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Blockchain for securing sustainable transport contracts and supply chain transparency

An explorative study of blockchain technology in logistics

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Abstract

Based on the imbalances caused by asymmetric information and opaque supply chains, this study aims to contribute to the research field of logistics and supply chain management by exploring the potential of blockchain technology within logistics. The main focus is on increasing supply chain transparency for both suppliers and consumers, and improving contractual coordination in order to secure fulfilment of sustainability clauses in transportation contracts.

The purpose of this paper is to explore the potential application of blockchain in the field of logistics in regard to supply chain transparency and transport contract fulfilment concerning sustainability clauses. The research is conducted through a case study approach, combined with a literature review and a semi-structured interview with an expert with in the field of blockchain technology.

The study has the potential to empower the position of consumers, suppliers and manufacturers regarding knowledge about the product and the social and environmental activities associated with the products supply chain. Findings show that the implementation of blockchain in logistics can potentially generate more awareness about the hidden layers of the supply chain, and global transportation. The results could contribute to improving service management within companies and improve their policies concerning sustainability and environmental impacts.

The thesis contributes to the expanding research field of blockchain technology within logistics.

Key words: blockchain technology; supply chain; transport contract; transparency; sustainability.

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Contents

1. Introduction

This chapter introduces the incentive, purpose and range of the study. There is an emphasis on supply chain transparency, fulfilment of transport contracts and the potential of the emerging blockchain technology. Two research questions are presented, limitations are set with the intention of specifying the scope of the study, and an outline is presented.

1.1 Background

The intricacy of supply chains, with their vast networks of different actors, consists of concealed elements for both supplier and consumer, which raise questions about the monitoring of the supply chains multiple layers. These layers can contain socially and ethically questionable activities, such as exploitation of natural and human recourses, leaving environmental footprints, contribution to waste from production and transportation. (Baker et al., 2015) In most transactions these factors are concealed due to either or both lack of transparency in the supply chains and information asymmetries in business agreements. In parallel, there is a growing interest for knowledge regarding product origins from consumers, and demand for sustainable transportation. (Carter et al., 2008; Svensson, 2009) Consider the origins of everyday commodities. Products are imported and sold with the limited information of a label addressing the manufacturing or production origins; commonly know as “Made in X”. (New, 2010; Williams et al., 2015) A decade ago neither supplier nor customer would reflect on the restriction of this information. However, with the expansion of the global market demand for information has increased. Sellers’ advantage of knowledge, regarding the demanded products and services, could contribute to low-quality services for high-quality prices in the pursuit of maximum profit. Consequently, buyers can pay the same amount for a high respectively low service quality due to their inability to access the same information. (Akerlof, 1970). Essentially, expectations do not match the perception of a service, for instance requesting and paying for green transportation but not receiving it. (Nilsson et al., 2015)

To counteract the imbalance caused by asymmetric information, and generate more knowledge about products, companies should aim to implement and produce more transparency in their business model. (Akerlof, 1970; Fung, 2013). Transparency has been defined as the disclosure of information (Egels-Zandén et al., 2015; Doorey, 2011; Mol, 2014) that enables fair competition (Akerlof, 1970), profitable business ventures (Tapscott et al., 2003), and company fulfilment regarding sustainability efforts (Kaptein et al., 2003; Kaynak et al., 2012). Knowledge concerning the supply chain is also extracted by instilling transparency. Supply chains need transparency in order to supply all actors with knowledge that equalizes the negotiation power between parties, and generates more information concerning product origins. (Lamming et al., 2001) This could in turn fulfil customers demand for more knowledge regarding product origins and demand for sustainable transportation. (Carter et al., 2008; Svensson, 2009).

Information is key in the pursuit of improving relationships between actors in the supply chain because an increase of coordination of transactions could reduce costs, risks and improve a supply chains' overall competitiveness. (Lee et al., 1999; Cachon, 2003; Fugate et al., 2006) A way to achieve this is by using contracts. (Naryanan et al., 2004; Eng-Larsson et al., 2014) Contracts bestow the ability to bind actors to each other, specify the conditions of the transaction and provide evidence and enforcement for execution of the set terms. (Blomqvist et al., 2005) Several studies on the modelling of supply chain contracting have shown that revenue-sharing contracts improve co-ordination and increase profitability, and that the insensitive for coordination depends mainly on the stipulated payment type and timing. (Dana et al., 2001; Cachon 2003; Leng et al., 2009; Hezarkhani et al., 2010; Eng-Larsson et al., 2014) However, ensuring contract fulfilment is still a concern due to asymmetric information. The ability to secure the realization of a contract is particular problematic when the contract regards sustainable transportation options. This stems from the customers' inability to confirm that the transport has been conducted according to the environmental requirements stipulated in the contract. At the same time that logistics service providers work in a system with multiple layers of freight carriers and forwarders that have in turn their sub-hauliers which could obstruct the agreement about sustainable transportation. (Eftestøl-Wilhelmsson, 2011). Unfulfilled clauses, or contracts, can be challenged but this contributes to additional transaction costs and involvement of a third party that weaker or smaller parties cannot afford. (Williamson, 1981) The third party is added due to systems operating in a centralized model, where all transactions are executed through a trust-based system making all participants dependent on the third party. (Nakamoto, 2008; Lee, 2013; Swan, 2015; ChainThat Limited, 2015)

The implication of the modern systems operating in a centralized model is that the execution of transactions are dependent on a third party i.e both the supplier and consumer must rely on the third party for the exchange of goods or services. (ChainThat Limited, 2015) Consequences of this implication is increased transaction cost, longer lead time and limited possibilities to conduct smaller business agreements. (Nakamoto, 2008) To counteract these limitations Nakamoto (2008) introduces blockchain as a innovative solution, which is a decentralized digital payment system, based on cryptography and a public ledger, containing information on every transaction made within a system. The use of this technology has made a big impact in the world of economics and finance because it enables transaction execution without the need for a third party in form of a bank or governmental institution.

Innovations in technology are reflected upon multiple areas such as politics, society and science, and not only economics. Consequently an innovation like blockchain technology should be regarded and approached on a global scale by all actors. (Kapil, 2014; Virdi, 2015; Swan, 2015; Berlit, 2015; Manuel et al., 2016; Walport, 2016) Potential benefits include surpassing governmental and hierarchical power structures that inflict demanding regulation within industries, elimination of inefficiencies in the global financial market, reduction of transaction costs, exclusion of intermediaries which diminishes the risk for human error by automated processing, and generate a secure platform for global communication, interaction and trade. (Swan, 2015; Manuel et al., 2016) New opportunities regarding traceability and control of goods are provided by the transparency of a blockchain. The recording and peer validation of transactions, on a public network, generate the possibility of tracking or retracing a products movement between different supply chains, from origin to end consumer. (Williams, 2015; Gonzales, 2015; Baker et al., 2016) Knowledge concerning who did what, when and where could disclose information regarding the degree of sustainable and environmental measures used across the supply chain, and reveal working conditions, which could comprise of slavery or child labour. (Berlit, 2015; Duque, 2016) In addition, the system could be used to identify the ownership and/or legal rights to products in the supply chain. (Berlit, 2015) Blockchain technology provides a form of supply chain mapping (Duque, 2016) where entities within the chain can represent currency, property or contracts. Imaging a digital encryption representing a pallet, container, trailer or barrel and being easily monitored and moved from one nod to the other. (Gonzales, 2015)

Based on the imbalances caused by asymmetric information and opaque supply chains, this study aims to contribute to the research field of logistics and supply chain management by exploring the potential of blockchain technology within logistics. Focusing on increasing supply chain transparency for both suppliers and consumers and improving contractual coordination in order to secure fulfilment of sustainability clauses in transportation contracts. Technology is seen as a way to instil transparency in a supply chain (New, 2010; Williams et al., 2015; Clancy, 2015), and blockchain has been recognized as a game changer with its function to register all transactions on the ledger (Nakamoto, 2008). So could blockchain technology be a potential tool in achieving supply chain transparency and securing contract fulfilment of sustainable transports.

The study has the potential to empower the position of consumers, suppliers (retailers and haulier), and manufacturers regarding knowledge about the product and the social and environmental activities associated with the products supply chain. This could potentially generate more awareness about the hidden layers of the supply chain, and global transportation. The possible results could contribute to improving service management within companies and improve their policies concerning sustainability and environmental impacts.

1.2 Purpose and research questions

Blockchain is recognized in research to be a financial technology, which requires an outline of what the technology originally entails to evaluate its potential in logistics and supply chain management. In addition, established practises within this area of research will be explored to evaluate the potential of implementation within logistics.

The purpose of this paper is to explore the potential application of blockchain in the field of logistics in regard to supply chain transparency and transport contract fulfilment concerning sustainability clauses.

In approaching the subject the following questions will be answered.

RQ1:
Why should blockchain technology be considered as a mean for generating transparency in the supply chain?

RQ2:
How could blockchain technology secure the fulfilment of sustainability clauses in transport contracts?

1.3 Limitations

The scope of the research is limited to the area of blockchain technology, supply chain transparency and fulfilment of sustainability clauses in transport contracts. This research area will be approached by exploring the potential of blockchain in providing transparency regarding product origins, transportation routes and involvement of different actors. In addition, blockchains' potential ability of securing fulfilment of sustainability clauses in transport contracts will be evaluated. The technology is new and has shown great potential in other areas where it has been implemented, such as in finance, banking and healthcare.

The main material for the research will be two white papers concerning the importance of competitive-cooperation for the efficiency of the supply chain, and the demand and possibility to gain knowledge regarding product origins by utilizing blockchain technology. These facts will be presented in the form of a case study. In addition, to an interview with an expert concerning the potential of blockchain in the field of transparency, tracking and transportation.

There is no emphasis on the technicality and actual data processing that is associated with blockchain technology or hash-functions, hence no detailed explanation of the systems processing functions.

1.4 Thesis outline

The thesis has the following structure.

1. Introduction

Introduces the incentive, purpose and range of the study. Two research questions are presented, and limitations are set with the intention of specifying the scope of the study.

2. Frame of reference

The following chapter presents and defines the main concepts used in the framing of this thesis, which includes transparency, contracts, distribution systems and blockchain technology.

3. Research method

The chapter features the research method containing the motivation for the choice of document analysis, case study and interview. It presents a reflection on the analytical framework and a critical evaluation of the research.

4. Empirical findings

The chapter presents the results of the conducted literature review, case studies and interviw and its implications to the research.

5. Analysis

The chapter analyses the frame of reference in relation to the collected information produced by the case studies and interview.

6. Conclusion & Discussion

The chapter aims to answer the research questions and highlight important findings and implications generated throughout the research process. Further, reflections on the limitations and potential implications of the study and recommendations for further research will be presented.

2. Frame of reference

The following chapter presents and defines the main concepts used in the study. Section 2.1 presents aspects of transparency that can provide balance between actors in a supply chain. Section 2.2 describes the meaning of a contract in business relationships on the supply chain. Followed by section 2.3 with a presentation of the distribution system that the blockchain is based on. Section 2.4 introduces the concept, function, and definition of technical terms, followed by the units of blockchain in section 2.5. And the last section 2.6 presents the reasoning for the analytical framework, which is based on diffusion of innovations theory.

2.1 Transparency & Supply Chain

Restrictions connected to information accessibility can be overcome by increasing or enabling transparency. (Fung, 2013) The distribution of knowledge concerning products or services is often disproportioned amongst transaction participants, and access to information can be non-existing. To counteract these information asymmetries, and increase the exchange of knowledge researchers suggest implementing transparency as a solution. (Laudal 2010; Gustafsson, 2004; Mol, 2013; Hahn et al., 2013; Egels-Zandén et al., 2015) In relation to supply chains transparency it is equivalent to traceability (Laudal, 2010; Doorey, 2011; Egels-Zandén et al., 2015), and disclosure of suppliers' policy regarding sustainability (Cramer 2008; Egels-Zandén et al., 2015). The perspective on sustainability concerns environmental footprints and labour conditions as consequences of production. (Hart, 1995; Egels-Zandén, et al., 2015)

Generation of more information through transparency enables outsider to evaluate the supplier, and monitor their action to ensure their compliance to set standards or policies. (Mol, 2013; Egels-Zandén et al., 2015) In this way suppliers can build a reputation of being environmentally conscious (Hart, 1995) and use transparency as a competitive advantage that would enable better performance and customer service. (Gustafsson, 2004) In contrast, Mol (2013) argues that the weaker party in a transaction, or agreement, would overtake some of the power from the opposing party by the gaining of more knowledge through transparency. Consequently, transaction costs would decrease (Tapscott et al., 2003), and a potential win-win situation would take place. (Carter et al., 2008) By providing transparency (sharing information) the global market gains access to information concerning product origins and movements throughout the supply chain. This would minimize the risk for deception enabling customers to conduct business with reliable suppliers. (Lamming et al., 2001)

Transparency is considered as information sharing within a supply chain relationship (Lamming et al., 2001), which corresponds with the European transport policy about transport networks being more assessable to enable a decrease of disadvantages in transport. Information sharing and co-ordination are beneficial for actors within the transport chain because it can generate more efficiency. However, the same actors perceive information as a competitive business advantage that should stay within the company. Transparency could disclose the level of quality, fulfilment rate of agreements and if there are different sub-contractors within a companys' transport chain. If actors come together and co-operate by sharing knowledge transparency can be an advantage for a complete business area. (Gustafsson, 2004)

2.2 Contracts & Supply Chain

Co-ordination of transactions should be emphasized (Fugate et al., 2006) because an increase could reduce costs, risks and improve a supply chains' overall competitiveness. (Cachon, 2003; Lee et al, 1999) A key instrument in accomplishing this is the contractual relations' between the different entities, in significance the contract. (Naryanan et al., 2004; Eng-Larsson et al., 2014) Several studies on the modelling of supply chain contracting have show that revenue-sharing contracts improve co-ordination and increase profitability, and that the insensitive for co-ordination depends mainly on the stipulated payment type and timing. (Dana et al., 2001; Cachon 2003; Leng et al., 2009; Hezarkhani et al., 2010; Eng-Larsson et al., 2014) Contracts, in general, involve some form of relationship management, which requires an amount of trust between the concerned parties. (Seshadri et al., 2004; Brown et al., 2006; Mouzas et al., 2007; Camén et al., 2011). These relationships are seen as investments that can generate future benefits in regards to resources that the counterparty has access to. For this to be realized trust is needed in the relationship, which in some cases is identified as the contract (Camén et al., 2011). Contracts bestow the ability to bind actors to each other, specify the conditions of the transaction and provide evidence and enforcement for execution of the set terms. (Blomqvist et al., 2005) In addition, it enables communication for the purpose of reducing risk and insecurities concerning the transaction. (Roxenhall, 1999; Malhotra et al., 2002; Roxenhall et al., 2004) However, there are implications that the physical contract is not needed or used in practice after it has been established. (Macaulay, 1963; Grönfors, 1995; Poppo et al., 2002) Contractual agreements can take the shape of transactional, (Lindvall, 2001) relational (Macneil, 1978), framework (Mouzas et al., 2007), performance (Vraalsen et al., 2001) or options-contracts (Tsai et al. 2009). The complexity of the contract depends on its completeness, i.e. complete or less-then-complete contract. (Hart et al., 1987; Merkert et al., 2013; Banker et al., 2005)

While drafting contracts actors usually reflect upon contract theory because agents and principles often act, or are adverse, according to different incentives. Transactions involve some degree of moral hazard, which emphasizes the importance of trust in contractual relations. This, in turn, influences the supply chain. (Schwartz et al., 2003) These factors are of significants because they are accompanied by underlying transaction costs. These "hidden" costs are what enables the realisation of a contract. They impact the total cost and lead-time, which are dependent on governmental institutions and banks that act as intermediates. (Camén et al., 2011; Eng-Larsson et al., 2014) All forms of transactions require a financial institution to complete the transfer of resources between business partners. This provides a form of security at the same time as it restricts the execution of transactions. Transactions requiring a third party are weakened as a result of being based on the trust-based model. Intermediates in these circumstances increase transaction costs, limit the size of a transaction, and restrict smaller, more casual transactions. (Nakamoto, 2008)

2.3 The Peer-to-peer distribution system

The emergence of the peer-to-peer (P2P) system is regarded as a paradigm of significance in regard to digital distribution of services such as information and resource sharing. (Rowstron, 2001; Schollmeier, 2001; Pandurangan, 2003; Swan, 2015) In a simple client-server model resources are stored by the server and only shared with the client upon request. It functions in the form of a one-to-many distribution model, where the client is dependent on the centralized entity in their quest for information. Whereas, P2P computing consists of an interconnected network where peers (computers) share resources and information without of the use of a central server. In essence, peers are identical and all hold the attributes of both the client and server. Hence, requests placed on the network can be reciprocated by any peer that holds the desired information. (Schollmeier, 2001; Yang, 2013) The system has the equivalents of a many-to-many distribution model, where all participants have the ability to respond to an enquiry in a decentralized manner excluding a centralized entity. The two models are illustrated below in figure 1. Direct access to multiple information sources instead of a single one generates faster execution and higher efficiency. Utilization of this system provides communication and information sharing regarding task distribution and transaction execution. (Xiong, 2004)

Figure 1. A one-to-many network: where a central server controls and distributes information, (left). A peer-to-peer network: where every node is both a client and a server, sharing information, (right). (Gigatribe, n.d.)

The P2P-system is of significance because the results from a search are based on recent data. This is possible due to the online interactions amongst peers, which generates or reflects real time pricing and inventory. (Pandurangan, 2003) Research has identified that the P2P architecture is applicable in many fields, especially concerning exchange and storage of data. The system can be used in areas such as communication and collaboration, Internet service support, database system and content distribution. (Rowstron, 2001, Androutsellis-Theotokis, 2004) The requirements for partaking in a P2P network are Internet access and P2P software, such as Kazaa and Limewire. (Rowstron, 2001; Christensson, 2006*)* By using the network instead of going through a centralized entity a connection or relationship between peers is created, which instils a sense of trust and generates new opportunities. In addition, P2P reforms the conventional hierarchy of information sharing. The system has no distinction of peers roles and their contribution; there is no emphasis on identification as producer, consumer or intermediary. (Educause.edu, 2009) However, it should be mentioned that, in some areas, the absence of a central authority has created disturbances concerning copyright, identity theft and illegal activities. Other concerns regard the application of the system in a larger scale due to the insufficient algorithms used in regards to localisation and transactions within the network. (Rowstron, 2001) In the realm of P2P-systems, the blockchain can be found.

2.4 Blockchain

The innovation behind cryptocurrency, like Bitcoin, is not the entity itself but the system that it rests upon and makes it applicable, the blockchain. It is a digital payment system that is based on cryptographic proof instead of trust, which allows two consenting parties to conduct a direct transaction between themselves instead of using a trusted centralized intermediate, such as a bank or governmental institution. (Nakamoto, 2008) In essence, the blockchain is a public ledger containing information on every transaction made within a P2P-system. (Nakamoto, 2008; Arias et al., 2013; Kosba et al., 2015; Kapil, 2014; Swan, 2015; Pilkington, 2015) Swan (2015) refers to blockchain as a giant global google.doc spread sheet representing the accounting of transactions and registry of both tangible and intangible assets such as currency, physical property or documents. In addition, the technology can be used for tracking and monitoring assets, communication and information sharing, and executing long-term and conditioned contracts. The essence of the blockchain is a distributed ledger auditing valuable information.

The establishment and introduction of blockchain technology solved the **double-spending problem** that had for a long time been associated with the implementation of digital currency. The usage of cryptocurrency within a decentralized system could be hazardous as a consequence of not having a trusted third party to ensure, by keeping a ledger, that the digital currency being used for one transaction has not already been spent on another transaction, the double-spending problem. (Naknamoto, 2008; Arias et al., 2013; Swan, 2015; Pilkington, 2015) To counteract this problem and enable secure digital transactions Nakamoto, (2008), proposes the use of a **peer-to-peer distribution** server where timestamps are used to register and confirm transactions in chronological order. These occurrences are validated by a **proof-of-work system** (see. Back, 2002) that has to be implemented. The proof-of-work is accomplished through the use of hashing (Nakamoto, 2008; Swan, 2015). A hash is created from processing original data (input) in a mathematical algorithm, and the results (output) represent the hash, which is placed on the blockchain. When input converts to output there is no possibility to reverse the process due to the cryptographic function of a hash. (Pilkington, 2015)

2.4.1 How blockchain works

Realising a transaction via a blockchain (illustrated in Figure 2 with cryptocurrency as the entity) starts with an identity, known as participant A, informing the network of his arrangement with participant B (another identity). Then B announces its acceptance, by using his public-key, to the network and simultaneously petitions the peers within the network to determine the authenticity of the transaction. Validation of a transaction is established by peer consensus. The verification is conducted with the use of minors (computer power). Minors extract the information from the block, in which it has been stored after B's acceptance, and turn it into a hash by applying a mathematical formula[1] to it (Kiviat, 2015; Pilkington, 2015). The validity of the hash is then processed within a proof-of-work system to guard the transaction from double-spending. When confirmed valid, a timestamp is added and the hash is placed, in chronological order, on a platform creating a blockchain. Hashes are built off of each other, which grants legitimacy to every block that is created later on along the chain. (Kiviat, 2015; CoinDesk, 2016) In effect, tampering with one block would alert the whole network because alterations would contradict the proof-of-work applied in the previous blocks. The only mode of procedure that could overturn a blockchain is if the culprit bestows 51 % of the network processing power. In essence, transactions that have been proven solid will be recorded in the public ledger, which makes it irreversible due to the networks awareness to sed action. When a block is admitted to a chain the transaction is considered completed. (Nakamoto, 2008; Swan, 2015; Pilkington, 2015)

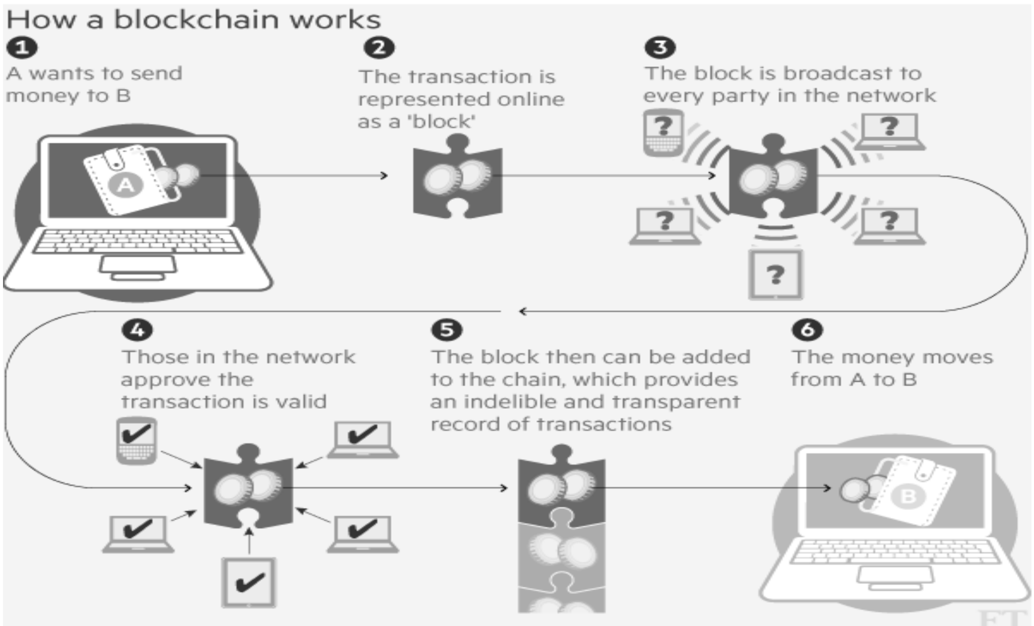

Figure 2. Illustrates the different steps of a transaction using a blockchain, the example is based in the transfer of currency. (Financial Times, 2015)

The system notifies the public that a transaction is transpiring. However, it does not disclose the parties of the transaction, it only states that size of the exchange, much like information concerning a stock exchange. An extra length of precaution is to use a new set of keys for every transaction in the notion of concealing ones identity from being linked to different transactions. Anonymity can be difficult to insure with multi-input transactions because the inputs show indications of being from the same owner. Exposing ownership of one key can lead to the uncovering of multiple transactions by linking. (Nakamoto, 2008)

1 More information concerning the formula see. Nakamoto (2008) and Back (2002).

2.4.2 Definition of technical terms

2.4.2.1 Public-Private key cryptography

Concerns regarding digital communication or information sharing arise from security and privacy reasons, such as unauthorised infiltration of an information stream. As a solution Diffie and Hellman (1976) presented the framework of public-key encryption. The technology is based on the combination of two keys – a public key and a privet key. The public key is used for communication amongst actors on the network, while the privet key is the enabler, or the "seal-of-approval", of a transaction and is only known by the receiver. These are found on a users' computer system, or BitcoinWallet, and are utilized for the purpose of encryption (public key) and deciphering (private key) of data. When A wants to send B a message, A uses B's public-key to for the encryption, and then B uses their own private-key to decipher it. (Diffie et al.,1974; Rivest et al.,1978; Tyson, 2001; Sorrell et al., 2016) The difficulty of this system is to know the recipients' public-key and therefore enabling the encryption of a message. A popular encryption system is Pretty Good Privacy (PGP), which was developed by Philip Zimmerman, and is accessible from the Massachusetts Institute of Technology for free. (Tyson, 2001)

2.4.2.3 The Proof-of-work system

Known as a CPU cost or pricing function, or client or computational puzzle, proof-of-work (POW) is a system (protocol or function) used to produce and verify the legitimacy of data. Production of this data is both time-consuming and costly, even though it is generated by computers. However, results of processed data are easy to verify by others due to the applied timestamp, which is beneficial for risk avoiding. The process is based on solving algorithms with the intention of reducing a user's accessibility rate to a server. "*For example, if you have a web service and you want to stop it from being overwhelmed by automatic clients you can set up an API which demands that each client solves a difficult but regular problem - like multiplying together two big numbers - before being allow to use the service. The client has to present the result of the multiplication as "proof of work done" and then it can use the service.*" (James, 2016) The system can be implemented to establish consensus within a multi-user network. (Krawisz, 2013) For a more technical explanation of the proof-of-work system and its application see Back, 2002.

2.5 Units on the Blockchain

Essentially the blockchain is a platform or network where transactions can be recorded and regulated. Hence, the entity can take different shapes, both tangible and intangible.

2.5.1 Smart property

The cryptography within blockchain technology makes it possible to "hash" (transform) tangible (real-estate, vehicles, appliances, food, construction material) and intangible (personal information, stock shares, certificates, votes) assets into hashes, which can then be exchanged and registered on the blockchain. These encoded assets are known as smart property, which originated from Bitcoins Colored coins[2]. Ownership, control and tracking of the asset is regulated with the privet key. (Szabo, 1997; Swan, 2015) The prospect of physically governing an asset via the blockchain could be possible with the help of some additional technology. By integrating or embedding software or technology, such as QR-codes, RFID, NFC tags, WiFi or iBeacons, into the asset control could be exercised in near-to-real time. Meaning that access to the asset would only be granted to the one in possession of the matching token. For example, smartphones registered on a blockchain could be locked or traced if stolen. Adding another dimension, smart property can be controlled by a smart contract. (Swan, 2015)

2.5.2 Smart contracts

"[...] smart property might be created by embedding smart contracts in physical objects." (Szabo, 1997)

The term "smart contract" was first termed in 1994 by cryptographer Nick Szabo[3] but the utilization and implementation of sed contracts has only recently been possible due to the advances in technology. In the forefront of development are Ripple's Codius[4] and Ethereum[5], which are projects based on blockchain technology. Smart contracts represent computer programs that automatically validate and execute conditions that have to be realised in order to complete a transaction. (Szabo 1997; Cassano, 2014; Swan, 2015; Walport, 2016) Contracts on the blockchain retain their default of being an arrangement between two or more parties regarding an exchange of resources. However, the need for trust amongst actors is replaced by cryptography, even the need of a third party is replaced. Smart contracts are defined by a code, and automatically enforced and executed by another code. The code is the key to a transaction. Legal code and technical code react differently to breaches of contract. The first mentioned is possible to break but is followed by reprimanding consequences until compliance is met. The second will not execute any activities if all stipulations are not fulfilled. (Walport, 2016) Characteristic of a smart contract are the elements of autonomy, self-sufficiency and decentralization. (Swan, 2015)

To illustrate the function of a smart contract the vending machine-example from Szabo (1997) is presented: *"[...] the machine takes in coins, and via a simple mechanism, dispense change and product according to the displayed price. The vending machine is a contract with bearer: anybody with coins can participate in an exchange with the vendor. The lockbox and other security mechanisms protect the stored coins and contents from attackers, sufficiently to allow profitable deployment of vending machines in a wide variety of areas.*"

[2] For more information see *http://coloredcoins.org/*
[3] For more information http://szabo.best.vwh.net
[4] For more information *https://ripple.com/*
[5] For more information http://ethereum.org/

Another aspect is the smart contracts stance on routine financial payment processes, and legal documentation. If called upon employment or utilization of legal counsel or banks are not questioned, even though their assistance consists of unremarkable routine tasks with high fees. (Cassano, 2014) The minimizing of transaction costs, such as contracting, documentation and enforcement is possible with blockchain due to it being a decentralised system. (Cassano 2014; Walport 2016) Hence, it makes low-value contracting economically beneficial for businesses. (Walton, 2016) This implies that the role of lawyers and financial advisors would change from *processor* to *provider* of contracts. Meaning that lawyers would provide templates of contracts that can be enforced on the blockchain. (Cassano, 2014; Swan, 2015) In addition, smart contracts operate in a computer language, in contrast to the traditional legal language. (Walport, 2016) Thereby, an overview of the legal framework would be required because the current law is not adequate to regulate cryptographical activities. This concerns mainly how a breach in contract should be treated, concerns even claims regarding damages. A simple safeguard would be to attach an agreed upon legal framework to the used code, such as Incoterms or CISG. (Swan, 2014) However, this still remains a concern (Cassano, 2014).

2.6 Diffusion of innovation

Innovations are characterised to being diffused according to different development stages and they entail an economic importance for theirs developers and users. Essential for innovations is to regard them as a process in which an idea initiates that a different approach can provide better results. (Mustonen-Ollila et al., 1998) Blockchain technology could be comparable to this based on its advocation of change in the execution of transactions and payment systems. Blockchain is considered as a decentralized payment system and has been label as a tool within banking and finance. (Nakamoto, 2008; Swan, 2015) This corresponds to Rogers (2003) considering innovation as an element taken from one area and implemented in another. Rogers (2003) identifies innovation as the perception of a new idea. The emphasise of the theory is to explain the reasoning, regarding how and why, and in what rate new ideas and technologies are spread through communication and adopted by society. In addition to, how different social groups “adopters” take part of the innovation over time. (Rogers, 2003) Diffusion of innovation presents a framework of the characteristics of innovation, evaluation the potential of identifying a new phenomenon or technology as an innovation. The characteristics that are involved are relative advantage, compatibility, complexity, trialability and observability. These factors evaluate current practice against the new idea to see what differences, beneficial or not, can be found. It is common for an innovation to generate novel needs resulting in the development of new dimensions of the innovation, which correspond to changes in the surrounding environment. (Mustonen-Ollila et al., 1998)

3. Research method

This chapter features the research method used to conduct this study. The research approach is explained and motivated beginning with a description of the data collecting process, section 3.1. Followed by explaining the choice of case study (section 3.2) and interview (section 3.3). The processing of the retrieved data is described in section 3.4 and the following section 3.5 presents analytical framework. The chapter ends with a critical evaluation of the conducted research in section 3.6.

3.1 Narrative literature review

In the process of developing a potential research area it is beneficial to conduct a literature review for the purpose of gaining enough knowledge to enable identification or discovery of possible gaps within conducted research, which enables the development of the research questions. The review of relevant literature generated broader knowledge in the selected research field, which provided the frame of reference for the appending analysis of this study. Collected literature consists of published academic articles, due to them being the latest source of information within a research filed (Patel el at., 2011). In addition, periodicals and books were selected as reinforcement of the frame of reference.

The material was scouted on the following databases; Web of Science and Google Scholar during the period from the middle of January to the beginning of April 2016. These search engines were chosen due to their prominence, accessibility and ability to view citations. Keywords used in the search consist of *blockchain, block chain, blockchain technology, logistics, transport, freight, supply chain, transparency, contract, contract theory,* and *sustainability,* which were combined with the use of Boolean operators AND and OR. Used combinations can be found in Table 1. The restrictions for the searches where narrowed down to English language, academic articles and the field tags topic (TS) and title (TI). These tags where chosen to increase the relevance of the generated results. Identical keywords where used in all search engines, however the Booleans and field tags are restricted to the Web of Science because Google Scholar has no such option that the author is aware of.

Table 1. Represent the search combinations that have been applied in the search for material in Web of Science.

TS=(block chain),	TS=(blockchain technology AND logistics)	TI=(blockchain AND supply chain)
TI=(block chain),	TI=(blockchain technology AND logistics),	TS=(blockchain AND transparency)
TS=(blockchain),	TS=(blockchain AND transport),	TI=(blockchain AND transparency)
TI=(blockchain),	TI=(blockchain AND transport),	TS=(blockchain AND contract)
TS=(blockchain technology),	TS=(blockchain AND supply chain),	TI=(blockchain AND contract)
TI=(blockchain technology),		
TS=(blockchain AND logistics)		
TI=(blockchain AND logistics),		

TS=(blockchain AND contract OR contract theory)
TI=(blockchain AND contract OR contract theory)
TS=(blockchain AND sustainability)
TI=(blockchain AND sustainability)
TS=(transparency AND supply chain)
TI=(transparency AND supply chain)
TS=(transparency AND contract)
TI=(transparency AND contract)
TS=(transparency AND transport OR freight)
TI=(transparency AND transport OR freight)
TS=(transparency AND sustainability)
TI=(transparency and sustainability)
TS= (contract AND transport)
TI= (contract AND transport)
TS=(contract theory AND freight)
TI=(contract theory AND freight)
TS=(contract theory AND transport)
TI=(contract OR contract theory AND transport)
TS=(contract OR contract theory AND freight)
TI=(contract OR contract theory AND freight)
TS=(contract OR contract theory AND transport)
TI=(contract OR contract theory AND transport)
TS=(contract AND sustainability)
TI=(contract AND sustainability)

In addition, to the written material gathered and used in fulfilling the purpose of the research, videos that explain or attempt to explain the phenomenon of blockchain and its functions have been screened in the pursuit to gather a better understanding of blockchain technology. Within research it has become more common to use existing videos to gather data. This form of data collection implies re-purposing of available vidoes that can be accessed, such as institution video databases, broadcast media (Chouliaraki, 2006), YouTube videos (Adami, 2010) and home-made videos. (Jewitt, 2012) Videos for this study have been viewed on YouTube and gathered by using the same keywords as previously mentioned above. The following table (Table 2) contains a list of videos that were viewed during the period of February to March 2016. Each video has been screened 2-3 times.

Table 2: Screening list of the videos that contain information about blockchain technology.

Title	**Publisher**	**Publication date**	**Link**
Andreas M. Antonopoulos - "The Potential of Blockchain Technology" - The Bitcoin Address	CoinJar	26 November, 2014	https://www.youtube.com/watch?v=r8JopZWlvtw
A Brief Introduction to Smart Contracts	Charles Hoskinson	16 October 2015	https://www.youtube.com/watch?v=3bY66Zgr8Cs
BBC on Bitcoin and The Blockchain	Satoshi Nakamoto	10 June, 2015	https://www.youtube.com/watch?v=2ky3mDUoh74
Bitcoin – Proof of Work	Khan Academy	1 May, 2013	https://www.youtube.com/watch?v=9V1bipPkCTU
Bitcoin – Transaction block chains	Khan Academy	1. May, 2013	https://www.youtube.com/watch?v=QzDO44oZWtE
Bitcoin: The End of Money As We Know It (Trailer)	Torsten Hoffmann	30 April, 2015	https://www.youtube.com/watch?v=lUF6klWuB38
Bitcoin For Beginners - Learn How To Mine Bitcoin ! - Part 1	MrJayBusch	13 May, 2013	https://www.youtube.com/watch?v=j7opj5-32hw
Bitcoin explained and made simple I Guardian Animations	The Guardian	25 June 2014	https://www.youtube.com/watch?v=s4g1XFU8Gto

Blockchain for dummies	Lesley Taihitu	20 February, 2015	https://www.youtube.com/watch?v=1ycJfp6-6Is
Blockchain Explained, What is Blockchain?,	Patrick Schwerdtfeger	14 September, 2015	https://www.youtube.com/watch?v=1ycJfp6-6Is
Blockchain Basics Explained - Hashes with Mining and Merkle trees	Chainthat	7 February, 2016	https://www.youtube.com/watch?v=lik9aaFIsl4
Blockchain: The Financial Challenge of our Time (Blythe Masters) FULL SESSION	Exponential Finance	15 August, 2015	https://www.youtube.com/watch?v=O1Yo8bt8JAU
Block chain technology	GO-Science / Foresight	19 January 2016	https://www.youtube.com/watch?v=6WG7D47tGb0
Blythe Masters of Digital Asset Holdings at AB Conference	Chris DeRose	20 July, 2015	https://www.youtube.com/watch?v=Clc3ZOP2zUo
Cryptocurrencies and Smart Contracts	Simons Institute	15 June, 2015	https://www.youtube.com/watch?v=FQ6Hii69b5U
Colored Coins - Coloredcoins.org	Colored Coins	16 August, 2013	https://www.youtube.com/watch?v=fmFjmvwPGKU
Hands on With Ethereum - Creating a Smart Contracts, Mining and More	Blockchain Meetup	13 January, 2016	https://www.youtube.com/watch?v=Bg-0JAmGUhQ
How Bitcoin Works Under the Hood	CuriousInventor	14 July 2013	https://www.youtube.com/watch?v=Lx9zgZCMqXE
How Bitcoin Works in 5 minuts. (Technical)	Ledger Wallet	4 May 2015	https://www.youtube.com/watch?v=GMKgB3zZ1so
Introduction to Smart Contracts	EtherCasts	20 mars 2014	https://www.youtube.com/watch?v=AHAAktdxSOE
Let's Talk Bitcoin! #246 Smart Contracts with Nick Szabo	The LTB Network	13 September, 2015	https://www.youtube.com/watch?v=_msk4-oJZV4
Let's Talk Smart Contracts	Yurii Rashkovskii	30 August, 2014	https://www.youtube.com/watch?v=_YpaFkq18LM
Michael Goldstein Explains How The Bitcoin Block Chain Enables Smart Property	Newfination	30 October, 2013	https://www.youtube.com/watch?v=KQ9KxFvstS4
Nick Szabo - History of the Blockchain	How to Create Resilience	14 November, 2015	https://www.youtube.com/watch?v=YpSeOU1VVj4
Nick Szabo speaks at Bitcoin Investor (Las Vegas) 2015-10-29	MadBitcoins	29 October, 2015	https://www.youtube.com/watch?v=cDO09EVFSmg
Origins & Future of Bitcoin - Nick Szabo	BitcoinInvestors .com	9 November, 2015	https://www.youtube.com/watch?v=r_yUeuKu7L4
Simple introduction to smart contracts on a blockchain	Chainthat	6 December 2015	https://www.youtube.com/watch?v=FkeLDPZ-v8g
The Bitcoin Private Key	Milly Bitcoin	11 April 2013	https://www.youtube.com/watch?v=oaG-XJlvFSc
The Blockchain: A Revolution You Need to Understand	MilkenInstitute	3 May 2016	https://www.youtube.com/watch?v=nQZUi24TrdI
The Blockchain Technology Explained – The real value of blockchains and crypto currency technology	Blockchain of Things	11 November, 2015	https://www.youtube.com/watch?v=BdN_-EyB224
The Blockchain Explained	The Memo	11 November,	https://www.youtube.com/watch?v=

		2015	wyfm92qqSh8
The real value of bitcoin and crypto currency technology - The Blockchain explained	intoblockchain	14 October, 2014	https://www.youtube.com/watch?v=YIVAluSL9SU
Top 10 Bitcoin Facts	WatchMojo.com	27 May 2014	https://www.youtube.com/watch?v=2UC_8NdR1To
What is blockchain?	World Economic Forum	21 January, 2016	https://www.youtube.com/watch?v=6WG7D47tGb0
What is Bitcoin and how does it work? | FT Business	Financial Times	3 Febuary, 2015	https://www.youtube.com/watch?v=f7iXTyHGYX4
Who executes a Smart Contract?	Chris DeRosa	1 July, 2015	https://www.youtube.com/watch?v=WA9ZY87wamA

During the selection of relevant research material the purpose of the thesis and research questions were taken into consideration. Useful sources were then categorized according to their relevance to the scope, which eased the writing process and made it easier to navigate between articles. When considering the number of hits and suitable articles it is reasonable to conclude that the academic research field has conducted a narrow discussion involving blockchain, supply chain transparency and contract fulfilment concerning sustainable transportation. Having this in mind, the research questions for this thesis have been constructed with the intention to explore the potential in this research field and potentially contribute to reducing scientific gaps.

3.2 Case study

A multiple case study will be conducted when approaching the topic of this thesis. The empirical data will be based on two case studies recognizing the value of blockchain in a business context. The choice of method is founded in case studies ability to investigate and describe a phenomenon in its real context that in turn can generate, test and develop theory. Enabling the construction of deeper understanding of the dynamics within a specific context, which is the case when extracting the knowledge of blockchain from the finance sector and evaluating its potential in the logistics field. (Eisenhardt, 1989) The method is considered appropriate due to the research question being based on “why” and “how” events happen. (Yin, 2009) This makes it an appropriate approach when considering the purpose of this thesis, of exploring the potential application of blockchain in the field of logistics, and clarifying the complexity of the research field (Meredith, 1998). The case study corresponds to a qualitative approach to the research with data collection consisted of secondary data in the form of two white papers. These white papers were selected due to their relevance and approach to the research topic. Each paper was first reviewed, and then the problem area was identified followed by the proposed solution and its potential business implications according to the authors of the white papers.

The author recognizes the acknowledgment that case study is considered as a “soft” method due to there being no mandatory processing systems according to Bryman (2004) and Yin (2009). However, Stuart et al. (2009) recognizes this method to be appropriate in situations where there is inadequate theory, which is the case concerning blockchain and logistics. In addition, the results are strengthened by the implementation of a two-case study instead of the weaker single-case study.

3.3 Semi-structured interview

A semi-structured approach is adopted in the realisation of the interview. The chosen method allows the researcher the opportunity to develop a broader understanding for the subject by observation and presenting questions in a more causal manner. (May, 2011) An interview guide was prepared in order to establish an area of interest concerning the research topic. The guide contained nine main questions each with 2-3 follow-up questions, which were specified to fill or confirm gaps that were identified in the process and results of the data collection. However, the session was approached with a mind-set of creating open-ended questions to generate more of a discussion. This provides the informant the freedom to express their views in regards to the topic. The meeting was conducted in-person in Gothenburg with the duration of approximately 1 hour and 30 minutes. Everything was recorded to secure that potentially valuable information could be transcribed (five pages) and used without the risk of excluding key functions of blockchain technology, which is recommended by Cohan (2006). Respecting the anonymity of the interviewee, no personal information is presented and referencing to statement from the expert will be referred to as Expert, (2016).

With the objective of gaining both validity and reliability to the conducted research, and a more in-depth perspective of blockchain an interview has been conducted with an expert in the field of blockchain technology. Because specific knowledge is required and the researcher is conscious of what information is necessary, the selection of interviewee is based on purposive sampling (May, 2011). The interviewee was introduced by a contact within the research field. The author is conscious of the questioning concerning the utilization of only one interview. As the research field can be described as unexplored or very limited it has been difficult to establish contact with individuals in possession of the required expertise and knowledge. This fact has been enhanced by the limited timeframe of the thesis in combination to the magnitude of time that has been spent exploring and getting acquainted with the topic of blockchain technology and its field of implementation.

3.3 Document analysis

The objective when processing the retrieved materials from the literature review and the two case studies is to locate and identify patterns with reference to similarities and differences in the material. (Eisenhardt, 1989) Information was thereby sorted under different categories (bitcoin, blockchain, smart contract, mining, supply chain, how it works, critics and definition) to illustrate such patterns. This would in turn generate an understanding of the concept, ease the writing process and navigation through the gathered information.

Information produced by the literature review form the frame of reference, while the case studies generate the empirical data, and together they constitute the foundation of the analysis. Throughout the thesis referencing to blockchain will alternate with ledger.

3.5 Analytical Framework

In development of the analysis a part of the diffusion of innovation theory by Rogers (2003) will be used as a reference in the identification of blockchain as an innovation within logistics. The factors that are considered are relative advantage, compatibility, complexity, trialability and observability, which are part of the characteristics of an innovation. These factors are evaluated when exploring the current state of the area of logistics and what blockchain could potentially contribute with if implemented.

Diffusion explains the spread of an element from one area to another. In this paper this represents the implementation of blockchain from the financial sector to the transportation industry. In effect the blockchain would embody the role of innovation that Rogers (2003) identifies as the perception of a new idea. The selection of this theory as a framework is based on its recognition and definition of innovations taken from one sector and applied to another. Originally it emphasised how new ideas are communicated throughout society, and how different social groups "adopters" take part of the innovation over time. (Rogers, 2003) However, the aspects of communication and adaptors are not of relevance for the scope of this study. Therefore, it is necessary to change and adapt the original framework to be applicable for identifying the potential of blockchain within logistics and transport. The frameworks *characteristics of innovation* are used as a guideline to prove that blockchain is a new potential innovation. The identification of the characteristics should portray the potential benefits of blockchain implementation and why it should be taken into consideration.

Table 1. From Rogers (2003) the characteristics of innovation.

Relative advantage	The degree of perception that an idea is better then the current practice. This could be measured in economic or social benefits, convenience and satisfaction. The perception of an advantage is of importance, when considering its adaptation. *How the blockchain is better then current practise?*
Compatibility	Considers the degree of an innovation of being in line with adopters' needs, existing values and previous experiences. The more consistent with social norms and systems the more applicable an innovation is. *Is blockchain compatible with current practise?*
Complexity	Perceived difficulty to understand and use the innovation. The easier to understand, the faster it will be accepted and adopted. *Is blockchain difficult to use or understand?*
Trialability	The length that an innovation can be experimented with

	before implementation. Pre-testing is considered as risk reducing and enables "learning-by-doing". *Possibility to test before committing to blockchain?*
Observability	Concerns the visibility of results from the innovation. Clear and concrete results decrease the actors' uncertainty of implementation. *Are there any visible results of blockchain utilization?*

The presented factors were evaluated when exploring the current state of the area of logistics and what blockchain could potentially contribute with if implemented. Rogers (2003) states that the mentioned factors form a valuable checklist for evaluating projects, improving behaviours or products and identifying existing weaknesses in a field or product. Questions that are considered while analysing the potential of blockchain in logistics can be found in Table 3 under each factor. The analysis will evaluate the frame of reference and findings from the case studies and interview, in regard to the presented characteristics of innovation to examine the potential of blockchain providing supply chain transparency and the ability of securing sustainable transport contracts.

3.4 Critical evaluation of the research

3.4.1 Validity

Conducting qualitative research has required a thorough description of the data collection process and the framework used for analysing the empirical findings in the pursuit to increase the validity of this thesis. This corresponds to the arguments from Bryman (2004) and Yin (2009) concerning validity in a qualitative research method approach. Retrievement of data was conducted with objectivity and no presumptions or bias from the researcher, which was insured by the researchers insufficient knowledge regarding blockchain. To ensure validity, multiple sources of material have been explored using methods like document analysis, semi-structured interview and case study. (Yin, 2009) Internal validity could not be confirmed due it not being applicable concerning descriptive or exploratory research. However, external validity was established by utilizing two case studies and one interview to generate broader knowledge of the research topic enabling generalization of potential implications. (Yin, 2009) This was accomplished by findings from secondary data being evaluated in corresponds to the findings extracted from the interview.

3.4.2 Reliability

With the objective of providing reliability the different keywords and search combinations are presented, and recommendations of multiple informative videos that would provide the same sources of knowledge that has been used in the constellation of this thesis. The analysis process of the collected data and for the main analysis is presented, in addition to the reasoning for the frame of reference and empirical findings. These indicators should be proficient enough to replicate the conducted research and contribute to similar results. (Yin,

2009) However, the chosen research field is constantly evolving and new material is being generated rapidly, which has been taken into consideration and should be recognized by others that attempt to replicate the research.

3.4.3 Ethics

The research field was approached objectively and materials have been viewed without excluding perspectives, implementation fields or status of the publisher or publishing company. Selected material has been presented and utilized without any form of manipulation or attempt to contort the information. The conducted interview was realised under voluntary circumstances with the permission to record and understanding of confidentiality and anonymity of the participant, which was achieved by not disclosing any personal information and providing an alternative reference.

4. Empirical findings

The chapter presents the results of the conducted research methods. Section 4.1 covers the findings generated from the literature review. Section 4.2-4.3 consist of descriptions of the case studies, each case presents a problem area, a solution and possible implications of the proposition. Section 4.4 provides a practical example of the implementation of blockchain. The last section 4.5 contains facts provided by the blockchain expert.

4.1 Findings from literature review

The majority of the search combinations including blockchain generated no results in Web of science and LUB-search, which in itself in a result. It indicates that there is a lack of conducted research within the subject of blockchain and logistics. The single keyword blockchain generated results, on Web of science, in the form of three academic articles, two in English (Kraft, 2016 and Kiviat, 2015) and one is written in Cyrillic's (Kuznetsov and Yakubov, 2016). The same keyword was applied in LUB-search and generated results of 33 academic papers, which consider blockchain only in association to Bitcoin (cryptocurrency), the financial market and payment systems. This is reflected in the sources of the published articles such as IT Professional, IEEE Technology and Society Magazine and New scientist. Again, this indicates the lack of research concerning blockchain and logistics. Google Scholar generated similar results concerning academic articles. However, it produced the finding of the book *Blockchain: blueprint for the new economy*, which seems to be the only one on the English speaking market. The book was used in establishing the description of the blockchain but it lacked more intricate recognition of blockchain within the field of logistics and transport.

In respect to the faulting academic research within the scope of the study aim, materials used to frame the concept of blockchain are mainly periodicals related to information technology and economics, some academic papers and whitepapers; *Blockchain: the solution for transparency in product supply chains, Distributed Ledger Technology: beyond block chain, and How a "3-D" supply chain process system could revolutionize business*. The original work about blockchain by Nakamoto, *Bitcoin - A Peer-to-Peer Electronic Cash System,* was cited in almost all of the other material, which was used as a reference point when choosing material. The same was done in concern to smart contracts and Nick Szabo, who was the first to coin the phrase. All of the chosen material was approached and analysed critically by documenting differences and similarities amongst authors. Information from the different sources was also categorized (as Bitcoin, blockchain, smart contract, mining, supply chain, how it works, critics, definition) to generate an understanding of the concept, which eased the writing process, and contributed to the development of current research questions. The categorization simplified the process of finding mutual understanding or definition of the blockchain technology amongst the collected materials.

The literature review comprises of the concept of blockchain technology because it's the main character for the study. As stated in the purpose, the study focuses on exploring the potential of using blockchain as a tool for improvement within transport and logistics concerning transparency in the supply chain and securing sustainable transport contracts. Literature concerning transparency and contracts was only collected if it was connected to logistics. In regards to transparency, most hits were related to supply chain transparency. Whereas literature about contracts related mostly to creating trusted relationships when choosing a partner and constructing a contract. Articles attended issues concerning principal-agent theory, fulfilment of contracts and the use of technology for the purpose of communication.

4.2 CSCMP's Supply Chain: How a "3-D" supply chain process system could revolutionize business

Businesses are responsible for constructing secure supply chain processes in the pursuit to retain and gain customers. The communication can be based on point-to-point (1-D), one-to-multiple or multiple-to-one (2-D), or multiple-to-multiple (3-D) process. Most common on the market is the 2-D option. A 2-D process can consist of multiple 1-D chains or networks; likewise can multiple 2-D networks construct a 3-D process, which requires a platform or infrastructure accessible to all participants of a supply chain. As information technology has evolved actors on the supply chain, such as logistics providers, have created their own platforms to increase efficiency and coordinate supply functions. This requires a great investment from the actor making it an unachievable target for small- and medium-sized suppliers. Which grants bigger actors a more dominant role on the market and making it harder for the smaller supplier to survive. To counteract or stop this development, Ho-Hyung Ho-Hyung (2013) advocates the need for a paradigm shift concerning the supply chain, a change of the game rules.

Ho-Hyung (2013) recognizes the development of information technology (IT) and computer network technology to be key aspects in business development and for the implementation of 3-D processes. It is acknowledged that the Internet is an efficient and public platform that can be used for multiple-to-multiple information sharing and communication, making it the equivalent of a 3-D process system. The ability to create a public, efficient and integrated 3-D information processing system for both tangible and intangible resources exists. However, it has not been established for physical products because they are restricted by time and space.

4.2.1 How it works

A 3-D process system can be created either by a) developing a transaction system where the actors (products, service providers and customers) are classified and the networking it for efficiency to construct a 2-D process to gain market shares. Or b) establishing a public 3-D system on a suitable platform. Creating a 3-D system requires four elements 1) standards and rules for transactions have to be simplified and transparent, 2) fair competition, 3) responsibilities of participants must be established and clear from the beginning, and 4) it should be applicable anywhere. The only real 3-D process system can be found at Toyota. Their production system provides workers with a platform (the production line) where all have access to the same information and machines, and set standards and rules. Meaning that the workers have individual responsibilities and a healthy competitive relationship to others in order to increase their own efficiency, workers aim to increase productivity of every machine and increase capacity of the whole production line. This generates a competitive-cooperative relationship amongst workers, which Toyota proves to be productive, efficient and increases application capabilities. Ho-Hyung (2013) suggests that the same principle can be applied on the any supply chain.

For this to be realised the four elements of 3-D processing must be fulfil, in addition to the splitting of the market in to multiple market divisions. The purpose of the division is to master the restriction of time and space associated with physical products in the supply chain. Additionally, a central third-party IT provider for communication purposes must be established. Every division can create a public information database using a supply chain infrastructure, with different supply function, that outside businesses can take part of or act upon. Implementation generates the potential to manage the entire supply chain through the digital third-party server. The delivery of a product would be preformed in the most efficiently available way and the costs would be divided amongst actors associated with the shipment based on their size. (Ho-Hyung, 2013)

4.2.2 Implications of the system

The establishment of a 3-D process system would generate competitive-cooperative relationships among actors within the same platform. Each supplier has responsibilities concerning productivity and application capacity within the supply chain, which creates healthy competition. Individual functions are not the only beneficiaries of the 3-D process, the whole supply chain profits from the implementation by increasing its efficiency. To increase one supplier's productivity sed supplier must insure the productivity of each function of the supply chain, which in turn increases the entire supply chains productivity. Implementation of 3-D process systems in a physical products supply chain would lead to better collaboration between businesses and outsourcing supply functions, and they would replace the 2-D process model. The participation is voluntary, the benefits comprise of clear responsibilities, centralized volume and equally divided costs, in addition to the bargaining power these process systems can generate. The system enables small- and medium-sized companies to compete on equal terms and terrain. (Ho-Hyung, 2013)

4.3 Provenance – Blockchain: the solution for transparency in product supply chain

In their white paper Dr. Jutta Steiner and Jessi Baker, with some insight from Dr. Gavin Wood at Ethereum, present Provenance, a project with the ability to securely trace documentation and other information within the supply chain by using blockchain technology. The prototype "model" enables every physical resource to be embedded with a digital "passport" or identification that confirms the resource and its origin. This generates a record of a products journey throughout a supply chain. Registering of the different links would present business, social and environmental benefits. For example counterfeit goods could be identified and stopped in a more efficient way. The model poses as a solution to potential certification and chain-of-custody challenges by assigning and verifying the warranty of the physical resources movements in the supply chain. From origin to end consumer the model recognizes the nature of the product "(what it is), the quality (how it is), the quantity (how much of it there is) and the ownership of the product (whose it is at any moment)". These four key elements are accessible via datasets (barcodes) and placed on a blockchain to be shared in a secure environment. The reasoning for using blockchain is its ability to monitor and audit all transactions of a product, and its unquestionable ability to authorise the given information.

Operational benefits generated by the blockchain interoperable, cost-efficient, auditable, public, real-time and agile, and guaranteed continuity.

4.3.1 How it works

The proposed model consists of six modular programs; registering, standards, production, manufacturing, tagging and user-facing. These are broadcasted and independently controlled on the same blockchain thereby enabling frictionless co-existence within the same system. (Baker et al., 2015)

Registering generates access to the system by a public or privet profile with an individual privet key, and the user regulates the degree of shared information on the profile. By registering one links the real-world identity to the digital-identity of the blockchain, and thereby enables interaction on the blockchain. (Baker et al., 2015)

Standards concerning the manufacturing and production of products must be meet to gain access to the blockchain. To be granted a certified program one must undergo an inspection for their facilities and questionings about chosen processes by a certifier or auditor. If deemed appropriate, the facilitator of the product would gain the equivalent of a physical-product in digital form (a token), which would be represented on the blockchain. (Baker et al., 2015)

Production and **manufacturing** programs are only possible after granted authorization. The production programs are the producers' tools for verifying the output of products. It stipulates and enforces requirements on the facility, such as production capacity, classification and categorization of the output with information regarding any additional label (fair trade) or specific trait (fair labour, organic) a product could possess, and proper accounting of annual production and sales. The requirement of a facility can be adjusted in relation to the company and the evaluation of a certifier or auditor. As the supplier of products, the producer programs are the source of traceability of goods, which are linked to the identity "passport" received when registering. The manufacturing programs are implemented to insure that the input of materials is used for the creation of output, with no leftovers. (Baker et al., 2015)

Tagging for the propose of linking the digital realm with the physical world, and creating a information "database" which allows for informed purchases, accessible throughout the supply chain and its end consumer. The technologies used for linking the two worlds on the blockchain are RFID- and NFC-tags, serial numbers, and QR- and barcodes. Choosing the right technology for the product is crucial for the identification on the blockchain. Its within the production and manufacturing programs that identities are assigned, reasonably existing serial numbers and bar codes should be the chosen form of tagging. The tags contain a hash that links them to the blockchain. (Baker et al., 2015)

Linking the digital world with the real one enables **user-facing**, generating the ability to inspect a products journey thought the supply chain. This is made possible by the full auditability and security of a blockchain. Information placed there is deemed trustworthy, which grants users a sense of assurance in their purchasing decisions. In addition, a guarantee that the products are genuine might increase the desire to buy. The screening of the supply chain via the blockchain is potentially done with smartphone applications that scan a tag to gain access to the information. By using conspicuous hologramatic or RFID tag, a brand or company could guarantee products authenticity. (Baker et al., 2015)

4.3.2 Implications of the system

"The success of the proposed systems relies on the registration of identities and recording of transactions and information." (Baker et al., 2015) Without the registration of product attributes the possibility of sharing information along the supply chain would be unattainable. However, the extent of information accessible to actors on the supply chain is adjustable, and is regulated by the privacy permissions set by a user. This indicates that identities can be hidden while still generating information on the blockchain. One example would be that an actor in the middle of the supply chain conceals its identity but successfully passes on a certification. The information provided is easily checked by customers, and customers can even use the system if selling a product on a secondary market. (Baker et al., 2015)

The system provides;

=> actors anonymity while continuing to transfer significant information
=> customers' access to check specific attributes of a product before purchasing
=> proof of ownership without revealing identities by using key cryptography

The main attribute of the blockchain is its recording of transaction. The ability to follow the chain-of-custody, from origin, ownership and exchange, provides a prevention tool regarding counterfeit and fraud. Counterfeit markets have a significant impact on the global market, for example in the UK 30 billion punds and 14,800 jobs have been lost to the counterfeit market. Some forgeries could even contribute to serious health risks, false medication. Another advantage, provided by the blockchain, is the potential of evaluating a product lifecycle and assessing the recyclability of sed product. The Povenance blockchain enables the tracking and recording of both the manufacturing and utilization (including maintenance) of a product. (Baker et al., 2015)

"By design, the blockchain enforces the transparency, security, authenticity, and auditability necessary to make tracing the chain of custody and attributes of products possible, which in turn allows customers to derive the high-quality information needed to make more informed choices." (Baker, et al., 2015)

The implementation of the blockchains in the supply chain will generate transparency that will reduce the cost/benefits ratio considered when making purchasing decisions. In addition, it makes transactions more cost efficient due to the decentralisation of the system. These factors can change the marketplace by creating awareness and enabling customers to seek and evaluate information with the ambition to make smart decisions. (Baker et al., 2015)

4.4 Everledger

There exists a clear correlation between the diamond and insurance industries. The hurdle is how to limit the negative effects that are caused by illegal activities, such as document forgery, theft, fraud and trade of "blood diamonds" on the global market. Founder and CEO Leanne Kemp saw the solution in blockchains and created Everledger. The blockchain based system uses cryptography to embed a digital "fingerprint" to each diamond, which in turn records its origins, ownership and transactions. (Hancock, 2016; Caffyn, 2015) Stones are in-scripted with a serial number that is hashed and placed on the blockcahin. Trying to remove this inscription would decrease the value of the diamond, which is not preferable even for a thief. For the system to be functional Everledger created a network with different actors within the diamond supply chain, such as diamond certifiers, incurrence companies and law enforcement. Each actor gains access to the information concerning a stone and the ability to add data, possible insurance claims and police reports, that could be helpful in recovering a stolen stone or tracing stones on the open market. (Hancock, 2016)

Everledger is mainly a business-to-business network, however the public can cross-reference diamond certificates through it. (Caffyn, 2015; Huckstep, 2015) By utilizing the blockchain, as a base for the network, transparency is generated and data is stored and validated. An additional feature of the blockchain is smart contracts, which have the ability to enforce contract stipulations and record transaction conditions or activities concerning financing, insurance policy and legal rights. (Hancock, 2016)

4.5 Findings from interview with expert

Studying the economic impact of decentralized systems, international management and supply chain introduced the concept of bitcoin. Further, investigations lead to the realization that the power of decentralized technology lies within the blockchain, which lead to etableting an own company focusing on the utilization of blockchain. When considering blockchain there are three core factors; the identity, entity and asset management, which essentially are digital codes representing tangible or intangible objects. Everything starts with creating a unique identity, which can represent the individual that wants to enter the blockchain. Next is the entity that represents the part, object or asset intended to be exchanged or transfer via the blockchain. The identity possesses the ability to manage and transfer the entity, or asset, how ever they see fit with all transactions being recorded on the ledger. Actors on the blockchain also have the ability to adjust the amount of information that they issue concerning their identity or transactions. (Expert, 2016)

To exemplify the functions lets consider a digital supply chain for the music industry. Essentially a small asset registry is created so that musicians could create an entity, representing the song, on the blockchain. Anything that is later recorded would be associated with the personal identity. The idea of this is to give musicians, the identity, near-to-real-time editing that is not possible with the current systems. This constitutes in insuring that musicians receive payment for their work when somebody uses or accesses their music, or property. Other areas that blockchain has been applied is within healthcare and governmental voting. (Expert, 2016)

The blockchain should be view as any other protocol, similar to the Internet that can be constructed according to the needs of the user and be utilized for both trade and secure storing of information. It should be considers as an enabler that can be applied to any current system. Ownership of entities or assets is confirmed by the codes they are embedded with in addition to the identity's privet and public key. This function prevents any questioning concerning rights to an entity or asset, if the codes match you are entitled to the asset. In connection to identities management possibilities in regards to information, businesses have the ability to share or protect internal information that exists between the different layers. Another ability provided by the blockchain is coding physical assets, which can then be placed on the ledger and followed throughout their journey in a supply chain. An attempt of this has been done within the wine industry enabling tracking of wine from the vineyard to the local retailer. This function has enabled the discussion of transparency from distributer to consumer, which complies with the notion that consumers want to know from where products originate. An additional aspect to the mentioned function is that one entity can be divided in to multiple entities along its journey through the supply chain and still generate the ability of tracking and retracing the chain-of-custody. To clarify, this is enabled by the coding and hashing of physical assets into smart property and the identity's unique code that regulates and confirms ownership. If the chain-of-custody or command is broken business misconduct should be considered. (Expert, 2016)

The technology's structure enables users to build different functions around the main ledger for the purpose of monitoring specific aspects related to a transaction. Subsequently, a system can be build to simply monitor the transportation part of a transaction. This would enable gaining information concerning whom, how, when and where goods have been transported via the blockchain. The function provides the mean to retrace products chain-of-custody regarding both the product origins and first nod of transport in the supply chain. Considering this, one should also reflect upon the financial implications. Delivering a blockchain registered asset entails near-to-real-time tracking enabling the possibility of an automated payment when utilizing a smart contract. Once the delivery of the asset is registered on the blockchain and the pre-requisitioned conditions are fulfilled the blockchain will activate the transfer of money. Smart contracts can substitute consignment notes that must be signed before to verify delivery and issue payment. This could be a way of insuring that the haulier that was contracted is the haulier that executes the transport. (Expert, 2016)

The ability of tracking assets via the blockchain enables certification of authenticity, which provides reassurance that assets are not counterfeit or stolen. In addition, it has the ability to insure that the chosen mode of transportation has been conducted and in turn insure that the agreed sustainability clauses in a transport contract are fulfilled. The supply chain has many layers, particularly the transportation part, which implies many actors that can delude the stipulations or demands of a contract. In essence, providing consumers with information about the activities in the supply chain is the first step to insuring contract fulfilment and sustainability. (Expert, 2016)

Another, aspect of the blockchain is that it eliminates the risk for human error due to the fact that they are not needed in the system. The intermediaries can be substituted, which generates less back-office work and more focus on the front-office. This change could result in better and more efficient service. (Expert, 2016)

5. Analysis

This chapter analyses the prospect of blockchain within logistics by analysing the data from the frame of reference and empirical findings in relation to the characteristics of innovations. Section 5.1 comprises of the five factors from diffusion of innovation theory that represent the characteristics of innovation. Each factor will in different sub-sections be analysed according to the gathered findings according to the frame of reference, case studies and interview.

5.1 Blockchain as an innovation in logistics

The global logistics industry is flawed. There is a lack of transparency and an imbalance amongst agents and principles on different layers of the supply chain. This creates a black hole concerning transportation protocol and product origins, which is in contrast to the interest and demand for more knowledge from customers. (Carter et al., 2008; Svensson, 2009; New, 2010; Eftestøl- Wilhelmsson, 2011; Williams et al., 2015) Transparency is considered as disclosure of information and is recognized in research to be the key component for a successful sustainable business. (Akerlof, 1970; Hart, 1995; Gustafsson, 2004; Fung, 2013) Information sharing generates and improves relationships between suppliers and customers making transactions more efficient (Lamming et al., 2001). The challenge is to find and implement the right system to establish transparency and profit from its benefits (Ho-Hyung, 2013). According to research the potential of using blockchain to generate transparency and ensure fulfilment of transport contracts is valid.

In accordance to Rogers (2003) this study has identified the blockchain as an innovation. The technology or concept originates from the finance sector and its potential to benefit the area of logistics is evaluated. The following table (table 3.) illustrates some factors that advocate the potential of blockchain as an innovation in the scope of this study.

Table 3: Factors illustrating the potential benefits of blockchain as an innovation within logistics based on the frame of reference and empirical findings.

Relative advantage	
	⇒ Reduction of transaction costs (Lee et al., 1999; Cachon, 2003; Fugate et al., 2006) ⇒ Exclusion of a centralized governmental institution (Nakamoto, 2008) ⇒ Open access to information concerning the activities within the supply chain (Baker et al., 2015) ⇒ Provides actors with the choice of buying sustainable products and transports (Baker et al., 2015; Expert, 2016) ⇒ Customers gain the ability to evaluate the product or supplier before making a decision (Baker et al., 2015; Hancock, 2016)
Compatibility	
	⇒ Provides customers with the information they want concerning

	product origins and the freight route (Ho-Hyung, 2013) ⇒ Reduces risk in regard to fraud or counterfeit goods (Hancock, 2016). ⇒ Easier to execute transactions by using hashes instead of physical documents (Hancock, 2016; Expert, 2016) ⇒ Enables monitoring, tracking and tracing transports (Baker et al., 2015; Expert, 2016) ⇒ Better tracking, tracing and recycling of the product lifecycle (Baker et al., 2015)
Complexity	⇒ Effective usage of QR-codes, RFID, NFC-tags, WiFi or iBeacons (Baker et al., 2015; Expert, 2016) ⇒ A network working on a platform in purpose of exchanging intangible and tangible resources (Lee, 2013; Swan, 2015; Baker et al., 2015; Expert, 2016) ⇒ Register as a user and access the network, no harder then using a smart phone (Expert, 2016) ⇒ Multiple active platforms to just access both private and public (Swan, 2015; Manuel et al., 2016)
Trialability	⇒ The extent of participation and information sharing is determined and regulated by the user (Szabo, 1997; Swan, 2015) ⇒ Active participation is not compulsory (Ho-Hyung, 2013)
Observability	⇒ Simplifies exchange of goods and payment systems (Nakamoto, 2008, Baker et al., 2015) ⇒ Gradual increase of blockchain start-ups, and active platforms (Lee, 2013; Gonzales, 2015)

5.2.1 Relative advantage

The degree of perception that an idea is better then the current practice. This could be measured in economic or social benefits, convenience and satisfaction. The perception of an advantage is of importance, when considering its adaptation. How blockchain is better then current practise?

Currently the ability to trace the origins of goods or gain more knowledge about them is almost non-existing. However, the blockchain provides a secure platform for actors to share and exchange information concerning their goods and products. By tagging goods or the mean of transportation an entity is created and can be placed on the ledger enabling the asset to be tracked. The success of the system depends on the co-ordination amongst the actors within the supply chain. By collaboration the manufacturer would embed the product with a code, which would be hashed and placed on the blockchain to ensure its existence and originality. The assets movement though the supply chain would be recorded on the ledger by scanning or registering the code. The insensitive for the manufacturers to make this investment of tagging their goods is that customers would deem them trustworthy because sharing information insinuates that there is nothing to hide. From a retailers perspective, the ability to share information and prove to consumers that their products originate from safe and sustainable producers could increase customer loyalty and hence profitability. This could be a way to eliminate potential scandals such as different meat scandals or the discoveries of dangerous chemicals in toy products.

The awareness of environmental impacts from freight has increased and hauliers have introduced sustainable options of transport, such as gas or electricity driven vehicles. However, the supply chain consists of many different layers and when booking a transport at a large logistics service provider they usually consult with a broker that in turn uses a sub-carrier to fulfil the order. Each layer along the transport side might not uphold the same standard concerning sustainability making it difficult to insure that a delivery is conducted according to environmentally friendly standards, which are contracted and usually are more expensive. In the pursuit to ensure sustainable transports hashes could be used to gain an overview of the trucks, drivers and routes involved in a transport. Having this information on the blockchain customers would be able to trace the goods back to the first node in the chain of transport. This would generate an insight to the chosen transport route and the choice of carrier.

To insure that the transport is in alliance with the contract agreement actors can add a smart contract to the transaction. The function of the smart contract would be that no payment or an adjustment of the payment would be automatically conducted if contracted stipulations are not fulfilled. In the same time a completed contract would initiate the execution of payment for the service or goods as soon as the delivery is completed. This would If a clause in the transport contract is not met this will be recorded on the blockchain and no further activities would be conducted until the clause is fulfilled or the contract is adjusted. Using the blockchain based smart contract actors would exclude or drastically reduce transaction costs, which on the current market would be expensive, especially for smaller actors. Smart contracts would be beneficial for both customer and transporter because the customer would be assured that they received the sustainable transport that they requested and are paying for while the transporter would receive the agreed fee that could include insurance. This is possible due to the recoding and auditing functions of the blockchain and its near-to-real-time tracking of the transaction. The later function executes the payment automatically or the rights of ownership as soon as the delivery is received and registered on the ledger.

5.2.2 Compatibility

Considers the degree of an innovation of being in line with adopters' needs, existing values and previous experiences. The more consistent with social norms and systems the more applicable an innovation is. Is blockchain compatible with current practises?

Global supply chains contain valuable goods and verifying documentation in the form of letters of credit or bills of lading that are moving across time and space. They also involve multiple actors along the way that come in contact or handle the transported items. The array of actors provides the risk of counterfeit, theft and decrement of valuable items. In addition, the traditional system requires trust amongst the actors in the supply chain and a centralized entity that controls and monitors all transactions. (Baker et al., 2015) Implementing the blockchain to the current system would erase the possibility to double-spend or falsify an item because information put on the blockchain cannot be altered and verifying an items authenticity would be done by matching the hash to the information on the blockchain. If a supplier lacks the ability to prove the origins of the goods then one should consider choosing another supplier.

Current practises in supply chains use some form of a coding system, usually related to the packaging barcodes or labels on the product. Existing software and technology utilize QR-codes, RFID, NFC-tags, amongst others. The issue is that potential information in connection to these codes is not accessible to outsiders and maybe not even to some insiders. Still these labels and codes exist. Actors on the supply chain should consider expanding the usage of these by putting them on a blockchain. Information concerning the product, from its production, handling and transport, can be accessed via the blockchain by scanning the chosen tag. Products embedded with a tag are transformed to a smart property and placed on a blockchain insuring the customer that the supplier conducts business and production within legal practises and environmentally friendly standards. One should consider that if a supplier is not willing to share information or certificates about the origins of their raw material or production area then there might be questionable actions within the company.

Transactions and transport services are usually associated with paperwork and documents for insuring that goods are transported in a safe manor, deliver to the right location and that liability and ownership is verified. Consignment validation and control is time-consuming and increased the transaction cost with the prospect of human error inflicting the process. Blockchain technology is self-executing implying that a service or delivery should only be registered for the payment or transfer of ownership to be issued. This function could counteract the use of illegal hauliers in other layers then the service provider that has been contacted to conduct the transport. The potential of this based on the keys or codes that have to be scanned or registered when unloading. Only the right key or code can trigger the payment of the service via the blockchain and if they do not match the haulier will not receive any compensation for their service. (Expert, 2016)

Further more, current practises enable the ability to track the shipment off en package through the compays' internal tracking system on their home page. However, the presented information is limited to timestamps of when the package enters the logistics service providers handling system. Registering a package on the blockchain would allow the buyer follow the movements' throughout the supply chain and gain more accurate information regarding the time of delivery.

5.2.3 Complexity

Perceived difficulty to understand and use the innovation. The easier to understand, the faster it will be accepted and adopted. Is blockchain difficult to use or understand?

Blockchain technology is a complex system considering the mining process and the algorithms imbedded in the hashing. Nevertheless, it should be considered as an enabler, similar to a car engine, with the ability to be applied in the background to any current system. (Nakmoto, 2008) Platforms could be constructed to match the need of either identity or entity could be specially designed to, for example, track transports. The advantage of the system is that any item, tangible or intangible, can be transformed into an entity on the blockchain and be managed by using public and privet keys. (Baker et al., 2015; Expert, 2016) The function of the keys is similar to the access to a social media account or mobile bank account, where the user is identified with a code and can regulate who has access to what information. The keys regulate the ownership, control and tracking of the assets, which can be conducted via an app in any mobile device. Authorisation, acceptance and tracking of any transaction is made by using the public or privet key.

5.2.4 Trialability

The length that an innovation can be experimented with before implementation. Pre-testing is considered as risk reducing and enables "learning-by-doing". Is there a possibility to test before committing to blockchain?

There are no restrictions or obligations when using a blockchain as a supplier or a customer. Being a registered member on a public platform provides access to the network. Establishing a privet chain could generate a cost to the provider because they custom-make the ledger according to the actors' specifications. Some providers of blockchain solutions create a demo-version for potential clients so experience can be gained before committing to a network. (Expert, 2016) There are many active providers with blockchain solutions, mainly for payment systems, therefore the possibility to find one that matches ones requirements is vast.

5.2.5 Observability

Concerns the visibility of results from the innovation. Clear and concrete results decrease the actors' uncertainty of implementation. Are there any visible results of blockchain utilization?

There is an emerging market where blockchain is the main character and the expansion is on going. This should be seen as a sign that many are seeing the blockchain as a tool to be reconed with. However, the technology is relatively new so more research and practical implementation should be conducted before stating anything about standard practices.

6. Conclusion & Discussion

The chapter aims to answer the research questions and highlight important findings and implications generated throughout the research process. Further, reflections on the limitations and potential implications of the study and recommendations for further research will be presented.

6.1 Blockchain and supply chain transparency

RQ1: Why should blockchain technology be considered as a mean for generating transparency in the supply chain?

The blockchain generates transparency by providing a decentralized public ledger of ownership that monitors and registers the goods movements throughout the supply chain, from origin to end-customer. Turning physical items or documentations in to smart property respectively smart contracts enables direct validation of an items originality and authenticity. Actors within the network have a copy of the ledger enabling them to gain information concerning any transaction. Additionally, the technology can be used for tracking and monitoring assets, communication and information sharing, and executing long-term and conditioned contracts.

Considering the conducted research for this study it can be implied that the utilization of blockchain could counteract information asymmetries and opaque supply chains. The reasoning for this is based on the open access to the ledger and the usage of tagging and registering the handling of items throughout the supply chain. These functions grant customers the ability to gain information about a suppliers product and the form of transportation of the goods. Making the supply chain transparent. This would in turn satisfy the buyers need and demand for information about product origins and mode of transportation. Knowledge concerning these aspects could be the deciding factor in determining if a transaction between actors will accrue. From the buyers' perspective, they can require the supplier to be active on a blockchain, otherwise a supplier that is could be chosen. This implies that there is a potential to level the imbalance between weaker and stronger actors in an agreement due to the access to information. Utilizing the function of blockchain insinuates that the supplier runs a legitimate business and fulfils certain standards that are expected from a supplier within the chosen area.

In the perspective of a supplier or manufacturer the blockchain can be used as a competitive advantage by providing customer with information about their products, manufacturing process and labour and sustainability policies. Recognizing that customers have over the years become more aware about where products come from, environmental impacts and footprints of production and emissions from transportation suppliers could inform customers about their stance of policy concerning these factors to gain more business. If the expansion of blockchain continues customers could disregard all suppliers that are not active on the blockchain and suspect that they are hiding something concerning production, labour conditions and quality of goods or services.

6.2 Blockchain and securing sustainability in transport contracts

RQ2: How could blockchain technology secure the fulfilment of sustainability clauses in transport contracts?

Blockchain could secure the fulfilment of sustainable transport contracts by utilizing the function of smart contracts. This form of contract has the ability to automatically validate and execute conditions in a contract in order to complete a transaction. Implementation of smart contracts could minimize transaction costs in relation to contracting, documentation and enforcement of contracts.

Utilizing a smart contract insures that the set stipulations will be fulfilled due to the possibility to deny or adjust the execution of payment. This implies that customers that request sustainable transportation of goods will receive it because otherwise the transporter risks not being compensated for their services. Using a smart contract would be a way to insure that any haulier, regardless of what layer of the supply chain they belong to, will conduct the transport in an environmentally friendly fashion. This fast should compel forwarders or logistics service providers to evaluate who they employ further down the multiple layers of the supply chain. If a haulier is used that dose not comply with the sustainability clauses in a transport contract, the blockchain will not execute any payment and neither the service provider nor haulier will be compensated.

The enforcement of smart contracts benefits retailers because they can supply their customers with the knowledge that they employ sustainable transports and consider environmental implication of the transportation of their goods. While working conditions for hauliers, including sub-hauliers, could improve because logistics service providers will be more conscious of whom they hire for their transports.

6.3 Implications of the research

The aim of this thesis was to contribute to the understanding and potential implications of blockchain technology within the research field of logistics. I believe that the presented findings show that there is great potential in the application of blockchain in logistics concerning the traceability of goods and the securing of transports being executed in an environmentally sustainable way. Customers would gain the knowledge about a products' origins and ensure it has been produced and transported in an sustainable way both for the environment and the production. The transparency of the supply chain would be simplified and better communication and understanding between consumers and suppliers would proceed. The ability to generate transparency could be used as a marketing and educational tool from the retailers' perspective, because it would be a way to show consumers how and where products have been produce and transported. In addition, providing customers with the insurance that if a sustainable transport has been agreed upon it will also be conducted in that way.

There is also the opportunity to use the blockchain in a form of "reverse-logistics" because the product can be traced even after the purchase. For example, a car or smart phone can still be traced in another line that is not connected to the retailer. This would be a way to expand the product lifecycle and increase waste management, because some parts of an electrical product might be re-usable, which provides the manufacturer with the insensitive to collect these items to re-use in the manufacturing or repairs of product.

The mentioned factors are all possible with the utilization of blockchain technology, as has been presented in this thesis. However, more research has to be conducted in the field of blockchain and logistics particularly in preforming particular examples of the utilization of blockchain and how it would work in practise. Still the blockchain should in general be considered as the new phenomenon, maybe even paradigm shift, of how business, trade and communication amongst actors in the supply chain is conducted.

6.4 Reflection on the research

Limitations are due to restrictions of time, the magnitude of literature that has to be collected to gain an understanding about this new technology but also due to the lack of academic literature and research concerning the topic of blockchain in the filed of logistics and transport. Availability and usage of academic papers is restricted or even lacking on account of the novelty of the topic. Academic publications mention blockchain in association to Bitcoin or the financial market but no reference to logistics. In effect, the choice of utilized information has been regarded with a critical eye and the publications public recognition is taken in to consideration when choosing material.

Only a general description of blockchain technology is presented because it's the concept behind it that is of relevance for the aim of this paper. This means that more detailed aspects are not mentioned or explained because they are of no relevance for the topic. However, references are made to different sources with the reasoning to provide the reader with easy access to more information concerning different topics or terms throughout the study. There is no emphasis on the technicality and actual data processing that is associated with blockchain or hash-functions, hence no detailed explanation of the systems processing functions. The theory behind the model is of interest and its application in new areas.

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Appendix

Interview guide for semi-structured interview.

Questions
How is a transaction actually executed? From beginning offer until the end exchange?

- *Currency?*
- *Property? On the BC is the property represented as a bitcoin?*
- *Contract?*

Is there a search function? Or is it a spotmarket?
Could the BC and its units be compared to the stock market?

- *Are there any form of funds, options, hedging?*

"BC provides transparency but at the same time users are kept anonymous"

- *Is that true? How is it possible?*
- *Can the level of anonymity be adjustable? The extent of information shared?*
- *Is there a demand of anonymity? On who's behalf, for who's benefit?*

If transparent - "BC makes it possible to follow a product throughout the supply chain"

- *In what regard is BC transparent?*
- *How can the information about transparency be found? Can anybody see/search for it?*
- *Tracking of resources – possible? How? Dose some kind of software have to be installed?*
- *Could the combination of smart property and smart contracts be implemented on containers?*

"The network requires consent from peers (at least 51%)"

- How does it work?
- Can the system determine who's "honest" and not?

"BC is basically a P2P-system"

- To what degree is the system public?
- Who has access to the network? Permission?

When a transaction is applied on the blockchain – is it irreversible?

"Public-key cryptography - When A wants to send B a message, A uses B's public-key to for the encryption, and then B uses their own private-key to decipher it.

- How is a transaction confirmed?
- How/where do you find the public-key for a pending participant?