviews with information regarding the interviewees position, the date of the interview, the duration of the interview, and finally the questioning form and documentation method used. Table 3 to displays all use of secondary data listing company websites, whitepapers, and one internal study conducted by Company D.

Company	Interviewee Position	Case	Date of interview	Length of Interview (minutes)	Questioning form	Documentation method
Company A	Chief Technical Officer	1	18-02-2021	30	Unstructured	Excessive Note Taking
Company D	Director of Operations	2	24-02-2021	32	Unstructured	Excessive Note Taking
Company A	Chief Technical Officer	1	09-04-2021	60	Semi-structured	Video & Audio Recording
Company C	Director of Strategy, Services, & Development	1	12-04-2021	68	Semi-structured	Video & Audio Recording
Company D	Director of Operations	2	12-04-2021	64	Semi-structured	Video & Audio Recording
Company B	Project Manager	1	13-04-2021	53	Semi-structured	Video & Audio Recording
Company F	Operations Supervisor	2	15-04-2021	58	Semi-structured	Video & Audio Recording
Company E	Software implementation consultant	2	16-04-2021	61	Semi-structured	Video & Audio Recording
Company D	Director of Operations	2	20-04-2021	13	Structured	Video & Audio Recording

Table. 2 Interviews

Company	Case	Document Type	Date of Access
Company A	1	Company webpage	17-02-2021
Company A	1	Whitepaper	18-02-2021
Company C	1	Company webpage	01-04-2021
Company C	1	Whitepaper	01-04-2021
Company D	2	Company webpage	01-04-2021
Company D	2	Whitepaper	04-04-2021
Company D	2	Internal research report	12-04-2021
Company F	2	Company webpage	12-04-2021
Company F	2	Whitepaper	15-04-2021

Table. 3 Secondary data

3.6.1 Population and sampling

As the researched phenomena of tokenization of indistinguishable assets is very new and complex, it was realized how very few relevant cases excited at the time of this research. For these reasons, a purposeful sampling method was selected. Participants were then selected prior to the data collection process based on a set of predetermined criteria (Collis, & Hussey, 2014).

Firstly, organizations were sought which offer supply chain management services, where blockchain technology is leveraged to tokenize assets and in turn help create secure and transparent supply chains for customers. This was done to put the phenomena into a business context where ensuring data accuracy is of critical importance. Secondly, the list of applicable companies was narrowed by solely looking for those in the food industry. This was done to create more similarity in the two cases so easier comparisons could be drawn between them. The food industry was specifically targeted as it is a large global industry with relation to production, manufacturing, marketing, and restaurants. The researcher argues this helps create some form of generalizability for the gathered insights while still putting focus into one industry. Secondly, large amounts of indistinguishable assets are highly common in the food industry where commodity food products are made and sold every day.

With the lack of companies which deal with the researched phenomena finding applicable case companies proved quite challenging. To ensure a larger sample size was assessed, and comparison could be analyzed between multiple case companies, no further criteria were set.

3.7 Question design and formulation

Throughout the interviews, a semi structured questioning approach was taken. The process consisted of both close- and open-ended questions, as well as follow-up up probing questions to get an in-depth understanding for the phenomena, while upholding a level of similarity in gathered data (Young et al., 2018). Firstly, close-ended questions were asked to help create an initial understanding. This was followed by open-ended questioning along with probing follow-up questions to get the maximum amount of data in relevant areas (Collis, & Hussey, 2014).

Furthermore, to ensure the research questions can be addressed through the lens of agency theory, questions were designed to align with existing concepts from the theory. Following grounded-theory research, the researcher leveraged sensitizing concepts, where applied concepts are adapted over the course of the study (Corbin & Strauss, 2015). Table 1a was used as a base and adapted to fit gathered information over the studied cases. Adjustments were then made after the two preliminary interviews were held, to accommodate the food industry and how the indistinguishable asset which are tokenized revolves around harvested produce. The task in these cases is then assumed to be verification of claims made by farmers about their supplied produce. The principal description is in turn updated to companies seeking claims verification about supplied produce. The agent is now assumed to be an individual or organization tasked to verify claims of produce made by farmers and other organizations. Finally, the sought relationship features will be narrowed to focus solely on outcome uncertainty, risk aversion, and information systems. Based on these new assumptions an updated table was created, Table 1b. This table was in turn used to create the full list questions used for the semi-structured interviews as seen in Appendix 1.

Agency Theory Concept	**Study Association**
Task	Verify claims made by a farmers about supplied produce.
Principal	Companies who seek assistance in performing produce claims verification
Agent	Individual or organization which is tasked by the principal to verify claims over produce made by farmers and other organizations.
Sought relationship features	How agents address outcome uncertainty, provide risk aversion, and leverage information systems to minimize agency costs.

Table. 1b

3.8 Procedure

For the purpose of this research, data was primarily collected through semi-structured interviews. To gain a full understanding for the investigated phenomena and acquire triangulation of acquired data, every case was investigated through statements from three representatives. For every case there is one case company and two partnering organizations who provide validation services. Interviews were held with one representative from each organization.

Initially an unstructured interview was held with each case company, Company A, and Company D. This was done to gather initial information on the companies and inform the representatives about the purpose of the research. This helped paint an initial picture of the case companies who would serve as principals during this research and task they sought agents for. More importantly, this helped the researcher identify potential agents which could be interviewed to help triangulate any statements made by the principals. Following this, semi-structured interviews were held with the case companies following the list of questions detailed in Appendix 1. From the given answers, agents were identified and two more semi-structured interviews were held for each of the two cases. As can be seen in Appendix 1, initial questioning for the principal focuses on giving a description to the interviewed participant and his/her organization. This is followed by inquiry about the use and involvement with blockchain technology. Finally, a question is asked seeking to identify who the agents are in the assessed case. From there the interview takes a more unstructured approach and focuses on finding information related to the sought tokenization issue and relationship features, as well as how the agency problem could be solved and or improved. The agent interviews take a similar approach but substitutes later structured questioning to address their view on how they provide validation services and address the sought after relationship features and solve the agency problem.

The initial interviews lasted around 30 minutes while the semi structured interviews lasted about one hour each. All interviews were held online. This enabled video and audio recording to be acquired of all interviews.

3.9 Data analysis

A grounded research approach was leveraged to analyze the data in a systematic manor (Corbin & Strauss, 2015). This was done through a thematic approach consisting of six stages. According to Guest and MacQueen (2011), a thematic approach is argued to be the most efficient and inquisitive analysis method for a qualitative study where large amounts of data are extracted from a small sample size. Similarly to a grounded approach, the analysis is conducted in stages where transcription of the data is followed by generation of codes (Guest and MacQueen, 2011; Corbin & Strauss, 2015). The researcher sought interesting statements which could be used to address the given research questions. Moreover, this was done through assumptions of agency theory. This was done to help ground the conducted research further in already existing research. The researcher then looked for principals, tasks, agents, and the predetermined relationship features detailed in Table 1b. Generation of codes was then followed by compiling and comparing codes in a systematic manor to create categories. During this third stage, triangulation was heavily sought to help ensure validity and replicability of the study (Carter et.al, 2014). Throughout this study, the definition of triangulation is derived from Carter et al. (2014) where it is a data analysis strategy that tests the "convergence of information from different sources." Specifically as the name suggests, this researcher looked for the convergence of three sources for each studied case. Following this, the two cases were compared to look for similarities and differences between them. The researcher believes this helped ensure the replicability and validity of the research further. However, the researcher acknowledges how triangulation of the cases themselves was not entirely possible due to the limited number of cases which were studied. The final stage focused on using the case comparison to generate a theory about the researched phenomena and its resolutions.

3.10 Data quality

3.10.1 Reliability

The term reliability herein refers to the degree to which the gathered data is reliable enough to where a repeat study would result in the same findings (Saunders et al, 2012; Collis, 2014). Since data is collected through semi-structured interviews where data to some degree is based on personal perception and where probing may lead to a varied line of questioning the issue of reliability is considered of critical importance. To help increase reliability the researcher makes use of triangularity (Patton, 1999). Data collection of each case consists of three interviews where any finding in one interview will look to be verified in the others. The researcher then hopes to leverage constant data comparison to increase the reliability of any presented data. Furthermore, the use of multiple cases will open up for further comparison to assess the reliability of the data.

3.10.2 Bias

Awareness and aversion of bias was given much consideration throughout this study. Issues of bias are particularly relevant within this study as it is conducted by a sole researcher and as a purposeful sampling method was used. Therefore measures were taken to avoid bias during the data collection phase. One measure was the use of open-ended questioning with careful consideration to avoid any leading language or tone (Saunders et al., 2012). All interviews were also recorded to allow for re-evaluation of all perceived findings. Bias was also discussed between researcher and supervisor to give an outside perspective to all taken measures. Finally, the researcher believes the issue of selection bias deserves mention. Due to the recent emergence of the researched phenomena a very limited sample of relevant cases was found. This meant purposeful sampling was chosen. To help mitigate selection bias, the researcher conducted multiple screenings of the chosen cases. An initial interview was therefore held to gather information over the proposed case to help assess if a fit with the study could really be found following the made assumptions of agency theory and the divide between the physical and digital world.

3.10.3 Validity

This research uses a definition of research validity given by Joppe (2000) stating:

"Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are."

Validity was ensured primarily through the use of existing literature. Existing research was used to create an initial understanding for the researched phenomena and was later used to assess the gathered data. All relevant findings are compared with completed research within blockchain, and supply chain used throughout this study.

3.10.4 Generalizability

Assessment of the degree to which the findings can be applied in other settings to draw general conclusions is arguably common issue in qualitative research due to the commonly small sample sizes (Saunders et al., 2012). It could also be stated that the issue is especially relevant for this research as the studied phenomena is seemingly entirely unresearched. By extension, this also means it can be hard to assess the generalizability as the findings cannot be compared to any similar cases. The researcher would argue how, while the solution to the issue of blockchain data entry might take different forms depending on industry and setting, an assumption is initially made for how the presented issue would remain the same. The applicability of the findings are therefore given space and detailed in the discussion section of this report along with suggested further research into the phenomena.

3.10.5 Ethical Issues

In line with researcher Maxwell's (2012) suggestions for qualitative research design the researcher has taken steps to avoid any ethical issues through the course of this research. Special consideration was given to interactions with the data collection participants during and after data collection. All participants were informed of the purpose of the research beforehand. It was also clearly stated how the report would be made publicly available. For this reason, the option was given to withdraw participation at any time. All participants were also given anonymity to ensure truthful answers could be given and no sensitive information was shared. Finally, participants were informed the interviews would be recorded and transcribed at a later stage. Throughout the interviews, careful consideration was given to not ask leading questions to ensure truthful responses. Participants were also asked in the end of each interview if they felt comfortable with the session and whether they wanted to redact any given response. Before final submission, all participants would finally be given the option to read through the report in its entirety and asked for their stamp of approval.

Regarding the gathered data, the researcher has to the best of his ability communicated the data as objectively and accurately as possible, with special consideration not to falsify, alter, or remove any gathered information (Adams et al., 2007).

4 Within-case analysis

4.1 Case 1 description

Company A is an organization founded in 2016 with the goal of helping millions of farmers around the world achieve a living income (Representative A, 2021). According to the company website, their approach is to track, trace, and tokenize commodity value chains in the food industry through a blockchain which accommodates smart contracts (Company A, 2021). The company white paper states that Company A hopes to show consumers where their products come from and inform the customer about what they are buying, how it's made, as well as how it gets to the store (Company A, 2021). They believe this will help create a more fairly distributed value exchange (Representative A, 2021). Their belief is that when consumers see where their money goes, and the change it creates, consumers will be willing to pay a premium to help those in need. When this research was conducted the company employed around 10 people (Company A, 2021). Company A was during the time of this research only working with small scale farms no larger than 10 hectares and independent individual farmers.

Company A's Chief Technical Officer (CTO), Representative A, was initially interviewed for this case. As a key member of the leadership team at Company A, Representative A is in charge of decisions regarding the overarching technology infrastructure that aligns with the company's mission and goals. One such responsibility is the acquisition of technologies which can be combined with a blockchain to create further traceability and transparency.

Initial questioning revealed that Company A leverages blockchain technology as a tool to display all the ethical practices and measures they take. Regarding blockchain, Representative A (2021) stated "the technology helps add additional trust." It was also added how "(Company A) use(s) blockchain as a lie detector," speaking for how the technology helps facilitate "claims verification." This was done through the use of smart contracts where relevant food products "(…)such as cacao and coffee beans are tokenized so they can be tracked through (the) supply chain in real time." Finally it was stated how "blockchain is just the first step in the tracking and verification process." Representative A stated how "blockchain helps you build a foundation of trust to work from." It was then added how additional technologies and solutions are then needed to fill in the gaps. Representative A also stated, "since you can upload pretty much anything you like to the blockchain, the key is in findings ways to verify that what has been uploaded is true."

Regarding such technologies, Representative A stated Company A "make(s) use of satellite imagery together with historical data and on (the) ground verification where (they) use photographs that (are) geotag(ed)". Such measures were primarily taken to address the issue of ensuring information added to the blockchain in the first steps of a supply chain were accurate. Representative A referred to this as "claims verification."

On the ground verification consisted of sending out a Company A representative on sight to assess, photograph, and geotag any new crops and produce. This was currently done by Representative B, an independent contractor working as a project manager for Company A to assess farms on site in Central Africa. Representative B had contracted with Company A for over three years at the time of the interviews, helping to continually assess and assist farms that are part of the Company A organization. According to Representative A, Representative B is“(…) the first step in our verification process.” Representative B (2021) explained how his position is to be the contact for the farmers in Ethiopia where a major production starts. He stated “I speak to them and look at their land and crops to see that everything is working as it should. Any time someone has a new tree or crops I go to look at it.” He added how this is followed by an additional step in claims verification whereby Representative B takes a picture of any new addition. This is done to create initial proof of what has been done. This is then accompanied by connecting the photograph to a location through geotagging. Representative B explained this was done as it “(…) lets us look at whatever it is from a satellite.” When questioned on Company A ’s cooperation regarding satellite imagery, Representative B stated he did not know too much about the organization itself but how he understood the workings of satellite imagery and that it was “another tool to verify claims.”

To leverage satellite imagery, Company A is partnering with Company C. Company C was launched in Europe a bit over five years ago and now houses around ten employees. According to their website they are experts in “developing, presenting and commercializing spatial data products and services for new markets” (Company C, 2021). Additionally, the company whitepaper states the company leverages spatial technology and satellite imagery, together with business analytics, to determine risk and opportunity for anything from cover classifications to waste dump detection. It was added how Company C also leverages artificial intelligence and machine learning to automatically detect range, material structure, and vegetation types (Representative C, 2021; Company C, 2021). The co-owner and director of strategy, services, and development, Representative C, was interviewed to assess claims made by Representative A . Representative C stated he has been the main point of contact “facilitating the cooperation between Company A and Company C” to implement claim verification services. According to Representative C, a key feature is their “ability to detect changes over time and assessment of historical data” (Representative C, 2021). Company C is then a company which uses spatial insights from space and business analytics to visually assess risk and opportunity for various situations (Representative C, 2021). Company C “assess geographical landscapes over fauna and farms connected to Company A.” They are then able to assess “changes in farmland and use historical data to validate the risk any registered produce rightly comes solely from a Company A registered farm.” Representative A (2021) gave the example of using historical data to determine “how much produce you can expect from one hectare of land or 50 trees.”

4.2 Case 1 findings

From the gathered data the researcher would argue validation of tokenized indistinguishable assets is done through the complimentary use of one-site assessment and geotagged photographs, together with satellite imagery. As such, two agents have been identified working the task of claims verification. As detailed in the question design and formulation following agency theory literature by Eisenhardt (1989), the task created by the principal and given to the agents revolves around verifying claims made by farmers about supplied produce (see Table 1b). Company A´s verification procedure is done in two stages and as such involves two distinct agents (Representative A, 2021). Firstly, an on-ground approach is taken where the first agent, Representative B, is sent on site to the farms to make his own interpretation and gather photographic evidence as a means to fulfill the given task. This is later combined with a second verification stage where an ariel-based approach is taken. The gathered photographic evidence and statements made by Representative B are assessed by the second agent Company C, a satellite imagery and historical data analysis company.

Further questioning focused on the targeted agency features of outcome uncertainty, risk aversion, and leverage of information systems. While two agents were used to address the task of claims verification, the next inquiry was over how Company A, the principal could address outcome uncertainty and minimize agency costs through trust in the agents to fulfill their given task. Representative A was then asked how claims made by Representative B and Company C could in turn be verified. Through a sigh and slight nod a sense was given to how this question was hard to address (Representative A, 2021). Representative A however, seemed to have given the issue much thought in the past and stated how Company A has taken "major steps to (ensure) claims verification" but how there is "no way to be completely sure of any (claim)". Representative A followed this by stating "there comes a moment in time when you just have to have trust and believe people will do good." It was then also stated how it was believed "the goals of (Representative B) and (Company C) align with (Company A's)" and this would help ensure trust is upheld. Regarding Representative B, it was also stated how he is "on our payroll" and as an employee was believed would work to further the goals of Company A .

When Representative B (2021) was inquired on the same line of questioning, a similar answer was given. Representative B stated trust was placed on him as he "worked for the company." He added how his background and education, along with his "inherent desire to help the farmers" were the primary reasons. He also said that over time at Company A he has "(…)proven himself many times." Representative C gave a much shorter answer to the question stating there is no direct system in place to “validate the (claims) we make, beyond our contractual obligation.” Further questioning with Representative C also divulged how satellite imagery came with inherent risks of margin of error determination, and potential cloud cover. It was also added that although their system was operated through machine learning and AI there were various points where a human element persisted.

Following this, an arguably interesting statement was made by Representative C regarding Company C. Representative C (2021) stated their goal is not to seek yes or no answers but instead “(they) look at scales.” This was elaborated on to explain how they focus on assessing the “(…) probability that a claim could be correct or incorrect.“ Representative C was adamant at how their system should only work as a starting point of claims verification. If their system identified any potential risk, it would then be the “responsibility to (Company A) to (assess) it further”. This was of interest, as Representative A (2021) had previously stated how Company A had “no way to ensure 100% verification on any claims made” that were added to the blockchain. However, it was believed that Company A’s two step verification process “makes it more difficult to not follow the goals of (Company A) and make (inaccurate) claims than it is to do what you should.” This statement was seemingly agreed upon by Representative C (2021) who emphasized how Company C was and should remain “only one way to check the statements,” referring to claims verification. Representative C then spoke of the “importance of combining verification methods” to “paint a better picture of everything.” Thirdly, Representative B (2021) also stated everything he did was kept on record, stating “everything is checked by other people,” presumably referring to Company C. The researcher would gather how the verification is done in two states but where verification made by Representative B needs to align with verification done by Company C, and vice versa. Outcome uncertainty and risk are averted not solely by the individual technologies, but by the multilevel system in place which leverages different but compatible technologies. This was illustrated well by Representative A through the example of a farmer producing coffee beans.

“If (Company A) knows thanks to historical data that 1 hectare of land produces (X) amount of beans per year and (has) assessed the farmland on site and (is) doing so continuously in the sky, then any inflated numbers are easy to spot.(..) And, any issue not spotted or purposefully avoided by Representative B would risk being seen by Company C and so forth. (Representative A, 2021)”

In terms of its relation to agency theory, it seems Company A makes use of multiple approaches to ensure the given task is preformed accurately. Firstly, Representative A (2021) believes “the goals of (Representative B) and (Company C) align with (Company A’s).” This statement is seconded by Representative B (2021) who spoke of his “inherent desire to help the farmers.” This was accompanied by statements for how Representative B was on the “payroll” of Company A (Representative A, 2021) and Representative C’s (2021) statement on having a “contractual obligation.” The researcher would argue these all align with behavior-oriented contracts where pursuit of the task is sought.

One statement from Representative C (2021) arguably follow result-oriented contracts where he stated he had previously “(…)proven himself many times.” This speaks of result rather than pursuit. However this sentiment was not seconded by Representative A (2021). Moreover, the main focus seems to be validating claims not through positive reinforcement such as through behavioral or result-oriented contracts, but rather through making the required cost of not completing the given task accurately so high that simply following the task is more beneficial. A party would, in a sense, need to overcome and influence both verification agents in order to make an inaccurate claim and have it registered on the Company A blockchain. This was expressed well by Representative A who said “(extreme) measures would need to be taken” to “get wrong information on our blockchain.” The researcher would argue how while this approach is seemingly highly secure, it entails much higher agency costs through adding multiple surveillance layers on top of one another.

4.3 Case 2 description

Officially launched in 2018 Company D has today grown to house over 50 employees according to the company website (Company D, 2021). Stated in their whitepaper Company D works within food supply chain management offering digital supply chain management systems based around blockchain technology (Company D, 2021). The company is run from its headquarters in America but holds a global reach thanks to its digital solutions (Representative D, 2021). The company themselves state they offer help to solve complex issues though innovative solutions at every stage of a supply chain, leveraging the transparency and immutability of blockchain technology (Company D, 2021). The company focuses on large scale farmer and cooperates with global players in the food industry.

For this study Representative D, the director of operations was interviewed. Representative D (2021) has been a part of Company D since its launch and is today in charge of policy creation, customer service, and technology implementation. As such, Representative D is in charge of everything connected to blockchain and affiliated technologies. To help verify claims made by Representative D (2021), Representative E, an independent software implementation consultant, was also interviewed. At his current position, Representative E serves as the leading software developer for Company D and dedicates most of his time to the "ins and outs" of their blockchain system (Representative E, 2021). He focuses on looking at areas where any blockchain enabled smart contract is added or adjusted to a clients supply chain.

From the start of the interview with Representative D (2021), it became clear the organization places a large focus on evening the playing field for farmers around the world. On the topic, Representative D expressed an issue with existing "(…) slim profit margins for farmers," also arguing how "most farmers are undefended." Representative D also stated that "in developing nations there is serious corruption issue." It was made clear how the organization leverages blockchain technology to "level the playing field." This to create greater traceability and transparency in a company's chain or operations to better "visualize the low margins many farmers are given to justify a fairer distribution". In Representative D's words, this is because "once data is written to the blockchain it cannot be removed and it is nearly impossible to change, creating an immutable record." However, Representative D acknowledged the limits of the technology stating blockchain "(…)is just a ledger. What makes it work is reliable ways to keep this ledger accurate and honest." Representative D also made it clear how Company D "(does not) provide any guarantees. Instead we mitigate risk by avoiding the human element." Their goal was stated to be "collecting enough data so we can see any anomalies (…) and address them".

The researcher would argue these statements align with the study from Adams and Tolko (2018) who state trust can be hard to obtain in developing nations. As a result, Company D seemingly attempts to leverage blockchain technology to bridge the existing gap of trust. While trust for people is limited, Company D is seemingly focused on substituting this trust in people for trust in technology instead. Moreover, it is in line with Lee, and Pilkington (2017) who observed blockchain technology can help geographically distanced parties feel closer to one another. These factors would perhaps be especially important in areas of high corruption.

The question was then asked how Company D ensures claims of indistinguishable tokenized assets are verified. Representative D (2021) stated "(…)the whole thing starts with the blockchain. We register all the food in smart contracts, so we can track it from farms to the stores." Here, Representative D (2021) was very adamant as to how no human element was present along the whole supply chain stating, "we have no human (data entry), so room for error is minimal." It was stated how instead the company makes use of "geofencing, IoT sensors, moisture readers, and scales". Representative D initially stated the first verification stage is when produce is "(…) first off assessed with optical sensors to get information for product amount, size, and chemical composition after harvest." However, an interview with Representative E (2021) revealed that the first entry point of data added to their system is done before any crop is even planted.

Representative E (2021) referred to this stage as the "preharvest process" where "crop yield and land use are (also) estimated." According to Representative E, the first data entered into a smart contract are "receipts of (purchases) made on seeds, fertilizer, and other planting materials." This entry is followed by geofencing the land used to "map out where crops are said to grow." This process was said to also "(…) geolocalize all the land, so (Company D) can keep track of what land is used by farmers." The next time any information is added to the blockchain was said to be after the "crops have finished growing." This process was later confirmed by Representative D (2021) in a follow-up interview who added he initially "didn't feel this was a verification stage." In his view it represented "(…)more of a data upload stage, but now I am seeing that it is an important part of our verification."

Stage two occurs when the produce is "assessed with optical sensors to get information for product amount, size, and chemical composition after harvest" (Representative D, 2021). Following this trucks are "followed with geofencing" and upon arrival, the company "use(s) large scales to weigh whole trucks". This was said to be done to assess if the registered weight matches expectations and verify expected-to-actual amount received. Following this, "(produce) is then scanned again using optical sensors."

The questioning then focused on partnering organizations Company D cooperates with to verify made claims. According to Representative D (2021), much of the technology comes from an organization called Company F, a company providing optical sensor technology and moisture readers. It was stated Company D makes use of different organizations for this purpose around the world, however "Company F is our South American partner."

Company F was founded in Europe during the late 1900s (Company F, 2021). According to their white paper, the company today has a global presence within material recovery and optical sorting solutions, and employs around 5000 employees (Company F, 2021). Company F provides Company D with optical sorting solutions. They then offer machines which automate the process of registering and sorting food products like corn or beans using cameras and lasers. According to their own internal study the technology is able to accurately recognize and store information regarding object color, shape, size, and chemical composition (Company F, 2021). Representative F (2021) was interviewed for this study and is the operations supervisor at the sorting division of Company F. Representative F has been with the company for almost 10 years and oversees technical operations of their optical sorting division.

From the interview with Representative F (2021), it was made clear early on how Company F does not work with blockchain technology themselves. Their involvement with blockchain technology is mostly limited by their cooperation with Company D. However, their systems were said to be "adaptable", and results can be "integrated into smart contracts and put into a blockchain." Representative F confessed to limited knowledge of blockchain technology but stated their cooperation with Company D focused on "analyzing and verifying (claims) of produce quality, amount, and storage condition(s)." Quality control and produce calculations were done through optical sensor machines. Finally, moisture readers were used to ensure accurate storage conditions were upheld during transportation and warehouse storage. Representative F was questioned on the accuracy of their sensors and readers, and in response stated their products were of the "highest standard." It was added how they leveraged machine learning technology to continuously adapt and improve their systems to reduce risk over time. Representative F added how they could never be completely certain of any claim, however their "sensors are more reliable than (the) human eye."

4.4 Case 2 findings

Similarly to Case 1, the data gathered on Case 2 suggests validation of assets is done though the complimentary use of verification processes and technologies. At least two agents were found to address the task of claims verification at Company D. The specific process however remains different. The researcher would argue four stages of claims verification have been identified, where one agent was responsible for two stages. The first stage is during the "preharvest process" as described by Representative E (2021) where relevant receipts are stored and digital mapping services are leveraged to estimate production rate based on the amount of land used. This stage is overseen by the first identified agent, Representative E (2021). The second verification stage centers around using optical sensor technology to calculate and weigh harvested crops. This process is done by Company F as described by Representative F (2021). The same crops are then weighed before and after transport by an unstudied third party, and the fourth and final identified stage uses optical sensor technology once again to ensure the entire harvest amount has been delivered to its end destination. This stage is again controlled by Company F.

Further inquiry targeted the sought features of outcome uncertainty, risk aversion, leverage of information systems. When questioned about outcome uncertainty and risk aversion Representative D (2021) expressed how the “absence of human (data entry), makes it so room for error is minimal.” He added how “people are reluctant to do business with one another. People are especially reluctant to do business in another country.” It was argued this is why their trust in technology had yielded such great results for the company. A similar statement was made by Representative E (2021) who stated the only human influence for the first verification step was on “controlling how the system should perform.” He added how he “designs for what info(rmation) should be added and how. But no one here has any part in adding the actual information.” In his words this was to “remove the human element” so that “(…)risk can be minimized.” He then stated how his goal is to create a system people can trust, “(…)without necessarily needing to trust me.” The lack of human interference was also reiterated by Representative F regarding the following verification stage. He then stated, “the system runs itself without us or anyone from (Company D) needing to intervene.”

However, further questioning over potential risks, revealed how, in the case of equipment malfunction Company F would send their own representative to fix the machine, not wishing to disclose certain details of its inner workings (Representative F, 2021). Furthermore, Representative F was also unable to mention any measures Company D had taken which would ensure any claims made by Company F machinery or technicians were accurate. The only assurance given was that “the technology is highly transparent and results can easily be checked.” It was also stated that Company F could be trusted as it was “their contractual obligation” (Representative F, 2021) Similarly, Representative D (2021) spoke of the “highly detailed contract” they had with Company F which “(lets) us know they will follow the task.”

The same line of questioning over outcome uncertainty and risk aversion was given to Representative E (2021) who seemed very happy to inform there had “never been an error” and there was no indication one would occur in the future. He believed this was due to the “simplicity” of the system and the “absence of human error”. He then added how the individual technologies used would be the only conceivable vulnerabilities.

Representative E (2021) seemed very confident in their systems. He explained how an “optical scanner or a faulty receipt could register the wrong data at one point of the supply chain.” This faulty information would then be added to the system and recorded on the blockchain. However, he also said that “this would be spotted at the next stage,” referring to the next time the data was assessed at the next point of the supply chain. His final remark was how it would require an “ incredible amount of (resources)” to mislead the whole system and get inaccurate data through the entire supply chain. He explained you would need to influence every stage of the chain or it would be noticed by the system. With a laugh, he finally added how it would be “cheaper to just follow the rules.” These statements were arguably mirrored by Representative F (2021) who explained that, in the event of an error or potential faulty claim, “machines send reports of what went wrong to us and our client.” This was done to uphold transparency and to help improve the products over time.

A final statement given by both Representative D (2021) and Representative F (2021) was how the combination of technologies used was the main factor for ensuring “claims of tokens” were accurately verified. Representative D (2021) said their “collaborations and combinations of technologies works (to) mitigate risk and paint a picture.” Similarly Representative F (2021) stated “our optical scanners are just one solution. The real strategy is to combine machines and processes so that if one is broken the others will notice.” While Representative E (2021) did not comment directly on the value of combining technologies he did say “the receipts and geolocating is just one step in the chain. While we are the first step in the chain we are not and should definitely not be the only step.”

From an agency theory perspective, the researcher would argue Case 2 focuses on completing the given task of claims verification of supplied produce though leveraging various information systems. Representative E (2021) spoke of creating a system people can trust, without needing to trust the person behind it. Representative D (2021) repeatedly spoke of removing the human element to instead placing trust in their technology. Finally, Representative F (2021) mentions their solution is capable of feats beyond that of humans. Their approach seemingly comes with very high agency costs as the described process focuses on increasing transparency and monitoring. In Case 2, trust for people, which is the prime focus in agency theory, is sought to be overridden by trust in technology instead. In a sense it could then be suggested their goal is to make the machinery the agent, rather than the person who creates and controls it. Looking to previous research it is perhaps the blockchain system itself which allows for this disconnect from the human element in the first place. As stated by Dobrovnik et al. (2018) the immutable and decentralized aspect of the technology helps users substitute trust in people with trust in the system itself. However, as grand of a vision as this may be, there was a mention in Case 2 of human influence where a behavioral-oriented contract was used. Representative F (2021), when pressed did state trust to some degree was upon company F and their representatives in cases of machine error. In such cases trust was placed on them to follow through as it is "their contractual obligation."

5 Cross-case analysis

When comparing the two cases, the researcher argues many similarities can be found between them. Firstly, their goal of helping farmers around the world seems to align. While Company A strives to offer a "living wage" (Representative A, 2021), Company B attempts to "distribute profits margins more evenly" and provide protection as, in their view, "most farmers are undefended" (Representative D, 2021).

Secondly, both cases place a high value on blockchain technology, but argue it holds little merit if not combined with complimentary systems or technologies. Representative A (2021) views blockchain as a "foundation" upon which trust can be built and views the technology as the first step in tracking and verifying a supply chain. In a similar manor, Representative D (2021) viewed blockchain as a way to "level the playing field," but also acknowledged it as nothing more than a "ledger." In Representative D's (2021) view, the real impact comes from "reliable ways to keep (the) leger accurate." The researcher would argue the main mechanism which impedes reliable tokenization of indistinguishable assets is the ability to upload anything to the blockchain. As it in essence is nothing more than a "ledger" the Representative A's statement paints the picture arguably well.

"Since you can upload pretty much anything you like to the blockchain, the key is in findings ways to verify that what has been uploaded is true."

The researcher would argue this to some degree helps highlight the value of claims verification solutions when blockchain is leveraged within a supply chain. While blockchain arguably holds a large potential, within supply chain the data collected suggests it requires supporting technologies to provide its desired function of transparency and traceability, at least when indistinguishable assets are involved. This would align with findings derived from research by Khanna et. al (2020), as well as Francisco and Swanson (2018) who suggest the increased traceability blockchain offers is present first when it is combined with other technologies. This is further highlighted by Adams and Tomko (2018) who spoke of the issues present when a tokenized asset in not easily identifiable or distinguishable. The argument also aligns with Pisa (2018) and Potdar el al. (2018) who state trusting the blockchain system, should not mean full trust in all claims made on it.

Secondly, the researcher would argue the data gathered from Case 1 and Case 2 show many similarities regarding their validation processes when analyzed through the lens of agency theory. Firstly, in both cases the case companies, Company A and Company D, well align with the used assumption of a "principal" detailed in Table 1b. Both Cases also seek to address the described task of verifying claims of indistinguishable assets made by farmers about their produce. Thirdly, both cases arguably take a similar approach to agents. Both principals make use of multiple agents to address the stated task. Moreover, both cases make use of agents which leverage varying technologies to fulfill the given task. While Case 1 uses satellite imagery together with historical analysis and geolocated photos, Case 2 primary uses Optical sensors along with geofencing, receipt tracking and weight assessment. The researcher considers these differences have arisen due to the differing scale of operations between the two cases. As Case 1 is working with small scale farmers and land no larger than 10 hectares, Case 2 assesses land up to 100 hectares in size. Due to the differences is scale the magnitude of verification solution has then arguably been adapted. The researcher would argue this points to how validation of indistinguishable assets does not hold any one solution. Instead validation can leverage a range of technologies.

In an attempt validate tokenization of indistinguishable assets, both cases indicated some form of a behavior-oriented contract was used. For Case 1 Representative A (2021) speaks of "aligned goals" between Company A, Company C, and Representative B. Representative A also mentions Representative B is acquiring monetary compensation through time spent pursuing the given task. Finally, Representative C (2021) speaks of having a "contractual obligation" to fulfill the given task. The same statement was also found in Case 2 where Representative F (2021) also mentions "contractual obligation" as a reason for their pursuit of the given task. This was however not found elsewhere in any of the interviews for Case 2 and was not confirmed or denied by the other representatives within the case.

However, the main approach used in both cases seems to best fit the first path detailed by Shapiro (2005), where steps are taken to increase monitoring, thereby giving the agent less room to act freely. Validation of tokenized assets was primarily done through a combination of monitoring technologies. However, the researcher would theorize both cases make use of a unique variant of the process detailed by Shapiro (2005). Rather than increasing monitoring through one service, the cases attempt to compile different monitoring solutions in tandem with one another. In this manor, no one agent or monitoring service holds complete authority over the given task. As stated, the goal is seemingly to make diverting from the given task so costly for an individual that simply doing the given task is more beneficial to each individual agent. This was iterated by Representative A (2021) who stated "(extreme) measures would need to be taken" to "get wrong information on our blockchain." It was also expressed by Representative E (2021) who stated an " incredible amount of (resources)" would be needed to get wrongful information through the supply chain to the degree where it was "cheaper to just follow the rules."

The researcher would argue another difference between the two cases is the degree to which this remains true. As Case 1 operates on a smaller scale with perhaps more limited resources they make use of more behavior-oriented contracts in places where a gap in their technological validation is found. It was only when pressed that Representative A (2021) disclosed how "there comes a moment in time when you just have to have trust and believe people will do good." As such, the researcher would argue the element of trust is to some small degree used within Case 1 to fill in the gaps of their tokenization issue solution. A similar scenario does occur in Case 2 where Representative F (2021) admitted Company D placed some degree of trust in them as people. In the one identified area this was stated to occur, it was the "contractual obligation" that this trust was built upon. The difference in scale can also be seen in the agents which the two cases make use of to complete the given task. While Case 2 prides itself of removal of the "human element" (Representative D, 2021), Case 1 still uses Representative B to investigate farmland and produce. Additionally, the technology used is arguably on a different scale where Case 2 heavily leverages high-end optical sensor technology, Case 1 uses geotagged photographs for their first verification step. Regardless the two cases show how the overarching process used for claims verification is leveraging multiple verification technologies in tandem with one another. To visualize the process Figure 2a and Figure 2b were created.

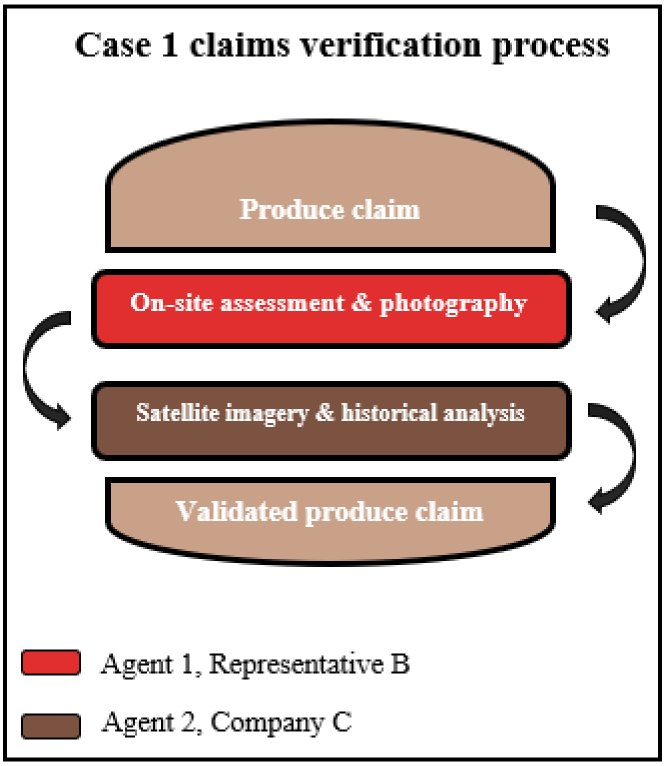

Fig. 2a Case 1 claim verification process

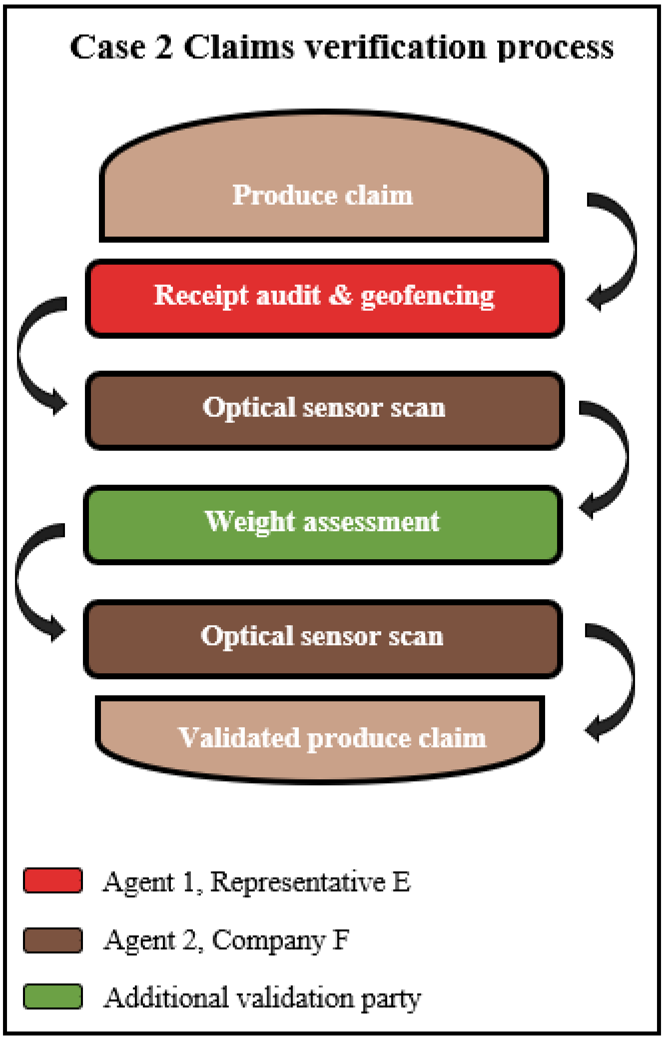

Fig. 2b Case 2 claim verification process

Figure 2a details the process of claims verification identified in Case 1. The visual model depicts how Company A's process of claims verification. As such, the model shows the task created by the principal of claims verification. The model follows the process from when a claim over new produce is made, through the validation stages of the supply chain on the point where it becomes a verified claim. Within the figure, the two middle blocks represent the respective agents and details the performed verification process. Finally the arrows show the transfer of the claim, through the different stages of verification. In the same manner, Figure 2b details Company D's process of claims verification detailed in Case 2. The four middle blocks represent the four stages of verification within this case. Similarly to Figure 2a, the blocks represent various agents acting on behalf of the principal to verify claims. The green block represents the described stage of weighing trucks of produce. However as no information was gathered on this agent the description of "additional verification party" was given. Finally, as the optical sensor scanning was found to be present twice throughout the verification process the brown block representing Company F was added twice, once right after harvest, and again after produce has been transported and the trucks have been weighed.

As such the researcher would theorize how the identified process of claims verification would generally look like Figure 2c. Adaption would then be made to add or remove stages, or to add more blocks for existing agents which maintain more than one verification stage, as was the case for Company F within Case 2 (see figure 2b).

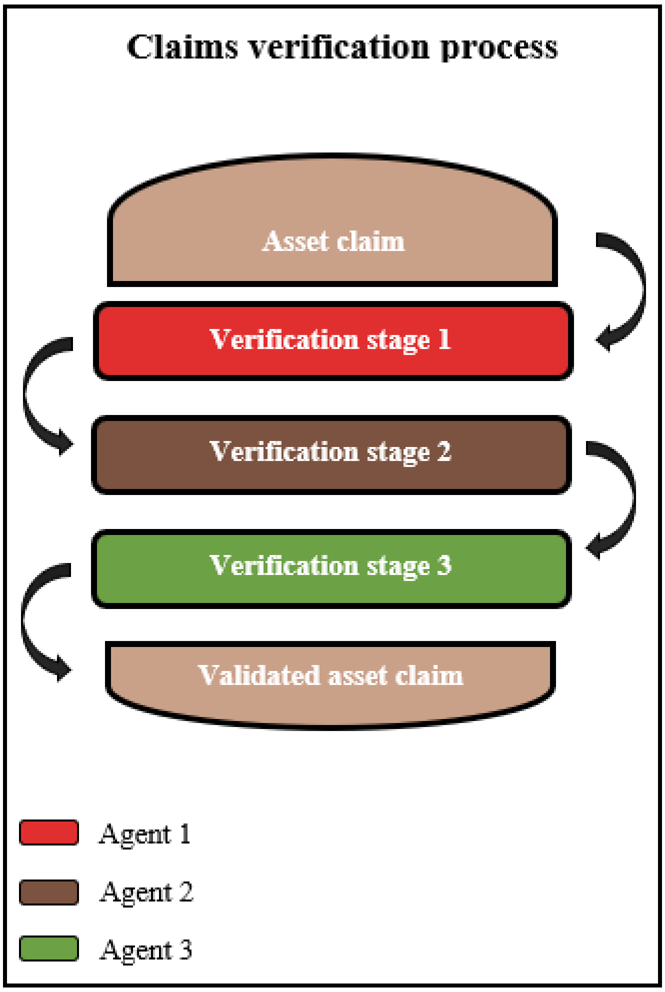

Fig. 2c Claims verification process

The researcher then believes the reason for this unique take on monitoring services is due to the structure of the blockchain itself. As stated by Nofer et.al (2017) each block in the chain holds transaction records, a timestamp, and a nonce. Any made claim can then be easily found and even holds a timestamp for when it was made. The nonce together with the consensus mechanism ensures any made claim cannot be removed or edited at a later stage (Swanson, 2015; Vitalik Buterin, 2015). Bracamonte and Okada (2017) even suggest the consensus mechanism democratizes validation of transaction where power is then dispersed among all participants. These features together make it very easy to hold all agents and farmers fully accountable to any claim they make and have made on the blockchain. If an inaccurate claim is identified down the chain the farmer or agent has no way to redact or remove their previous statement and proof of guilt is very easy to obtain. It is perhaps for this reason Chen at. Al (2018) argues blockchain and smart contracts will bring "trust, security and decentralization into current business systems" where the technology can be leveraged.

The researcher would also make an argument for how the identified cases could improve operations and reduce existing agency costs. While the cases displayed solutions to the tokenization issue which arguably offer a high amount of transparency and security for the organizations, the agency cost incurred is understandably high. As both companies collaborate with multiple agents to solve the given task and as the agents in turn leverage various high-end or time consuming validation processes, the cost incurred by the principals is understandably large. Looking to agency theory research the researcher believes behavior-oriented contracts could be leveraged to a larger degree. From the literature review covering agency theory in supply chain management, behavior-oriented contracts were stated to commonly be used by purchasing organizations (Zsidisin & Ellram, 2003). Common examples were systems for information sharing and initiatives to tighten supplier relationships. Within Case 1 Representative B spoke of sending information in the form of geotagged photographs to Company C to assist in their satellite imagery process. The researcher would argue this is an instance where a behavior-oriented contract is used as information is shared and the relationship between agents is tightened. Following the definition given by Eisenhardt (1989) agency costs refer to the time spent and resources allocated to ensuring an agent acts in a favorable manor to complete a given task. As such the researcher would argue this collaboration between Representative B and Company C helps reduce time spent on the validation process for Company C and incurs no identified cost in resources for either party. Furthermore, the adjustment would not alter existing process and the existing approach to claims verification would still remain. The researcher would then theorize how the agency cost from validation of indistinguishable food assets within a supply chain could be reduced through placing a larger emphasis on behavior-oriented contracts where possible. As is evident from Case 1 and to some extent from Case 2 this would also not alter the presented solution to the tokenization issue where validation technology is used in tandem with one another. It would only serve to tighten the collaboration between the different technologies used. To help visualize this adjustment Figure 3a was created.

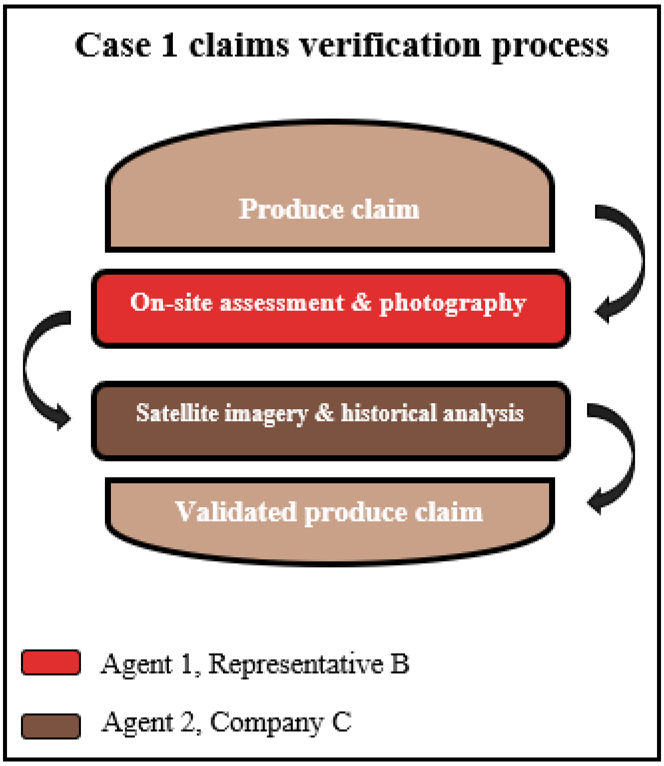

Fig. 2a Case 1 claim verification process

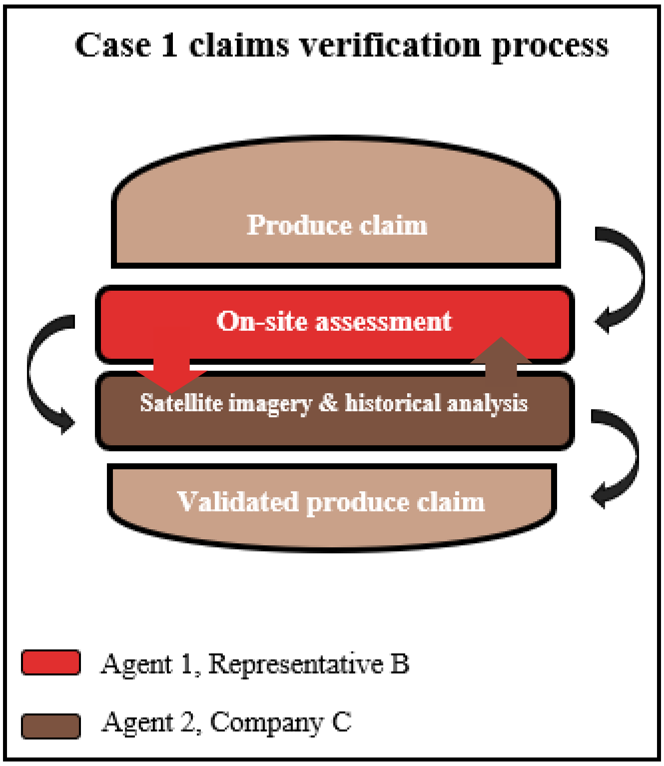

Fig. 3a Adjusted Case 1 claim verification process

The use of behavioral contracts, as stated, is estimated to help reduce agency costs. Figure 3a visually depicts the blocks of Representative B and Company C placed closer to one another. The added arrows between them is to symbolize the information sharing that bridges the agents closer together. Beyond this, the two figures remain identical. This was done to visualize how leveraging behavioral contracts should not impact the existing process of claims verification. The researcher would argue this adjustment could be made for Figure 2b, if behavioral contracts were leveraged to a larger degree. The researcher would argue this can even be generalized and would hold for Figure 2c.

6 Conclusions

Throughout this research two cases were identified which both place a high value on leveraging blockchain technology to create transparent and secure supply chains. Both cases conceded how blockchain on its own was only the base or steppingstone to make this a reality, and stated other technologies needed to be used in tandem with blockchain technology to reach reliable results. From the generated insights, the research would suggest it is fundamentally the wide applicability of smart contracts which, in essence, allow for any asset to be tokenized, since “you can upload pretty much anything you like to the blockchain,” (Representative A, 2021) as it is “just a ledger” (Representative D, 2021). For indistinguishable assets, any claim can therefore be made about the tokenized asset. The researcher would then argue the two presented cases bring forth the critical importance of leveraging validation services when tokenizing indistinguishable assets.

The research then made use of assumptions found within agency theory to show how both cases displayed similarities in their role as principal, as well as the task they sought agents for. The first identified difference between the two cases was the technologies used in tandem with blockchain technology to complete the task of claims verification. While Case 1 focused on satellite and geotagging technology, along with the expertise of Representative B, Case 2 repeatedly emphasized “removal of the human element” (Representative D, 2021) and heavily leveraged optical sorting technology together with receipt tracking and geofencing. The researcher believes this difference takes root in the varying scale of operation between the two cases although no direct evidence was found which backs this claim.

The researcher would also argue the difference in validation process highlight the indifference towards which validation technology is used. From an agency theory perspective, both cases mainly leveraged an increase of monitoring services to hold agents and farmers accountable for made claims. However, as stated, the key to tokens being validated reliably, is seemingly not the specific technology used. Instead the process focuses on layering multiple validations systems together with one another, to disperse power among the agents to where they, in a sense, monitor not only the farmer’s claims, but also one another. This resulted in a system so secure, where an agent would benefit more from accurately following the given task, rather than pursue any self-interest that would bare cost for the principal. This was captured very well in the statement from Representative E (2021) who stated as an agent it was “cheaper to just follow the rules.”

The researcher argues this a very secure approach, although it seemingly comes with a high agency cost. The researcher then believes these costs could be reduce though larger emphasis on behavior-oriented contracts. While behavior-oriented contracts were found in both cases, the data stated it was more prevalent in Case 1 than Case 2. The gathered insights also point to behavior-oriented contracts being leveraged without the need to compromise on pursuing multiple validation services in tandem. Instead, this would entail creating closer collaboration between the varying validation services to create a more seamless process, thereby reducing agency costs.

7 Discussion

7.1 Implications

The implication of this study extends to the application of blockchain technology. The study assesses cases within the food industry where the findings are believed to be most applicable. However, as the findings indicate a variance in technologies used for validation of indistinguishable assets, with instead an emphasis of layering validation systems with one another, the findings to some extent are believed to be applicable in other industries. The researcher then hopes this research can be viewed as a starting point for identification of what technologies and systems can work in tandem to create such solutions in other industries.

7.1.1 Theoretical implication I

The researcher hopes this study highlights the issue of tokenization of indistinguishable assets, where a digital representation of a physical asset is created. Blockchain has received much praise since its creation by researchers like Wladawsky-Berger (2019) and Hall (2018). The technology has also evolved, and with the creation of smart-contracts could now be said to bridge into our physical world. The researcher then wants to bring forth some of the security issues this evolution comes with, as suggested by Tikhomirov (2018). The findings seem to support how the transparency of blockchain does not fully translate when physical assets are tokenized. Furthermore, the issue seems to center around the ability to make any claim and upload any information onto the blockchain, with no processes in place to control made claims. The researcher believes this highlights the importance of Implication II, the importance of complimentary validation services.

7.1.2 Theoretical implication II

What the researcher believes to be the most interesting finding is that the data supports reliable tokenization of indistinguishable assets are best validated by mixing a concoction of monitoring services, layering them together with one another. It seems validation of claims is not done by any one technology or process, but through multiple stages and technologies working in tandem. As initially stated in the Implications, the researcher believes this means the research is more applicable within other industries where other technologies and processes would be leveraged to validate varying indistinguishable assets.

7.1.3 Theoretical implication III

Finally, the researcher argues this study highlights how existing agency costs of time and resources could be reduced through greater leverage of behavior-oriented contracts, as suggested to be commonplace within supply chains by Zsidisin and Ellram (2003). The researcher would state the main benefit of this adjustment is how the existing solution of layering validation services would not be altered. Instead, the researcher believes greater leverage of behavior-oriented contracts would only serve to strengthen the existing system through increasing relations and information sharing between validation service suppliers, and in turn reducing existing agency costs.

7.2 Further research

Although this research is believed to be replicable to some degree within other industries beyond food, the researcher believes research into the accuracy of this claim is highly relevant. While validation services in tandem was found to be prevalent within the food industry, no evidence directly suggested this would translate into other industries. Research into other industries would then serve to strengthen the insights gathered through this study and perhaps help create a stronger theory for how indistinguishable assets can be reliably tokenized.

Secondly, the researcher believes it would be of interest to investigate to what factors impact which validation services are chosen. This would help assess if there is a relationship to be found regarding robustness of the used technology and scale of operations, or if technological infrastructure is of any relevance. It would also benefit to research if scale of operations impact to what extent behavior-oriented contracts can be used together with information systems. The research does display a difference where Case 1, with a noticeably smaller operations scale, leveraged behavior-oriented contracts to a larger extent. Case 2 on the other hand frequently spoke of removing the human element and only made use of behavioral contract in one minor instance.

7.3 Limitations

While the choice of a qualitative approach allowed for a deep dive into the researched phenomena, the researcher acknowledges how this comes with a smaller sample size. As such the research cannot serve to create a complete representation of the studied phenomena. The insights gathered from the two cases are to some extent generalized and assumed to hold for the entire blockchain-leveraged food industry. Secondly, the research stives to emphasize three-point triangulation throughout to help combat this issue and must then also acknowledge how, due to lack of available data sources, only two cases were studied, meaning triangulation of the cases themselves could not fully occur.

Moreover, all interviews during this study were held online via a digital calling service. While this benefitted the researcher in terms of easy audio and video recording, it also limited the data which could be collected. As a qualitative approach was chosen, the researcher hoped to gather data beyond what was said by the representatives. While body language could be assessed through video, the full extent of non-verbal communication which is present during an in-person interview could not be analyzed by the researcher.

The research was also limited to some extent by the lack of fluency in English by Representative D. The researcher would argue the representative held a strong vocabulary and understanding for the English language. However the lack of fluency was present when translating given quotes directly, which proved to be a common issue as the representative would use many words where only one was needed.

Finally the lack of existing research on the researched phenomena limited the research to some degree. While relevant sources were found for the areas of blockchain, supply chain, and agency theory, no found study covered issues with tokenization of physical assets. This did give the researcher an open path to create new theory, but also left the researcher, to some extent, with a lack of guidance and navigation tools to leverage for studying the researched phenomena.

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Appendix 1

Principal Introductory Questions

- What is your name & position?
- Can you please describe what your organization does?

Principal Interview Questions:

- How does (your organization) leverage blockchain technology?
- What are the benefits of using blockchain compared to other systems?
- Are there any benefits to tracking a supply chain with blockchain technology?
- Are there any points of vulnerability when using blockchain technology to uphold a supply chain?
- Have there been any hurdles for you to overcome when applying blockchain to your supply chain?
- Looking at the input stage, who uploads data to the blockchain? How is this done?
- How is any information added to the blockchain verified? Who does this?

Agent Introductory Questions

- What is your name & position?
- Can you please describe what your organization does?
- What is your connection to (case company)?

Agent Interview Questions:

- Is it true that your organization assists (case company) in verifying made claims?
- How does your organization help (case company) verify information added to their blockchain leveraged supply chain?
- Are there any benefits to tracking a supply chain with blockchain technology?
- Are there any points of vulnerability when using blockchain technology to uphold a supply chain?
- Have there been any hurdles for you to overcome when applying blockchain to your clients supply chain?
- Is there any point of human interference in your system?
- How can (case company) ensure any claims you make are accurate?
- How do you ensure the goals of (case company) align with your own?