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Implementation process of Block-chain Technology to Logistics and Sup-ply Chain industry

Case Kouvola Innovation Oy project leader of SmartLog

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Abstract

Recent trends in blockchain technology have led to a proliferation of studies devoted to the implementation of this technology in business processes. Currently, the adoption of new technologies is a strategic priority for any organization, and its impact on various industries cannot be ignored.

This study aimed to contribute to this growing area of research by exploring issues related to the implementation of blockchain technology in supply chains and the logistics industry. It also aimed to provide a critical assessment of the advantages and challenges by studying how this technology affects visibility and trust in supply chains.

The theoretical part of the study explains all the terminology that was used for defining the topic. For the primary data, the qualitative research approach was used, and information was collected from seminars and interviews in a case study. For the secondary data, information was collected from books, articles and reports by means of a systematic literature review.

The findings of the study on blockchain technology led to the justification of the usefulness of the technology for many organizations. Therefore, recommendations of adoption, were presented by considering all the advantages and challenges of blockchains for the logistics area. The advantages included increased efficiency of processes achieved through their high level of visibility and trust in the supply chain.

Keywords/tags (subjects)

Blockchain technology, blockchain applications, smart contracts, supply chain.

Miscellaneous (Confidential information)

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1 Introduction

Recent developments in blockchain technology and its wide adoption by big corporations have heightened the need for executives to study this topic in order to understand the concepts which this technology can offer for each industry and to be able to adopt such technology for their own companies. The main goal of this thesis was to find answers to three research questions focused on the implementation of blockchain technology in the supply chain and logistics industry and on the related advantages, challenges, trust and visibility. The study was implemented as a case study for which the data was collected from interviews and a seminar concerning the SmartLog project where Kouvola Innovation was one of the main project leaders. This study systematically reviewed the literature for answering the research questions, aiming to provide the insights on the place that new blockchain technologies have in logistics and the supply chain sector.

The author used qualitative research method, since the work was based on a case study and group interviews. Using the literature review method focused on the research questions helped to collect and summarize and analyse all information related to them. The second chapter explains in more detail the research methods of the work and how the information was collected.

The definition and the elements of blockchain technology are clarified and explained in the third chapter of the thesis. Moreover, the logistics and supply chain management objectives are explained in the fourth chapter. For the research purpose, not only on one case study on blockchain technology in the supply chain but also examples of two successful adoptions done by IBM with Maersk and SAP are presented in Chapter five. The main case study is reviewed in the sixth chapter, and the last two chapters present the literature review results and answers to the research questions.

2 Research overview

David Scott and Robin Usher (1996, 29-31) state that during a research process, people search for new knowledge and conduct a systematic investigation of facts established in advance. In a sense, research on educational issues and problems is something that is probably also found in everyday practice. When considering research from the point of view of social practice, it is necessary to consider a number of questions including the theory of justification, the adoption and the objectivity of the models of explanation of what constitutes knowledge. Work on scientific issues is invariably associated with scientific research, carrying out various studies and experiments in order to expand the existing knowledge and acquire new knowledge.

The Kouvola Innovation Oy, a project leader of the case study, is currently undergoing a stage of introducing new technologies. SmartLog is an EU funded platform for storing and providing shipment status information for all companies involved in the process. The Blockchain technique is used to preserve the transactions affecting shipments. The goal of the main plan is to reduce the period of transportation of freight units in the two key European transport corridors of TEN-T: the Scandinavian-Mediterranean and the Northern Sea-Baltic. The project consists of six organizations from four countries: Kouvola Innovation Oy as the leading partner from Finland, Tallinn University of Technology, Valga County development agency and Sensei OÜ from Estonia, Örebro Region from Sweden and the Transport and Telecommunications Institute from Latvia. (Lammi 2018.)

The importance of this thesis was based on the lack of transparency in the supply chains as well as a high level of bureaucracy, which significantly slowed down the process, reduced the reliability of the chain and increased costs. It should also be noted that there is a lack of basic blockchain research in the field of logistics, and thus, the scientific base is quite limited. However, there are several fundamental works in this area that could bring significant improvements to the field of logistics, such as TradeLens, for example. The technology itself is only just beginning to be studied and adopted by large companies and industry leaders.

It is very important to assess the sources that are used during research, and one approach of verifying the reliability and credibility of the sources is to use a test invented by The California State University. The tests consist of five main steps of evaluating the source, and it consists of the following terms: Currency, Relevance, Authority, Accuracy and the Purpose. (Blakeslee 2004, 6.) The assessment guarantees that the chosen sources are not damaging or making the bad effect on the thesis work. This test can be performed for various resources containing the necessary information, it can be used for websites articles, news articles, books and journal articles. It is always important to consider the five main terms of the test while making decisions on the relevance of the sources. The data collected should always be relevant to the work.

The outcome of the present study was relevant to many companies considering the adoption of blockchain technologies as well as to students interested in blockchain applications. The results of the study show how the use of blockchain in logistics and the supply chain can increase visibility and trust. In the thesis, the author describes the advantages and challenges of the technology. The object of the study was the SmartLog blockchain system implementation process in the logistics environment, as well as going through literature review focused on a research questions to evaluate and summarize all information and arguments related to the questions. This study can support many companies in their decisions on the adoption of the technology into their business.

2.1 Research questions

The main objective of the research is to study process of implementation of the blockchain technology based on a real cases and define how it can affect visibility and trust in the logistics and supply chain industry. Another objective was to show the advantages and challenges of the technology.

The most important research question was as follows:

- What should companies consider to successfully implement Blockchain technology?

The sub-questions were as follows:

- What are the advantages and challenges of the blockchain technology?
- How does blockchain technology affect visibility and trust in the logistics and supply chain industry?

When gradually answering these questions, the thesis goes deeper into specific areas chapter by chapter and presents the results of the study as shown in Figure 1 below.

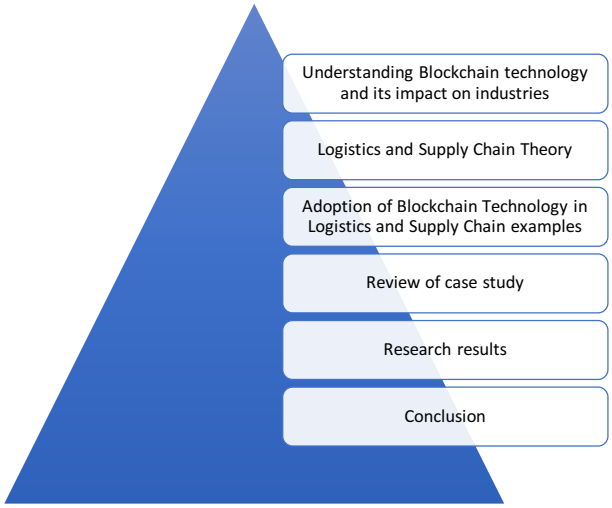

Figure 1. The structure of the thesis

2.2 Scope and limits of the research

The study was implemented based on a main case study on group of companies working in cooperation with the Baltic states of Finland, Sweden, Estonia and Latvia. It means that the conclusions can be generalized with focus on those areas. The limitations which may follow with this case study, that the companies who are interviewed are not willing to share the confidential data, this can affect the research. As mentioned before, SmartLog is a project which aims to reduce overall cargo unit transport times in two of the European main TEN-T transport corridors: the Scandi-

navian-Mediterranean and the North Sea-Baltic. Project SmartLog's goal is to introduce a blockchain technology application into the operational data transfer traffic in the logistics business. (Lammi 2018.)

As for research part of the thesis, a systematic literature review was utilized on theoretical and practical studies in the use of Blockchain Technology. The study also included an analysis of the case study documentation including SmartLog official documentation and related support materials.

Since the main target of the thesis was to study and present the blockchain technology in the logistics and supply chain industry, the theoretical data was collected from different sources. However, there are limitations in the study of blockchains because this technology may be used in other industry sectors, such as banking or healthcare. The aim of the study was to confirm that the potential use of blockchains in logistics and supply chains could increase visibility and trust and also with accordance to all advantages and challenges to show what exactly companies should consider before making decision upon implementation and adoption of technology to supply chain and logistics sector.

2.3 Theoretical framework

The research focused on questions concerning the implementation of blockchain technology, and considering the fact that this technology has not been widely adopted by many industries, the main concepts should be explained. The theoretical framework consists of an introduction to blockchain technology and its applications as well as smart contracts. Those concepts are defined and described in the third chapter.

Another theoretical base that should be defined for a clear understanding of the topic is logistics and the supply chain. The complexity of the supply chains networks and their importance to the logistics system in receiving customer goods are very important key theories which are introduced in the fourth chapter.

The focus of the fifth chapter of the thesis is on examples of adoptions of blockchain technology in logistics and supply chains. With the support of the theoretical base from the two previous chapters, real life cases are shown and described.

The review of the case study and the literature review in the sixth chapter respond to the main research question and the sub-questions. After the analysis made based on the case study and literature review, the answers to the questions are presented in the last chapter.

2.4 Research Methods

Finding answers to questions by applying scientific practices is the principle of any research work. The key idea of research is to uncover hidden information or knowledge that has not been discovered. (Kothari 2004, 2.)

In each area of research, general methods for obtaining results are identified. These methods transform over time as technology progresses, and researchers find more sufficient and competent ways. Certain methods are best suited for a certain field of research, and it is good to follow the standards of each field to ensure correlativity and ease of displaying the results. (Edgar & Manz 2017, 63.)

To summarize, in the process of studying a research problem, all methods that help to solve the research tasks and that are directly used by the researcher are called research methods. The method is needed for finding the truth and correctly understanding and explaining the current situation. The method used in the research is disclosed in the practical part of the thesis. It also describes the results of the application of the method and their analysis. The choice of methodology directly depends on the goals set in the work, and there should be a strong correlation of the available data for analysis. (Kothari 2004,8.)

2.4.1 Quantitative Research Methods

Quantitative research is a method of collecting data of a scientific base in order to analyze and describe the research area. By a quantitative method of data assemblage, we can understand a method that is based on measuring the data of a large number of respondents. The collected data is then processed and statistically analyzed. (Kothari 2004, 3.)

The method of obtaining information used in quantitative research includes many different tools for further evaluation of the collected data, such as statistical and mathematical data, experiments and surveys. The collected results are most often presented in the form of graphs and tables. This method is best for classifying, comparing, and identifying patterns. (Brannen 1995, 16.) The collection of required data for the study is necessary to confirm the hypothesis and may cover questions that are open/closed, factual/opinion based, and allows the respondent to determine the validity and veracity of the research hypothesis. (Scott & Usher 1996, 60.)

2.4.2 Qualitative Research Methods

A qualitative research method is a method of collecting, processing and analyzing information of a studied subject. The purpose of this method is to gain a deep understanding of specific research issues. The method of qualitative research is mainly observation of participants and interviews. If the research problem is poorly understood and incomprehensible, and questions to respondents can lead to complex answers, additional methods, such as in-depth interviewing, may be required. (Brannen 1995, 16.)

Widely used for this research method is the collected and analyzed information or data consisting of text materials, transcripts of interviews, video materials, photographs, and Internet pages. This method documents human experience from which subjectivity follows due to the conventionality of the results. (Saldana 2011, 3-4.) However, subjectivity itself can be different qualities. According to Steinar Kvale (1996, 146), it is necessary to distinguish between prejudiced subjectivity as poor-

quality and unreliable work, when a researcher notices only that which reinforces his opinion and misses everything that contradicts him, and the subjectivity of different views the ability of researchers to take different positions in relation of data and, accordingly, subtract slightly different meanings in them. The first subjectivity really needs to be avoided, and for this, constant checks of one's own judgments are introduced into the analysis process.

The case study method is very popular in qualitative research. In such method, a detailed research and analysis of events, processes and the conditions of their relationships is observed. The main methods of data collection are monitoring the projects or particular company and consulting interviews with employees. The purpose of the method is to explain the relationship between various factors in a case study. (Kothari 2004, 113.) Usage of case study design is better in areas where researcher want to have integrated perception of the situation. (Kumar 2011, 127.)

2.4.3 Selected Research Methods

The type of research is suitable for finding different aspects. Qualitative research is more appropriate for studying and understanding meanings and describing situations. In quantitative research, the main focus is to identify the expansion of these situations. (Kumar 2011, 104.)

The chosen research methods for this work were mostly qualitative because the thesis was based on a case study, and this method specifically supported the author in finding the answer to each of the research questions. With a case study and evaluation of the implementation of blockchain technology in logistics and supply chains supported by information gained and analysed through interviews, the author obtained enough information to answer the main question. Since the study focused on explaining and discovering results and facts, the qualitative method with all its benefits, such as case studies, group interviews and literature reviews allowed to have a better insight for the research.

2.5 Data Collection

There are two ways to collect data, and one of them is collecting from primary sources, and this method consists of observations, interviews and questionnaires. Sources, such as books, articles or earlier studies are considered secondary sources. (Kumar 2011, 139.) For this research, data collection was performed based on both primary and secondary sources.

For primary data, an interview was organized with one of the project leaders in the company Kouvola Innovation Oy in Finland, and observations were collected from the final project seminar. Steinar Kvale (1996, 2) defines an interview as an approach to gather information from individuals with a specific purpose of defining the core answers upon a theme. Mika Lammi, the Head of IoT Business Development, agreed to arrange an interview with the duration of one and a half hour. The interview was recorded as agreed and it conducted as a structured interview. A structured interview consists of previously identified questions executed in the same order (Kumar 2011, 145).

Secondary data is collected from books, articles, reports and internet pages. A systematic literature review method with content analysis is applied after the required information has been collected. That method is used in research to critically examine several studies and compare the collected data and information with one's own findings in order to allow the author to make a deep analysis on the research topic. Kumar (2011, 31-32) states that in the beginning of research work, the method of a literature review supports the creation of the theoretical basis of the study, formulating findings and developing the research methodology. Analysis of the literature is intended to expand and consolidate one's own basis of knowledge and to help to combine the acquired information with the existing knowledge.

The systematic literature review in present study focused on exploring the literature related to the research questions and showing the concepts of the technology and all data collected from multiple sources as shown in Appendix 1 using the Google

Scholar and related websites. The chosen stages of the literature review are defined and presented in Figure 2. The first stage is important in order to collect exact information related to the research questions. The second stage focuses on selection of relevant and critically evaluated data, it should be appropriate for the research and for that author decided to use the assessment test mentioned in Chapter 2 from California State University for evaluation the sources. The third stage include combination of selected and extracted data, sorted by four objectives related to the research questions as can be seen from Appendix 1. In sub-chapters 6.2.1; 6.2.2; 6.2.3 and 6.2.4 shown the tables representing the types of publications and years Tables 2-4, 6-7. The last stage represents the analysis and review of the literature that have been selected and categorized in the previous stages.

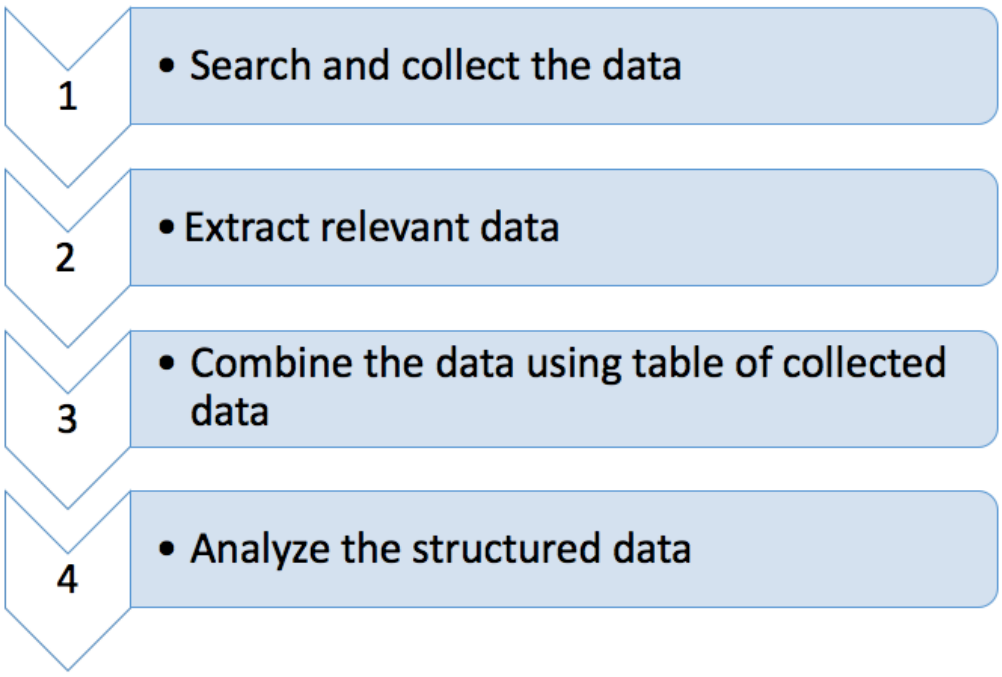

Figure 2. Steps of literature review

3 Introduction to Blockchain technology

Since its inception, blockchain technology has drawn a great deal of attention not only to fields directly related to information technologies, but also to people who

have learned about this technology through the media. There is a large body of published literature and research emphasizing the importance of blockchains. In order to better understand this technology and the functional basis of its applications to the logistics and supply chains industry, the blockchain should be defined, and the questions “What is a blockchain?” and ”How does a blockchain operate?” should be answered.

3.1 Definition of Blockchain

Introducing a concise history, in 2008 author whose identity has not been revealed, reported the white paper “Bitcoin: A Peer-to-Peer Electronic Cash System” where the cryptocurrency Bitcoin was described (Nakamoto, 2008). It might be that pseudonym Satoshi Nakamoto used not just for one person, but for a whole group of people working on blockchain-based innovation Bitcoin.

Nakamoto (2008) does not give any explanations about blockchain, although blockchain provides the means to record and store Bitcoin transactions (Gupta 2018, 6). The problem that Santoshi sees is that all transactions are highly dependent on trust in all current payment systems. Firstly, in the existing system of electronic payments, all transactions go through an authorized person, as a rule, the bank acts as such a person. Reffering to a middleman makes each operation more expensive, making infrequent or small transactions unprofitable, but with findings of Nakamoto peer-to-peer electronic transactions with cryptographic proof instead of central trust does not need third party involvement by letting the online payments to be transferred directly. (Nakamoto, 2008.)

After white paper of Nacamoto was presented, large volume of published studies and researches describing the role of blockchain technology appeared. Daniel Drescher (2017, 35) defines the blockchain as a decentralized, distributed peer-to-peer system of registers with common application area. The information content is ordered, and connected between each blocks of structured data which follow the certain regulations. Security technologies combined with cryptography proof and

hash algorithm that utilized to obtain and preserve integrity, by not allowing to perform any internal or external changes. Definition of blockchain is ambiguous, it can be applied for different cases such as technological, business or legal. Blockchains can be considered as a trust based area, an exchange medium, a secure channel, a set of decentralized capabilities, and even more. (Mougayar 2016, 23.)

To recapitulate, blockchain finds a way to solve the problem of continuity in a distributed peer-to-peer system, composed of an undefined quantity of peers with unknown reliability. (Drescher 2017, 31.) And from an economic point of view, the blockchain network is effective as it reduces doubling of operations and eliminates the need for intermediaries. Blockchain is less vulnerable because the models for checking incoming information are reliable. Transactions are verifiable and authenticated, with the same participants in transaction systems when record of the systems shared and available for all parties involved. (Gupta 2018, 7.)

3.2 Elements of Blockchain

In order to understand the principle of operation of the blockchain as a whole system, it is necessary to determine the main elements of which the systems consist.

Peer-to-Peer (P2P) System

The computers which involved in to the network and being available to all other networks members, all based on equal rights of participants without exception, and all nodes which providing network of the client and server, describe the term of peer-to-peer. The networks of peer-to-peer system are decentralized. (Antonopoulos 2017, 171.)

The applications of P2P system consist of such features as assuring confidentiality, sharing the data and distributing content. Those applications transform user's computers within network into nodes of which whole distributed system consists of. And depends on how many users operate the software we can know how big and how powerful the system can be. (Drescher 2017, 15.)

Blocks

Block has container data structure which associate transactions for insertion in the public register which is blockchain. A block includes metadata with a list of transactions. Each block refers to a previous block in the chain how shown in the Figure 3 below, including its hash-required amount and also the hash-required amount of the previous block in its own header. All following blocks have to be edited concerning change the information in one block, however, since copies of the chains of block are saved in many different computers separately from each other this creates problems for the purpose of changing data inside of the block. All blocks headers in the chain have special hash algorithm which defines each block. (Antonopoulos 2017, 195-196.)

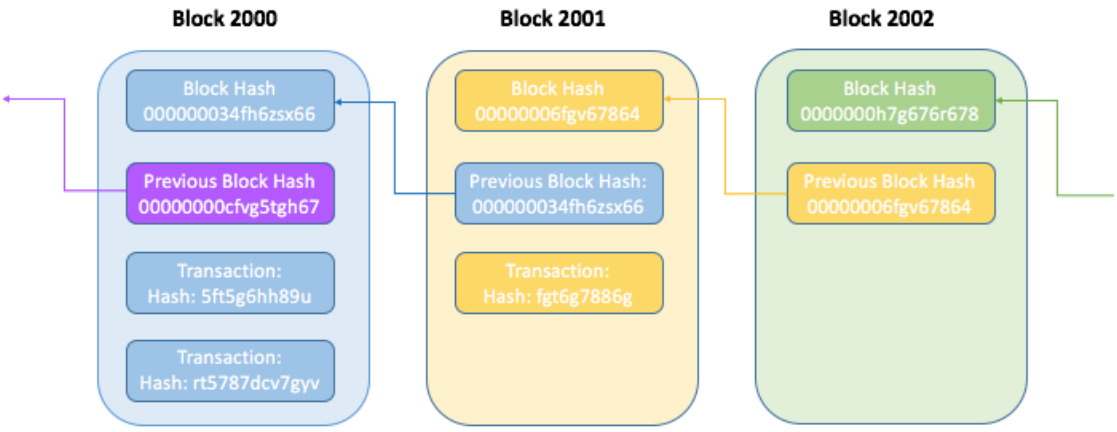

Figure 3. Blockchain connected blocks (Adapted from Gupta 2018, 14.)

Each block created from the moment of the zero block can automatically track it as its parent block through links with previous blocks. The sequence of hashes connecting each block to its previous block returns a chain to the first block created, called the Genesis block. (Antonopoulos 2017, 197.)

Node

Nodes are the main unit of the network each node can be seen as an individual computer as can be seen from Figure 4 below. All nodes have the same functional abilities and liabilities. (Drescher 2017, 23.) Each node in the system collects, stores and forwards information to all other nodes. (Iansiti & Lakhani 2017.) Blockchain node can authoritatively and independently verify any transaction without reliance on any other node or source of information. (Antonopoulos 2017, 180-181.)

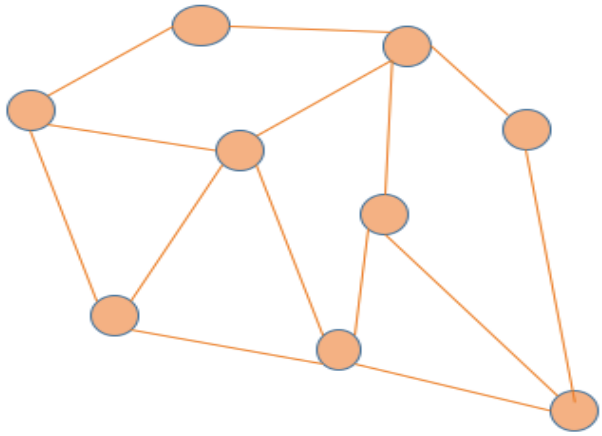

Figure 4. Nodes in distributed architecture (Adapted from Drescher 2017, 11.)

Nodes in peer-to-peer network provide and consume assistance (Antonopoulos 2017, 171). Each node collects new transaction data in an inbox and selects new blocks for further processing. New blocks processed by the node instantly with highest precedency. Blockchain node operate recent transaction records by approving them for authorization, configuration correctness and semantic accuracy. Each node collects only valid transaction data and making a new block. After new block has been created its sends to all other nodes in the system for next verification. (Drescher 2017, 159-161.)

Transaction

Transactions are group of logically combined sequential data structure operations, that encrypt value transfer between system participants (Antonopoulos 2017, 117). The description of the transfer of ownership goes through the information provided

by the transaction data. To provide an opportunity to influence the result of aggregation of transactional data, the transaction is performed by adding it to the transaction data history. (Drescher 2017, 68-69.)

When the owner of the value allows the transmission of this value for a different keeper, the transaction informs the network about it. For clarity, transactions can be compared with the marks in the double-entry records ledger. Every transaction includes one or several “inputs”, and on the another border of the transaction there are one or more “outputs”. The transaction has verification of ownership of each quantity of input data presented in the scheme of a digital signature of the owner, which can be confirmed by anybody independently (Antonopoulos 2017, 18-19). Transaction history is used to confirm the current state of ownership. (Drescher 2017, 190.)

Hash Functions

Hash functions are small computer programs that convert any type of data into many fixed lengths, regardless of the size of the input data. Converting an array of input data of arbitrary length to an output bit string of a specified length, performed by a certain asymmetric algorithm shown in the Figure 5. (Bakhtiari, Safavi-Naini, Pieprzyk 1995.)

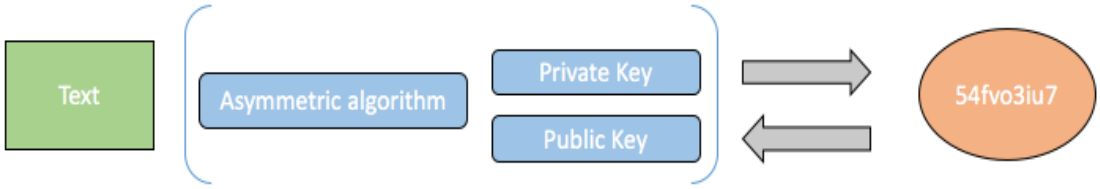

Figure 5. Hash Functions (Adapted from Drescher 2017, 76.)

A cryptographic hash value uniquely identifies any type of data. A hash reference is a link, which becomes irrational after changing the reference data. A hash puzzle is a complex computational task. (Drescher 2017, 190-191.)

3.3 Technical concepts

It is important to mention the technical concepts whose enable blockchain operations. Specifically, for the needs of this thesis only main concepts will be described, which are smart contracts, distributed ledger technology, digital signature and cryptography. With understanding of those topics it will be easier to comprehend how blockchain operates.

3.3.1 Smart Contracts

Smart contracts are digital contracts that allow the use of terms that depend on decentralized consensus, which are protected from unauthorized access and, as a rule, self-funded through automatic execution. Consensus assures that all nodes in the system use the same transaction data history (Drescher 2017, 191). Consensus is an agreement to the inclusion of a specific block into the blockchain. A consensus mechanism similar to the blockchain is necessary when digital assets and rights to these assets must be transferred from one owner to another (Casey, Vigna 2018, 238). The contracts include all the fundamental data for the transfer of ownership. With regard to the actions, subjects, objects and conditions to describe desired transfer of ownership, smart contracts are by far the most flexible in relation to them. These contracts are written in the specific programming language based on blockchain, and they are also autonomous computer programs. Being the most significant and prospective development of the blockchain over the past years, smart contracts have every chance to be applied to display a wide range of real-life contracts, such as providing insurance payments in the event of defects or the presence of difficult incidents. (Drescher 2017, 240-241.)

To ensure the functional implementation of a specific requirement, smart contracts are used, which, in addition, demonstrate evidence that these specific conditions were met or not fulfilled. While not essentially a law, smart contracts, being completely computer programs, are just a stimulating technology, but their actions can lead to consequences that can become part of a legal agreement. The results of

smart contracts can be used to prove compliance with the terms of the legal agreement being followed or not. Considering smart contracts from a technical point of view, it turns out that this is program code representing business logic that launches the blockchain, and they are launched by some external data, which allows them to change some other data. The database is updated by the program only if certain conditions are observed in smart contracts. Smart contracts apply to almost everything that changes its state over time and can have a meaning associated with it. Based on this, smart contracts have a fairly expanded range of applications. (Mougayar 2016, 42-43.)

In ordinary contracts, various hassles and delays are often present, to prevent this smart contracts include a contract into the transaction, thereby reducing risks. Since the advent of smart contracts, the need to send documents by e-mail or fax for subsequent processing such as peer review, revision and signature has disappeared. With the help of these contracts the blockchain establishes the conditions under which a transaction or exchange of assets is possible. (Gupta 2018, 23.)

3.3.2 Distributed ledger technology

Blockchain is a distributed ledger that follows every transaction handled in its system, authorizing the user's computer to control the accuracy of every transaction, so that it can never be ambiguous or double-counting. The transaction history shared between network nodes using a distributed ledger (Drescher 2017, 191). The ledger can be confidential, public or semi-private, and it can also be shared by several parties. (Mougayar 2016, 21.)

The absence of any central element of coordination or control is the main feature of the components of distributed systems, as well as the lack of connectivity at least indirectly between components in the system, architecture is presented in Figure 3. The computing power of distributed systems prevail over each individual computer. This power in distributed systems appears after combining the computing power of all computers connected to the network. It is possible to increase the computing power of the entire system provided that additional computers are connected to the

system. The result will increase the computing power of the entire system. Even in the event of crash or untimely failure of individual computers, the entire network consisting of these computers can continue to work, this fact determines the increased reliability of the distributed system. (Drescher 2017, 11-13.)

A distribution system can be described as a system that includes a set of independent computers that are assembled into a single system, independence is due to the fact that it is completely hidden from users of the system, that there are even several computers (Tanenbaum, Steen 2007, 1). Blockchain implements a goal the essence of which is to achieve and maintain integrity in distributed systems. (Drescher 2017, 17.)

Each bookkeeping node is independently responsible for updating the ledger in coordination with other ledgers, since the ledger is not located in one place, but in many. After the computer updates the ledger and all the evidence that its work was performed, all other computers on the network concurrently update their versions with the new update. Thus, the familiar centralized master copy is no longer held, as it is constantly updated record of a truth. (Casey, Vigna 2018, 65.)

3.3.3 Digital Signature

A digital signature is an agreement with the contents of transaction data (Drescher 2017, 190). As the equivalent of handwritten signatures, digital signatures were created, they use cryptography-based hashing, as well as a private-to-public information stream of asymmetric cryptography. With the help of digital signatures, it is possible to identify cases of fraud, as well with the help of them, the input data is verified, which is easily feasible by all participants in the system. Digital signatures indicate whether the account holder agrees with the transfer of ownership of the specific transaction data, they uniquely identify their author. Signatures are relevant for the reason to prevent the use of the contents of these transactions for the authorization of other transactions without the consent of the author. Only the owner of the account handling transfer of ownership has the opportunity to create a digital signature. In blockchain technology, two options for working with digital signatures are

used: this is verification of transaction and signing of a transaction. Digital signatures of transaction data consist of cypher text and a combination of the cryptographic values of the hash function of the transaction data, this can be traced back to the proper account private key. (ibid., 107-109.)

The authorization of the owner of the private key is confirmed by digital signature and in all cases the proof of permission is undeniable. After signing, the transaction has not been changed and cannot be changed by anyone, which is proved by the digital signature. There is no relationship between each transaction input that includes any signature on any other input or signature. Signing only one input for each transaction can be achieved by several parties with joint cooperation to create transactions. A digital signature is a numerical program consisting of a method for designing a signature applying a signing key from a transaction and the accompanying algorithm responsible for verifying the signature taking into account the message and the public key. (Antonopoulos 2017, 138-139.)

Multiple signature is a type of electronic signature that allows multiple users to sign one document. To prove the validity of the transaction, most users must agree to this. (Gupta 2018, 16.)

3.3.4 Cryptography

Cryptography is based on mathematical functions that allow to create digital codes and digital signatures enduring in the system (Antonopoulos 2017, 56). The need for cryptography is determined by ensuring data security, including identification, authorization and authentication (Drescher 2017, 46). Also, transaction protection on an individual level becomes possible with cryptography. (ibid., 59.)

To achieve optimal data protection, cryptography uses codes composed of a set of possible numbers. The detection of undisclosed code by examining and dropping every potential number is consuming lots of time and becomes impossible due to the huge number of different possibilities and variations (Casey, Vigna 2018, 32). Being

cryptographically protected and conclusively related several alternative cryptographic tools are used to perform register entries in a way that associates them with an inextricable series of mathematical locks in a completely verifiable progression. Cryptography protects the integrity of forms of an endless chronological series of transaction data or blocks (ibid., 65). Just like with most copyright claims, cryptography keeps the database secure and inviolable as long as users trust claims of authorship of certain data. (ibid., 238.)

In order to ensure the security of the network for the blockchain, cryptography is used in several places. Cryptography uses three basic concepts described earlier in more detail by the author which includes: digital signatures, keys, and hashing. Cryptography is established on public or confidential authority, which is a public visibility, but confidential test (Mougayar 2016, 12). To ensure timely authentication of the transaction source, hash-based cryptography is used to eliminate the need for a central intermediary. To achieve the complete absence of a duplicate record of the same transactions, it is necessary to combine blockchain technology with the knowledge and capabilities of cryptography. (ibid., 25.)

3.4 Transaction Security and Validation

In this chapter author explains the meaning of the term Transaction Security and give reasons why it is so important in order to make transfer of ownership. The Figure 6 illustrates how blockchain technology works from the moment of creating transaction, till the transaction becomes accomplished through seven steps. First step shows how user creates a transaction that may contain data records or other information for contracts. The second and third steps illustrates how transaction is sent to the peer-to-peer nodes of the computer network and nodes check transaction and user status using algorithms. After validation successfully completed in the fourth step, verified transaction has been added to other transactions to create a data block in the registry as followed in step five. Last two steps represent how a new block is per-

manently added to the sequence of blocks and making changes to the transaction after that becomes impossible. After that the transaction is considered to be completed inside of the system.

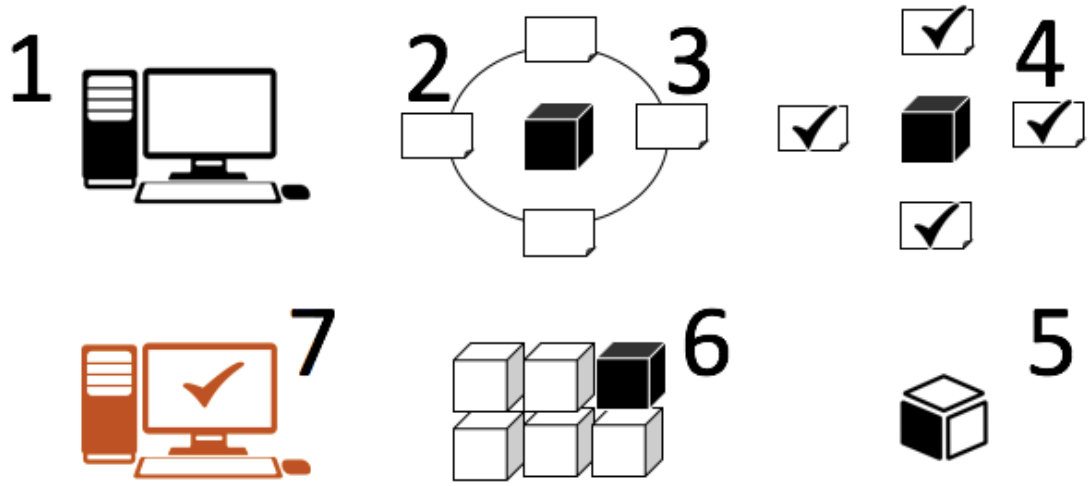

Figure 6. Illustration of a blockchain technology transaction processing (Adapted from Katsman n.d.)

Another subsection of this chapter explains validation for block headers and for transaction data, which helps to enable security of blockchain operations.

3.4.1 Transaction Security

The term transactions can be represented as small contracts that include all the fundamental data to transmit ownership. The embodied idea of running program code allowed developers to create applications on the blockchain, and not just support transparent transaction information. (Drescher 2017, 240-241.)

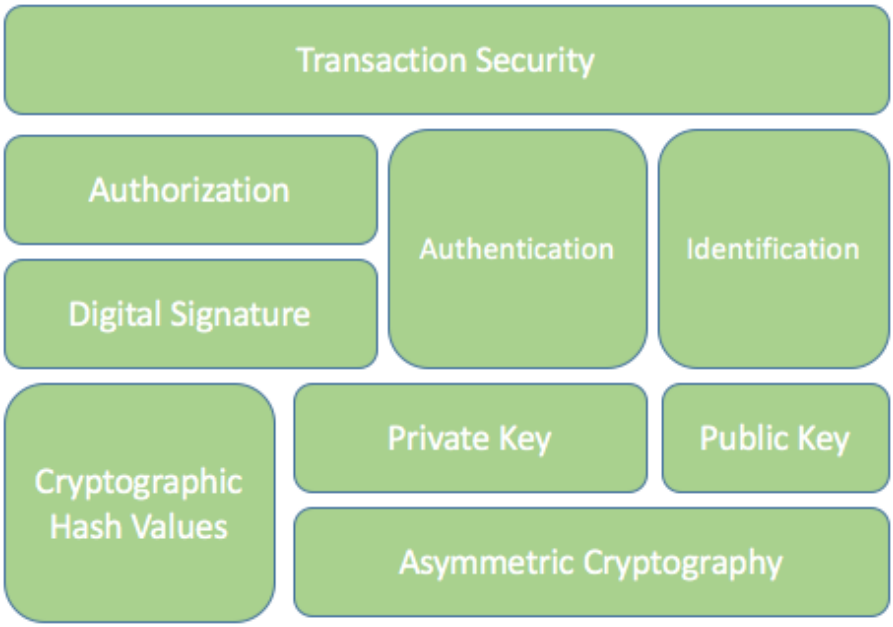

Figure 7. Main concepts of transaction security (Adapted from Drescher 2017, 196.)

Only a legitimate owner has the right to transfer ownership to another account and gain access that is what the transaction security establish. Figure 7 shows the concepts that are used to secure transactions. On the lower rectangles are located the main concepts including the values of cryptographic hashes and asymmetric cryptography. Since all subsequent concepts are based on the main ones, respectively, they are located in the rectangles standing over them. Authorization is located above the digital signature because the signature is a way to approve the transaction. (ibid., 195-196).

3.4.2 Validation

The blockchain algorithm, which main goal is to ensure that the blockchain data structure includes only valid constructs consisting of real transaction information and also real and valid block headers. Drescher (2017, 156) identify the validity of information for two groups based on their validation rules:

- block headers validation rules
- transaction data validation rules

Block headers validation rules

According to Antonopoulos (2017, 238-239) confirmation of new blocks is performed independently by each system node. The regulations focus on the grammatical and proper correctness of block headers. When a new block goes across the network, each node for subsequent verification conducts several tests for subsequent distribution, which promises the distribution of exclusively right blocks. If the received block does not meet the criteria, the node automatically rejects the failed block. In case of successful passage of the headers of the check blocks by complying with the rules, the blocks can be processed further. Some criteria by which blocks are evaluated are presented in the list below:

- syntactically valid data structure
- target value greater than block header hash
- taking into account temporary errors, the timestamp of the block in the future is less than two hours
- block size fits within acceptable limits
- each block header contains a valid hash reference to the previous block
- the block contains a one-time number. (Drescher 2017, 140-141.)

Transaction data validation rules

Rules for validating transaction data includes certain categories necessary to describe the transactions. (Drescher 2017, 156.)

In the same way as when checking block headers, only those transactions that have undergone thorough verification can spread across the network, but when transactions fail to be verified, they are automatically discarded on the first counter node. An excerpt from a large list of rules and the criteria by which nodes verify transactions is presented below:

- transactions must be syntactically correct

- transaction data structure must be correct
- input / output lists are empty
- maximum block size must exceed transaction size
- transaction size more or 100 bytes
- reference output exists for each input (Antonopoulos 2017, 218-219).

3.5 Possibilities of Blockchain Technology usage

Blockchain has a big range of applications, it can be used in many industries and sectors such as energy sector or machine industry, but in this chapter author explains four sectors where companies may or already uses the blockchain technology, which is finance, logistics and supply chain, health care and public sector. Concerning the topic of the thesis, it is important to describe and present implementation use cases in logistics and supply chain where real companies adopting and using the blockchain technology which will be described in details in chapter 5.

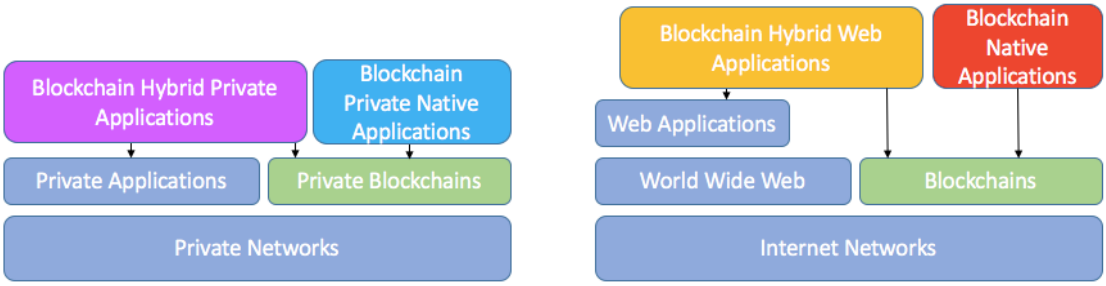

Figure 8. Types of Blockchain Applications (Adapted from Mougayar 2016, 8).

As shown in the Figure 8, the blockchain applications need access to the Internet network because the systems are based on it. But since one of the most promising opportunities that the blockchain can give is bypassing Web and providing a more decentralized option. There are several versions of creating a blockchain application, those that can be initially created on the blockchain or those that are mixed in an existing web application, in the figure above this type of application is called hybrid blockchain application. The division can be seen in the figure into two different networks of private and public, respectively, blockchains also can be private and public.

Similarly, some will be tied to the blockchain, in the figure they are listed like native applications, while others may be part of an existing application, i.e., hybrid ones. (Mougayar 2016, 6-7.)

3.5.1 Finance sector

There are many examples of blockchain applications in the financial industry. Quite often adoption of the technology can be found in small networks of firms from which the coordination requirements are not so extensive. Many banks in America and stock exchanges are testing blockchain technology in order to replace paper and manual transactions in several areas, including financing, currency conversion, cross-border settlements, derivatives, swaps and processing of transactions related to securities. (Iansiti & Lakhani 2017.)

It is very important for all bankers to understand how blockchain-relevant technologies can simplify and replace many processes of transferring securities and currencies between banks requiring a lot of processing time. Blockchain technology allows to reconcile documents during factoring, which significantly reduces delivery verification time, as well as a common scam base and, most importantly, lower costs and simplify trade transactions. Back-office expenses are reduced by using a reliable distribution ledger, which can be updated by banks unions in real time. A large amount of capital saved can go to the company's investment. (Casey, Vigna 2018, 10.)

Indeed, with the advent of all those opportunities that blockchain technology now offers, the next generation of financial services now already has a highly innovative environment, since crypto currency volatility is abate-they will become popular. This will create a new market for trading financial services as investments, loans and many other financial instruments will be able to have their own version of crypto currency. (Mougayar 2016, 22) In order to be able to successfully adapt innovations demonstrated by the blockchain technology to the financial services industry, it will be recommended to postpone new regulation while at the same time updating the long-existing one. (ibid., 107.)

3.5.2 Logistics and Supply Chain sector

More often, suppliers use a common information storage platform for exchanging data related to their business processes, all of this can be achieved using blockchain-based supply chains. By virtue of this platform, efficiency is increased, accountability and financing are improved with the common goal of producing certain types of goods. (Casey, Vigna 2018, 8-9.)

In companies whose logistics activities are highly dependent on many external suppliers, difficulties arise such as accountability in complex supply chains and a lack of transparency. Based on accepted agreements of parties own records and storage of data on stock movements and internal work processes in each company involved in the process, exactly these agreements that make it difficult to transfer information between companies. Through the blockchain and related technologies, companies can use cryptographic hashing of information to verify the execution of key procedures without encroaching on sensitive data. All members of the chain have access to the blockchain, where the hashes are stored, thus increasing confidence in the data, since the record will be easily tracked and it will be impossible to change it. (ibid., 141-142.)

The use of smart contracts for logistics and supply chains enables payments to the supplier being sent using such contracts right after the goods have been delivered. With the help of blockchain, a company can notify of delivery and receiving of goods or that the goods may have GPS, which allows company to track its movement in real time. Contracts are an integral part of any organizational and logistic activities, as they document the relationship between suppliers and customers, as well as the relations of employees within the organization (Iansiti & Lakhani 2017). As soon as the client selects and confirms the contract of carriage, the platform enters into a smart contract with all participants of the carriage, including the insurance company, thereby controlling the transportation using smart contracts. (Sekhon 2016.)

M. White suggests the idea of making global trade digitalization for future business processes improvements as can be seen from the picture below. (White 2018.)

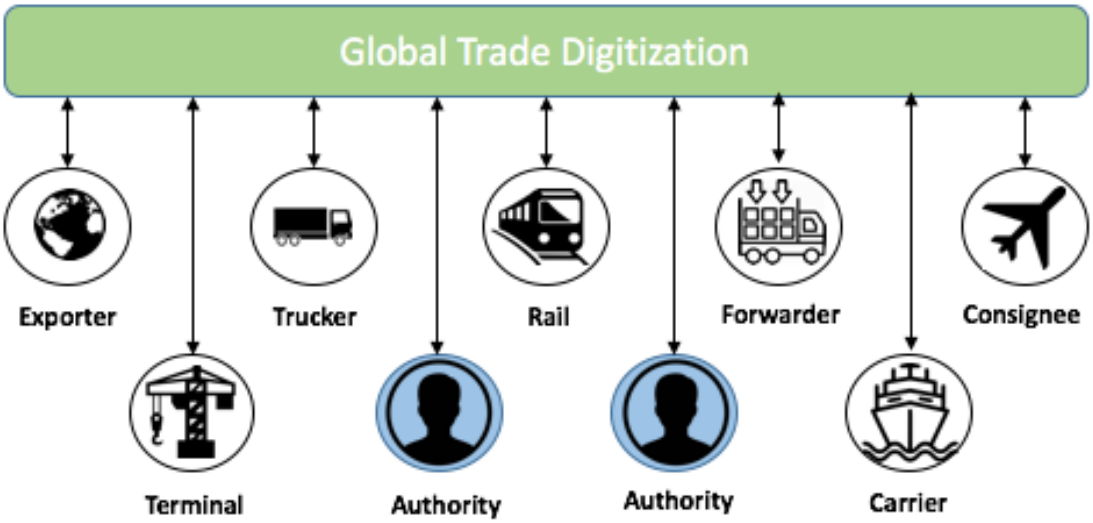

Figure 9. Global Trade Digitization (Adapted from White 2018).

Summarizing the key goals of using blockchain technology, several can be distinguished: this is the achievement of accelerated payments or their full automation, reduction of fraud risks, simplified settlement of claims, elimination of intermediaries and reduction of paper work. By introducing blockchain supply chain certification, transparency can be achieved. Each element of the supply chain allows you to check the continuous supply chain from the initial component of the product to the final sale. (Sekhon 2016.)

3.5.3 Healthcare sector

Laboratories, hospitals and insurance companies operate separate, isolated databases where highly sensitive medical records are distributed. Each of these institutions stores its own sectors of sensitive data and the chance of cyber-attacks are quite high in this case (Casey, Vigna 2018, 47). Blockchain effectiveness can solve many problems in the healthcare field, by solving problems with medical records and patient confidential data. (Mougayar 2016, 118.)

The Estonian government has launched a successful project, the main idea is to safely publish medical data on the blockchain with confidence in the safety of data and that only authorized persons can access private data. Blockchain technology is responsible for mass authentication of data without the use of third parties. In the

Estonian project, the technology uses only cryptography with hash functions, which allows the verification to focus on the availability of the public ledger and the security of hash functions. (Allison 2016.)

One example of using blockchain technology in healthcare sector could be DNA wallets for storing medical and genetic data. All data stored in these wallets is protected using the blockchain and available if the user has private keys. For health care providers, this will allow the safe exchange of patient data, and it is also possible to monetize this data by helping pharmaceutical companies in the efficient selection of medicines. Another example can be to use blockchain in the confrontation against fake drugs to guarantee the legality and eliminate illegal drug manufacture. (Cordwell 2015.)

The purpose of the application can be to control the product at all stages of the value chain, as well as transparent, reliable and relevant information on the movement of products for management reports. New opportunities that have emerged with the advent of blockchain technology allow the safe development of online trading without the risk of growth of counterfeit products and the potential reduction of corruption through a transparent trading platform.

3.5.4 Public sector

For the implementation of services such as issuing passports, marriage registration, taxation, licenses, patents, voting and other operations using blockchain technologies, governments will need a lot of time but eventually can all benefit from blockchain properties. A full impact analysis is recommended, including the possible consequences of such large-scale projects. However, in the advantage will be small countries or individual districts, cities when launching early projects to implement blockchain in a public service, since they avoid possible limitations on the scalability of the blockchain. (Mougayar 2016, 117.)

While implementing blockchain technology into the public sector several cases may be used. For example, to prove ownership of property, such as homes, cars, or other

assets, people can use the property registers. Self-sovereign identity cards that are independent of either government or company can also be used in the public sector (Casey, Vigna 2018, 8). The objectives of the application may be to secure the storage of voting results data, as well as provide access to open verification of results.

Projects to introduce blockchains in a public service are financed by taxes in the same way as any government projects and, as a result, are free from most commercial restrictions that can affect or directly affect blockchain projects in the private sector. Implementation of projects can take place in the context of e-government initiatives, which is aimed at the idea of replacing infrastructure and digitizing manual processes. However, some legal issues as well as laws of some states regarding privacy and data security policies can significantly limit the benefits of blockchain in the public sector. (Drescher 2017, 247.)

3.6 Blockchain platforms

In order to implement a new technology to your business it is very essential to chose the right method of doing that. There are quite many of already existing and promising blockchain development platforms, but in this chapter author focuses on three most popular and more commonly used of them. Does company prefer to establish its own blockchain platform or will it use already developed and used by many corporations, platform such as Ethereum, Corda or Fabric? In this chapter author illustrate and describes each of those platforms, describes their specific features and advantages for different industries, as well as some challenges companies may face while adopting blockchain in one of those platforms for creating enterprise solutions. Those three sub-chapters examined between each other and results of analysis and comparison are presented in a fourth sub-chapter.

3.6.1 Ethereum

Ethereum was presented in white paper by Vitalik Buterin in 2013. The idea of the platform was to transfer not only currency without intermediaries using a blockchain

network, but also everything that can exist in digital format and spread over the network can be inserted into a blockchain transaction without the ability to change the record. Working with this platform can greatly simplify the development of online contractual agreements, including decentralized applications. The founder of the Ethereum platform has developed a new decentralization-based program that will launch special decentralized applications optimized for smart contracts with the ability for users to exchange anything. (Buterin 2013.)

Ethereum works according to the principle of a method in which each computer in the network of validators must proceed and accept a complete list of new transactions in each block (Casey, Vigna 2018, 133). The Ethereum blockchain contains a list of transactions characterizing transactions between the current block and the previous blocks in each block, as well as a separate state tree that provides a real balance of each address. (Mougayar 2016, 24.)

The Ethereum platform has the ability to allow programs to run on the blockchain without demanding from developers about the internal architecture of the computer (ibid., 68). A state in the Ethereum platform consists of accounts, each of which has transitions between these states. Statuses itself are targeted transfer of information and related data between accounts. (ibid., 131.)

Working with Ethereum platform helps to create own virtual organizations in which specific issues can be resolved by voting of all participants in the organization. This platform offers languages based on the Turing-complete, as well as command-line tools built into Python, C, Java and others. The Ethereum wallet allows developers to protect and preserve crypto property, and also helps streamline the work with smart contracts. (Maltseva 2018.)

Using such a complex Ethereum platform requires a lot of resources and is very expensive to operate. The complexity and cost of establishing based on fact that all the computers in the system must perform the same computational process, by checking the same transactions, participate in the transfer of assets, confirm their identity and work with smart contracts. (Casey, Vigna 2018, 258.)

3.6.2 Corda

Corda is open source blockchain based platform which is making permissioned distributed ledger systems and that was created for financial institutions and for companies working closely with them, the main task of the platform is to optimize daily securities bank transfers. (Casey, Vigna 2018, 10.)

Corda has created and patented a ledger that assist an infrastructure chain that allows financial services companies and technology firms to develop their own ledger-based applications and services. The technology with which Corda works focuses on business applications, such as checking transactions between banks or setting inter-bank offer rates. (Shieber 2017.)

Corda guarantees the safe storage of information, as well as the permanent recording of data. Of all the platforms currently available, only Corda can create compatible networks with the blockchain and they operate in conditions of high confidentiality. Corda is the only distributed ledger platform with involved and plugged consensus. (Maltseva 2018.)

3.6.3 Fabric

The Linux Foundation developed and released in 2016 blockchain-based Hyperledger Fabric projects. To work with smart contracts, Fabric uses Docker containers, the platform itself is written in the Go programming language and also Node.js. The platform supports the use of one to several networks and is the basis for creating solutions with a modular architecture based on the blockchain. Fabric is better suited for the development of enterprise solutions, guaranteeing a high level of reliability and scalability, and also has channels to ensure the exchange of sensitive data. Transactions contain the signatures of absolutely all supporting peers and go to the ordering service. Fabric provides the best solutions for creating permissioned blockchains. (Maltseva 2018.)

The platform allows the use of consensus protocols to simplify the mining process and ensure the fulfilment of smart contracts, agreed protocols are used for these purposes. Fabric provides Hardware Security Module (HSM) support for securing private information and digital keys. (Why use Hyperledger Fabric for building enterprise blockchain solutions n.d.)

3.6.4 Comparison

The developers of Hyperledger Fabric, Corda, R3 Consortium and Ethereum see their platforms in a variety of applications. Corda is primarily for the financial industry. Fabric takes a more holistic approach, intending to promote its product in various markets - from banking to healthcare. Ethereum positions itself as a fully universal platform, not tied to any specific application. More detailed comparison can be seen from the table below. (Сравнение Ethereum, Corda и Fabric [Comparison of Ethereum, Corda and Fabric] 2018.)

Table 1. Comparison of blockchain platforms(Adapted from Сравнение Ethereum, Corda и Fabric [Comparison of Ethereum, Corda and Fabric] 2018).

Characteristic	**Ethereum**	**Hyperledger Fabric**	**Corda**
Definition:	Platform for distributed applications	Modular blockchain platform	Specialized distributed ledger platform for financial industry
Creators:	Ethereum developers	Linux Foundation	R3
Operation mode:	Permission-less private or public	Permissioned, private	Permissioned, private

Smart Contracts:	Smart contracting as an independent application	Smart contract code Go, Java	Smart contract code Kotlin, Java Smart legal contract
Currency:	Tokens via smart contract	Currency and tokens via chaincode	None

4 Logistics and Supply Chain Theory

For a successful study regarding the improvement of supply chain reliability, it is necessary to provide definitions of the main terms that will be used in this work. Complexity of the supply chains networks of different entities consisting of hidden elements for both the supplier and the consumer, raise questions about monitoring supply chains at several levels and also importance of the logistics system in receiving customer goods are the key theories which are introduced in the fourth chapter. The introduction to logistics with covering topics about transactions and logistics information will be presented in sub-chapter 4.1. Supply chain management with view on transparency of the chains and trust between parties will be shown in second sub-chapter.

4.1 Logistics

Logistics system plays a significant role in the overall chain of receiving the goods by the client, since the speed of delivery and the quality of the goods received depend on logistics. Considering that, there is a need to gain a competitive advantage through supply chain management.

Logistics studies the functional actions responsible for the movement of materials and information in the company from the beginning of production at the suppliers to the delivery of finished goods to customers, and is also responsible for after-sales service. (Ghiani et al. 2013, 1.)

According to Weele (2010, 253) the term logistics management means the management of raw materials supply, transportation, storage of goods with subsequent distribution as well as the management of material planning. Often in many organizations there is reverse logistics responsible for the processing of surplus and recycling packaging materials. The goal of logistics is to improve processes by which a company can provide improved customer service. Processes performed in logistics are aimed to ultimately fulfilling clients demand. The flows of procured materials, production and subsequent delivery of goods to the client all this must be taken into account in the management of logistics. The first step to start the logistics process is a temporary selling agenda and an associated product plan.

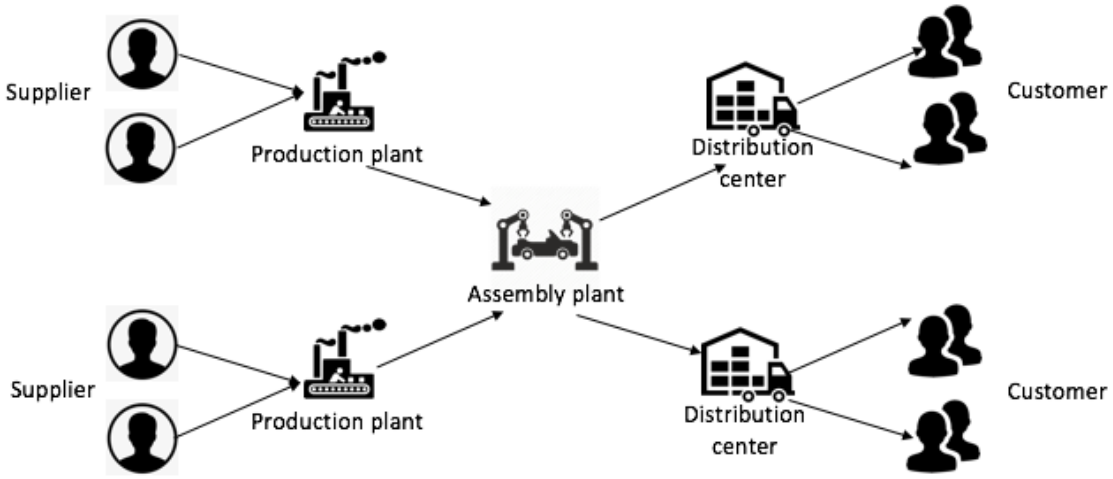

Figure 10. Logistics system (Adapted from Ghiani et al.2013).

The classification of logistics processes directly depends on their location in relation to the process of production and distribution. For example, in the management of the supply of materials and components the material and technical supply carried out in front of production enterprises, depending on the production plan of the company. The processes included in the internal logistics consist of the receiving and

storage of materials received at the warehouse, followed by transfer to the production line and transfer to the packaging department for further storage of the finished and packaged product. As an example Figure 10 represents logistics system of materials flow. Distribution occurs after production and before direct sale. Distribution centre supply to the stores, as well as customers. External logistics processes include supply logistics and distribution logistics. The main activities of the logistics are the storage and further transportation of finished goods. Logistic activities can be delegated to a third party or carried out by the organization itself. (Ghiani et al. 2013, 5.)

4.2 Supply Chain Management

Supply chains consist of separate independent organizations. As specified by Weele (2010, 251-252) supply chain management shows how supply chain processes are controlled and ordered in the companies and this term also related to managing components processes. But this designation refers to the method of controlling external material processes, where obvious differences between the incoming and outgoing flows of materials are visible. The types of activities needed to optimize product flows from suppliers to consumers within the company are covered by the incoming flow of materials, called material management and those activities are one of the main tasks in supply chain management.

In order to achieve efficient supply chain management, it requests management of the supplier database, because suppliers who can comply with all the requirements and conditions of the firm's functional systems are in high interest. Relations with suppliers should be as efficient and profitable as possible in order to control expense over the supply chain. Procurement and supplier management are the main activities in managing supply chains. (ibid., 255.)

During the work process between the supply chains, a huge amount of information passes daily, since joint work requires integration as well as the unity of processes. Olson (2011, 2-3) defines the main processes in the supply chain which are: product development, which is needed to recognize a product with a competing life cycle in

the process of communication between suppliers and customers; sourcing, which carries out the selection of supply chain participants; manufacturing process to develop the best combination of risk as well as cost during the life cycle of a product, taking into account rapidly developing market environment; physical distribution which provides the movement of goods in the supply chain from suppliers to consumers; customer relationship management which is responsible for relationships between company and its clients and performance measurement to track and evaluate organization performance.

Supply chains use a specific coding system that gives other digital information input mode, usually associated with packaging barcodes or labels on the product. During supply chain activities such as planning, inventorying, delivery and control together with existing software and technologies use quick response codes, radio-frequency identification, near field communication tags, etc. (ibid., 3.)

4.2.1 Trust between parties

There is a significant lack of transparency as well as responsibility in the difficult supply chains of companies that depend on many suppliers. The internal divergence of interests among different participants in the chain complicates the interchange of data between them, as they also participate in purchasing contracts. Referring to a model agreement consisting in the fact that each party keeps a personal journal of information on private labor activities and also transfer of reserves. The problem is that the visibility of processes is implicit by each supplier, despite the fact that technologies such as barcodes and radio-frequency identifications have improved the situation with the ability to track the movement of products. (Casey, Vigna 2018, 141-142.)

Trust in partnerships between all participants in the supply chain plays a major role. As Weele (2010, 176) notes that the need for a complex legal contract is higher with a large number of parties due to the lack of trust between those parties. And depending on the capability and flexibility of the relationship among the parties, less

precise contracts are needed. The process of exchanging information between partners is greatly complicated due to a lack of trust. The main thing for the parties is to understand that this process of building trust is time-consuming. But because many participants are afraid of competition and loss of control in the market for their products that they rarely share data first. (ibid., 375.)

Before companies begin to share sensitive information and data of high interest, they must trust each other. From the technology point of view, it is not always possible to guarantee absolute system security when working with web applications. Cooperation between companies requires long-term work with a fair distribution of risks and mutual benefits, so the development of exceedingly combined supply structure becomes difficult and time-consuming (ibid., 380-381). Building trust in relationships will require experienced workers, as well as their competent fulfillment of the terms of the contract with obligations in accordance with the most significant professional and moral standards. (ibid., 397.)

4.2.2 Networks complexity

One of the main problems that are exists in the supply chain is that since the supply chains networks are long and have many inventory levels that are between production and the point of sale, and the work of the supply chain is organized on forecasts, not on demand. The network structure is the foundation of the supply chain being built by the company, and its rational configuration largely determines the efficiency and competitiveness of the chain. It is difficult to design and manage the supply chain that the total cost of supply chain is minimal and the service remains at a given level. In network management, actions are taken aimed at managing information flows, integrating proficiency and organizing responsibility. (Andriani, Passiante 2004, 5.)

5 Adoption of Blockchain Technology in Logistics and Supply Chain examples

This chapter shows the examples of how companies adopted the blockchain technologies into their business and explains how the system works in each case of implementation.

5.1 Maersk and IBM case TradeLens

International Business Machines Corporation known for making and providing tools and computer programs, information technology assistance and advisory and Maersk which is Danish multinational organization professional in global transportation and harbor services in 2017 announced the project for commercialization established on Hyperledger, which goal to reduce paper work and reliability management related problems, to get better visibility of supply chain processes. (White 2018.)

Later in 2018 IBM and Maersk launched a platform based on blockchain technology named TradeLens the aim of it to reach the high level of supply chain management of the transportation processes within a chain and increase visibility of those activities. The platform goal is to develop the shipping costs and increase the visibility of the system. Platform ensures visibility of the supply chain, which allows all participants in a worldwide delivery to interchange real-time shipment activities safely. Another platform advantage allows to get rid of paper work by converting all documentation to digital format and subsequent automation of documents for transportation of product, allowing users to approve documents when crossing international borders and transfer within companies safely. The system of platform consists of a structure of shipment corridors that serve to connect harbors, stations, domestic transportation (ibid). Figure 11 illustrates the network coverage across the world. In total 61 terminals and ports connected to TradeLens.

Figure 11 TradeLens ports and terminals (Adapted from TradeLens Ecosystem n.d).

At the year 2018, the platform starts financial offer of goods, the publication counter shows more than a million transportation actions per day. In mid 2019, new entrants, the biggest marine shippers, becoming a part of the TradeLens system. By the end of 2019, about 175 companies are involved to the network, about two million transportation actions are published per day. TradeLens gives highly profitable possibility for users to exchange data speedy and with minimum failures, so that companies in the network do not need third parties to proof the transactions. (TradeLens Digitizing the Global Supply Chain n.d.)

One of the main goal of a project is to create one ecosystem which includes companies participating supply chain, for example delivery companies, transportation suppliers, cargo companies, sea transportation, harbor and stations, custom and different legislative parties. Organizations attached and collaborate in one whole system network, where all activities computerized. Another goal of the project is to provide secure data exchange. TradeLens arranges quick, secure and protected process of data providing to all parties in the system. For example, vehicle used at the moment, its location information about it, customs and commerce documents. Interested parties as sending organization, transfer association, receiver and end consumer can follow the situation of the products movement, cargo and all additional documentation relevant to it. Also important possibilities are establishment of collaboration and

trust, since TradeLens automatize and make digital large amount of work related activities. Blockchain provides reliability, safety and fast transactions operation. The last but not the least goal of the project is to stimulate novelty. Platform TradeLens establishes the base for further development, introducing marketplace which gives opportunity to the third parties develop and run applications on TradeLens. (Musienko 2019.)

TradeLens work example can be seen as sensors attached to the vehicle, consignment and harbor facilities which truck the movement and another indicator, it could be degrees, moistures etc. The data collected from sensors registered to the blockchain and can be viewed by all supply chain organizations involved. With this feature companies can follow the movement of goods and its status in the real time. In some case separate sensors can interact via smart contracts. (ibid) With the help of smart contracts, processes can be added toward the system, delivered over the chain, making it impossible for any participant to modify the existing data. (TradeLens 2019.)

The TradeLens system consists of several participants. Advisory council has the most power because it creates a system and chooses validators. The main participants usually big corporations and governmental parties focused on transportation. Second group consist of validators who are network participants as servers or nodes, who authenticate activities and design new blocks. Typically, position of validators received by big and internationally significant carrier companies. The last group is another participant, which are companies, agencies, harbors, customs etc. (Musienko 2019.)

To ensure proper security of the system, TradeLens uses experts to test insertion and agreement with the requirements of ISO 27K. IBM developed safe processes for inspecting origin codes, introduced common encode methods and work with system vulnerabilities. This development is constantly in the development and improvement of processes, as well as assistance. All data flows inside the system are protected by the HTTPS protocol via TLSv1.2. (Biazetti 2019.)

5.2 SAP case

SAP corporation offers blockchain and distributed ledger functions and applications for organisations to clarify complicated activities and establish trustworthy between companies. (Blockchain applications and services n.d.) With the Hyperledger Fabric on SAP Cloud Platform customers can design nodes and link those to a blockchain system. With the control panel, users can evaluate current code and relevant transactions. SAP platform provides high level of management and safety of the business processes, disabling transactions to be attacked. (SAP Cloud Platform n.d)

The SAP organization designed supply chain resolution with SAP Transportation Management to build, control and share product possession of property. The platform uses the approach and technologies of blockchain to support a supplementary level of safety and data integrity. SAP platform enters blockchain technology to a supply chain system. Blockchain capabilities will ensure clarity of business operations, when connecting digitalized documents and signatures. (Blockchain based ocean shipping n.d.)

The process is as follows, a bill of lending document is a data transported and defined through blockchain, with which users can download and distribute additional documents. The consignor and the consignee after the signing of the contract begin to create financial documents, and banks evolved to those activities inspect this documentation and, if the inspection is successful, validate the documentation. The shipper provides a consignment upon receipt of the goods from the direct sender. Customs can view and establish the condition of customs approval for products on the platform. It is also possible to register a transport company on the platform including driver information, thereby allowing the administration and operators to verify identity of the carrier using the data in the blockchain, releasing product to be delivered to its terminal. (ibid.)

The SAP Cloud Platform uses sensors from Modum.io to track the movement of goods. The data received from the sensors displays the state of the goods at every

moment of the journey, so each participant in the chain receives the necessary information. (Galer 2019.)

There are multiply benefits of the platform, since it is enables collaboration between companies that can interact with each other and transfer transactions between business processes. A number of users can asset the data to the blockchain. Since with a lack of trust through the activities the blockchain guarantees absolute clarity, a number of operations which earlier retained data now attaching to the blockchain, which spread delivery condition to any interested company. Document scam, cargo diversion during transportation, and other risks can be eliminated by using transparent information on ownership and liability for products. Replacing the physical documentation with a digitalized one will reduce costs for every organization involved, as well as reduce processing time. The absence of the need to involve third parties in the work is caused by improved data exchange between partners in the network. (Blockchain based ocean shipping n.d.)

6 Research results

This chapter reviews two main collection of data that have been collected for the research in order to answer to the posed questions. First sub-chapter reviews the SmartLog case study and the second shows the literature review.

6.1 Review of case study

The SmartLog project was conceived with the aim of adapting blockchain technology to logistics information and data sharing systems to which each party can participate. The project is financed by the European Union Interreg Central Baltic the total budget between six partners for three years is 2.2 million euros. The main goal is to improve the flow of goods. The grant was received by the project participants to countries: Finland, Estonia, Sweden and Latvia. Kouvola Innovation Oy manages and coordinates the work, which is split into areas of responsibility: the selection, support

and management of pilot companies. Measurement, data collection and analysis are the responsibility of Tallinn University of Technology, and the development and use of equipment is the responsibility of Kouvola Innovation Oy. The project is being implemented in Örebro County in Sweden, at the Transport and Telecommunication Institute in Latvia, as well as in the Valga Region Development Company, Sensei OÜ and Tallinn University of Technology in Estonia. The main focus of the project is to decrease the transportation time of goods along the two TEN-T corridors in the Baltic which are Scandinavian-Mediterranean and North Baltic Sea. (Lammi 2016.)

From the interview with the Head of IoT Business Development Mika Lammi interviewee answer the question concerning percentages of actual cargo transit time reduction in overall transport times. In end to end connections companies basic finding is the longer the distance the greater the percentage that can be reduced. It depends a much on how many trunk lines which are fixed time tables are used in the connection. Sea transport and train transport are quite schedule dependent so they cannot be affected, but loading and unloading time and route transport what companies can affect and this has been projects specific focus. Mika Lammi has not give any exact percentages number, because it is greatly depending on scenario, but according to him it can be anything between 5-15 percent.

According to the seminar speaker Riivo Pilvic, who presented the analysed data from the project, and concluded that time reduction of 3-8% should be realistically achievable with shared data in process. Based on simulation of data samples estimated average lead time reduction is 6.3%. Some time events are fixed that may not be impacted such as train and ship schedules. Results in time savings may be delayed, due to progressive grow of critical mass of users and impact of reorganisation of processes. (Pilvic 2020.)

The main project timelines starting from May 2016 when the funding was approved and the official launching started in September 2016. In the beginning of the project strategic approach was to contact transport companies along the corridors, then to find pieces of supply chains and terminals and conduct measurements and interviews with stakeholder representatives. In May 2018 was mid-term evaluation and the first

modification request. The strategy change focus to supply chain and stakeholders, the cases were build based on the cargo traffic produced and controlled by them. In June 2019 there was second modification request and the strategy adjustment enhance focus to the stakeholder interviews and other qualitative methods. The current project end date is May 2020, and the operational phase has been ended in February 2020. (Lammi 2020.)

During the interview with Mika Lammi, the author found out the reason of the extension in the schedule which were many factors, but the most significant factor was the strategy the project approached, and in the end appears that the companies are not ready, so project recently turned directly to the transport companies, but realized that transport companies are not interested parties who make decisions on the start of using various types of digital communications, but their customers who are industry representatives, such as large manufacturers who order transport services. Project leaders spoke with this kind of company sector over the past years, and they are very interested, and they would like to try it, but they would prefer it to be a commercial service, they are not really ready to participate in small demonstration or pilot activities with research projects. This was the main factor that project had to get the expansion.

The project itself has been split into main stages. The first stage is work with the logistics organizations who will participate in project and use the application. The second stage to create the blockchain application, the project leaders from Kouvola designing the platform for organizations and containers that will be used in the activities of collecting and producing appropriate operational data for subsequent evaluation. The third stage is examining the information collected from the organizations using the created application, the main focus to determine how blockchain technologies affecting the time of transportation and the responsible party Tallinn University of Technology. (Lammi 2016.)

The project creates an opportunity to optimize freight transportation with the development of a new type of information technologies solution the Internet of Things for the logistics industry, which will improve the flow and punctuality of goods flows, as

well as shorten delivery times and reduce operating costs. In addition, the flow of information is accelerated and becomes more transparent. The goal is to create a more independent freight transport. The project also measures the benefits that the application brings which are changes in delivery times and operating costs. (Laakso 2018.)

In June 2017, SmartLog held a demonstration and seminar of the operation of blockchain application with a supply chain in the Estonian freight port. During the demonstration, the movement of ten sea containers was monitored during the passage of nine checking stages since the order of the container, its delivery and before preparation for departure. Stages contain data transferred to the application by approximately ten organizations. Real-time organizations information in online passes through the application broadcasting the status and transportation of containers. As the project develops, new organizations join the blockchain application every month, which allows precise analysis of effectiveness of the way of exchanging information. (Lampinen 2017.)

Ideas for the implementation of the project were improved through negotiations with professionals from the IBM. Every company connected to the SmartLog blockchain has personal transaction log and all the tools for connection. The companies see containers on the platform since placing an order to request a container until the container passes through the framework of organization's supply chain, further information will not be needed and available. Efficiency gains are related to the duration of the supply chain, which is calculated by companies. In the system, visibility can be achieved only if organizations will share container transactions information. (Lammi 2018.)

The SmartLog creates application using the Hyperledger platform to receive information. Those messages characterize any modification in container condition through movement in the supply chain. These messages are encrypted before they written on the blockchain to maintain the safety of the data of interested parties. The decryption keys are received by the direct users involved in the exact supply chain process, but those users who are not related to the message information will

not know about it. The platform is specialized on applying in the property of the decision to relay notifications among computers in the sense that all input information will come from the personal information systems of the host company, and all output information will be read the current systems. The platform also provides companies with patterns of entering information and viewing the user interface, all of which can be changed if necessary for each company requirements. (ibid.)

After discussing with Mika Lammi the preferred platform chosen by the SmartLog leaders, appeared that at the launch of the 2016 project, Hyperledger Fabric was the only platform capable of deployment on an industrial scale, even at that time it was very new. Ethereum was very limited in it scope, it didn't really scale well and SmartLog needed to demonstrate the scalability at least the potential of having industrial level scalability, Ethereum didn't have that promise at the time of 3 years ago. Corda at that time wasn't a platform or framework even it was a loose collection of technologies it has come along a lot since then and at the time it was not feasible, so Hyperledger Fabric was an only option.

The project uses open source technology Docker, it is a digital special container that makes it possible to run program regardless of the surroundings or foundation in which it is defined. A special container presented as an independent software package that contains all required to start it: code, scope, options, tools and system storage. Differences of the development and intermediate environments can decrease incidents among teams that use different programs in the same infrastructure. Containers are application-level that combine code and dependencies. A number of containers can operate on one computer, as well as share the information with other containers. Unlike virtual machines, containers consume less space and load faster. Using these technologies, SmartLog platform can be provided in any framework with effective support of the code base. (Lammi 2018.)

During the project, it was found that it was difficult for companies to make even small investments in experimental and limited duration software testing, but if it was a commercial service, companies would join it. The project was successful in creating a prototype software and open sourcing it for the basis of future development and to

use in research. It was also successful in exploring and creating valuable information and experience for creating a distributed model of data exchange in a multi-user business ecosystem with stakeholders. (Lammi 2020.)

The case study where information was collected through live seminar and interviews with the project leaders gave insides information concerning the adoption process of blockchain technologies which allows author to use it in the research while analyzing the project outcomes comparing to the previous case studies.

6.2 Literature review

For the literature review, Appendix 1 represents all the different types of publications collected and categorized in terms of four objectives referring to the research questions. Table 2 shows the total amount of literature and years of publications used in research.

Table 2. Total amount of literature and years used for research

Publication type	Total
Article	15
Blog post	17
Book	3
Case study	4
Interview	1
Journal report	1
Podcast	1
Report	2
Study	1
Survey	1
Thesis	1
Video	1
White paper	4
Total	52

Years of publication	Total
2020	4
2019	16
2018	16
2017	11
2016	5
Total	52

6.2.1 Implementation and adoption

The general information collected for the first research question consisted of nine types of publications devoted to the implementation and adoption of blockchain technology into business. These collected data were relatively new and did not exceed five years from the date of publication as can be seen in Table 3.

Table 3. Publication types and years. Data for Implementation and adoption of blockchain technology

Implementation and adoption	Article	Blog post	Book	Podcast	Report	Survey	White paper
TOTAL	3	1	1	1	1	1	1

Implementation and adoption	2020	2019	2018	2017
TOTAL	1	2	4	2

There is a relatively new body of literature that is concerned with blockchain implementation, referring to an IBM Blockchain study (C-Suite Executives Exploring Blockchain Aim to Disrupt, Not Defend 2017), one third of the 3000 CEOs participating in the survey already utilized or were planning the implementation of blockchain technology in their business, and eight out of ten respondents who studied the new technology were investing in the possibility of developing new business models.

The white paper from the World Economic Forum suggests two criteria which are the determination of a particular user case and recognition of the challenges or business possibilities on which the decision to implement the blockchain should be based (Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits 2019, 14). Martin and colleagues (2018, 3) believe that companies should have the same serious and dedicated approach to blockchain technology adoption strategies as to any alternative strategy. Creating a strong business case for the technology is essential in order to involve all required participants in the system. Ivan Kot (2020) also outlines the importance of a smart approach to implementing the blockchain, moreover its adoption should follow a balanced and sensibly staged way. A suitable step-by-step approach is suggested by Gupta (2017, 37-41) who states that the first

step before implementing blockchain technology is the number of questions that organizations should ask themselves and decide on the actual need for the technology in the company's industry. The following two steps are to precise checks of all the processes in the company for ineffectiveness and defining the benefits of the blockchain in a particular process. The remaining steps are aimed at selecting a framework and establishing the network and application. The last step is to test and configure the created application and the network.

A strong understanding of the theory and analysis of all problematic processes are needed in order to say whether the introduction of blockchain technologies will help to improve supply chains and logistics. The technology does not promise a successful solution to all industry related problems. (Francisco, Swanson 2018, 11.) Based on the research conclusions of Kamble and others (2018), a more important reason that explains why organizations implement blockchains to the supply chain is primarily the benefits from the blockchain technology for the industries.

The article of Dalal and Piscini (2018) shows that the approximate timeline for implementing the technology takes from two to five years, including all phases from the establishment of the project to its further launching. At the moment, the skeptical society is a significant obstacle to the implementation of the blockchain, and another important factor concerning companies is regulation. As follows from the IBM podcast where Rachel Wolfson (2019) advises beneficial cooperation between companies to avoid scepticism about a successful implementation of blockchain technology based on the fact that a network cannot consist of only one company, the adoption depends on groups of organizations working together.

6.2.2 Advantages and challenges

This sub-chapter represents a review of the collected literature from different types of sources presented in Table 4. For the research question, it was essential to review data concerning the advantages and challenges of blockchain technology separately from each other in order to have a clear structure of the review. In total, this review

consisted of 22 sources, and 14 of them discussed the advantages of blockchain implementation, and eight of them highlighted the related challenges. The author also specified the publication years of the literature for pointing out the actuality and the development of the technology within the last four years.

Table 4. Publication types and years. Data for advantages and challenges of blockchain technology

Advantages and challenges	Article	Blog post	Book	Journal report	Report	Study	Thesis	White paper
TOTAL	8	7	1	1	1	1	1	2

Advantages and challenges	2019	2018	2017	2016
TOTAL	7	7	5	3

Advantages	Article	Blog post	Book	Journal report	Study	Thesis	White paper
TOTAL	4	5	1	1	1	1	1

Advantages	2019	2018	2017	2016
TOTAL	4	3	5	2

Challenges	Article	Blog post	Report	White paper
TOTAL	4	2	1	1

Challenges	2019	2018	2016
TOTAL	3	4	1

The table below summarize all advantages and challenges according to the data selected for the literature review. More detailed descriptions of the table with the author's comments are presented in Chapter 7.

Table 5. Advantages and Challenges summary

Advantages	Challenges
business processes executed automatically and fast	big amounts of data to collect and implement
consensus	cooperation
cost reduction	designing an ecosystem
ease of integration with core system	flexibility
efficiency improvements	governance
enable digital ownership	high investments
enhanced privacy	lack of knowledge of blockchain technology
immutability	lack of qualified IT professionals
improved auditability	not rapid return on investments
increased transparency	time consuming adoption
increased worker productivity	time consuming to correct records
new forms of value	
no need in intermediaries	
processes time savings	
reduced working capital	
reliability	
revenue growth	
scale	
security	
traceability	
trust	
visibility	

Advantages

A growing body of literature has investigated concerning the advantages that can be achieved with the blockchain technology for the organizations, the author presents the review based on selected studies which are appropriate and can help to answer for the second research question. Casey and Long (2018) examined the main advantages of the blockchain and sorted them into three categories: reduction of costs, revenue growth and working capital reduction, also based on their research, most of the early attempts at technology implementation were concentrated on costs elimination. The white paper of World Economic Forum carried out a number of investigations into the topic of evaluating benefits of blockchain technologies and reducing costs for organizations and conclude that it is also possible to increase the level of trust in information flow without the need to verify it manually. (Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits 2019.)

Team of researchers from IBM Blockchain Pulse studied the effects of blockchain benefits on organizational performance and found that the benefits of consistency, speed, scale, and the consensus of recorded transactions are effective for faster resolution of conflicts (IBM InterConnect highlights: Blockchain is here, now! 2017; IBM InterConnect: Reimagine your industry with blockchain 2017). Gupta (2017, 9-10) also provided his assessment of the impact on improving functional effectiveness.

Once the transaction is confirmed, it cannot be changed (Antonopoulos 2017, 138) the advantage which is worth mentioning, as the technology allows parties with a lack of trust in each other to participate in the transaction without the need to involve a third party for validation (Nakamoto, 2008). Wladawsky-Berger (2019a) analyzed the data collected during his research and came to the conclusion that blockchain technology allows the exchange of important information necessary to confirm identity not using main platform or third parties.

An analysis of the advantages of the blockchain Bhattacharyya (2018) found that it is possible to increase reliability even while working with organizations that are tend to fraud. One of the most convincing features of technology promises that in any corporation it is able to protect sensitive information and prevent cyber attacks. (Daley 2019.)

Several articles mention the usage of blockchain technology in supply chains and logistics, Sekhon (2016) indicates the huge capabilities in the blockchain for improving clarity, while Francisco and Swanson (2018, 11) claim the competitive advantages of the companies in achieving absolute traceability of processes.

A study conducted by Vovchenko N.G. et al. (2017, 4) showed that the competitive benefit of technology is not only the possibility for extending the operation mechanism, but also the ability to make new agreements. With the creation of blockchain technology, enterprises can create completely new value and ways of working, since with the blockchain, all society, resources and companies are connected in one system (IBM Study: C-Suite Executives Exploring Blockchain Aim to Disrupt, Not Defend 2017). Hua and Notland (2016, 21-22) argue that in the future, the adoption of such

technologies may provide a competitive advantage for companies, as customers will better understand the origin of products and their conditions.

Challenges

In a controlled study of blockchain technology, Wladawsky-Berger (2019b) reported that with the initial implementation of blockchain, network development is a main task, while managing becomes huge problem in organizing these networks, which demands close cooperation with all interested parties and competitor companies. Creating a complicated and global network requires high investment and time, since it is challenging to get all network participants to cooperate collectively in the same direction. Reduction of these difficulties may lead to the interruption in implementation processes. (The future of financial infrastructure. An ambitious look at how blockchain can reshape financial services 2016.)

According to the research from World Economic Forum 87% of participants said that it is more difficult to adopt a new technology when a significant part of the investments has been spent on legacy technology. Participants of questionnaire waited for a 24% return on their investments to blockchain technology projects, but the revenue received was only 10% (Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits 2019, 12). Batubara and colleagues (2018, 8) conducted a series of studies on the blockchain and during the studies revealed that the main problems in the implementation of the technology are based on technological feature, such as safety and adaptability.

Kamble and others (2018) studied the impact of blockchain technology on logistics and supply chains and concluded that logistics specialists do not have of enough of experience and knowledge about all the capabilities of the technology, since blockchain is a new technology and so far not many companies have gone to its full adoption in their supply chains. Dalal and Piscini (2018) claim that companies who are planning to implement blockchain technology are facing the significant problem due to lack of skilful information technology personnel in their organization. It will be difficult for the IT department to gather all the information and adopt the blockchain,

Robinson (2018) suggests that before starting adoption of the technology, companies must certainly decide which specific business activities will be based on it.

6.2.3 Visibility

This subchapter aims to review the literature in order to answer the third research question how does the blockchain technology affect visibility. There is a large volume of published studies describing the role of visibility in supply chain. All selected and required data from ten different studies gathered and consists of six types of publications which can be seen from Table 6.

Table 6. Publication types and years. Data for visibility affect on blockchain technology

Visibility	Article	Blog post	Book	Case study	Interview	White paper
TOTAL	2	4	1	1	1	1

Visibility	2020	2019	2018	2017	2016
TOTAL	1	5	1	2	1

From the interview to IBM, Javaheri maintains the idea of combining technologies such as blockchain, Internet of things and cognitive analytics in order to improve the visibility of product tracking throughout its path (A Taste for collaboration 2019, 4). As follows from the white paper, the possibility to track the delivery of goods in real time provides certainty and creates the possibility to fast respond for interruption to all companies involved. (Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits 2019, 9.)

Kuiper (2019) concludes that the blockchain technology approves users to create a centralized history of the data collected and reflecting all the information related to the product as it goes through the supply chain. Improving information regarding the movement of goods along the supply chain becomes possible due to the rapid exchange of events and records on the network (Maersk and IBM Unveil First Industry-Wide Cross-Border Supply Chain Solution on Blockchain 2017). Miller (2018, 2) points out that data visibility corresponds to the role of each participant in the chain and its access to it.

Mentioning the example of participants in the supply chain, showing how the visibility achieved with the blockchain technology which helps to obey with the law on the safety of the supply of drugs, and also prevents the illegal allocation of fake medicines (Protect Pharmaceutical Product Integrity with the Pharmaceutical Utility Network 2019). Sekhon (2016) supports the idea that blockchain allows companies to better regulate their activities and also monitor the condition of goods being transported.

In the beginning of adopting the blockchain, one of the key goals of this technology was to lower the costs from retailers in order to expand supply chain transparency and increase the value of the information (Ignite success on any cloud 2019, 5). Singh (2020) indicates that supply chains, with the support of blockchain technology, have enabled companies to provide better visibility for quick dispute resolution with the consequent benefit of developing working capital. Gupta (2017, 24) examined the potential of the blockchain and determined that supply chains are the main model of using blockchain technology to complete changes across industries.

6.2.4 Trust

The last subchapter here includes review which is focused on the third research question how does the blockchain technology affect trust in logistics and supply chain industry. Much of the literature emphasizes the importance of trust between parties in the especially in supply chain networks. The author chose to include to review eight studies from multiple publication types. The timeframe of each article, post and video record shown in the Table 7.

Table 7. Publication types and years. Data for trust affect on blockchain technology

Trust between partners	Article	Blog post	Video			
TOTAL	4	6	1			
Trust between partners	2020	2019	2018	2017	2016	2015
TOTAL	2	1	3	3	1	1

Blockchain creates a peer-to-peer network of shared, replicated and permissioned registers to record transaction history, based on technology applications increase transaction transparency, increase trust among participants and decrease costs (Building trust and transparency in insurance policies with blockchain 2018; Blockchain comes to SXSW with The Linux Foundation's Hyperledger Fabric and IBM 2017). Sekhon (2016) carried out a number of studies on the subject of blockchain technology in supply chain and logistics and found that the transportation of goods can be tracked till the end of the deal what eliminate the problems of trust between the partners, because every activity registered on the blockchain.

Lieber (2017) studied the effects of blockchain on trust and concluded that analytic and cognitive abilities can improve decision-making. Companies will take advantage applying blockchain technology to create trust for establishing cooperation, as well as developing existing information.

Dr. Garrett (2019) analyzed the required data and claimed that using the blockchain, organizations can come to mutual trust with companies that follow the global standards, thus saving time on audit agreement with their business partners. In an analysis of blockchain applications, Schlapkohl (2020) found that top managers are actively exploring industry-specific applications and are aware of the value that blockchains can provide in their business, such as increasing trust and eliminating risks.

In a study conducted by McGowan (2020), it was shown that every input in the blockchain has a time stamp and individual cryptographic signature, so that all allowed users can simultaneously access identical information. At the moment, blockchain is the main means of conducting transactions based on verification between parties that do not trust each other. (Vo et al. 2018, 445.)

7 Conclusion

The last chapter of discussions goes over the objectives and shows the answers to the research questions in first sub-chapter. The following chapters focus on reliability of research and suggestions for the future studies.

7.1 Discussion of research questions

What should companies consider to successfully implement Blockchain technology?

After studying this research question, as well as having conducted an analysis based on a review of the selected literature, author can make a conclusion concerning the successful implementation of the technology to the logistics and supply chain sector. At first, companies need to make a strong planning before starting the adoption, to frame the contexts, it is important that the goal of the technology is defined, specifically how this can be useful for the business and outline what is a problem that blockchain can solve and how is this problem seen by the target group. After the organization made a decision the next step is create the first demonstration or concept, test it with few companies and present to them and their stakeholders. There might follow many changes of concepts, but it is important to remember that implementation is also a learning process. It is essential for companies to choose the framework on which they will design a blockchain application, however organizations may build their own blockchain, but according to literature research it will require them a lot of time and investments. From the author point of view, the most rational way is to choose the existing one like Hyperledger, Ethereum or Corda depending on the core goals of the company. As shown from the review of case study, the SmartLog company discovered during the project a lot of features, concepts and ideas about how blockchain can be useful and meaningful toll in industrial contexts and throughout the project it appeared that it is largely an unexplored area. Author believes that the prospects of this technology with a deep understanding of the topic can motivate many corporations to adopt such technology into their business, that

the findings are interesting and valuable for future project managers and people who are interested to apply this technology in real life.

What are the advantages and challenges of the blockchain technology?

The second research question about the advantages and challenges of the blockchain technology. The advantages, if implemented properly are enormous, since blockchain can be limitlessly scalable and extremely efficient information management toll, it can bring really huge benefits if its used properly, but it requires precise and careful planning. Many of defined advantages listed can be seen from the Table 4. Considering the most important benefits specifically for the supply chain and logistics, several properties of the technology can be distinguished, for example reliability of the processes and significant improvements of efficiency. Based on the blockchain theory, that technology makes the business operations more clear, with increased level of transparency of processes which can affect the choice of goods or carrier. The technology provides significant advantages by reducing manual processing of documentation, since all data is stored and processed in a digitalized format. Everything what is on paper now will be digitized and blockchain will be used to coordinate and truck those documents, so it will reduce all bureaucracy. Another distinctive feature of the technology as well as a strong advantage of the blockchain which indicate increased security of the system, since it is very difficult and almost impossible to hack and steal any data stored on the blockchain.

According to the research done, author determine several challenges presented in a Table 5. Firstly, the greatest challenge is to understand the problem properly, if company does not understand the problem and does not have any comprehensive explanation why it need to adopt the technology it may lead to huge delays in a project and probably it will not be launched. The second challenge if organization are trying to use blockchain to solve a problem the executives have to make sure that they and their team understand blockchain really deeply, because it is not a tool like any other tool, it is a very unique approach and it does not fit in all the problems that are common those days. Blockchain technology is a very specific solution, and everybody who are making a decision about adopting it or not need to understand it very

deeply, otherwise the success will not be grate. Another important challenge concerning the co-operation and controlling the network which includes all parties involved into the supply chain processes as well as competitors in this chain. It is essential to understand the common goal for all participants if they want to have beneficial application to use.

As shown on the Table 4, presented in the Chapter 6, the amount of advantages exceeds the amount of challenges, but from the author point of view it does not guaranties that this technology will be useful to implement for every company, since such a technology requires a deep understanding and it is essential for executives to know the use cases and how exactly they are planning to reach their goals with the help of blockchain.

How does blockchain technology affect visibility and trust in the supply chain and logistics industry?

According to the research findings, visibility of the supply chain which is traceability of products as they progress through the supply chain, is significantly improved with the help of blockchain technology. This ability to track the movement of products on each section of their path is a significant factor for improving delivery processes, since in the event of loss or damage of the products, responsible chain members will immediately know about the incident due to fast information flow in a system, which will allow to managers to subsequently make timely decisions to prevent forfeits. Based on these findings concerning visibility, it can be concluded that for the logistics industry where the movement of goods along the supply chain occurs every day, the implementation of blockchain technology can serve as a key factor in improving efficiency of the processes.

The confidence in managing the supplies is very fragile, often mutual distrust between partners, suppliers and consumers can be seen. If taking as an example a large production company with many suppliers, then the question of trust becomes the main stumbling block preventing many organizations from reaching agreement without fear of fraud, delays in deliveries and mistrust. With the blockchain technology,

these problems can be solved. Trust is achieved by the ability to verify information, since only authorized network participants can work with certain documents. This feature is very unique, since not many technologies have this possibility to reach confidence in processing transactions without the participation of third parties verifying the authenticity of the operation. It can be concluded that the companies that decided to implement this technology into their business will have competitive advantage against their opponents, who cannot provide sufficient visibility, as well as establish trust within the network, which is so important in supply chain.

7.2 Reliability of research

The research performed based on the qualitative method and literature review. The limitations may occur while selecting the data for the literature review, because important part of research was the data collection and analysis. The primary data selected for the research is a qualitative data which is collected from the case study which is SmartLog project, interviews with a professionals and leaders of the project and information gained from attending the seminar. The limitations concerning case study may appear due to the lack of insides information of the project, because companies are not able to reveal confidential information. The secondary data collected from articles, blog posts, videos, white papers, podcasts, books, professional journals and reports and critically analysed by the author. Important part of the selecting the proper literature for the research is relevance, data have exact focus on research question and specifically for logistics industry, since there is huge amount of articles related to the blockchain implementation to the banking, government and medical industry, which are not important for this work. Another factor which influenced the selecting process was the novelty of the data, since blockchain technology is a fast developing and it is essential for this study to have up-to-date information upon a topic. The data also should be trusted and accurate, the majority of the findings were collected from the academic articles and blog posts. Considering the above may conclude that all the data presented and the research can be trusted.

7.3 Further research

Further studies regarding the implementation of blockchain technology to the logistics industry are necessary, since the relevance of this technology will only grow and every year more companies will be interested in adopting this technology into their supply chains. For a detailed study of the implications of technology adoption, longer-term studies can be conducted. The study did not specify the economical aspect of the implementation of technology, which implies further research with a detailed studies of adoption costs. As well as economical benefits of the blockchain is not defined in this study, which could be good future research topic.

Since the methods of this study were strongly based on literature and case study reviews, the suggestions for the further research can be probably done for master studies, where the research concerning the implementation of technology can be done together with the company who is interested and planning to invest to blockchain.

References

A Taste for collaboration. 2019. IBM interview with Guilda Javaheri. Accessed on 18 April 2020. Retrieved from https://www.ibm.com/downloads/cas/D2L1BJVA

Allison, I. 2016. Guartime Secures over a Million Estonian Healthcare Records on the Blockchain. IB Times. Accessed on 10 March 2020. Retrieved from http://www.ibtimes.co.uk/guardtime-secures-over-million-estonianhealthcare-records-blockchain-1547367

Andriani, P., Passiante, G. 2004. Complexity Theory and the Management of Networks: Proceedings of the Workshop on Organizational Networks as Distributed Systems of Knowledge. University of Lecce. Published by Imperial College Press. Italy. 5-6

Antonopoulos, A. M., 2017. Mastering Bitcoin. Published by O'Reilly Media, Inc.

Bakhtiari, S., Safavi-Naini, R., Pieprzyk, J. 1995. Cryptographic Hash Functions: A Survey. Technical Report 95-09, Department of Computer Science, University of Wollongong. Accessed on 25 January 2020. Retrieved from http://citeseer.ist.psu.edu/bakhtiari95cryptographic.html

Batubara, R. F., Ubacht, J., Janssen, M. 2018. Challenges of Blockchain Technology Adoption for e-Government. Article from Delft University of Technology Netherlands and University of Sumatera Indonesia. Accessed on 17 April 2020. Retrieved from https://dl.acm.org/doi/pdf/10.1145/3209281.3209317

Bhattacharyya, S. 2018. Brands are using blockchain to promote sustainable products. Article from Digiday website. Accessed on 16 April 2020. Retrieved from https://digiday.com/retail/brands-using-blockchain-promote-sustainable-products/?is=1

Biazetti, A. 2019. 5 key points about TradeLens platform security. Page on the TradeLens website. Blog post. Accessed on 10 April 2020. Retrieved from https://www.tradelens.com/post/5-key-points-about-tradelens-platform-security

Blakeslee, S. 2004. "The CRAAP Test" LOEX Quarterly: Vol. 31, 6-7

Blockchain applications and services. N.d. Page on the SAP website. Accessed on 11 April 2020. Retrieved from https://www.sap.com/products/intelligent-technologies/blockchain.html

Blockchain based ocean shipping. N.d. Page on the SAP Innovation Guide website. Accessed on 11 April 2020. Retrieved from https://innovation-guide.sap.com/blockchain-for-international-trade

Blockchain comes to SXSW with The Linux Foundation's Hyperledger Fabric and IBM. 2017. Blog post from IBM Blockchain Pulse website. Accessed on 19 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2017/03/blockchain-comes-sxsw-hyperledger-fabric-ibm/

Brannen, J. P. 1995. Mixing Methods: Qualitative and Quantitative Research, Routledge Publisher, 16

Building trust and transparency in insurance policies with blockchain. 2018. Video of IBM, AIG and Standard Chartered. Accessed on 19 April 2020. Retrieved from https://www.youtube.com/watch?v=Mhpe0d-nE7k

Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits. 2019. White paper of World Economic Forum. Accessed on 15 April 2020. Retrieved from http://www3.weforum.org/docs/WEF_Building_Value_with_Blockchain.pdf

Buterin, V. 2013. Ethereum White Paper: A Next Generation Smart Contract and Decentralized Application Platform. Accessed on 12 March 2020. Retrieved from https://whitepaper.io/document/5/ethereum-whitepaper

C-Suite Executives Exploring Blockchain Aim to Disrupt, Not Defend. 2017. Survey on IBM Blockchain website. Accessed on 15 April 2020. Retrieved from https://www-03.ibm.com/press/us/en/pressrelease/52418.wss

Casey, M. J., Vigna, P. 2018. The Truth Machine. Published by St. Martin's Press.

Casey, M., Long, C. 2018. The Cost-Cutting Potential of Blockchain. The Wall Street Journal report. Accessed on 16 April 2020. Retrieved from https://www.wsj.com/articles/the-cost-cutting-potential-of-blockchain-1520993100

Cordwell, J. 2015. Blockchain in Healthcare: From Theory to Reality. Healthcare blog website. Accessed on 10 March 2020. Retrieved from http://blogs.csc.com/2015/10/30/blockchain-in-healthcare-from-theory-to-reality/

Dalal, D., Piscini, E. 2018. Blockchain To Blockchains: Broad Adoption Enters The Realm Of The Possible, Part 4. Article from digitalist magazine. Accessed on 15 April 2020. Retrieved from https://www.digitalistmag.com/cio-knowledge/2018/05/21/blockchain-to-blockchains-broad-adoption-enters-realm-of-possible-part-4-06167061

Daley, S. 2019. Blockchain and IOT: 8 examples making our future smarter. Blog post from Built in website. Accessed on 16 April 2020. Retrieved from https://builtin.com/blockchain/blockchain-iot-examples

Drescher, D. 2017. Blockchain Basics: A Non-Technical Introduction in 25 steps. Apress Media LLC.

Edgar, T. W., Manz D. O. 2017. Research Methods for Cyber Security. Syngress Publishing, 63

Francisco, K., Swanson, D. 2018. The Supply Chain Has No Clothes: Technology Adoption of Blockchain for Supply Chain Transparency. Article from Department of Marketing & Logistics, University of North Florida. Accessed on 15 April 2020. Retrieved from https://www.mdpi.com/2305-6290/2/1/2/htm

Galer, S. 2019. Future Trends 2019: Supply Chains Among Top Contenders for Blockchain growth. Page on the SAP website. Accessed on 11 April 2020. Retrieved from https://news.sap.com/2019/01/video-blockchain-trends-2019-supply-chains/

Garrett, N. 2019. Blockchain helps trace responsibly produced raw materials. Blog post from IBM Blockchain Pulse website. Accessed on 19 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2019/10/blockchain-helps-trace-responsibly-produced-raw-materials/

Ghiani, G., Laporte, G., Musmanno, R. 2013. Introduction to Logistics Systems Management, John Wiley & Sons, Incorporated.

Gupta, M. 2018. Blockchain for dummies. 2nd IBM Limited Edition. Published by John Wiley & Sons, Inc.

Hua, V. A., Notland, S. J. 2016. Blockchain enabled Trust & Transparency in supply chains. Project Thesis from Faculty of Social Science and Technology Management Department of Industrial Economics and Technology Management. Accessed on 16 April 2020. Retrieved from https://www.pdf-archive.com/2017/02/01/project-thesis-anders-j-rgen/project-thesis-anders-j-rgen.pdf

Iansiti, M., Lakhani, K. R. 2017. The Truth About Blockchain. Harvard Busineaa Review. Accessed on 15 January 2020. Retrieved from https://hbr.org/2017/01/the-truth-about-blockchain

IBM InterConnect highlights: Blockchain is here, now! 2017. Blog post from IBM Blockchain Pulse website. Accessed on 16 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2017/03/ibm-interconnect-highlights-blockchain-is-here-now/

IBM InterConnect: Reimagine your industry with blockchain. 2017. Blog post from IBM Blockchain Pulse website. Accessed on 16 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2017/03/ibm-interconnect-reimagine-your-industry-with-blockchain/

IBM Study: C-Suite Executives Exploring Blockchain Aim to Disrupt, Not Defend. 2017. Study from IBM Blockchain website. Accessed on 16 April 2020. Retrieved from https://www-03.ibm.com/press/us/en/pressrelease/52418.wss

Ignite success on any cloud. 2019. Case study from IBM Blockchain website. Accessed on 18 April 2020. Retrieved from https://www.ibm.com/downloads/cas/BW1WJJVR

Kamble, S., Gunasekaran, A., Arha, H. 2018. Understanding the Blockchain technology adoption in supply chains-Indian context. Article from International journal of production research. Volume 57, issue 7. Accessed on 15 April 2020. Retrieved from https://www.tandfonline.com/doi/full/10.1080/00207543.2018.1518610

Katsman, G. n.d. Учет лекарственных средств. [Medicine Accounting]. PwC website. Accessed on 15 March 2020. Retrieved from https://www.pwc.ru/ru/services/technology/blockchain.html

Kot, I. 2020. Is blockchain hype over? Reality vs misconceptions. Blog post on the Itransition website. Accessed on 15 April 2020. Retrieved from https://www.itransition.com/blog/blockchain-hype

Kothari, C. R. 2004. Research Methodology-Methods and Techniques. Second revised edition. New Delhi: New Age International (P) Limited Publishers.

Kuiper, J. 2019. Blockchain brings visibility to the finished vehicle supply chain. Blog post from IBM Blockchain blog. Accessed on 18 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2019/10/blockchain-brings-visibility-to-the-finished-vehicle-supply-chain/

Kumar, R. 2011. Research Methodology a step-by-step guide for beginners. Third edition. SAGE Publications Ltd.

Kvale, S. 1996. Interviews: an introduction to qualitative research interviewing. Thousand Oaks Publisher.

Laakso, K. 2018. SmartLog. Page on the Kouvola innovation website. Accessed on 14 April 2020. Retrieved from https://www.kinno.fi/en/node/501

Lammi, M. 2016. SmartLog. Page on the Kouvola innovation website. Accessed on 13 April 2020. Retrieved from https://www.kinno.fi/en/smartlog

Lammi, M. 2018. Project SmartLog: blockchain in logistics. Page on SmartLog website. Accessed on 20 January 2020. Retrieved from https://smartlog.kinno.fi/articles/project-smartlog-blockchain-logistics

Lammi, M. 2020. SmartLog. Power point presentation. SmartLog seminar 14 February 2020 in Helsinki.

Lampinen, A. 2017. Blockchain technology tested in supply chain information management. Page on the Kouvola innovation website. Accessed on 14 April 2020. Retrieved from https://www.kinno.fi/en/news/blockchain-technology-tested-supply-chain-information-management

Lieber, A. 2017. Trust in trade: Announcing a new blockchain partner. Blog post from IBM Blockchain Pulse website. Accessed on 19 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2017/03/trust-trade-announcing-new-blockchain-partner/

Maersk and IBM Unveil First Industry-Wide Cross-Border Supply Chain Solution on Blockchain. 2017. Blog post from IBM Blockchain website. Accessed on 18 April 2020. Retrieved from https://www-03.ibm.com/press/us/en/pressrelease/51712.wss

Maltseva, D. 2018. 10 most popular & promising Blockchain platforms. Dev community website. Accessed on 12 March 2020. Retrieved from https://dev.to/dianamaltseva8/10-most-popular--promising-blockchain-platforms-djo

Martin, A., Nagarajan, S., Pureswaran, V., Soman, S. 2018. Building your blockchain advantage. IBM company report. Accessed on 15 April 2020. Retrieved from https://www.ibm.com/downloads/cas/KLA16WMZ

McGowan, C. 2020. Anatomy of an intelligent blockchain trading solution. Blog post from IBM Blockchain Pulse website. Accessed on 19 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2020/03/anatomy-of-an-intelligent-blockchain-trading-solution/

Miller, D. 2018. Blockchain and the Internet of Things in the Industrial Sector. IBM article. Accessed on 18 April 2020. Retrieved from https://ieeexplore-ieee-org.ezproxy.jamk.fi:2443/stamp/stamp.jsp?tp=&arnumber=8378971

Mougayar, W. 2016. The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology, John Wiley & Sons, Incorporated.

Musienko, Y. 2019. Maersk Blockchain use case. Page on the Merehead website. Blog post. Accessed on 10 April 2020. Retrieved from https://merehead.com/ru/blog/maersk-blockchain-use-cases/

Nakamoto, S. 2008. Bitcoin: A peer-to-peer electronic cash system. White paper. Accessed on 5 February 2020. Retrieved from https://bitcoin.org/bitcoin.pdf

Olson, D. L. 2011. Supply Chain Information Technology. Published by Business Expert Press.

Pilvic, R. 2020. SmartLog Research. Power point presentation. SmartLog seminar 14 February 2020 in Helsinki.

Protect Pharmaceutical Product Integrity with the Pharmaceutical Utility Network. 2019. Blog post from IBM Blockchain Pulse. Accessed on 18 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2019/12/protect-pharmaceutical-product-integrity-with-the-pharmaceutical-utility-network/

Robinson, A. 2018. Blockchain Technology in Logistics: What Are the Implementation Challenges? Article from Cerasis website. Accessed on 17 April 2020. Retrieved from https://cerasis.com/blockchain/

Saldana, J. 2011. Fundamentals of Qualitative Research, Oxford University Press, Incorporated, 3-4

SAP Cloud Platform. N.d. Page on the SAP website. Accessed on 11 April 2020. Retrieved from https://www.sap.com/products/cloud-platform/capabilities/integration.iot.html

Schlapkohl, K. 2020. Blockchain applications that are transforming the world. Blog post from IBM Blockchain Pulse website. Accessed on 19 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2020/04/blockchain-applications-that-are-transforming-the-world/

Scott, D., Usher, R. 1996. Understanding Educational Research. Routledge Publisher, 29-31

Sekhon, J. 2016. Blockchain Technology in Supply Chain and Logistics. Medium website. Accessed on 15 March 2020. Retrieved from https://medium.com/@johnsekhon/blockchain-technology-in-supply-chain-and-logistics-210eeb8fe1d2

Shieber, J. 2017. Blockchain consortium R3 raises $107 million. TechCrunch website. Accessed on 12 March 2020. Retrieved from https://techcrunch.com/2017/05/23/blockchain-consortium-r3-raises-107-million/

Singh, A. 2020. The biggest, baddest thing in supply chain for 2020. Blog post from IBM Blockchain website. Accessed on 18 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2020/03/the-biggest-baddest-thing-in-supply-chain-for-2020/

Tanenbaum, A. S., Steen M. V. 2007. Distributed systems: principles and paradigms. Upper Saddle River, NJ: Pearson Prentice Hall, 1

The future of financial infrastructure. An ambitious look at how blockchain can reshape financial services. 2016. World Economic Forum report. Accessed on 17 April 2020. Retrieved from http://www3.weforum.org/docs/WEF_The_future_of_financial_infrastructure.pdf

TradeLens Digitizing the Global Supply Chain. N.d. Page on the TradeLens website. Accessed on 10 April 2020. Retrieved from https://www.tradelens.com/about

TradeLens Ecosystem. N.d. Page on the TradeLens website. Accessed on 10 April 2020. Retrieved from https://www.tradelens.com/ecosystem

TradeLens, 2019. Platform security gets pushed in controlled test; shines. Page on the TradeLens website. Blog post. Accessed on 10 April 2020. Retrieved from https://www.tradelens.com/post/platform-security-gets-pushed-in-controlled-test-shines

Vo, T. H., Kundu, A., Mohania, M. 2018. Research Directions in Blockchain Data Management and Analytics. Article from IBM research Australia and USA. Accessed on 19

April 2020. Retrieved from http://www.dke.jku.at/general/news/res/N000026/Mohania%20EDBT%20paper-227.pdf

Vovchenko, N. G., Andreeva, A. V., Orobinskiy, A. S., Filippov, Y. M. 2017. Competitive Advantages of Financial Transactions on the Basis of the Blockchain Technology in Digital Economy. Article from European Research Studies Volume XX, Issue 3B. Accessed on 16 April 2020. Retrieved from https://www.ersj.eu/dmdocuments/2017-xx-3-b-19.pdf

Weele, A. J. V. 2010. Purchasing and Supply chain management: Analysis Strategy, planning and practice. 5th edition. Hampshire: Cengage Learning.

White, M. 2018. Digitizing Global Trade with Maersk and IBM. IBM Blockchain Blog. Accessed on 9 March 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2018/01/digitizing-global-trade-maersk-ibm/

Why use Hyperledger Fabric for building enterprise blockchain solutions. n.d. Smartym Pro website. Blog post. Accessed on 12 March 2020. Retrieved from https://smartym.pro/blog/why-use-hyperledger-fabric-for-building-enterprise-blockchain-solutions/

Wladawsky-Berger, I. 2019a. The Transformative Power of Blockchain. Blog post from personal blog of author. Accessed on 16 April 2020. Retrieved from https://blog.irvingwb.com/blog/2019/07/the-transformative-power-of-blockchain.html#more

Wladawsky-Berger, I. 2019b. Blockchain - the Networked Ecosystem is the Business. Blog post from personal blog of author. Accessed on 17 April 2020. Retrieved from https://blog.irvingwb.com/blog/2019/05/from-the-network-is-the-computer-to-the-blockchain-is-the-business.html

Wolfson, R. 2019. Episode 12: Blockchain journalist talks top trends. Podcast from IBM Blockchain blog. Accessed on 15 April 2020. Retrieved from https://www.ibm.com/blogs/blockchain/2019/11/episode-12-blockchain-journalist-talks-top-trends/

Сравнение Ethereum, Corda и Fabric [Comparison of Ethereum, Corda and Fabric]. 2018. Chain Media website. Accessed on 12 March 2020. Retrieved from http://chainmedia.ru/articles/eth-vs-fabric-vs-codra/

Appendices

Appendix 1. Table of articles collected for the research

Objectives	Author	Year	Topic	Publication type	Findings	Future research
Implementation and adoption	Matt Hooper and Rachel Wolfson	2019	Episode 12: Blockchain journalist talks top trends	Podcast	In order to successfully adopt the blockchain strategy or implement one (build one), it is really helps if you already think differently about the nature of a corporate innovation, corporate business strategy, so that you opened to new miles of colaboration in a way that it naturally encourages coapetition multy colaboration, not in within technology, but culturally, companies need to be abel to find ways to collaborate in order to implement the solutions they building. The Blockchain requires collaboration. It's not a 'me' technology; it's a 'we' technology.	-
	IBM Blockchain	2017	IBM Study: C-Suite Executives Exploring Blockchain Aim to Disrupt, Not Defend	Survey	In the largest study to date among C-Suite executives seeking their perspective on blockchain, one third of almost 3,000 executives surveyed are using or considering blockchain in their business. According to the new IBM study, eight in ten of those exploring blockchain are investing either in response to financial shifts in their industry or for the opportunity to develop entirely new business models.	-
	Andrew Martin, Shyam Nagarajan, Veena Pureswaran, Smitha Soman	2018	Building your blockchain advantage	Report	As blockchain adoption continues to gather momentum, organizations must approach their blockchain strategies with the same rigor and commitment as any other new and transformative strategies. They can't just fall back on prototypes alone. They need to build a robust business case for blockchain that includes a fair incentive model to attract all the partners required for the success of their networks. (p.1)	-
	World Economic Forum	2019	Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits	White paper	The decision to implement a blockchain solution should be based on having identified a specific use-case, as well as a concrete problem or opportunity for the business. (p.14)	-
	Darshini Dalal, Eric Piscini	2018	Blockchain To Blockchains: Broad Adoption Enters The Realm Of The Possible, Part 4	Article	The general expected timeframe for blockchain technology adoption is two to five years, with some notable exceptions. In most regions, the main barrier to adoption is public skepticism as well as concerns about regulation.	-
	Kristoffer Francisco, David Swanson	2018	The Supply Chain Has No Clothes: Technology Adoption of Blockchain for Supply Chain Transparency	Article	The development and implementation of novel technology does not guarantee that it will be used and otherwise succeed. A theoretical insight is required to better understand the underlying motivators and barriers that will lead companies, or discourage them, from adopting blockchain technologies for supply chain traceability. (p.11)	How will non-technological external factors such as regulation, company culture, and social acceptance impact adoption? Who will lead demand for greater transparency to compel downstream adoption?
	Ivan Kot	2020	Is blockchain hype over? Reality vs misconceptions	Blog post	As with any other business opportunity, enterprises first need to decide on an implementation strategy, find a use case etc. The reasonable business approach is a vital missing in blockchain adoption. Blockchain should be implemented with a measured and pragmatic step-by-step approach.	-
	Manav Gupta	2017	Blockchain For Dummies	Book	Ten steps to your first blockchain application: 1) deciding whether blockchain has a place in your industry; 2) examine your current business processes for inefficiencies; 3) determining how blockchain can help; 4) choosing an appropriate use case; 5) determining the goal of your blockchain network; 6) identifying dependencies; 7) choosing a blockchain platform; 8) develop and deploy a blockchain application and network; 9) testing and fine-tuning your application and network. (p.37-41)	-
	Sachin Kamble, Angappa Gunasekaran, Himanshu Arha	2018	Understanding the Blockchain technology adoption in supply chains-Indian context	Article	The results of study suggest that the proposed BT adoption holds a significant explanatory power. The study reveals that the most critical constructs explaining behavioural Intention for BT adoption in supply chains are perceived usefulness, attitude, and perceived behaviour control.	-
Advantages and challenges	IBM Blockchain Pulse	2017	IBM InterConnect highlights: Blockchain is here, now!	Blog post	(A)Through blockchain, all parties in this business network can collaborate and share records of transactions through a decentralized ledger. Benefits have included security, immutability, speed and scale	-

	IBM Blockchain Pulse	2017	IBM InterConnect: Reimagine your industry with blockchain	Blog post	(A)Other benefits of using blockchain included: -Ease of integration with the core systems. -Role-based access and separation of data among different original equipment manufacturers and suppliers. -Immutability and consensus of recorded transactions for faster conflict resolution.	the production system is in development. But company isn't stopping there. The group is developing several other use cases, including one for insurance renewals, another for material procurement linked to delivery and receipt at the manufacturing site, and more.
	Irving Wladawsky-Berger	2019	The Transformative Power of Blockchain	Blog post	(A)Blockchain technologies have the potential to address these serious Internet problems by enabling the exchange of the critical data required to validate identities in a secure, decentralized manner without the need for a central platform or other intermediaries. Over time, blockchain-based applications could be used to coordinate the self-organizing activities of large numbers of individuals and institutions in a secure and decentralized manner.	-
	IBM Blockchain	2017	IBM Study: C-Suite Executives Exploring Blockchain Aim to Disrupt, Not Defend	Study	(A)Since blockchain creates new ways of working, they are also springboards capable of launching organizations in new directions. By linking people, resources, and organizations in an interactive ecosystem, businesses can create entirely new forms of value. For example, organizations could support micro-payments and skip the fees imposed by intermediaries or put different types of media into the direct control of their creators, which could solve the challenges associated with global licensing and royalty payments.	-
	Michael Casey, Caitlin Long	2018	The Cost-Cutting Potential of Blockchain	Journal report	(A)Traditional benefits can be grouped into three categories: cost reduction, revenue growth and reducing working capital. As in any digital transformation, identifying areas to take out cost may be the easiest exercise, which could be why most early blockchain efforts have focused on stripping out cost.	-
	Suman Bhattacharyya	2018	Brands are using blockchain to promote sustainable products	Article	(A)Other benefits could include brand uplift from reputably tracking goods on a blockchain, improved reliability – even in industries ripe with fraud – and reducing environmental damage to the communities they serve.	-
	World Economic Forum	2019	Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits	White paper	(A) Given blockchain's ability to provide a shared ledger of transactions to all parties, with full traceability of any assets and associated activity, organizations can not only cut their auditing costs but raise levels of confidence in the data they are producing without having to manually validate the data. Blockchain technology can enable true digital ownership of both real-world goods and digital assets by creating improved intellectual property and personalized data profiles, without the need to check the history or current state of the item. Blockchain enables business processes to be executed automatically via rules-based algorithms. Organizations can use blockchain to look for improvements in efficiency, cost savings and increased worker productivity. Blockchain technology can enable true digital ownership of both real-world goods and digital assets by creating improved intellectual property and personalized data profiles, without the need to check the history or current state of the item. (p.10)	-
	Sam Daley	2019	BLOCKCHAIN AND IOT: 8 EXAMPLES MAKING OUR FUTURE SMARTER	Blog post	(A)One of the most attractive characteristics of blockchain, in any industry, is its ability to secure data and thwart cyber attacks. Blockchain can also make the IoT industry faster. With a peer-to-peer model, making payments and executing contracts are easier.	-
	John Sekhon	2016	Blockchain Technology in Supply Chain and Logistics	Article	(A)One of the elements of businesses that blockchain technology is believed to aid in improvement is supply chain and logistics. In supply chain and logistics, blockchain has a great potential in increasing transparency.	-
	Kristoffer Francisco, David Swanson	2018	The Supply Chain Has No Clothes: Technology Adoption of Blockchain for Supply Chain Transparency	Article	(A)The possibilities of blockchain are diverse and impactful, including applications such as traceability, security verification, secure transactions, and rapid processing via smart contracts. Each of these areas provides potential for firms to gain competitive advantages. Blockchain technology also offers an opportunity for new entrants to showcase the virtues of their supply chain. This can be a significant advantage over less-agile, larger and more established competitors. (p.11)	How will non-technological external factors such as regulation, company culture, and social acceptance impact adoption? Who will lead demand for greater transparency to compel downstream adoption?
	Anders V. Hua, Jørgen S. Notland	2016	Blockchain enabled Trust & Transparency in supply chains	Thesis	(A)In the future having implemented blockchain technology might also yield a competitive advantage as consumers become more aware of the provenance of products and working conditions. (p.21-22)	Further research would need to explore and find the incentives for the actors in the supply chain to implement such a technology. The research would have to present clear gains and profits for the actors themselves by having such transparency. There is also a
	Ivan Kot	2019	Blockchain limitations: when your company doesn't need blockchain	Blog post	(A)Blockchain technology offers several advantages. First, the processing power can be distributed. Second, once confirmed, each transaction record becomes immutable. This is a prerequisite for one more advantage: blockchain allows mutually mistrusting parties to engage in a transaction without the need for a third party to validate it.	-
	Manav Gupta	2017	Blockchain For Dummies	Book	(A)For business, blockchain has the following specific benefits: Time savings, Cost savings, Tighter security, Enhanced privacy, Improved auditability, Increased operational efficiency. (p. 9-10)	-
	N.G. Vovchenko, A.V. Andreeva, A.S. Orobinskiy, Y.M. Filippov	2017	Competitive Advantages of Financial Transactions on the Basis of the Blockchain Technology in Digital Economy	Article	(A)The blockchain technology use based on the contracts' information transparency provides the companies with competitive power, as well as reduces the costs of economic agents' contracting, allows managing the companies' operational risks and controlling costs on the network and financial transactions. The blockchain technology competitive advantages are not only the ability to expand the tools of operations, but also the new deals formation. (p.4)	-

	Irving Wladawsky-Berger	2019	Blockchain - the Networked Ecosystem is the Business	Blog post	(C)When first organizing a blockchain, designing a minimally viable ecosystems that equitably incentivizes all participating network members is a key challenge. To do so, it's important to pick relatively simple-to-understand and implement use cases that can help incentivize members to join and remain in the network. Governance is the biggest challenge in creating such industry networks, which requires collaborating with other industry players, including otherwise fierce competitors.	-
	World Economic Forum	2016	The future of financial infrastructure. An ambitious look at how blockchain can reshape financial services	Report	(C)Transforming the highly complex global financial ecosystem will take considerable investment and time. It requires the close collaboration of its various stakeholders, including existing financial institutions, startups, merchants, government regulators, and individuals around the world. Getting them to work together and pull in the same direction is a major undertaking, given their diverging, competing interests. Overcoming these challenges will likely delay large-scale, multi-party blockchain implementations.	-
	World Economic Forum	2019	Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits	White paper	(C)Some 87% of survey respondents acknowledged that it is far more challenging to undertake the implementation of a blockchain solution as part of an existing digital transformation – especially when a substantial amount of capital has already been spent on a legacy technology. Survey respondents on average expected a 24% return on investment on their early blockchain projects, but realized only a 10% return. (p.12)	-
	Darshini Dalal, Eric Piscini	2018	Blockchain To Blockchains: Broad Adoption Enters The Realm Of The Possible, Part 4	Article	(C)As interest in blockchain grows, organizations looking to implement blockchain solutions may find it increasingly challenging to recruit qualified IT professionals. In this tight labor market, some CIOs are relying on technology partners and third-party vendors that have a working knowledge of their clients' internal ecosystems to manage blockchain platforms.	-
	Adam Robinson	2018	Blockchain Technology in Logistics: What Are the Implementation Challenges?	Article	(C)Systems collect orders from customers and send them to a provisioning system. In turn, the latter activates the shipping system. Such a company will also need a billing system that generates bills after the orders are completed. All these systems are isolated. They are focused only on certain objectives. It will be a huge challenge for IT to connect all data and implement new technologies. Before a blockchain can be used, it must be re-architected for particular proposes. Organizations need to clearly define what business operations will be based on blockchain.	-
	Ivan Kot	2019	Blockchain limitations: when your company doesn't need blockchain	Blog post	(C)Applied to business transactions and data transfers, companies could face a serious blockchain challenge. For example, if businesses were to use an immutable blockchain to record transactions and an accidental transaction were to occur, correcting the records might be a time consuming.	-
	F. Rizal Batubara, Jolien Ubacht, Marijn Janssen	2018	Challenges of Blockchain Technology Adoption for e-Government	Article	(C)The main challenges in blockchain adoption are rooted in the technology aspects such as security, scalability and flexibility. Meanwhile, the need for new governance models and acceptability of this technology are the major challenges from the organizational perspective. (p.8)	Empirical studies using rigorous research protocols should be enforced in government context to study the various potential benefits of blockchain adoption. Empirical studies will increase the reliability and clarify the validity and limitations of the advantages and potential benefits of blockchain
	Sachin Kamble, Angappa Gunasekaran, Himanshu Arha	2018	Understanding the Blockchain technology adoption in supply chains-Indian context	Article	(C)Blockchain technology is a new technology, and not many companies have gone for its full-fledged deployment in their supply chains yet. The supply chain practitioners are familiar with this technology but lack experience or practical knowledge of its various know-hows.	-
Visibility	IBM Blockchain	2019	Ignite success on any cloud	Case study	There's lack of visibility in this supply chain. The bulk liquid transportation supply chain is a very complicated supply chain with tens of thousands of potential participants. (p.2) One of the major goals of the Vertrax blockchain was eliminating unnecessary spends by retailers to increase visibility of supply chain. They have the tank monitoring in place with residential users. They're monitoring gas at the retailers. Utilizing those systems and putting them on the blockchain can add value to the data. (p.5)	To get new network participants and how company can scale this even further to handle billions of transactions. Company also aiming to applying artificial intelligence to get more insight into the data than what humans can predict.
	IBM Blockchain Pulse	2019	Protect Pharmaceutical Product Integrity with the Pharmaceutical Utility Network	Blog post	The visibility offered by blockchain makes it easier for pharmaceutical supply chain actors to comply with The Drug Supply Chain Security Act (DSCSA), prevent the distribution of counterfeit drugs, facilitate the drug recall process and more.	-
	Jon Kuiper	2019	Blockchain brings visibility to the finished vehicle supply chain	Blog post	When looking for the right technology to build a platform to provide end-to-end visibility in the finished vehicle supply chain, blockchain emerged as the clear technology of choice because it hit on all key requirements around transparency and data sharing. First and foremost is blockchain's distributed ledger technology, which allows us to create a centralized history a single source of truth for everything that happens to a vehicle throughout the supply chain.	-
	IBM an interview with Guilda Javaheri	2019	A Taste for collaboration	Interview	When you think about the supply chain today, that one-up, one-down visibility is very limiting. The blockchain solution is about the convergence of technologies like IoT, cognitive analytics and blockchain through IBM Food Trust to track, trace, and monitor the freshness of the product as it goes through its supply chain journey, as well as providing inventory visibility at all times through the shelf life of the item. (p.4)	-

	Anu Singh	2020	The biggest, baddest thing in supply chain for 2020	Blog post	Blockchain-enabled supply chains have allowed organizations to grant better visibility to multiple levels in their supply chains, resolve disputes faster, do zero-day invoicing and improve working capital. Visibility, agility, and the ability to connect disparate data in supply chain will be the way forward for businesses. Intelligent supply chains of tomorrow will provide end-to-end visibility, eliminate process inefficiencies, reduce cycle time, create new opportunities to deliver value for customers, build deeper supplier relations and deliver information quickly that can be acted on.	-
	World Economic Forum	2019	Building Value with Blockchain Technology: How to Evaluate Blockchain's Benefits	White paper	Being able to track the shipment in real time provides all parties with increased confidence in their goods and the ability to quickly react to any unexpected disruptions. (p.9)	-
	IBM Blockchain	2017	Maersk and IBM Unveil First Industry-Wide Cross Border Supply Chain Solution on Blockchain	Blog post	Blockchain, an immutable, security rich and transparent shared network, provides each participant end-to-end visibility based on their level of permission. Detailed visibility of the container's progress through the supply chain is enhanced with the real time exchange of original supply chain events and documents.	-
	John Sekhon	2016	Blockchain Technology in Supply Chain and Logistics	Article	A range of steps taken by numerous participants of the chain can be efficiently built into a blockchain system open to consumers and regulators to access whenever they need. It will also allow companies to have greater control over the processes and better visibility over vendors and the quality of materials delivered.	-
	Manav Gupta	2017	Blockchain For Dummies	Book	By improving visibility, blockchain has the potential to transform entire ecosystems. Supply chains are prime examples of blockchain's potential for transformation that spans industries. (p.24) Complete visibility of the order-to-delivery pipeline. Greater visibility of transaction status, current balance, and tracking over time (p.26-27)	-
	Dennis Miller	2018	Blockchain and the Internet of Things in the Industrial Sector	Article	Each participant has visibility to pertinent shipment data in the blockchain based on the participant's role. Logistics management systems are used by manufacturers to query the blockchain for shipment data and provide additional shipment information to the blockchain. (p.2)	-
Trust between partners	Dr. Nicholas Garrett	2019	Blockchain helps trace responsibly produced raw materials	Blog post	With blockchain, small companies that adhere to international standards can be validated and trusted, which takes the burden of compliance auditing off their trading partners.	At RCS Global next evolutionary step will be to look at how we can effectively incorporate AI into our processes, specifically at the potential value it can add in the context of more informal economies
	IBM, AIG and Standard Chartered	2018	Building trust and transparency in insurance policies with blockchain	Video	Blockchain establishes a peer-to-peer network of shared, replicated and permissioned ledgers which improves transactions transparency, strengthens trust and reduces cost and friction.	-
	IBM Blockchain Pulse	2017	Blockchain comes to SXSW with The Linux Foundation's Hyperledger Fabric and IBM	Blog post	A shared, immutable ledger for recording the history of transactions, blockchain technology is fostering a new generation of transactional applications that establish trust, accountability and transparency among participants in a transactional business network.	-
	Ciaran McGowan	2020	Anatomy of an intelligent blockchain trading solution	Blog post	we.trade is a digital platform that helps buyers and sellers trade across borders in a new way. Powered by the IBM Blockchain Platform from the cloud, it ensures that traders can trust the other party and streamlines trading transactions. Each entry on the blockchain is given a timestamp and a unique cryptographic signature, and all permissioned parties can access the same information concurrently for complete transparency.	-
	Aaron Lieber	2017	Trust in trade: Announcing a new blockchain partner	Blog post	Blockchain could enable data to be shared instantly to all permissioned participants in a network. Partners can collaboratively forecast to improve efficiencies across the supply chain. Advanced analytics and cognitive capabilities could enhance this decision-making power. Organizations can achieve these benefits by using blockchains to build trust in the most important parts of their operations, develop partnerships to expand the data available to assist decision making and create differentiated values for customers and partners.	-
	Kyle Schlapkohl	2020	Blockchain applications that are transforming the world	Blog post	Executives are already exploring industry blockchain applications and realizing the value that removing friction, building trust and unlocking new value across their business can provide.	-
	John Sekhon	2016	Blockchain Technology in Supply Chain and Logistics	Article	The blockchain technologies help to eliminate the problem of trust, information barriers and legal costs. Cargo transportation can be monitored until the successful closing of the deal. All actions are recorded in the blockchain, which omits trust issues between parties.	-
	Hoang Tam Vo, Ashish Kundu, Mukesh Mohania	2018	Research Directions in Blockchain Data Management and Analytics	Article	Blockchain technology has emerged as a primary enabler for verification-driven transactions between parties that do not have complete trust among themselves. (p.445)	Future study could provide a basis for further research of common issues of on-going data management and analytics problems encountered in the development of real-world blockchain applications, to identify