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# BLOCKCHAIN TECHNOLOGIES AND TRUST FORMATION IN TRADE FINANCE

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ABSTRACT OF THE MASTER'S THESIS

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Abstract

This thesis focuses on distributed ledger technologies, commonly known as blockchain technologies. In this study, blockchain technology is seen as an innovation that will change how trade finance industry will function in the future. In general, trade finance industry is based on risk mitigation, and this thesis studies how the implementation of a trust-free blockchain technology will affect how this industry operates.

The study aims at understanding the effect of blockchain technology being implemented into the trade finance industry. In general, blockchain technology affects both, trade finance operations and how trust formation between the trade partners. This study combines model of diffusion innovation by Rogers (2003) and trust categorization of Jøsang et al. (2005). These models formulate the theoretical framework for the research.

The nature of this study is qualitative research, which utilizes abductive reasoning, and has both theoretical and empirical part. Theoretical part consists of three chapters, focusing on the basics of blockchain technology, trade finance industry and the concept of trust. Empirical part is based on documentary data and semi-structured interviews of blockchain and trade finance professionals.

Results show that trade finance, which is based on risk mitigation of international trade is slowly progressive, manually handled and paper-based process which has not been able to grasp the potential of automation advances made in other financial sectors. Trust between trading partners has previously been based on context-dependent trust, but the there is a shift towards more context-independent trust that is based on algorithms and ratings. Blockchain technology is based on immutable ledger technology and thus possesses the capability to change how trade finance functions.

Keywords
Blockchain technology, trade finance, trust, diffusion of innovation

Additional information

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# 1 INTRODUCTION

Schumpeter (1934) has described innovation and invention clearly when stating that they can be seen as a "new combination" leading into a new product, and eventually to the commercial introduction. Invention, specifically, is part of the realm of science and technology. By applying the ideas of Perez (2009), we can expand the perspective by stating that technological revolutions are based on individual innovations that form the technological systems.

Blockchain technology is a new technological innovation, and its first application, Bitcoin, is based on the whitepaper by Satoshi Nakamoto (pseudonym) in 2008. The original idea of Bitcoin was to solve the question of what an electronic peer-to-peer equivalent to cash without the need of intermediaries, such as banks would look like (Bott & Milkau, 2016). Beck et al. (2016) indicate that after the initial phase of using blockchain technology for cryptocurrencies such as Bitcoin, the range of possible applications has gotten wider. For example, the technology has been used to power Internet of Things solutions by IBM and Samsung.

Blockchain is based on distributed ledger technology, which is built upon growing number of blocks that keep the copies of the ledger in sync. It is a "defined sequence in one block and… [attached] new blocks at the end of the chain." (Bott & Milkau 2016: 3). The greatest advantage of blockchain technology is that it allows people without prior knowledge to have trust or confidence in each other without any central authority (Walport, 2016). The Economist has claimed that Blockchain is a machine for creating trust for that reason.

This thesis focuses on analyzing the effect of blockchain and distributed ledger technologies in the trust formation between the parties of the trade finance transactions. McKenzie (2017) states the current situation of the trade finance as a slowly progressive, manually handled and paper-based process which has not been able to grasp the potential of automation advances made in other financial sectors. According to technology experts, bank officials and enterprise treasurers the blockchain and cryptotechnologies, in general, have the potential to revolutionize the trade finance industry (EBA, 2016; McKenzie, 2017; Zaddu, 2017). Mattila (2016)

explains the disruptive nature of the blockchain technology by stating that people rely on trusted intermediates in their day-to-day life and they have gotten used to it. Adopting a whole new way of thinking might be difficult, at least in some traditional sectors such as banking. According to the Euro Banking Association's white paper (2016) about applying cryptotechnologies in trade finance implicate that blockchain and distributed ledger technologies have been widely regarded as a new way to arrange payments securities settlement, but they also carry the potential to disrupt the 300-year old way of conducting trade finance.

## 1.1 Motivation

There has been a tremendous hype around the blockchain technology and Gartner (2016), for example, has reported that blockchain is at the peak of the hype curve. At this moment, only a few commercial introductions of this innovation have been published, and the total potential and fit are undetermined. However, according to PriceWaterhouseCoopers (2016) financial institutions are heavily investing in the technology and starting to roll out their versions of blockchain and that the amount of venture capital distributed into developing blockchain technology is increasing vastly. In addition to venture capitalist and financial institutions, also governments and consulting agencies have raised their interest towards the technology (Leibowitz, 2016; Millar, 2016).

Brunner, Abderrahmane, and Muralidharan (2016) have stated that even though it has proven to be hard to find sustainable use cases for blockchain, trade finance is one of the most potential candidate. The reason for this is that trade finance has remained the same for the last centuries and has been regarded as inefficient. (Standardized trust, 2016.) Trade finance is based on contracts, transactions, and their authentication, all of which are phenomena that digitalization and blockchain technology has the potential to make more efficient. Brunner et al. (2016) continue that the change towards digital, automated and transparent trade finance is already technologically possible. European Banking Association (EBA, 2016) believes that the adoption of technology will be gradual, which helps the different stakeholders to understand the value these cryptotechnologies possess, and that full-scale adoption is not possible in short timeframe.

Another critical issue that Morrison and Sinha (2016) raised is that blockchain is more than just bitcoin or cryptocurrency because it has the potential of removing friction from different transactions. The distinction between blockchain and bitcoin is important, and the path of innovation from bitcoin to more widely used technology is imminent. According to Perez (2009: 2), "radical individual innovations are usually introduced in a relatively primitive version, and once market acceptance is achieved, they are subjected to a series of incremental innovation." Thus, the diffusion of innovations like blockchain are important. Rogers (2003) has been studying how the diffusion of innovation happens, and in this thesis, parts of his studies will be used as a theoretical framework on determining how the uncertainty around new innovations gets overcome. Sahin (2006: 1) states that uncertainty as one obstacle to adoption of innovation and in order to mitigate that obstacle, it is extremely important to keep the participants "informed about its advantages and disadvantages to make them aware of all its consequences." This thesis will utilize five attributes of innovation rate of adoption by Rogers. These attributes are (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability.

Main motivation of the thesis is to combine blockchain and distributed ledger technology, trade finance and the concept of trust, because the research on the topic is currently underdeveloped. Clear evidence of this is presented in the white paper published by Standardized Trust collegian (2017: 1) as they state in the opening sentence of their paper that "something needs to be done" in order to clarify the potential benefits of blockchain technology in the context of trade finance. The business importance of the thesis is apparent, as blockchain and distributed ledger technology could be the next revolution of information and value sharing in trade finance. In addition, the potential change in overall business models and their efficiency is likely to play a huge role. The overall change from centralized into decentralized business models that the blockchain technology enable is a significant factor to take into consideration in the near future. For example, a report from Elinkeinoelämän Tutkimuslaitos (ETLA) Blockchain as a Path to a Network of Systems (2015) has emphasized the importance of blockchain technology in the process of realizing the actual value from the internet of things. Mattila and Seppälä (2015) recognize blockchain as an interesting technology from both social and industrial digitalization. This is because of the huge amount of venture capital it has

raised during the past years. The diffusion of innovation model by Rogers (2003) has been used in innovation research. According to Sahin (2006: 1) this model has mainly been used to study the adoption of technology in higher education context, but he also states that it has been used as a framework in many other fields of business such as economics, science and political science.

## 1.2 Problem area

Seppälä (2016) has listed the main issues related to the use and study of blockchain and other cryptotechnologies. The biggest obstacle is the relatively small number of academic journals and researchers on the topic. Especially papers that cover both blockchain and trade finance are rare. Papers that included both of these topics were the non-academic white papers written by Standardized Trust Collegian (2016), Hong Kong Applied Science and Technology Research Institute (Hereinafter Astri, 2016) and European Banking Association (hereinafter EBA 2016). Further, Seppälä mentions that the terminology around the subject can be seen as inconsistent which may lead some to misunderstand the whole meaning of blockchain. During the time of writing this thesis, only the research paper by Seppälä covered both blockchain and trust. The paper of Seppälä concentrates on how blockchain changes business model and how trust is involved in this process. Seppälä concluded that blockchain will have an effect on business model innovation and that concept of trust could help in determining where blockchain is applicable. Thus, building on the ideas of Seppälä, blockchain based trust is investigated in this research. Research gap is evident, since there were no papers available covering blockchain, trade finance and trust.

Trust is one of the main themes in this thesis. Trust is a complicated term in general and especially in the same context with blockchain and trade finance. Trust has many different meanings among different fields of study and it can be seen as a subjective phenomenon. The shift and the different perspective that blockchain provides to digital trust is enormous. According to Seppälä trust has many definitions in sociology theory, but it is much more complicated to define in the computer science, where the meaning varies a lot in different subfields as we can see in the quotation below.

> "Within computer science, trust has been co-opted by many subfields to mean many different things. It is a descriptor of security and encryption; a name for authentication methods or digital signatures; a measure of the quality of a peer in P2P systems" (Golbeck 2006: 134).

When trying to get a comprehensive understanding of trust in this research setting, where both sociological and computer science definitions of trust collide, further consideration of the meaning of trust is required in this specific context. In this research setting trust will be categorized according to the theory of Jøsang et al. (2005: 2). This categorization includes context-independent 'reliability trust' and context-dependent 'decision trust'. This categorization forms the theoretical framework for the research together with the model of diffusion of innovation by Rogers (2003). In addition, a concept of trust-sphere is used, especially in the empirical part of the research when doing interviews. Trust-sphere means all the different trust relationships that are present in the trade finance transaction: trust between the buyer and seller and trust between the buyer and third-party bank.

Including the concept of trust into the innovation research has not been done before in this particular context. By doing this, the research builds the theoretical perspective of trust and innovation research. In addition, the empirical side of these concepts will be addressed as well.

### 1.3 Research scope and goals

I will focus on the research gap that exists in the intersection of blockchain technology, digitalization of trade finance and how the concept of trust changes between the different parties attached in trade finance transactions after implementing blockchain technology to the setting. This particular research gap is being addressed by conducting a thematic analysis, complemented with semi-structured interviews with professionals from fields of blockchain, trade finance and trust. The scope of the research is limited to the banks and companies that are located in Scandinavia. The research questions addressed in the thesis can be summarized as follows:

*RQ1: How does the implementation of blockchain technology changes trust formation in trade finance?*

*RQ2: What are the advantages and disadvantages of blockchain technology in handling trade finance?*

By addressing these research questions, the gap in the intersection of blockchain, trade finance, and trust will be studied. The second research questions addressees the total usability of blockchain technology in trade finance setting, while the first research question includes the concept of trust and its effect in ex-ante and ex-post way of research. The nature of the two research questions is different. The first research question is more theoretical combining all the different categories of the research: blockchain, trade finance and trust. The other research question is more practical in its nature as it focuses on finding the advantages and disadvantages of blockchain technology in trade finance setting. The second research question also addressees the managerial implications of the advantages and disadvantages of blockchain technology in trade finance. Even though the questions are different in their nature, they still produce a coherent view of the topic in hand by addressing the topic from many perspectives.

These research questions are to be addressed in the following way: first, a comprehensive literature review on the topics of blockchain technologies, trust and trade finance related literature is conducted. The literature review will be based on articles published during the last two years. In addition, a couple of key white papers will be used as documentary data. Secondly, primary data is collected though semi-structured interviews where six relevant stakeholders are being interviewed and this data is analyzed by utilizing the theoretical framework consisting of the models of Rogers (2003) and Jøsang et al. (2005).

The main material for the study consists of different white papers published by a workshop of trade finance industry professionals. Another white paper is written by European Banking Association and the last by Astri. Additional information is gathered by interviewing the individuals involved with drafting of whitepaper from the workshop by Finnish trade finance professionals. The nature of the interviews was

to deepen the information gathered from the whitepapers and fill the gaps that were present.

This paper is structured in the following way: firstly, the foundation for technological innovation is constructed by utilizing the paper of Perez (2004) about techno-economic paradigms. After that, blockchain technology is linked to the discussion of innovation as part of the fifth disruptive computing paradigm. Secondly, trade finance will be introduced to the discussion by stating the past and current way of doing international business by utilizing trade finance products. Thirdly, the idea of diffusion of innovation by Rogers (2003) is presented. Blockchain act as the innovation and trade finance industry will be the social structure where this innovation will diffuse. The diffusion model does not include the concept of trust, and therefore the categorization of trust classes of Jøsang et al. (2005) will be attached into the model of Rogers. This combination of two different models forms the basis for the theoretical framework that will be used as a lens through which the analysis is made in the later part of the paper. The fourth part of the thesis introduces the methodology and the data used in the research. Fifth part of the thesis focuses on analyzing the written data and interviews by using the combined model of Rogers and Jøsang et al. The last chapter of the thesis is conclusion and discussion, where the research questions are to be answered, validity and reliability of the thesis will be evaluated, and future research agendas presented.

# 2 BLOCKCHAIN AS AN INNOVATION AND TECHNO-ECONOMIC PARADIGM

The purpose of this section is to provide a foundation for understanding the basic concepts of cryptotechnologies and their relation to the research setting. This section is therefore divided into two parts. Firstly, the foundation and justification for the raise of new technologies such as blockchain is laid by explaining the concept of ICT-paradigm by Perez. Secondly, blockchain technologies are invited into the discussion.

## 2.1 Techno-economic paradigms

Technological revolutions have changed the world in waves many times. Starting from the industrial revolution in England, continuing to the age of railways, and all the way to the age of oil. What is common in these revolutions is that during the deployment period of each revolution, the infrastructural networks have been acting as platforms for the change. During the time of industrial revolutions, canals and mail coaches acted in this role. During the age of oil, it was highways and airways that acted as platforms for the change. Lastly, during the current period of the age of information technology, global ICT-networks act as the platform for the change. Piscini et al. (2016) have stated that the biggest impact of the age of information technology came with internet and how it revolutionized the way communication was handled in the world. Blockchain, on the other hand, has the potential to "similarly disrupt transactions, contracts, and trust—the underpinnings of business, government, and society" (Piscini et al., 2016: 1).

### 2.1.1 Blockchain as a part of computing paradigms

"One model of understanding the modern world is through computing paradigms, with a new paradigm arising on the order of one per decade" Swan (2015: 11). These disruptive computing paradigms, starting from the mainframes in the 1970s, PCs in the 1980s, Internet in the 1990s, and social Media in the 2000s, have paved the way for the fifth paradigm: information and communication technologies. Blockchain technology can be seen as one part of this fifth computing paradigm. Swan sees that during this decade blockchain technology could enable the connected world of

computing to emerge. The economy that is based on the blockchain cryptography affects both, the transfer of money and information. Blockchain is even seen as the "seamless economic layer of the web" as Swan (2015: 12) puts it. It is interesting to see blockchain technology both as a successor and a product of the incremental development of previous computing paradigms that have changed the world, but it also has the nature of radical innovation.

### 2.1.2 Incremental and radical innovations

Perez (2004: 5) makes a distinction between incremental and radical innovations by stating that "incremental innovations are successive improvements upon existing products and processes" and "a radical innovation, by contrast, is the introduction of a truly new product or process". The introduction of blockchain technology has characteristics from both type of innovations. As a radical innovation, blockchain can either form totally new industries or make the existing ones more efficient by changing the way business is handled, thus making radical innovations the driving force behind the overall growth and structural change in the world (Perez, 2004).

On the other hand, distributed ledger technologies and blockchain architecture are successors from interrelated technical and organizational innovations, which are based on techno-economic paradigms. Perez (2004: 14) describes techno-economic paradigms as follows: "As it spreads, this new paradigm gradually takes root in the collective consciousness, replacing the old ideas and becoming the new 'common sense' of engineers, managers and investors for the most efficient and 'modern' productive practice across the board." What this implies in the context of blockchain, is that the current business models, such as banking, which are based on centralized systems could shift into business models that utilize decentralized systems. This shift combined with the overall digitalization of different industries could enable a quantum jump in the overall productivity of the economy.

Perez (2004) also discusses quantum jump in potential productivity for all, related to the technological revolutions. It means that technological revolutions have synergy effects also to other industries, not just the focal one. In this regard, blockchain was first introduced as a cryptocurrency, but it is now used in voting systems (e.g., Estonia)

and healthcare information systems (e.g., Finland). Perez (2004: 14) has concluded the previous as follows: “each technological revolution brings at the same time a set of new industries, with a low-cost input at the core, and a set of generic all-pervasive technologies and organizational principles capable of renewing all the other productive activities.”

According to Perez (2004), the timeframe it takes for the techno-economic paradigm to mature is long, and it can take decades from the early adoption to the maturity phase illustrated in the figure 1 below. She also mentions that sometimes the early adopter can utilize the innovation long before the masses even notice it. Blockchain technology was first introduced in 2008, and after a decade, other mentionable and functional applications started to surface in addition to Bitcoin. Perez argues that the leadership of established firms is one of the strongest obstacles to the adoption of these new techno-economic paradigms. Furthermore, EBA (2016) suggest that there are two levels of obstacles in the adoption of cryptotechnologies to different setting. Firstly, there are obstacles to adopting cryptocurrencies in general. Secondly, there are also issues in specific industry related cryptotechnologies and how they are standardized and implemented on top of the legacy systems that banks utilize, for example.

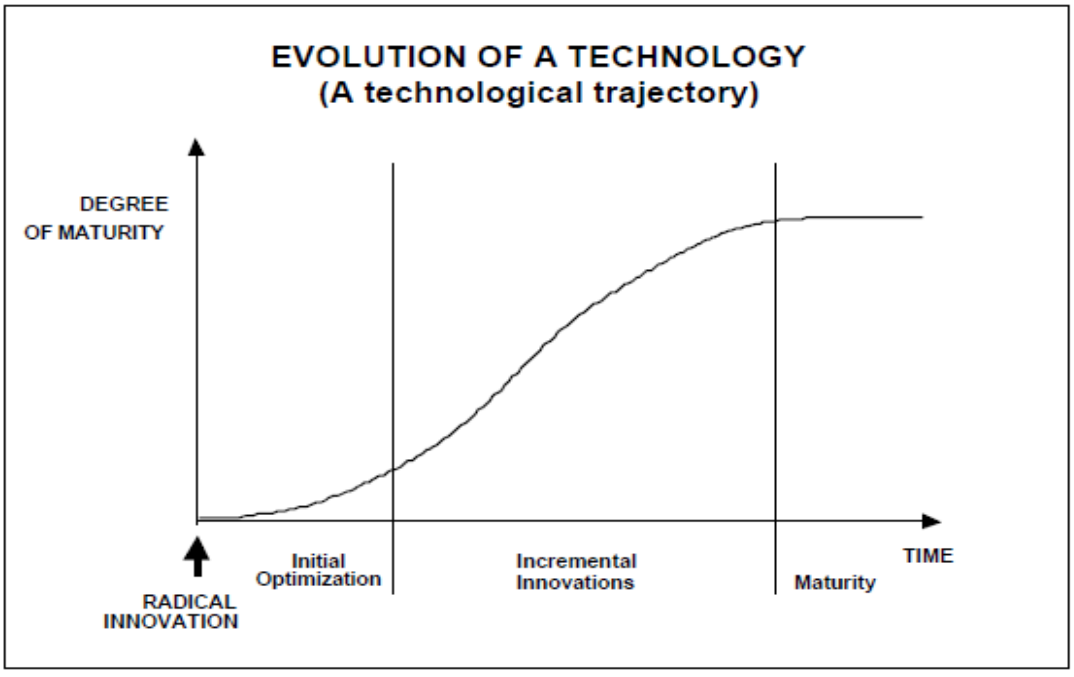


**Figure 1: Evolution of a technology (Nelson & Winter 1982 via Perez 2004)**

To understand the time, it takes for a techno-economic paradigm to mature, I utilize a model that Perez (2004: 23) has formalized. It consists of three inter-related paths that each techno-economic paradigm is constructed in and diffused through:

> 1. "As a set of real new technology systems which grow and diffuse in the productive sphere" (Perez, 2004: 23)

This is the first phase or the "initial optimization" seen in figure 1 above. Blockchain technology is currently at the end of this phase as new products surface in many areas, but they still are not seen as the best practice on a given field.

> 2. "As a new 'best practice' model adapted to the new technologies and capable of taking best advantage of them. This model diffuses across all industries and productive activities, modernizing them and establishing the emerging managerial common sense for investment and innovation." (Perez, 2004: 23).

Reaching this level fully requires still time and money spent on research. Also, the legislation around the topic needs to get further to fully enable the incremental innovations to grow exponentially.

> 3. "As a more general set of "common sense" principles for organizational and institutional design" (Perez, 2004: 23).

Later stage of the implementation of cryptotechnologies, which consists of decentralization of systems at a larger level in society.

## 2.2 Blockchain as a digital platform and a boundary resource

How innovations are spread into the society and what does the platform thinking mean? In section 2.1 the disruptive technological revolutions were described and how they acted as platforms in different times. Lauslahti, Mattila and Seppälä (2017: 7) have described digital platforms as "the term digital platforms refer to IT systems via which different parties can do business that adds value to the whole ecosystem".

According to Lauslahti et al. (2017: 7) digital platforms "are shifting the boundaries of industry ecosystems, transforming how value is created and captured, as well as changing job descriptions and the trust relationships between different parties in the economy." Their view on spreading the platform innovation with others is to make "boundary resources" available to as many as possible willing to participate. These boundary resources, according to Lauslahti et al. (2017: 7) "refer to contractual and other co-operative regulations as well as software tools and interfaces which act as an open interface between the digital platform company and any other third party". This issue is related to the blockchains' effect on many industries, since according to Seppälä, et al. (2015) different parties are interested in the financial benefits that are the result of networking activity based on the platforms.

Cryptotechnologies and especially blockchain can be seen as a boundary resource in this regard. Digital platforms and their relation to agreements and technological compatibility can be seen in the form of boundary resources, which can also be seen as the opposite to barriers to entry (Lauslahti et al., 2017: 7). Since the value of any blockchain related technology is in the wide standardization and adoption, the concept of boundary resources is helpful in explaining why the owners and developers of this new digital platform have the incentive to share it with third parties and other players in the network that they are part of. These new networks built by decentralization of business models are presented next.

### 2.3 P2P networks

Blockchain technology is based on decentralized model of peer-to-peer transactions. This means that there are no intermediaries in the transaction process. The introduction of peer-to-peer (P2P) networks have made a huge difference in the digital distribution of services and information sharing (Rowstow, 2001; Aberer, 2011; Swan, 2015). Peer-to-peer system differentiates from the traditional client-server architecture, in which the data is stored in a certain server and is distributed only when a related party demands it. This kind of system has been called one-to-many, because parties involved must rely on a centralized source of information. P2P network, on the other hand, is built upon the decentralized network, where different peers share information with each other without the central authority (Shollmeier, 2001).

Decision-making power or the possession of the data is located in a single person or single point in a centralized network, whereas in the decentralized model the situation is completely different because decisions can be made in different places and more than one entity holds the data or the information. The centralized model allows closer monitoring, but on the other hand, the decentralized model is more cooperative (King 1983).

Lauslahti et al. (2017) see blockchain technology as an enabler of decentralized networks as they state that blockchain technology can be seen as a potential technology for digital platforms and their boundary resources in the future. One notable thing that Lauslahti et al. raise is that in the past, digital platforms have usually been company specific. However, at least in the context of blockchain related technologies, digital platforms are more valuable when considered as decentralized rather than centralized networks.

Mattila and Seppälä (2015) see the importance of the distributed network effect since the centralized or decentralized methods are not optimal in all scenarios. An example of centralized method is certain server product where the information is stored. A cloud based network can be seen as an example of a decentralized system. Mattila and Seppälä state that these kinds of systems are not functional when the products that are used in the network are low cost but have long life-cycle. Many times, the application of cryptotechnologies is mostly a distributed ledger and it thus utilizes the distributed network effect described above.

## 2.4 What is blockchain?

The previous part of the thesis laid the foundations for the blockchain technology by describing its potential as a techno-economic paradigm, and how centralized networks differentiate from the decentralized solution that blockchain technologies can offer. Next, more specific blockchain description will follow.

As mentioned earlier, technological development can be described through different revolutions. It all began with the industrial revolution in England and the recent ICT-revolution has increased the speed of progress manifold. Blockchain technology has

also been seen as part of the fifth disruptive techno-economic paradigm. It is based on a stack of cryptography that shifts the focus from centralized business models into decentralized ones.

Blockchain technology was first introduced in the whitepaper by Nakamoto (2008) as the driving technology behind the cryptocurrency Bitcoin. During the last decade Bitcoin has gained reputation and it still remains the most important product made on top of the blockchain technology so far. Since 2008 many different versions of blockchain have emerged, but at the moment of writing this thesis, Bitcoin remains the main application. Nakamoto (2008: 1) describes the Bitcoin system as "Peer-to-peer distributed timestamp server that generates computational proof of the chronological order of transactions." Blockchain technology enables a completely different way to handle business from traditional applications, since it removes the need for the middlemen in the process, thus making the system decentralized instead of centralized. It is important to remember that different blockchain applications can be utilized also for other purposes than Bitcoin, as Nakamoto explains. Usually, the middleman is the central entity that verifies transactions and ensures consistent data storage. Verification process in blockchain technology is handled differently, since there is not one central entity, but rather the network is required to achieve a consensus about the order of the blocks that are chained together by referring to the previous block. In other words, a chain of blocks filled with data are tied together by utilizing cryptography, which means that all parties within the network follow the same rules and therefore it is possible to establish a common and irreversible view of the distributed ledger (Mattila, 2016). Distributed ledger means all the participants on the network share the same ledger and all changes in it will be distributed to everyone.

## 2.5 Bitcoin

The technology used for Bitcoin is a secure transaction ledger, which can be either public or private. These qualities make it possible to handle transactions without the verification of a central entity, since the verification is handled by the members of the distributed network. This is possible since the ledger keeps record and stores all transactions in the network, creating an irrevocable and auditable transaction history. Technology also makes it possible to have a consensus when multiple parties make

changes at the same time. (Peters & Panayi, 2015; Wyman, 2016.). In a public ledger, everyone is able to join and leave the network, but in private ledger participants not are able to come and go freely.

Swan (2015: 1) has described Bitcoin as "a giant interactive spreadsheet that everyone has access to and updates and confirms that the digital transactions transferring funds are unique." Bitcoin blockchain is made out of blocks that store the information of multiple transactions. Pilkington (2015) describes that the chain of blocks gets bigger when the participants of the network - so called miners - validate transactions. The process of validating transactions starts when the members of the network make payments and send that information to the network to be confirmed. The second part of the process is that the miners see those payments unconfirmed and bundle them together. In a third part of the process miners need to solve a mathematical problem by brute computational force. After one miner finds the solution to the problem, she then puts the bundled transactions in the chain of blocks. In other words, when the problem is solved, a new block is added into the chain along with a certain number of transactions or data attached. Miners get reward from solving these problems and thereby authenticating the transactions in the blockchain. The aim of the reaching consensus by validating transactions in this way is to prevent dishonest parties from attaching false blocks to the chain.

There are different ways for a network to validate the transactions so therefore it varies between different consensus mechanism which solution will be added to the chain of blocks. This kind of incentive system where there are "miners" authentication the blocks is one way to increase security, but on the other hand, it is an extremely costly way to achieve security through cryptography and brute computational force. (Peters & Panayi 2015).

### 2.5.1 Cryptography

Pilkington (2015) defines cryptography as a set of scientific techniques which enable storing of data and communication with it in a secure way. Cryptography has been used widely for a long time. Starting from the ancient times, when messages needed to be encrypted by rearranging the letters, cryptography is being used widely in modern

times, for example in all credit card payments using cryptography. A secure way to transfer a message means that the message is not modified during the process, and the participants are who they are supposed to be (Delfs & Knebl, 2007; Buchmann, 2013). The aim of cryptography is to increase the confidentiality of the communication process.

Cryptography used in blockchain helps to overcome two problems known as the double spending problem, which is related to the fact that with digital currency, there is a higher possibility to copy bits than paper. In other words, physical currency cannot be in two places at once, but with a digital currency that is a possibility without proper prevention systems like Bitcoin has. The other problem that blockchain technology mitigates is byzantine general's problem (Lindman, Rossi & Tuunainen, 2017). Byzantine general's problem refers to a situation where every participant of a given network must agree on messages that are transmitted on the network. If some participants are corrupted, it might affect the whole network. Lamport, Shostak and Pease (1982) have described Byzantine general problem with the following scenario. The Byzantine Army has encircled a city. The generals of the army must formulate a common plan whether to attack or retreat, and they can communicate with each other only by using messengers. Some generals may want to attack and some to retreat, but the most important thing is that the decision is unanimous, since it is better that everyone attacks or retreats than if half of the troops attack and the other half retreats. To solve the problem, generals must formulate some algorithm to be sure that the other generals are not changing their vote, or that the messenger does not change its content after the general hands the order to him. The proof-of-work consensus mechanism is one way to overcome Byzantine failure. It also helps to reach an aligned global view of the system state in the ledger (Peters & Panayi, 2015).

In the blockchain context, cryptography means the consensus mechanism that is utilized to maintain the ledger in order. According to Swanson (2015: 4), a consensus mechanism is a process "in which a majority (or in some cases all) of network validators (miners) come to an agreement on the state of a ledger." More technically, it means the defined rules and procedures that are utilized by the members of the system. Bitcoin utilizes the proof-of-work consensus mechanism which is one of the possibilities to verify the legitimacy of the data in a blockchain setting. This is done

by solving a mathematical equation by computational force. Proof-of-work requires a lot of computational work and is time-consuming, however, the results are easy for other users to verify because of the time-stamping feature (Vukolić, 2015). In a bitcoin setting, proof of work is done by so-called miners, who solve these complex algorithms that form the next block in the chain for a reward of a certain number of bitcoins. According to James (2016), proof-of-work system is beneficial in establishing a consensus in multi-user network.

Beck et al. (2016) state that it depends on the blockchain protocol at hand how cryptography is used to formulate the blocks in the chain. They all however share the same principle: one is able to find all of the transactions made in the network by going back in the chain of blocks. Pilkington (2016) states that it is the public-private key cryptography that makes blockchain functional and prevents the double-spending problem. The public-private key system means that a public key is shared with everyone in the networks, whereas private key verifies the transactions and is known only by the owner of the digital wallet or else (Segendorf, 2014; Delfs & Knebl, 2017). Pilkington (2016: 5) defines the process of a transaction in blockchain network simply by stating that "the future owner of the coins (or digital tokens) sends his/her public key to the original owner. The coins are transferred by the digital signature of a hash."

According to Beck et al. (2016), it is these functions combined with the decentralized network and to the transparent nature of the chain that makes blockchain desirable through cryptography. Beck et al. (2016: 5) state that: "the combination of security and transparency is what makes the blockchain a trust-free technology." What this means is that blockchain is a special technology when it comes to mitigating trust in the environment where the technology is being used.

### 2.5.2 Permissionless vs. permissioned blockchain networks

There are two possible ways to utilize the blockchain technology, a permissioned or a permissionless system (Swanson, 2015; Pinna & Ruttenberg, 2016). The original intention of the blockchain was to utilize the permissionless system in the form of Bitcoin cryptocurrency. In a permissionless system, an individual may remain anonymous, and everyone has the possibility to join the network and to utilize it

depending on the validation system (Swanson, 2015; Pinna & Ruttenberg, 2016.) The permissioned system, on the other hand, is more suitable for banks and other financial institutions since the members can be identified and held accountable if necessary. Other difference from a permissionless system is that in a permissioned system the ability to join and utilize the system is not open to all and only approved member can validate transactions. Permissioned system is beneficial for the financial institutions because it reduces the need for other validation systems, which might be costly (Swanson, 2015; Pinna & Ruttenberg, 2016). A permissioned system can be based either on whitelisting or blacklisting (Swanson, 2015). In defining those groups, certain know-your-customer processes are utilized. Whitelisting means that all listed participants are allowed to participate in the network. Blacklisting, on the other hand, means that a listed party is not allowed to participate in the network.

Swanson (2015: 6) continues that differences between permissioned and permissionless systems include speed of transaction execution, cost reduction, censorship, reversibility, and finality. As mentioned before, permissioned systems tend to work better in the financial sector: they are cheaper and they settle and clear assets faster than permissionless systems. Swanson (2015: 5) also predicts that banks are not able to implement permissionless systems because they are "vulnerably of transaction reversal by anonymous attack", which means that theoretically in a permissionless system a fraudulent party can affect the blockchain ledger if she possesses over 50 % of the computational force in the network.

This chapter discussed about technological progress in the world and how blockchain technology is part of that continuous progress. Blockchain technology has been characterized as an application of the fifth disruptive computing paradigm of our time. The characteristics that blockchain technology possess, such as the ability to come up with a commonly accepted distributed ledger with people that do not know or trust each other is a unique feature, and it will provide possibilities for many business models. Next, the theory of trade finance will be introduced and connected to blockchain technology.

# 3 TRADE FINANCE

The idea of trade finance is to utilize trusted third parties in mitigating the risk in international trade. In this chapter, the basics products and procedures of trade finance are introduced. In addition to defining the concept, it is connected to the other main concept of the thesis: blockchain.

## 3.1 Trade finance basics

When companies are facing risky international business operations, they tend to mitigate the risk by utilizing trusted third parties and trade finance products. The biggest problem at this moment in trade finance is that it relies heavily on paper documents when handling the information flow between different parties. By digitalizing the trade finance transactions and utilizing distributed ledger technology, banks and other related companies can save time and money (Silitschanu, 2016).

Cryptotechnologies carry the potential to change the way how trade finance is conducted. (Astri, 2016; EBA, 2016). EBA predicts that cryptotechnologies will not revolutionize trade finance overnight – but, rather gain momentum gradually around specific use cases or defined instruments around the theme. However, EBA sees that blockchain does possess the capability to change the trade finance in the long run.

To exemplify a trade finance transaction, the following example is presented. A QWE company in the United States is about to buy products from a supplier company ASD located in China. The importing company QWE wishes to pay as late as possible to make sure that the goods are going to arrive as planned. On the other hand, the exporting company ASD cannot be sure about the payment and might hesitate to ship the goods without being certain about the payment. Here we have a classical example of a situation where the parties need to make decisions under uncertain environment. At this moment, to counter this imbalance in trust and risk, both parties use intermediary banks to handle some parts of the transaction in the form of providing for example a letter of credit and bills of lading. Banks attached to the transaction act as third parties and also hold the cash for the companies.

The defined structure has been used in world trade for hundreds of years, with only minor changes along the way, thus making the whole process ready for a technical makeover because of the cumbersome and inefficient nature. The process however continues to rely heavily on physical paperwork which must be authenticated by all parties included in a transaction at every point (e.g. importer, exporter, importer's bank, exporter's bank, shipping company, receiving company, local shippers, insurers and others) (Silitschanu, 2016; TreasuryToday, 2016). One feature of international trade is that the parties do not trust each other perfectly and the transactions costs are high. When transactions are handled with manual work rather than through blockchain, there is a possibility for illegible signatures, which can cost delays in the process. Handling the process with paper and manual inspection also requires more steps than a digitalized version of foreign trade (Standardized Trust, 2016; EBA, 2016).

Especially the exchange of trade data has been an important factor in defining how trade finance works and how it evolves (EBA, 2016.) The exchange of trade data is related to the change of ownership of the assets in its innermost meaning. Instruments used in this information-exchange procedure aim to the approval and matching of data between trade partners and other parties involved in the process, such as customs and logistics. By applying cryptotechnologies, EBA predicts that the industry can improve the speed, efficiency, and security of the entire process.

By digitalizing and utilizing the blockchain or distributed ledger technology in trade finance brings benefits to all parties related to the transactions. Beck, Dicaprio and Pokharel (2015: 103) describe those benefits in detail as follows:

> "For buyers, it reduces working capital requirements by stretching out payment terms to suppliers, enhances relationships with suppliers through early payments, and helps secure delivery of supplies. For suppliers, supply chain finance creates the opportunity to receive early payment of invoices, reduces working capital requirements by reducing payables outstanding, allows better and predictable payment flows, creates an enhanced buyer relationship, and reduces financing costs. For lenders, supply chain finance leads to increased buyer financing with enhanced returns, efficient transparency and visibility of underlying

payables with an automated supply chain finance platform, and the opportunity to enhance relationships with buyers and their suppliers."

In other words, it has been stated that blockchain provides enhanced security and cost-effectiveness to trade finance (Korpela, Hallikas & Dahlber, 2017).

McKinsey (2016) has calculated that after applying blockchain technology to trade finance, banks can reduce operational costs by USD 13.5-15 billion annually worldwide and the trade partners, on the other hand, are able to reduce their cost of capital by USD 1.1-1.3 billion annually and also the operational cost by around 2 billion annually. Guo and Liang (2016) emphasize that in addition to cost savings, implementing blockchain technology to trade finance also saves time. Usually, a transaction process takes 7-10 days, but with blockchain UBS has estimated that it would reduce to about 4h. Less time means fewer risks according to Guo and Liang.

Next, open account way of doing trade finance will be explained. Open account trade finance is currently the most popular way of doing international trade.

### 3.2 What is open account trade

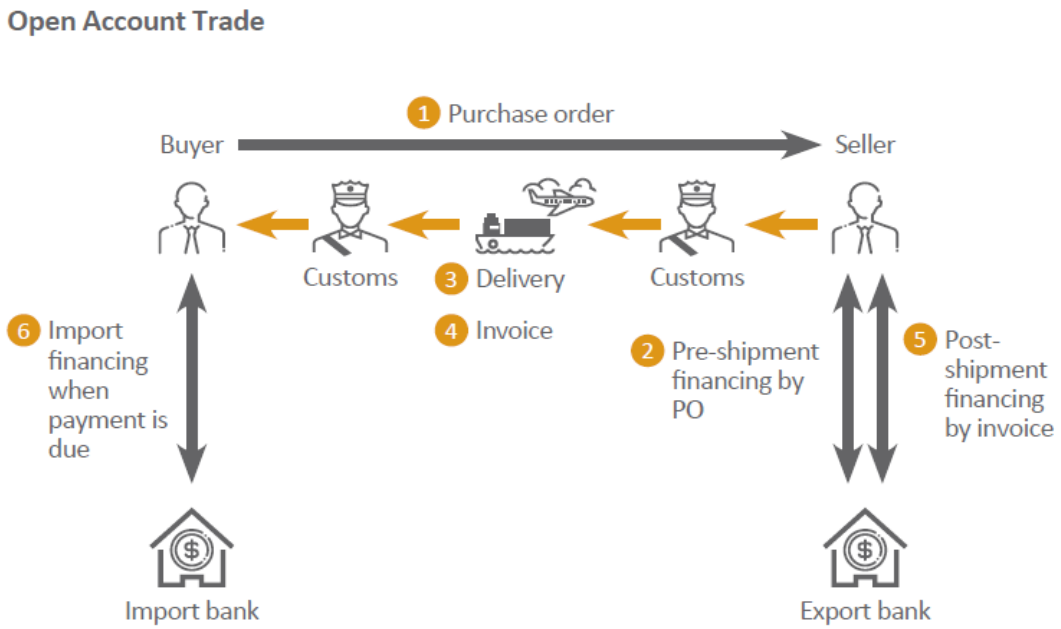


**Figure 2: Open account trade (Astri, 2016: 77)**

Open account based trade was chosen as an example of how trade finance is handled because it is the most widely used method in world trade. To understand how to overcome the pain points in this form of trade, it is vital to understand how it works. The picture above, provided by Astri (2016), demonstrates the overall structure of the different parties attached to a transaction, and what happens in each step.

Astri (2016: 78) defines the different steps as follows:

> 1. "Buyer and seller agree on a trade transaction on open account terms at a specific date and time. A buyer (e.g. a retailer) creates a Purchase Order (PO) and sends it to a seller (e.g. a supplier) for confirmation."
>
> 2. "The seller presents the PO to the export bank to request financing. The export bank determines pre-shipment financing subject to risks, such as that the PO is not confirmed or that financing is duplicated."
>
> 3. "After the goods have been transported to the export terminal and inspected by customs, they are transported by freight to the importing country. After customs inspection in the importing country, the goods are delivered to the importer. Neither the importing bank nor the export bank has access to the status of the goods delivery."
>
> 4. "The seller provides invoices, bills of lading and other transport documents to the buyer via a document courier."
>
> 5. "The seller asks the export bank for post-shipment financing by presenting the invoice. The export bank determines post-shipment financing for the seller, subject to the risk that duplicated financing and/or fraudulent transactions may have taken place."
>
> 6. "The buyer accepts the invoice and asks the import bank for import financing. The import bank determines the import financing, subject to the risk that a fraudulent transaction, duplicated financing, or financing of the seller may have taken place."

Astri (2016) describe that the traditional way of handling trade finance tends to be rather labor-intensive and time-consuming because rather heavy due diligence processes are needed to be sure about the validity of the trading partner. This process also requires reliance on the third-party activity in the documentation process to reduce the risk.

### 3.3 Problems of trade finance

Brunner et al. (2016) see that the vulnerability that is present in the traditional trade finance is multifaceted. It involves complex transactions, which are not cheap to execute. In addition, all this is done in a global context using multiple of legacy programs that are not interoperable.

Biggest problems in current trade finance are related to the data transferring between the different parties, which is extremely time-consuming. EBA (2016) states that the main pain point in the current way of handling trade finance is that the trade finance products and offerings are not well cooperative with the trading cycle. In a typical transaction, both, buyer and seller issue information to their banks which then verify and exchange that information. This kind of system is suitable for payments but inefficient for information because of the different information systems and legacy systems. Especially the letter of credit transactions has been extremely complicated when it comes to exchanging necessary information related to the transactions. (EBA, 2016.) According to Korpela et al. (2017), information exchange is handled by using computer-paper-computer manual operation model. The problem in this kind of information exchange system is that the necessary computer programs used by the different entities are not similar, and thus require a lot of manual entry and scanning (Korpela et al. 2017).

### 3.4 Smart contracts and trade finance

While the first generation of blockchain was focused on cryptocurrencies, the second-generation technologies enable smart contracts. These smart contracts are carried out by computation on a network based on conditional terms that have been agreed upon before the transaction, and they also rely on external variables in transactions where

exporter and importer along with banks and other intermediaries facilitate the financing (Peters & Panayi, 2015).

Lauslahti et al. (2017) state that it was the American cryptographer Nick Szabo who was the first one to explain the concept of smart contracts in his paper Smart contracts (1994) and that still nowadays the definition of smart contract is not clear, and especially the legal status of such contracts remains unsolved. Glatz (2014) via Lauslahti et al. saw that the it-infrastructures were not ready for the full-scale adoption of smart contracts back then, but there have been many experiments regarding the idea since. Especially, the blockchain technology has paved the way for the success of smart contracts (Marino 2016).

Cohen and Tyler (2016: 1) describe smart contracts as follows:

> "In the simplest terms, smart contracts are just computer programs designed to facilitate, verify, or enforce the performance of a conventional contract or, it is sometimes posited, make the use of a conventional contract unnecessary in certain cases. The computer code for a smart contract will be intended to validate and execute whatever terms have been agreed by the parties"

Differences between normal contracts that usually are in the form of writing, action or speech and smart contracts that are only computer programs are somewhat evident. One interesting difference is that while normal contracts are static, smart contracts are able to react to the information and data coming from outside (Lauslahti et al., 2017).

Cohen and Tyler (2016) have predicted that with smart contracts companies are able to grasp the full potential of the blockchain technology in many fields, especially in finance. Other fields have been interested in the combination of smart contracts and blockchain, but at the moment, only the financial sector has been able to come up with decent applications by applying blockchain technology. It is possible to create different kinds of ecosystems around smart contracts (Lauslahti et al., 2017).

The legal issues related to the use of smart contracts and other cryptographic law has been seen as a problem worldwide amongst the legal scholars (Lauslahti et al., 2017). In addition, the current state of the research regarding the technology is underdeveloped (Koulu, 2016). The current research agenda towards the topic is usually set to serve global perspective rather than one single juridical area, which is a welcomed approach, since the majority of smart contracts utilized in the future can be seen as having global as well as local reach.

The purpose of trade finance is risk mitigation in international trade. In order to fully understand the meaning of risk, we also need to discuss about the concept of trust, which will be done in the next chapter. Next chapter will also introduce the model of diffusion of innovation by Rogers (2003). This model is used to analyze how innovation diffuse into different social structures, into trade finance in this context. The aim of the next chapter is to bring the model of Rogers and Jøsang et al. (2005) together to form a foundation for the analysis part of the research

# 4 DIFFUSION OF INNOVATION AND TRUST

Diffusion of innovation has been studied at least for the past thirty years (Sahin, 2006). Sahin continues that the model of Rogers (2003) has been used recently in a variety of research disciplines including technology diffusion and adoption as the main framework. Rogers has been researching diffusion of innovation for a long time, and his first book about the theme was released in 1962. After that Rogers has revised his theories and this study is built on his 3rd revision that has been published in 2003.

Rogers (2010: 35) describes diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system." In this research blockchain is the innovation that is being analyzed and the social system is the trade finance industry. Diffusion of trade finance innovation includes human interaction among the members of a social system of trade finance. Since trade finance industry operates globally, those interactions often happen between people that have not had a prior contact with each other, which causes uncertainty. Haider and Kreps (2004) states that uncertainty is one obstacle to adoption of innovation. Uncertainty is present in trade finance daily. In addition to uncertainty that is built in to the international trade and which can be seen as mistrust, "one kind of uncertainty is generated by an innovation" (Rogers, 2003: 1). This can be seen in a situation where organizations or individuals are not sure if new innovation is better than the old way of doing things. The model of Rogers is used in this research to determine if attaching blockchain to trade finance is beneficial.

Haider & Kreps (2004: 7) has criticized the diffusion research saying it has been biased towards pro-innovation by stating the following: "implication of most diffusion research is that an innovation should be diffused to and adopted by all members of a social system, that it should be diffused rapidly, and that the innovation should be neither re-invented nor rejected." Even though the model of Rogers has been criticized, it provides a framework for investigating how blockchain technology diffuses into trade finance.

According to Sahin (2006) the model of Rogers (2003) has been widely used in fields of technology and education in determining how new innovations are adopted. Badzar

(2016), for example, has already utilized the model of Rogers in her study. Her study has similar presumptions: the original technology of blockchain was introduced first as a cryptocurrency, but after that it has been diffused in the finance sector. I will utilize a similar approach to the Rogers model since the scope of the study is to determine the usability of an innovation: blockchain theory in the mature field of business such as trade finance is. Badzar did not utilize the whole model of diffusion of innovation of Rogers. Instead, she concentrated on the five attributes of rate of innovation adoption.

The diffusion of innovation model by Rogers (2003) does not address the concept of trust. However, the concept of trust is emphasized in the research question and in the research gap. Therefore, it is important to include it also into the diffusion model of Rogers. Trust is an important issue in this context, and Clegg et al. (2002: 3) discuss that trust is present in innovation. They define innovation trust is as follows: "an expectancy of reasonable and positive reactions by others in response to individual innovation attempts." According to their paper, the innovation trust plays a significant role in the diffusion of innovation process. Because trade finance is so depended on mitigating risk and increasing trust, it is vital to integrate the factor of trust into the model of Rogers.

When integrating the concept of trust into the model of Rogers (2003), it is possible to widen the theoretical discussion around the diffusion of innovation research. Rogers (2003: 232) already addresses uncertainty towards the new technology in his model as he sees innovation distribution process as "an uncertainty reduction process". combined, uncertainty towards the innovation, and the mistrust between the participants of trade finance transaction are both being addressed. The uncertainty reduction process in innovation diffusion that Rogers addresses is not enough when studying diffusion of innovation in the context of trade finance, and therefore the model of Rogers is made wider by attaching the concept of trust into it.

As mentioned earlier, innovation distribution process has been seen as uncertainty reduction process. In this context uncertainty comes from both, new technology and from the nature of trade finance which is uncertainty mitigation. Therefore, the five attributes of rate of innovation adoption are being used from the model of Rogers

(2003). Rogers (2003: 23) define rate of adoption followingly: “it is the relative speed with which an innovation is adopted by members of a social system” In this context, the innovation is blockchain technology and the social system is the trade finance industry. It is important to determine the potential rate of adoption, because it is an important feature of adopting technologies that are built on top of blockchain technologies, which are based on network effect. In other words, there is no point in using any blockchain technologies if it has not been adopted by the masses.

These five attributes are (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability. These attributes reflect on how innovations are perceived by individuals. Table 1 below explains the meaning of each attribute. Since trade finance is a global phenomenon and there are multiple stakeholders and trading parties attached to each transaction, it is wise to understand how different people perceive blockchain as an innovation in trade finance from their perspective.

| | |
|---|---|
| **Relative advantage** | “The degree to which an innovation is perceived as better than the idea it supersedes” (Rogers, 2003: 15). |
| **Comparability** | “The degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters” **(**Rogers, 2003: 15). |
| **Complexity** | “The degree to which an innovation is perceived as difficult to understand and use” **(**Rogers, 2003: 16). |

| | |
|---|---|
| **Trialability** | "The degree to which an innovation may be experimented with on a limited basis" **(**Rogers, 2003: 16). |
| **Observability** | "The degree to which the results of an innovation are visible to others" **(**Rogers, 2003: 17). |
| **Trust**<br>• **Reliability**<br>• **Trust** | Not part of the original model of Rogers (2003). Attachment made in this research in addressing the trust factor in innovation research. |

**Table 1. Models of Rogers (2003) and Jøsang et al. (2005)**

Blockchain technology shifts the nature of trust towards process based trust, which will be addressed when discussing trust in trade finance context in the future scenario. Trust can be seen as a feature of the technology, and since trust has not been studied with to both blockchain and trade finance, it is important to create semantics and a framework for this kind of integration. This framework is created by integrating the parts of the diffusion of innovation theory by Rogers (2003) and the conceptualization of trust classes in internet applications by Jøsang et al. (2005) together as seen in the table 1 above.

These five attributes are integrated to Jøsang et al. (2005) categorization of trust, which includes context independent 'reliability trust' and context depended 'decision trust". This categorization of Jøsang et al. fits into the context of trade finance because both context dependent and context independent trust plays a role in mitigating the risk that trade partners are facing in international trade. Context dependent trust is present in

transactions where the parties know each other, whereas context independent trust means more trust based on reports of credit rating agencies.

The idea of the next chapter is to introduce the reader to the concepts of risk and trust, and how they are further divided into sub-categories such as decision trust and reliability trust. These sub-categories will be used later in the empirical part of the thesis. Concepts of objective and numbers-based reliability trust and more subjective traditional trust will also be utilized in the empirical part of the thesis. In addition, the concept of trust-sphere was utilized, and it means net of different trust-relationships between the trading partners in a trade finance transaction.

## 4.1 Trust and risk

Trust has been an important factor in the market structures throughout the history. Daignault et al. (2002) see that trust plays an enormous role in all sorts of business transactions even though there are legal remedies available. Another important issue, which Daignault et al. present is that during the rapid development of online business, all the characteristics of offline trust are not present in the online context. As mentioned in the chapter 2, where the impact of technological revolutions is described, it is important to notice that technological progress has an impact also on fundamental issues, such as how trust is seen in the world. Previously trust has been seen more like a personal relationship between the trustor and trustee. Now, it is interesting to see how trust can act like a feature of technology, when it comes to blockchain technology, and online trust.

What both offline and online trust have in common is that trust and risk are closely interrelated. Trust and risk are present in situations where a decision must be made in an uncertain environment. According to Aljazzaf et al. (2010: 1) “in human communities, there is uncertainty about the behavior of strangers. People who do not trust others avoid interacting with them”. This basic assumption about the mistrust between different people does not differ in the context of world trade. However, in order to trade, different parties must cooperate, even under a situation which includes a lack of trust between the parties. Up to this date, the lack of trust has been countered

with third parties such as banks or other financial institutions in trade finance setting. Distributed ledger technologies, on the other hand, have the potential to change this.

There are plenty of different definitions for trust in social sciences. Defining it is challenging, mostly because it has been considered as a subjective term (Aljazzaf, Perry & Capretz, 2010: 1) Further complication emerges in the context of blockchain when trust is either improved between the participants of certain transactions, or the need for trust is negated (Seppänen, 2016; Mattila & Seppälä, 2016.) In one example, Järvenpää and Teigland (2017) have stated that blockchain has the capability to enable the digitalization of a trust in the form of process based trust.

Reliability trust is defined by Gambetta (1988) via Jøsang et al. (2005: 2-3) as "trust is the subjective probability by which an individual, expects that another individual, performs a given action on which its welfare depends." (Jøsang et al., 2005: 2-3). define decision trust as "trust is the extent to which a given party is willing to depend on something or somebody in a given situation with a feeling of relative security, even though negative consequences are possible." One aspect of the reliability trust that is present in this research setting is the fact that in permissioned blockchain system different parties are legal entities that need to think about their real-world reputation as well. In trade finance, the reliability trust also has another aspect as the different parties are usually rated based on their behavior, which affects the trust setting.

Trade finance is built upon mitigation of risk, and it is therefore clear that trust between trading partners plays an enormous role. We must also understand the differences in the meaning of trust for different stakeholders in trade finance transactions. There is a trust-relationship between the trading partners, between the trading partner, and the bank, and between the banks that handle the financing. These different trust-relationships create the trust-sphere of trade finance network. The figure 3 below describes these different trust relationships between the parties that are present in trade finance transactions.

Suitable trade finance products are chosen depending on the amount and nature of reliability trust and decision trust between the import. Usually the combination of these two types of trust is different between each trade partner.


**Figure 3. Trust-sphere**

Botsman (2017) raises an interesting question: "The blockchain raises a key human question: How much should we pay to trust one another?" The essence of risk and trust in every market situation is captured in this phrase. This is also the reason why trade finance products exist: trading parties are willing to pay banks for taking some of the risk related to international trade. Botsman argues that banks and other third parties really need to prove their worth, because blockchain based immutable ledgers are able to supplement their offerings on mitigating trade risk. Leibowitz (2016) argues that it is the distributed nature of the blockchain ledger that makes the technology trust-free. According to him, if all the transactions are executed in that kind of a ledger, the parties in that transaction do not need to have established a trust relationship. In other words: "If each participant in the transaction trusts the blockchain itself then they do not need to directly trust each other" (Leibowitz, 2016: 1). Blockchain has been seen as the gateway to trust-free cryptographic transactions by Beck et al. (2016). The basic idea of a trust-free blockchain is to utilize decentralized rather than trust-based centralized transaction systems. In decentralized transaction, the parties do not have to trust each other, but they trust the system which has the characteristics of being immutable as well as irreversible, and everyone possess the one truth by seeing the whole content of the ledger. Even though blockchain technology has been seen as trust-free technology, it is still important to attach trust factor into the model of Rogers (2003) which we use to analyze the diffusion of this innovation to trade finance. By including the trust to the analysis, we are able to determine whether or not blockchain truly is a trust-free technology in this context.

## 4.2 Theoretical framework and conclusion of the literature review

This thesis is focused on fulfilling the research gap in the intersection of blockchain technology, trade finance and trust literature. This research gap is addressed with two research questions which are:

RQ1: How does the implementation of blockchain technology changes trust formation in trade finance?

RQ2: What are the advantages and disadvantages of blockchain technology in handling trade finance?

The theoretical framework for the thesis is built from the model of diffusion of innovation by Rogers (2003) and trust categorization by Jøsang et al. (2005). These two models have combined together in order to achieve a coherent view of the blockchain innovation diffusion process in the context of trade finance. Diffusion of innovation model by Rogers has been widely used (Sahin, 2016). In the context of blockchain, at least Badzar (2016) has utilized the model of Rogers previously. The concept of trust has not been studied in this context previously. Therefore, it is important to attach the trust categorization into the model of Rogers.

The methodological approach that is applied in addressing the research questions is an abductive analysis. Reichertz (2010: 15) has described abductive analysis as follows: "Abduction is therefore a cerebral process, an intellectual act, a mental leap, that brings together things which one had never associated with one another". In this context we are bringing together blockchain technology, trust and trade finance. Blockchain technology has been associated with either trust or trade finance previously, but this research is the first one that combines all three together. When doing abductive research, researcher starts with a pre-theoretical knowledge. In this regard, this pre-theoretical knowledge is built on the model of Rogers (2003) and Jøsang et al. (2005). This pre-theoretical knowledge formulates a lens for the researcher through which she observes the phenomena at hand. In this research, the phenomena is blockchain technology in the context of trade finance. The researcher does not try to prove a theory, but works towards a "discovery of an order which fits the surprising facts; or, more precisely, which solves the practical problems that arise from these." (Reichertz

(2010: 17). In other words, the theory orientates, but does not determine how researcher focuses the research, gathers the data and analyses it.

First research question includes all three concepts that form the thesis: blockchain, trade finance and trust. Theoretical background for all these concepts will be presented in the chapters two to four. Blockchain technology is introduced to the research setting by integrating it to the line of technological innovations in the history. This was done by introducing the concept of techno-economic paradigms by Perez (2004) into the discussion. Here, blockchain was seen as one application of the fifth disruptive computing paradigm, ICT-technologies. The nature of blockchain as radical and incremental innovation was also discussed based on the papers of Perez. After the discussion where blockchain was framed to the larger picture of technological progress, it was discussed in more detail. This section included technical discussion about the features of blockchain technology.

Trade finance was introduced in the third chapter of the thesis. The digitalization of the banking industry has made trade finance easier since the need for physical papers has decreased and automation helps along the process. However, only after the emergence of blockchain and distributed ledger technologies can the true benefits of digitalization be achieved in the trade finance context. The exchange of trade data (EBA, 2016), and financing and risk mitigation (Astri, 2016) are considered as the main areas in trade finance where blockchain and distributed ledger technologies have an opportunity to improve the efficiency and save for all the trading partners. In this chapter the basic concepts of trade finance such as open account trade. Based on the current state of trade finance and the problems its face, also the linkage to the blockchain powered trade finance was introduced. This was done by introducing the concept of blockchain based smart contracts as an option for the future trade finance.

The ideas of Roger's (2003) diffusion of innovation will form the foundation for the analysis for the research. Part of diffusion his of innovation theory will be used in analyzing how blockchain as an innovation spreads to the field of trade finance. The factors that are used from the framework of Rogers are relative advantage, compatibility, complexity, trialability and observability. Trade finance is closely related to risk and trust, and since blockchain has been called a trust-free technology,

it is vital to include the concept of trust into the theoretical framework. Therefore, the model of Roger's is combined with the categorization of trust classes done by Jøsang et al. (2005). The first research question is addressed with the model of Rogers and the second research question is addressed by using the categorization of trust classes by Jøsang et al.

# 5 METHODOLOGY

## 5.1 Introduction to the chapter

The purpose of this chapter is to define and justify the chosen research methodology. This is done by introducing the research process, philosophy and design. After that the methods of data collection and data analysis will be described.

## 5.2 Research philosophy

The research method applied is qualitative. The research approach is built upon abductive reasoning, which is based on the pre-theoretical understanding of the models of Rogers (2003) and Jøsang et al. (2005). "Abductive approach is designed to address the weaknesses associate with deductive and inductive approaches" (Dudovskiy, 2018: 83). According to Dudovskiy (2018: 83), the shortcoming of deductive approach is "lack of clarity in terms of how to select theory to be tested via formulating hypotheses." He continues that the weakness of inductive reasoning is that "no amount of empirical data will necessarily enable theory-building". According to Dudovskiy, abductive reasoning follows pragmatist perspective, and the researcher can utilize multiple different methods to when addressing the research questions. The purpose of abductive reasoning is to find best predictions based on incomplete predictions (Dudovskiy 2018: 84).

An abductive-natured thematic analysis will be conducted in the process of approaching the research questions. The approach was selected because it was seen the best way to investigate underresearched topic without many past applications. Those applications that have been seen are strictly proof-of-concept level projects, and therefore interviewees did not share much in this relation referring to trade-secrecy. Abductive approach enables to visualize and create a deeper understanding of the technology and processes around it in a specific context in trade finance and trust related setting, when there is no previous study about the topic, since the aim is not to find one truth, but rather the best guess based on the information available.

## 5.3 Research design

In order to understand the area of research, it is important to conduct a literature review on the topic. Literature review was the first part of the research. Literature mainly consisted of research articles. The lack of books in the literature review is explained by the pioneering nature of the study, and by the fact that the latest information on the technology can be found the articles and news pieces. Alongside the written material, also videos were screened to better understand the meaning of the blockchain technology and especially the logic how trade finance works now and what kind of applications have been presented. Mostly, the videos that I have screened for this research have been from YouTube and they have been found with similar keywords that were used to find the written material.

Empirical part of the research includes thematic analysis based documentary data and semi-structured interviews. Thematic analysis is the process of finding patterns or themes within qualitative data. Braun and Clarke (2006) see thematic analysis rather method than methodology. They also suggest that thematic analysis is not tied to any particular epistemology or theoretical perspective, and thus, it is a flexible method. Flexibility of the analysis method suits this research, since I will combine thematic analysis and the models of Rogers (2003) and Jøsang et al. (2005) in the analysis of the data. The purpose of thematic analysis is to find and identify themes in the data and do the analysis based on these themes or patterns. (Maguire & Delahut, 2017.)

## 5.4 Methods of data collection

As table 2 below presents, the primary data of this research is documentary data consisting of multiple whitepapers. Written material was gathered mainly by utilizing Google Scholar during January 2017 to the beginning of June 2017. This search engine was chosen mainly, because of the number of results, accessibility and the ability to utilize citations straightly. Most frequent keywords that were utilized were blockchain, blockchain technology, trade finance, supply chain finance, trust, digital trust, smart contract, platform, and standardization. These keywords were used solely and by utilizing Boolean operators AND and OR. There was no need to make any further restrictions because the number of the results were so little in general.

All sources were categorized under three main themes, based on the thematic analysis: blockchain technology in general, trade finance related literature and trust related literature. Doing this makes it easier to navigate between the sources. As Badzar (2016) has concluded, the number of academic papers about the blockchain is quite low, and research field is narrow and concentrated on financial services rather than other fields like trade finance. This narrow research field allowed me to construct meaningful research questions that will contribute to the field and remove some gaps in the trust-atmosphere of the trade finance after the implementation of blockchain or distributed ledger technologies.

The majority of the results from Google (around 100,000) provides non-peer reviewed articles that all share the basic principles of the blockchain and their potential in trade finance, while some of the papers only address Bitcoin. These papers are marketing-related and usually, do not include any scientific research or citations to such research. The searches from Google Scholar provide around hundred results with the Boolean operators AND and OR when combining the main research combinations, such as "blockchain AND trade finance" and "blockchain or distributed ledger technology AND trade finance." Given the large difference between the number of the results in Google and Google Scholar with similar key-words, indicates that the hype is larger in the financial institutions than in the academic world around the topic. Thus, we can conclude that there is a lack of academic research concerning the trade finance and cryptotechnologies. However, the interest towards these technologies in the financial sector is increasing based on the amount of marketing material and presentations that different banks have published.

Since the fact that the number of academic journals that are strictly related to the combination of cryptotechnologies and trade finance is limited, the main materials that provide the foundation for the analysis and to the framing the concept of blockchain are mainly whitepapers published by the European banking association (EBA), Hong Kong Applied Science and Technology Research Institute (ASTRI), and a group of Finnish trade finance and treasury professionals (Standardized Trust). These papers were chosen because of their prominent role in the field. These white papers were different in their nature and they all have been written from different perspective. European Banking Association is European Commission backed entity. Their focus is

to “foster dialogue and experience exchange amongst payments industry practitioners towards a pan-European vision for payments.” (EBA, 2017). Astri is a Hong Kong Applied Science and Technology Research Institute, and their paper was focused on blockchain technology in general in finance sector, whereas the paper of EBA was concentrated on trade finance perspective. Lastly, the whitepaper from Standardized Trust Collegian is also fully concentrated on the combination of trade finance and blockchain. This paper differs from the others in a way that the writers are trade finance professionals, all working in banks and other publicly-listed companies.

In addition to documentary data, interviews were conducted with industry professionals and researchers active in the field. These interviews are listed in the table 2 below. This was done to get as wide a perspective to the issue at hand as possible. The nature of trade finance also requires interviewing multiple sources, since in a trade finance transaction there are multiple different parties with differing incentives. The total number of interviewees was six. Three of them were trade finance professionals working in director-level positions in banks. Two of them were researchers working at an independent research facility. The last person was a treasury and a trade finance professional working for a publicly listed company. All the interviewees were Finnish nationals, and the interviews were conducted in person in Helsinki during June and July 2017.

| Documentary data: | Type of data: | Additional information; |
|---|---|---|
| European Banking association (2016) | White paper | 25 pages, EBA is an industry forum in Europe |
| Hong Kong Applied Science and Technology Research Institute | White paper | 98 pages, a research HKMA (Hong Kong Monetary agency), has commissioned the Hong Kong Applied Science and Technology Research Institute (ASTRI) to conduct |
| Standardized Trust collegian | White paper | 10 pages, a reform club run by trade finance professionals |
| Interview data: | Type of data: | Additional information |
| Banker 1 | Interview | Trade finance executive |
| Banker 2 | Interview together with trade finance professional | Trade finance executive |

| | | |
|---|---|---|
| Banker 3 | Interview | Trade finance executive |
| Trade finance professional | Interview together with banker 2 | Head of structured finance |
| Researcher 1 | Interview together with researcher 1 | Junior researcher |
| Researcher 2 | Interview together with researcher 2 | Senior researcher |

**Table 2. Documentary and interview data**

I produced an interview guide to categorize the questions under the three main themes of the thesis. Chosen categories were general blockchain related questions, trust related questions and trade finance related questions. In total, there were around ten questions with 2-3 follow up questions related to them. Main themes for the questions were blockchain, trade finance and trust. The duration of the meetings varied between one and three hours. All discussions were recorded and later transcribed to increase the validity of the research.

Doody and Noonan (2013) describe that semi-structured, or open-ended questions are related to the qualitative research method, both which I adopted to this research since the research setting and design dictates the best-suited method for getting the answers to the research question. Holloway and Wheeler (2010) state that the majority of qualitative researches utilize the semi-structured interview method. The benefit of the semi-structured interview is flexibility and spontaneity provides (Berg, 2009). In this research setting, semi-structured interviews were extremely beneficial because of the

nascent nature of the topic, which prevents the researcher from knowing all the relevant aspects of the topic, and the lack of public data. Hall (2017) has stated that semi-structured interviews are often preferred over structured interviews when researchers do not have well-developed understanding of the topic. Gray (2004) also mentions the usefulness of the semi-structured interview method in situations where the researcher is not able to consider all the different outcomes of the research. The conversational style that focuses on the topic enables approaching this kind of nascent topic most easily (Patton, 2002). Doody and Noonan describe that the possible drawback of semi-structured interview method is that the researcher is unable to keep the conversation to the point and is not able to ask more prompt questions when needed. Dearnley (2005), on the other hand, sees that semi-structured method of interviewing increases the validity of the research since open questions make the interviewees answer in more depth.

## 5.5 Methods of data analysis

This research consists of two kinds of data. Firstly, white papers as documentary data. Majority of the analysis is based on the documentary data. This data will be analyzed by using the model of diffusion of innovation by Rogers (2003). This model consists of the following attributes as categories: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability. Results from thematic analysis will also be utilized in the utilization of model of Rogers.

These factors will be considered from different scenarios, which will be the present and the time after the implementation of blockchain or distributed ledger technologies. In other words, an ex-post & ex-ante approach is conducted on the implementation process of these technologies. Since the adoption of the technology is an essence in gaining the network effect and thus far meaningful, it has an imminent meaning how people perceive these innovations, which are not similar in their nature. This is the reason why the model described above is so useful in this context in predicting the future success and the potential threats of the technology in this field.

The other set of data that will be analyzed is the interview data gathered from six interviewees. The interview data will be analyzed by using the thematic analysis approach, which is introduced in the next.

Nowell et al. (2017) has described six phases of thematic analysis as follows:

1.) Familiarizing yourself with your data
2.) Generating initial codes
3.) Searching for themes
4.) Reviewing themes
5.) Defining and naming themes
6.) Producing the report

The data set that was collected in interviews was transcribed and familiarized well in the beginning of the thesis process. I transcribed the data myself which helped in the familiarization process. Second phase of the process was to generate the initial coding. This part of the analysis is set to organize the data in structured way. By doing this, I coded each segment of raw data. Coding was not done in inductive way, where every line would have been coded, but rather each segment of the text was coded separately. Codes that were found are listed below under the themes.

Blockchain:

- Smart contracts
- Regulation
- Centralized
- Decentralized
- Permissioned
- Permissionless

Trade finance:

- Standardization
- Instruments
- Platforms
- Documentation
- Market practice

- Interoperability

Trust:

- Context specific trust
- Context unspecific trust
- Unknown partner
- Partner
- Risk
- Finance risk
- Counter party risk

Third stage of thematic analysis is the search for themes. In the end, it was natural to choose blockchain, trade finance and trust as preliminary themes, since they guided the literature review as well. Fourth and fifth stage of the analysis review and define themes, and this is done based on the preliminary themes (Maguire and Delahunt, 2017). Firstly, coded data is reviewed again for each initial theme to be sure that they produce a coherent view. Secondly, these pieces of data will be modified and developed in order to make the theme work better in the context of the whole research. The thematic map below provides the final themes based on the preliminary segments. The analysis of the data will be based on these final themes.

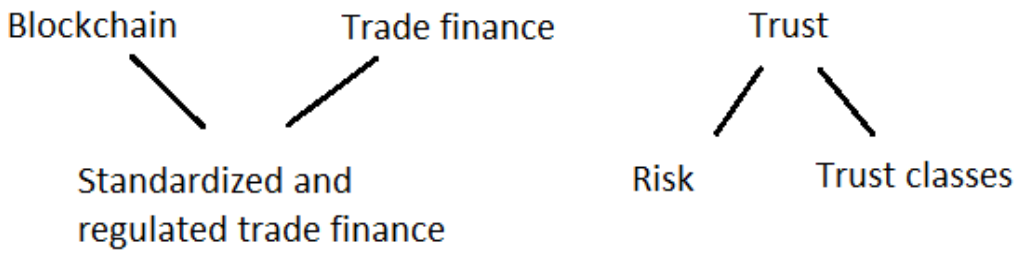


**Figure 4. Final themes of thematic analysis**

# 6 EMPIRICAL ANALYSIS

In this chapter written and interview data are presented and analyzed by using the models of Rogers (2003) and Jøsang et al. (2005), and by utilizing the themes resulted from thematic analysis. Written data will be analyzed mainly with the ideas of Rogers, and the interview data related to the concept of trust will be analyzed with the help of the model of Jøsang et al.

## 6.1 Diffusion of innovation – blockchain technology and trade finance

In the following diffusion of innovation analysis will be presented. The first part of the analysis chapter focuses on addressing the second research question with attributes of Rogers (2003), mainly based on the documentary data, while the other part of this chapter focus addressing the first research question based on the model of Jøsang et al. (2005).

## 6.2 Relative advantage

"The degree in which the innovation is perceived as better version than how things are done at this moment" (Rogers, 2003: 229).

According to Sahin (2016) it is the cost and social status motivational that mainly construct the relative advantage for the innovation. Are blockchain and distributed ledger technologies a better way to handle trade finance than the current way? Are they worth the investments and ready to be accepted as acceptable market behavior? This might not be the case in every context.

ICC Banking commission (2017) reminds us that the blockchain was truly a buzzword during the year of 2016. In 2017, the financial markets have noticed that the blockchain is not a silver bullet that has got an answer to all questions in finance, but rather it is the distributed ledger technologies, which should be the phrase used and that it does not offer an answer to all questions. It should also be noted that a critical cost-benefit calculation should be performed when even considering implementing any blockchain

or distributed ledger technologies because why implement a system if there is a cheaper way to do the same thing.

Trade finance is based on risk mitigation, and currently, the lack of trust is managed by utilizing various trade finance instruments offered by third party authorities such as banks. By doing this, the firms are able to have that amount of trust that enables them to conduct international trade. However, relying on heavy trade finance instruments and third-party authorities comes with a high price in costs. Blockchain technologies are a joint-effort between the different entities in trade finance context. There is no point in producing a solution in isolation. Both, cost structure and social acceptance are easier to achieve when working in consortiums. Blockchain technologies also might make it easier for smaller companies to conduct international trade because of the lowered cost structure.

Blockchain and distributed ledger technologies are able to overcome some aspects of lack of trust between the trade partners since these technologies offer tamper-proof contracts, transparency to the whole transaction, and traceability to the goods. The need for heavy trade finance instruments is not that high, which in the end saves a lot of costs. The ability to save costs should increase the total trade activity and enable even smaller players to participate in the international trade more easily. Especially open account trading, which is a cheaper yet more vulnerable way to handle trade, is benefitting from the improved transparency that blockchain and distributed ledger technologies can offer. In addition to transparency and the ability to avoid using heavy and costly trade finance instruments, by implementing these new technologies, banks are able to make their trade financing more agile and lower the risk of fraudulent financing. (Astri, 2016.)

These issues directly related to costs and new ways of handling trade finance are usually the first arguments in favor of adopting these technologies. However, in addition to such issues, there are also indirect benefits that are often not considered such as lowering the risk of manual errors in the process.

A notable issue is that all the whitepapers state that the banks are not going to disappear from the trade finance in the future. Astri (2016) for example discuss that in open

account based trading banks are still needed in financing, data transferring and matching. The implementation of blockchain technologies will only make processes more transparent and thus increases the trust in the trade finance setting. Astri (2016: 79) has further described three major factors that trade finance proof-of-concepts are aiming to achieve in the near future, "the use of smart contracts in open account trade, tracking of trade transaction statuses, and the matching of invoices to purchase orders."

### 6.3 Compatibility

"Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers, 2003: 15)

According to Sahin (2016) compatibility and relative advantage are seen somewhat similar, but are different in their nature. Sahin (2016: 18) continues that "if an innovation is compatible with an individual's needs, then uncertainty will decrease and the rate of adoption of the innovation will increase." Can blockchain and distributed ledger technologies be seen as compatible with potential needs of trade finance practitioners?

EBA (2016) states the current situation of the trade finance and the problems related to it are solvable with the technological progress, but despite the effort that banks and trading partners have put in to modernize the field, very little has happened. The trajectory that has been followed lately includes digitalization of current trade instruments (e.g. The Bank Payment Obligation) and the trade documentation related systems such as SWIFT's MT798. These initiatives have not been widely implemented and include many pain points. Main reasons why these initiatives have not worked is two-fold. Firstly, the lack of adoption, and secondly, interoperability between the legacy systems is difficult. Current programs are not planned interoperable between themselves, and there are separate programs for financing, invoice exchange, and for the ownership related issues (EBA, 2016: 7; Standardized trust, 2016).

The whitepapers utilized (EBA, Astri and Standardized trusts) all recognize that the blockchain or distributed ledger theories do not offer an all-out solution to the trade finance as mentioned above. Instead, they all see that the exchange of trade data and

financing aspects of trade finance truly can be affected by the technology. The exchange of trade data has been seen as the backbone of trade finance by EBA (2016), thus making it a potential starting point for the implementation of the technology in the trade finance context. A collegian of trade finance experts in the standardized trust whitepaper sees the way forward in a more general level than the other whitepapers as they see that instead of focusing on the trade finance instruments into the management of business models that the new cryptotechnologies make possible. Their argument is based on the idea that with this revolutionizing technology, there is no point in trying to optimize current systems and the status quo that they provide at this moment. Instead, there should be more focus on the wider business model transformation before any proof-of-concepts.

The past experience and social and market standards of trade finance have been centralized networks and ledgers for hundreds of years. As the compatibility factor measures how the new way of doing things differs from the previous when it comes to adopter's needs, existing values and previous experiences, that blockchain and distributed ledger technologies may well change the game. This game changing factor is the shift from centralized networks and ledgers into decentralized ledgers. This shift not only changes the previous experiences and the way business has been handled, but it also totally changes the values of participants. Still, the change is in line with the needs of the adopter's, since the decentralized way of handling trade finance enable so many things that centralized ledgers do not.

Moving from paper-based documentation into standardized digital documentation is another issue that will challenge the current status quo. Of course, the digitalization of the finance sector that has been present for some time has initiated this process, but the implementation of blockchain and distributed ledger technologies will speed up the process. Standardization of the documentation and smart contracts are also essential.

Another pressing issue is the interoperability between different blockchain and the overall interoperability of legacy systems and blockchains. Firstly, the adoption of blockchain and distributed ledger technologies are facing challenges because of the different legacy systems of banks and corporations. In an ideal case, the platforms that

are attached on top of legacy systems are so easy to implement that it will not cause any problems and hinder the implementation process. Secondly, the interoperability between different blockchain and distributed ledgers is an issue that will be discussed a lot in the near future. The standardization of trade finance instruments and documentation is of an essence in this matter.

### 6.4 Complexity

"The degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 2003: 15)

Unlike other attributes, complexity is negatively correlated with the rate of adoption (Rogers 2003). How hard it is to firstly understand blockchain and distributed ledger technologies and secondly, will the applications be hard to use?

Blockchain and distributed ledger technologies are hard to understand because of many reasons. Firstly, the inconsistent terminology around the subject causes misunderstandings. Secondly, the complex nature of different consensus mechanisms and differences amongst where and when a certain system is applicable complicates discussion on the subject. For example, many people cannot see the difference between cryptotechnologies and cryptocurrencies or the difference between permissioned and permissionless distributed ledger technologies.

The complexity of the technology may hinder the adoption process of the technology. In addition, the fact that these technologies must be integrated top of legacy systems which are not designed to function in a decentralized way may cause problems in the future.

Standardization and interoperability of the trade systems were issues that were raised in all whitepapers. Firstly, the standardization of trade finance instruments is seen as an important way forward by the standardized trust whitepaper. Standardization is the most important step in removing complexity around the topic. With standardized trade systems, the adoption of the innovation is easier. In addition, the interoperability of platforms used by different participants is important. Interoperability is often achieved

when standardization has been thought beforehand. At the moment, the interoperability of platforms poses a huge threat to the facilitation of trade, because most banks have their legacy systems, which have been built in the 1980s. The key to solving the interoperability issue is to a combination of standardization of trade finance instruments and the ability to integrate the chosen platform on top of different legacy systems. According to EBA (2016) these legacy systems and paper instruments which are needed to operate between different versions of the ledgers, are a weakness because they are not designed to be operated over the internet and in wide networks.

One crucial aspect related to standardization and interoperability of the systems is the need of a network effect and wide adoption of the standards and platforms by different participants. Without the critical mass adopting these fore mentioned issues, it is quite hard to see their success. A good example of this is the attempt to digitalize trade finance recently by utilizing the Bank Payment Obligation (thereinafter BPO) was not successful because it did not acquire wide enough adoption, according to Standardized Trust (2016).

One problem in the future implementation of blockchain is that there might be many different blockchain architectures and they might not be interoperable as they are (Roxas, 2016). De Meijer (2017) sees an integration of different parties into standardized network difficult and uncertain for several reasons. Firstly, all parties in a transaction must integrate the chosen blockchain, which is a huge infrastructural investment. Secondly, if all parties are not going to integrate the system, they still need to have some cooperation with the system, and thus need tools to participate in the payment and document transferring process.

Roxas (2016) sees that the poor interoperability of legacy systems that banks use is a threat to the adoption of blockchain in trade finance. In addition, he sees paperless transactions also as a huge barrier to adoption, because of the culture related to it. Roxas is amazed by a habit of still using paper as a means of trade finance transaction even though banks have invested heavily on digitalizing their operations. Roxas continues that purely investing on the technology will not solve the problems that trade finance is facing, but also industry collaboration, legal frameworks, and standards are needed to fully be able to grasp the potential of the technology.

Written data discussed not only regulatory issues but also included security related concerns. In general, since the whole area of cryptotechnologies is still quite new, there is no defined regulatory landscape presented to deal with the issues that might emerge. Another important issue is that usually the use of cryptotechnologies include multinational transactions, and thus far the regulatory landscape will be even more difficult to define since there are many legislations to be taken into consideration. In addition, the banking industry is already a heavily regulated industry, which will complicate the upcoming struggle to unify the regulatory space for cryptocurrencies and cryptotechnologies in general. One potentially stable scenario for all the participants would be a defined legislative space in cryptotechnologies, because based on the whitepaper by EBA (2016), many corporations might not implement the products they would like if they are unsure about how regulators will react.

Difficulty in understanding the phenomena of cryptotechnologies amongst banking professionals and boards is a big obstacle in the adoption of the technologies. Firstly, according to the interviews, the knowledge about the technology is not that widely spread amongst trade finance professionals. Naturally, there are entities that are aware of the potential of the technology in the field, especially amongst the financial technology companies, but the knowledge of a representative board-member is insufficient at the moment. The interviews also showed that some of the fintechs pitching blockchain-based solutions are not aware of what they are doing neither.

Regulatory questions around cryptotechnologies remain an unresolved yet extremely important issue. The reason for urgency is that regulatory framework around the topic remains unclear because of the nascent nature of the technology in hand (EBA, 2016). Regulating the industry around the technology is important, because uncertain playing field may hinder the adoption of the technology. Banker A’s opinion was that corporations and banks will use blockchain technologies regardless of whether they are formally regulated, and the regulators will allow them to do until something goes wrong. Formal regulation is likely to only emerge retrospectively, to prevent misuse? happening again.

## 6.5 Trialability

"Trialability is the degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003: 16).

Rogers (2003) has stated that adoption and ability to try it are positively correlated. Can blockchain and distributed ledger technologies be tested in a smaller scale before the actual implementation to the trade finance?

As mentioned in the trade finance chapter, this form of business conducted by the banks is essential in keeping the international trade flowing, because of the lack of trust between the different trade partners. Astri (2016) reminds us that the functions that banks provide to the trade partners are assurance and liquidity. In addition to these basic functions, the implementation of cryptotechnologies will, according to Astri (2016: 76), help to digitalize the manual process of documentation between the parties, improve operational efficiency, reduce errors and make the working capital more predictable.

The first major change in the way trade finance is handled was the shift to the open account based trade from the documentary credit based trading, which means the letter of credit trading. According to Astri (2016), the change from letter of credit to open account based trade increases the risks, at least from the bank perspective, since the risk of money laundering and overall fraud is more imminent, because third parties handling the documentation are not needed in the same respect than in the traditional letter of credit based transactions. EBA (2016) has estimated that roughly 90% of the global trade is handled using the open account based trade. It is therefore inevitable that these difficulties must be overcome to keep the trade flowing in the future as well.

European banking association EBA (2016), Hong Kong Applied Science and Technology Research Institute also known as Astri (2016) and Standardized Trust collegian (2016) all suggest that cryptotechnologies are the best way to deal with these problems face in the open account based trade finance nowadays. EBA (2016) predicts that the wide adoption of cryptotechnologies will not be fast and wide, it will rather

concentrate on few cases. In the context of trade finance, these use cases will relate to the change of trade data and financing.

The trialability of blockchain and distributed ledger technologies is an important step in the adoption process. Many companies are part of consortiums that have been running proof-of-concepts around the topic in small scale. However, these consortiums have a tendency for high turnover in the number of participants, which can cause problems. For example, many banks have terminated the cooperation with one of the most visible consortium, the R3 Cev. Goldman Sachs, JP Morgan & Chase, and Santander are one of the biggest companies that have changed their alliances when it comes to blockchain consortiums. Hackett (2016) suggests that this kind of activity is a sign that the field is getting increasingly mature. At the time of writing this thesis, there are however still some 70 members in the R3 Cev consortium making it the biggest in the market, including Finnish banks such as Nordea and OP financial group.

The importance of the network effect is manifold in blockchain and distributed ledger context. Firstly, since the technology is based on shared ledgers, it is extremely important to include as many parties as possible in the platform that is being built. This brings huge scalability benefits to all participants. Secondly, since distributed ledger technologies will be implemented on top of old legacy systems, which are not designed to be used in distributed way, it is more useful that there are many parties included in the process, and that the systems will be interoperable.

Usually, the trialability of blockchain networks is easy due to the network being designed to be permissionless. Participants can also join and exit as they wish. However, in the permissioned networks – which trade finance networks will become – joining and exiting is much harder. Joining and participating in consortiums or other blockchain alliances can be based on blacklisting or whitelisting (Swanson, 2015). This practice of listing is based on knowing the identity of the participant, which is a common procedure in the finance sector and permissioned systems, but not in the permissionless cryptocurrency systems. Having this kind of procedure for knowing the identity of the parties in the network is essential in trade finance, which is based on mitigating risk.

## 6.6 Observability

"The degree to which the results of an innovation are visible to others" (Rogers, 2003: 17).

Observability is also positively correlated with the adoption of the innovation. Especially peer-observations are important, according to Rogers (2003). What are the visible benefits of blockchain and distributed ledger technologies in trade finance setting?

After the successful implementation of distributed ledger technologies into the trade finance sector, benefits become visible as the cost structure gets cheaper, and risk assessment is easier with credit ratings in immutable ledgers. In addition, there will be an increased speed in clearing the transaction which is no longer based on the handling of physical papers. These benefits are mostly observed by the insiders of the trade finance setting. However, there are also visible results for outsiders, which are important in the model of Rogers (2003). These benefits can be experienced in increased volume of trade finance and in the increased number of companies using the trade finance services. This is likely because after implementation, such services will be more affordable even for the smaller firms.

However, the implementation of blockchain technologies will also disrupt the banking and finance sector. There will be growing number of financial technology companies and other companies competing with established companies and trying to take away parts from their value chain.

The smart contract in the trade finance setting is another concept that is present in every publication and interview that was conducted. EBA (2016: 12) sees smart contracts as an "application layer" built on top of the cryptotechnology platform. The main function of smart contracts is that they are self-executing and based on a computer code, which enables contracts that cannot be altered and which will be carried out surely when the defined event has occurred. These features of smart contracts disable the possibility for double invoicing and make the triggering events more precise. In addition, the decreased manual processing will reduce the amount of

handling error made by humans, which is another fact that is widely appreciated (EBA, 2016).

Because of the way smart contracts are written and executed, banks and other legal agencies might have an advisory role in the future in advising their clients about using and developing smart contracts (EBA, 2016). It is not only the technical aspects of the smart contracts that can cause confusion among the companies, but also the terms of the contract that needs to be translated into code, along with know-your-customer procedures (EBA, 2016).

The first part of this chapter concluded that blockchain has the potential to revolutionize business models in general towards the direction of a decentralized way of doing business. This idea is based on the potential of the technology and the idea that with technologies such as blockchain, business models should be restructured completely rather than just trying to optimize current ways of working by integrating blockchain technology to them. On the other hand, it has been said that blockchain technologies will not solve all problems that companies currently have. There is no point implementing blockchain technologies if there is no business value in it, even though there is a hype around the technology.

When building completely new business models on top of new technology, a few things need to be in place for such efforts to be successful. As mentioned in the chapter 6.4, it is vital that standards are formed beforehand to make sure that systems are interoperable, which is the most important feature of decentralized systems. Regulation should also be taken into consideration when creating new business models on top of new technology such as blockchain. At the moment, the regulation towards cryptotechnologies is not implemented or drafted. Interviewees concluded that there are two possibilities how regulation will be arranged. Firstly, regulation will come from within the market initiated by the companies themselves. Secondly, regulators in different countries will come forward and implement regulation to cyptotechnologies

Documentary data was analyzed by using the model of Rogers (2003). Main findings from the five attributes of diffusion of innovation are listed next. Firstly, the relative advantage of blockchain technologies in trade finance sector are related to the fact that

these technologies offer tamper-proof contracts, transparency to the whole transaction, and traceability to the goods. In addition, there will be no need for heavy trade finance instruments, which lowers the overall cost structure. The ability to save costs should enable even smaller players to participate in the international trade more easily. Secondly, the compatibility factor measures how the new way of doing things differs from the previous when it comes to adopter's needs, existing values and previous experiences. Blockchain technologies may well have an effect in the trade finance industry. This game changing factor is the shift from centralized networks and ledgers into decentralized ledgers. This shift not only changes the previous experiences and the way business has been handled, but it also totally changes the values of participants. Thirdly, interoperability and standardization of trade finance systems along with the implementation of blockchain technologies will be beneficial, because the lack of interoperability and standardization make trade finance complex at this moment. Fourth, the possibility for trialability of blockchain is a necessary step in the adoption process. To this point, companies have formed consortiums that have been running proof-of-concepts. In addition, the importance of the network effect is manifold in blockchain context. This is because the technology is based on shared ledgers, which makes it vital to include as many parties as possible in the platform that is being built. In addition, since blockchain technologies will be implemented on top of old legacy systems, which are not designed to be used in distributed way, it is more useful that there are many parties included in the process, and that the systems will be interoperable. Fifth, the observability of the successful implementation of distributed ledger technologies into the trade finance sector is important. The benefits become visible as the cost structure gets cheaper, risk assessment is easier with the credit ratings located in immutable ledgers. Along with that, the clearing of the transaction is not based on physical papers, there will be an increased process. These benefits are mostly observed by the insiders of the trade finance setting.

## 6.7 Trust

Next, the main findings from six different interviews will be presented and analyzed. For the sake of anonymity, different interviewees will not use their own names, but rather pseudonyms such as banker 1. Previous chapter did documentary analysis based on the written material that was gathered for the thesis and concentrated on addressing

the research question two about the usability of blockchain technology in trade finance. This section focuses on addressing the first research question,

The structure of the trust analysis is as follows: first, the interview data is used to create ex-ante view of the trust-sphere and trust classes. Secondly, an ex-post approach is taken by utilizing the same interview data. After the interview data is presented and analyzed by using the ex-ante and ex-post analysis, the trust categorization of Jøsang et al. (2005) is introduced and the results of ex-ante and ex-post analysis are reflected against it. Themes that were identified in the thematic analysis will be utilized also in this part of the research.

As mentioned in chapter four, the nature of trust is manifold and usually hard to conceptualize because of its dynamic and context-dependent nature. This issue caused challenges in interviews because trust was understood differently amongst the interviewees, and the context is different for each party attached to trade finance transaction. To overcome this issue, trust was divided into two categories to present it in a simplified way: the trust-sphere, which means different trust relationships between the trade partners on trade finance setting, and types of trust. For the interviewees, the trust sphere was easier to understand because the setting was familiar to them. For example, the trust relationship is different between the buyer and the seller than it is between the buyer and her bank. In addition, the trust towards the platform that is being utilized in the network is part of the trust-sphere. The other category was the categorization of Jøsang et al. (2005).

The diffusion of innovation model by Rogers (2003) described in chapter four does not include the trust factor built in the diffusion of innovation framework. The prominent role of trust in the diffusion of innovation is apparent because of the uncertain nature of innovations, especially when trying to diffuse them into business settings. Clegg et al. (2002: 3) define innovation trust as “an expectancy of reasonable and positive reactions by others in response to individual innovation attempts.” According to their paper, innovation trust plays a significant role in the innovation process. Because the model of Rogers does not include the concept of trust, the model of Jøsang et al. (2005) is attached to it. This provides the other categorization to trust in addition to trust-sphere. Also, Clegg et al. see trust in the innovation process as

being of key importance. Especially the perceived characteristics of innovation section can benefit from consideration of trust, since it also affects whether individual companies will adopt the new innovations or not. The issue under investigation is the materialization of trust through a technological approach which is based on algorithms and cryptotechnologies.

### 6.7.1 Observations from current situation in trust formation between the trade partners before implementation of blockchain technology

Consensus answer from all participants was that at this moment, lack of trust is the main reason for corporations to utilize trade finance instruments and third-party intermediaries. Banker 1 described the meaning of trust and the main risk attributes in international trade which trade finance is designed to mitigate:

> "When conducting international trade, possibly with unknown partners, the meaning of trust is extremely important and the main reasons for the lack of trust at this moment are the follows; finance risk, counter party risk, country risk and political risk."

Banker 3 continues the following idea and reminds about the basic principles that are dominant at this moment:

> "Today, it is possible to handle risky transactions because of the third-party intermediaries that are willing to take the risk for certain compensation."

Banker 1 also followed that especially the risk that is related to financing and mitigating the payment risk are the main attributes of risk that banks are able to mitigate with trade finance instruments in exchange for money. All bankers were aligned with the idea that the use of trade finance instruments can be based on the lack of trust between the trading partners currently. They also all agreed with the idea that current trade finance instruments are not able to mitigate all the risk in the transaction such as political risk or country risk.

The amount of risk that the trading partners carry in transactions is an important topic. Blockchain and distributed ledger technologies might have the ability to make the distribution of risk more equal between the partners. At the moment, according to banker 1:

> "At the current model of how trade finance is handled the distribution of risk should be equal between the partners, but in the reality, it is the seller that carries bigger amount of total risk that is present in the transaction since that party makes the product, ships to the customer and expects to be paid."

> "Also, the buyer has got her own risk; am I going to get such a product that I ordered, will it arrive at the specific time. That risk is also considerable, since the buyer may have had other commitments that are related to the ordered product."

When estimating the distribution of risk between the partners, it is extremely important to have some understanding of the counterparty. To understand this better, all bankers used decision trust and reliability trust aspects in explaining the overall trust-sphere between the partners. Trust was seen collectively as a subjective term, and it was concentrated more on the personal relationships between the individuals that represent the companies. Banker 3 explained the following:

> "Previously, this kind of context dependent decision trust was utilized more, but nowadays the importance of compliance and regulatory issues have made the importance of quantified or context independent reliability trust or reliability more dominant."

This means that the decision trust which can be seen as more subjective and regulation-free was dominant in the past, but nowadays the more numbers-based reliability trust is more important because of the tighter regulatory landscape.

In addition, the representative from the large Finnish corporation agreed that trust is more of an issue that the third-party banks must deal with and the trust relationship

between buyer and seller remains as an important issue when deciding how heavy instruments will be utilized in the transaction.

### 6.7.2 Predictions on the future state in trust-formation between the trade partners after the implementation of blockchain technology

A shared view between the bankers for the future state of the trust formation after the potential implementation of blockchain and other distributed ledger technologies was that the risk-element cannot be fully overcome with any technology, even with trustless cryptotechnologies. There will always be country and political risk which can change the circumstances for the trade partner. Another shared view was that it is hard to determine whether the proportion of trust that is carried by the trading partners change somehow, but it will be lower on a general level when some parts of the risk can be mitigated with the cryptotechnologies, and costly trade finance instruments might not be needed. Banker 1 described this effect:

> "After the implementation of transparent and immutable cryptotechnology, the trading partners do not need the focus on the risk of copying and double spending. Once the information is put in the shared ledger, it will remain there, or it will be rewritten under a consensus."

Banker 2 stated the following about the overall improvements in the trust-sphere after the implementation of distributed ledger technologies:

> "After the integration of blockchain or some similar shared ledger technology, the trust in a permissioned network will be better all-around because of the transparency and immutability, but the risk of cyber-risk must be remembered."

Even though not all risk can be forgotten after the implementation of the cryptotechnologies in trade finance, the risk mitigation potential can yet have significant impacts on all the parties attached to the trade finance transaction. The role of the trusted third party will also change after such implementation, but they will not

vanish from the setting. Banker 2 and the corporate representative stated that the subjective decision trust between the individuals representing the trade partners will not change after the implementation, but the importance of reliability trust that can be based on ratings and credit-worthiness will have a bigger role, as the distributed trust white paper also predicted.

As we have stated many times, the basis for trust in the distributed ledgers in trade finance context is the transparent and immutable nature of the technology that will be utilized eventually. However, there are also privacy issues related to the discussion. Banker 2 and the corporate representative along with banker 3 were all worried about leaks of sensitive information when data is stored in a distributed ledger. According to them, for the solution to be implemented it must be designed in such way that the information is only available for the party that needs to see it. Price and quantity information were seen as too sensitive to be visible for certain participants in the distributed ledger.

According to banker 1, after the implementation process, the role of open account based trading will become even more important, and the need for old and heavy trade finance instruments will decrease, but not disappear. Banker 2 and corporate representative pointed out that the trust between different permissioned ledgers that are formed by multinational banks is an important issue, and that most likely the trust between these permissioned ledgers or consortiums will be more important than trust between individual banks, because the trust and risk is distributed in such networks, unlike in the present situation.

Trade finance platforms will be based either on consortiums platforms (Corda) or platforms designed and manufactured by a single entity (IBM). The difference in these two options is evident. The issue is present also in the standardization of the trade finance instruments and practices in the future. There, the approach can be either market-initiated (someone's initiative will be followed), or an institution/regulator initiated (based on International Chamber of Commerce initiative).

As Swanson (2015) suggested the consortiums and other distributed ledgers will be based on white- or blacklisting the participants, which means that they are legal entities

which will be evaluated and their actions can have juridical consequences. This kind of know-your-customer and know-your-business approach to the permissioned network was seen as an important matter by banker 2 and the corporate representative. Thus, in the case of trade finance, when a party is seeking protection from fraud, the answer is a permissioned network that utilizes white- or blacklisting to new participants.

The second part of this chapter focused on the interviews which linked the trust factor into the discussion. Because there were no articles available that included trust, trade finance and blockchain, it was crucial to interview professionals from each field and focus on the trust factor in the interviews. A conclusion from the interviews was that currently trade finance is based on risk mitigation. Where there is a risk, there is also a need for trust. Blockchain is able to mitigate risk and increase trust in trade finance setting because of its unique features based on cryptotechnologies. By utilizing these technologies, it is possible to mitigate some parts of the risk and therefore revolutionize how trade finance will be done. On the other hand, blockchain technologies are not able to mitigate all the risk, such as country risk.

# 7 CONCLUSION

This concluding chapter answers the research questions and sums up the most meaningful findings and implications of the research. The empirical findings and analysis are combined to present coherent answers to the designated research questions. Finally, the reliability and validity of the research are discussed along with potential recommendations for further research objectives.

This research was built around the new innovation, blockchain technology. I have described blockchain technology in relation to wider technological progress with reference to Perez's theory of techno-economic paradigms, where blockchain technology was seen as one application of the fifth disruptive computing paradigm of our time.

Next, blockchain technology was connected to trade finance literature and trust. Both of these concepts were defined, and I explained how they interact with blockchain technology. In conclusion, blockchain technology has been seen as the technology that is able to change how the practices of over 300-year old trade finance are conducted. Secondly, the concept of trust in trade finance setting was discussed with trade finance professionals, and their opinion was that blockchain helps to mitigate some aspects of trust-related problems in trade finance, while still being inefficient in mitigating all risk related to trade finance.

The model of diffusion of innovation by Rogers (2003) combined with the trust classification by Jøsang et al. (2005) formulated the theoretical framework for the research. This framework formulated a pre-theoretical understanding theory, and acted as a lens through which I observed the phenomena at hand which was blockchain in trade finance context. This pre-theoretical understanding orientated the data gathering and analysis, but did not determine it. Next, research questions will be addressed one by one.

RQ1: How implementation of blockchain technology changes trust formation in trade finance?

Chapter four highlighted that trust is an extremely complicated concept because it can be seen as having subjective features, it is dynamic in its nature, and it is context relevant. To understand trust in this context, and to make it more digestible for the reader and the interviewees, trust was categorized in three ways. Firstly, a trust-sphere in trade finance context was created. In this sphere, there are three different relationships; the relationship between the buyer and the seller, a client and the bank, and the overall trust on the platform that is being utilized in the network. Secondly, the difference between subjective decision trust and objective reliability trust was utilized in the interviews, and the difference in the tone of the trust was proven important in understanding the overall trust in trade finance. In answering the research question, an ex-ante and ex-post approach was utilized to understand the change in the way how trust affects the field after the potential implementation of the distributed ledgers and blockchain technologies. In addition, an attachment of innovation trust was included in the model of diffusion of innovation by Rogers (2003) to better understand this aspect of trust in this diffusion process. These answers are mainly based on the interviews, while the answer for the other research question is mainly based on the issues that were present in the white papers as written data.

Based on the interviews and the white papers, the lack of trust on the trading partners is the main reason for using trade finance products and trusted third parties in the international trade. This lack of trust is based on different categories of risk such as financial risk, counter-party risk, country risk, and political risk just to name a few. By utilizing the trade finance products that are present today, companies are able to mitigate the risk as banks take some part of the risk but require compensation for this. Another key factor that was discovered was the use of subjective decision trust between the individuals representing the companies: it has been more important in the past than it will be in the future because the regulatory landscape has tightened, and because of the continued dominance of reliability trust based on credit ratings.

In the future when distributed ledgers and other blockchain are implemented, the nature of trust is likely to change slightly, towards the direction of context independent reliability trust, according to the interviews and the white papers. What is important to remember is that these technologies are not able to remove all risk, and there is still room for trusted third parties and banks in the future. Their role may however change.

Since distributed ledgers are able to solve the problem of double spending, and they are immutable in their nature, the transparency of the whole transaction is improving, and the need for trust will be smaller in the future according to the interviews. Therefore, it must be stated that blockchain cannot be seen as truly trustless technology as predicted before starting this thesis.

In conclusion, the change in trust will be based on the change from an approach where trusted third parties are used to mitigate risk into a more open version where the trust is based on algorithms, smart contracts and immutable ledgers with credit ratings of different parties.

## 7.1 Opportunities and threats of cryptotechnologies in trade finance

RQ2: What are the advantages and disadvantages of blockchain technology in handling trade finance?

Trade finance is an industry that has long roots in history, and it has remained fairly unchanged for centuries. It is one of the key banking businesses that continues to use paper-intensive processes. Trade finance is conducted traditionally to overcome trust and risk related issues that are present when companies conduct international business and do not know the trading partner nor trust them.

The number of different benefits the technology can offer is promising. The main idea of the technology is to provide transparency to the industry by utilizing decentralized ledgers, which means that all participants in the network hold a copy of the ledger, instead of the traditional centralized ledgers. By applying decentralized version of the ledger transparency is improved, and the need for traditional trade finance instruments is decreased. Blockchain technologies also enable the use of smart contracts that are able to validate and execute transactions, and the originality and authenticity of items that are being utilized in the network.

When considering the benefits that are applicable directly to trade finance, the answer is manifold. Some benefits are related to technological breakthroughs that enable different business models to be utilized in the future, while some benefits are related

to improving the present systems. Overall, the digitalization of trade finance that has already begun before the integration of any distributed ledger technologies will speed up, and the shift from paper-based to standardized and digital documentation is on the way. In addition, the tamper-proof nature and immutability of the technology increases the transparency in trade finance overall, which in turn increases the overall trust and decreases the costs for all players. Because trade finance has already shifted more towards the riskier open account trade, all of the mentioned abilities of trade finance will be welcomed, and since the open account based trade does not utilize as much trade finance instruments, the ability of distributed ledgers to provide a more transparent and real-time based supply-chains is a great benefit.

Overall, companies are dealing with the possibility of frauds and errors because of the manual work that is needed in the present trade finance documentation and financing. By implementing distributed ledgers and blockchain technology solutions, these issues can be overcome since the immutable data can be verified and cross-checked more effectively and the need for trusting the other party changes.

Distributed ledgers and blockchain technologies are not a silver bullet that solves all the problems related to finance. Even though these technologies solve many problems in trade finance, they do not remove all the risk from the industry, and they might not be the most suitable solution for all aspects of trade finance. Why would you implement a technology somewhere if it does not cut down the costs or solve any problems?

Firstly, the regulatory and legal issues around the topic remain unclear, which can have an effect on the implementation of the technology. These issues are pressing since the regulatory landscape is already complex because of the international perspective of the trade. Secondly, the standardization of the processes and documentation poses a threat, since the systems are fully functional and can provide cost savings only if they are widely used. There is an open discussion whether standardization will become market-initiated or if the ICC will have a big role in it. Combined, these two issues make up the most pressing threats to the implementation of these technologies and the near future will show how these things are handled.

Based on the model of Rogers (2003) rate of innovation adoption, blockchain possesses a lot of factors that increase the rate of innovation adaption. From relative advantage point of view blockchain decreases the cost structure and reduces the number of manual errors in the process. Compatibility of blockchain technologies in trade finance will challenge the status quo of the trade finance since it will shift the processes from manual and paper-based documentation into digital and algorithm based one. Complexity of the implementation of blockchain technologies into trade finance correlates negatively to the rate of adoption. Interoperability with the legacy systems will be a complex operation and take time. Therefore, blockchain will not be implemented overnight. The trialability of blockchain and distributed ledger technologies is an important step in the adoption process. This will most likely happen through consortium based proof-of-concepts. This kind of market penetration is about to happen during the year of 2018.

## 7.2 Reliability and validity of the study

The reliability and the validity of the study have been kept in mind when choosing the research methods, doing the interviews and conducting the analysis. Because of the nascent nature of the technology and the phase of implementation of it in the trade finance, the amount of knowledge available is quite limited, but there are some whitepapers available to present a coherent view of the present situation and about the potential future. By doing an interview research and by interviewing a wide range of professionals interested in the blockchain the validity and the reliability of the research got better and the overall picture about the future was easier to produce also for the writer. The validity that was achieved is based on this wide number of professionals having different incentives towards blockchain and by comparing it to the whitepapers that were present. On the other hand, the reliability of the interviews can be challenged, since not all of the interviewees were fully capable of talking about the technical perspectives of blockchain and thus they might have presented biased answers. Validity of the data was increased by the interviewing not only banking professionals but also corporate treasurer and independent researchers. The data might be geographically biased since all of the interviewees were located in Finland, but that was tried to overcome by choosing multinational companies to be interviewed. The reliability of the study was increased by choosing the semi-structured interview. This

approach was fruitful because the technology is so new and the knowledge of the writer was not clear at the time of the interviews. Also, the interviews were recorded and later transcribed to increase the reliability.

## 7.3 Future research agendas

Seppänen (2016) has listed the current main problems related to the use and study of blockchains. At this moment, the lack of research paper is the biggest problem when doing research on blockchain technologies. Especially papers that cover both: blockchain and trade finance are rare. Further, Seppänen (2016) mentions that also the terminology around the topic is currently inconsistent and some people might misunderstand the whole meaning of blockchain because of this matter.

Blockchain and distributed ledger technologies remain extremely interesting research setting for the future as the applications start to surface and there will be more data available. The impact of trust in the context is also a future research agenda since the effects on trust are not visible until the proof-of-concepts are rolled out and tested in the real world. It would be interesting to have a similar research setting, but with more focus on the trust-sphere, where all of the participants in the transaction are included. This kind of research can be done within the next few years after there will be enough data and the relevant participants are ready to share information after implementing the systems.

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