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Strategic effects of Distributed Ledger Technology on banking sector in Finland

Master's Thesis

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Vuodesta 2007 alkaen Suomen pankkisektori on käynyt läpi murrosta johon on vaikuttanut niin talouden vaihtelut, kiristyvä sääntely kuin digitalisaatio. Uusi teknologia-arkkitehtuuriratkaisu, hajautettu tilikirja teknologia on noussut tämän jälkeen esiin ja saanut osakseen paljon huomiota. Teknologian on kuvattu olevan suurin mullistus sitten internetin kaupallistumisen. Hajautetun tilikirja teknologian vaikutusten on esitetty olevan erittäin voimakkaasti disruptiivisia erityisesti pankkialalla. Tämän tutkimuksen tavoitteena on hahmottaa hajautetun tilikirja teknologian vaikutuksia Suomen pankkialaan ja sen kehitykseen tulevaisuudessa. Tutkimus on empiirinen ja siinä käytetään kvalitatiivista Delfoi tutkimusmenetelmää pankkialan tulevaisuuden hahmottamiseen. Tutkimus lähestyy hajautettua tilikirja teknologiaa sekä sen vaikutuksia Christensenin Disruptiivisen Innovaatio teorian kautta. Työssä esitetään nykytutkimuksien eri määritelmiä hajautetulle tilikirjalle ja korostetaan tarvetta yhteisesti hyväksytyn määritelmän löytymiselle. Tutkimuksen mukaan Hajautetulla tilikirja teknologialla on suuria vaikutuksia Suomen pankkisektorin tulevaisuuden kehitykseen. Teknologian kuvataan aiheuttavan strategisia muutoksia vaikuttamalla markkinan rakenteeseen ja kilpailun kehitykseen sekä edistävän liiketoimintamallien muutosta pankkien tulonlähteiden muuttuessa. Suorat strategiset vaikutusten Suomen pankkialan toimijoihin muodostuvat lisäksi tehokkuuden merkittävästä paranemisesta ja nykyisten kulurakenteiden muutoksista jo seuraavan vuosikymmenen aikana.

ABSTRACT

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Since 2007, the Finnish banking sector has undergone a transformation that has been affected by economic fluctuations, tightening regulation and digitalisation. A new technology architecture solution, Distributed Ledger Technology has emerged since and received a lot of attention. Technology has been described as the biggest revolution since the commercialization of internet. Distributed Ledger Technology have been expected to be highly disruptive especially in the banking sector. The aim of this study is to outline the effects of Distributed Ledger Technology on the Finnish banking sector and its future development. The research is empirical and uses the qualitative Delphi research method to outline the future of the banking industry. The research approaches Distributed Ledger Technology as well as its implications through Christensen's Disruptive Innovation Theory. The study presents the different definitions for the Distributed Ledger Technology and emphasizes the lack of a coherent universal definition, which complicates the research of the technology. According to the study, Distributed Ledger Technology has major implications for the future development of the Finnish banking sector. The technology is introduced to influence the development of market structure and competition environment, as well as drive banks to review their business models as traditional revenue streams in banking sector are expected to change. The technology is proposed to improve efficiency and change cost structures of banks and thus have a direct strategic impact on the operators in the Finnish banking sector over the next decade.

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Espoo, June 2020

Lasse Huokuna

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LIST OF SYMBOLS AND ABBREVIATIONS

AML	Anti-Money Laundry
E.G.	For example
EU	European Union
BFT	Byzantin Fault Tolerant
DLT	Distributed Ledger technology
KYC	Know-Your-Customer
PoW	Proof of Work
PoS	Proof of Stake

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1 INTRODUCTION

1.1 Background

Since the 2007 financial crises the financial markets and especially the banking sector has been in continuous transition period of increasing regulations, cutting costs and digitalizing services. Banks in Europe have also gone through difficult times with the Euro crises and the protracted period of low and negative interest rates which has led to reconsideration of strategies and business models as old income stream has become an expenditure (Gardo & Martin, 2010). In addition to the difficult economic situation, the industry is facing challenges with rapid technological development and digitalization while the level of regulations, demanded transparency and security are increasing (PwC, 2014). Extensively evolving and growing ecosystem of financial industry is creating disruption on banking sector in which the technological development is working as a catalyst.

The technological development has been fast in recent decades starting from the commercialization of internet. In the 1990 the Finnish banking sector was forerunner of technological banking developments, but after the beginning of 2000s brave innovative experiences have lagged behind larger countries in the development of technological banking solutions. (Karhonen & Korkeela, 2017)

In Finland the development of banking sector have been historically deregulation driven and it has focused close to upswings and downswings of the economy. (Hyvärinen & Laine 2000; Kauko, 2003) The competition has mainly consisted of domestic players but in recent years traditional banks have gained completely new types of competitors (Karhinen & Korkeela, 2017). The challengers of different cross industry technology companies as well as start-ups which have specialized in smaller business segment have entered to traditional banks market. Due to globalization and digitalization the competitive environment has become more international and this trend is expected to continue as technology evolves even further.

Distributed Ledger Technology (DLT) was first introduced in 2008 with a new rise of cryptocurrencies as pseudonym Satoshi Nakamoto (2008) introduced white paper of Bitcoins blockchain. The new innovative solution, DLT has been referred to be the most disruptive innovation since internet (Hiesboeck, 2016). It has been recognized as a potential reforming and disruptive force on financial sector and especially for banking sector as it may reduce the need of a central authority and it is expected to provide large efficiency gains (PwC, 2014) Even though there has been a lot of hype over DLT the true potential of the technology and actual use cases are still to unveil (Mattila et al., 2019). Which raises the question how DLT is going to disrupt banking sector and what kind of effects will that cause in a short and long perspective.

To understand how disruption affects the banking industry, one must understand how disruptive innovations typically occur and how they progress toward the mainstream. Chistensen & Bowers (1995) introduced the theory of disruptive innovation which Christensen has since developed further. It sought to explain the process on how small company, a new entrant to the market, is able to challenge the established business and rise from the bottom of the market to challenge the incumbent for the mainstream market (Christensen, 2015). The theory can be used to understand and identify the threats and opportunities of new innovations and the process on the market progress (Christensen & Reynor, 2003). This theory can offer a valuable and interesting insight for how the reacts and evolves when disruptive innovations are introduced.

The number of academic researches and studies of the technology has increased rapidly during last year as the potential of the technology has been better understood. Current research of DLT in banking sectors perspective has largely focused on how new the technology could be utilized in seemingly the most promising business fields. (See. Guo & Liang, 2016; Pinna & Ruttenberg, 2016; Mills et al., 2016) Although DLT has been introduced as disruptive technology for banking sector it has not been well researched from the perspective of disruptive innovation theory, which can help to better understand the future development of the banking

sector and offer valuable insights of the development process. This research sought to provide view of how DLT effects to Finnish banking sectors, what opportunities and threats it opposes and how it impacts to its development in the future.

1.2 Research objectives, question and contribution and limitations

This study examines DLT a novel technology solution, its future effects on the banking sector in Finland and the disruptive potential it is expected to have. The objective of this research is to provide an outlook of how DLT will affect to the development of Finnish banking sector and its operators business in the future.

The research consists of theoretical and empirical parts. The aim of the theoretical part is to create an overview and understanding of DLT and its definition, Finnish banking sector's development and disruptive innovations as process. The empirical part examines the impact of technology on the banking sector as well as the opportunities and threats it creates. The aim of the empirical part is to create future prospect of how DLT is affecting to the development of banking sector and how great these effects are, as well as, how these effects are reflected in the business of banks operating in Finland. Additionally it seeks understand the timeframe in which the effects are expected to be seen in banking sector.

Research questions are divided into main research question and sub-research question. The main research question is:

- How distributed ledger technologies will change the banking sector in Finland?

The sub-research question of the research is:

- Can distributed ledger technology be classified as disruptive innovation for the banking sector?

The research questions are intended to outline the impact of technology on the development of the banking sector and to better understand it as a process. Questions are addressed through both empirics and theory to obtain a sufficient overall picture.

1.3 Contribution and limitations

This research provides important insights of future development outlook of Finnish banking sector for businesses operating and entering to it. Current research mainly focuses on the possibilities, applications and use cases of DLT (See e.g. Guo & Liang 2016, Pinna & Ruttenberg, 2016, Mills et al., 2016, Cong, 2018). Therefore this work takes a closer look at the development of the entire industry offering insight of market dynamics and future outlook.

The study is limited to Finnish banking sector and commercial banks operating in Finland. The impact of the DLT on central bank operations and future prospects has been excluded from the study because the role of central bank differs significantly from commercial actors on banking sector. Therefore the generalizability of the results are limited only to Finnish banking sector and businesses operating in the same market with Finnish commercial banks.

1.4 Structure of the Thesis

The thesis is structured into eight chapters. The first chapter presents the transformation period banking sector is going through and introduces the emergence of DLT, which is believed to be highly disruptive for banking sector in the future. Further, the research questions and objectives are presented as well as contribution and limitations of the study.

The theory part of the thesis is presented in chapters two, three and four. The second chapter reviews the operating environment of Finnish banking sector and its current state and development history. Additionally it introduces the development of

competitive environment and technological development in Finnish banking sector. Distributed ledger technology is presented in chapter three. The main understanding of DLTs main features are introduced and classifications of different DLT systems are presented. This chapter also introduces the definition of DLT used in this thesis and emphasizes the lack of universal definition by presenting different definitions for the technology. In the end of chapter three the potential benefits and challenges it creates for banking sector are reviewed. The chapter four presents disruptive innovation theory, how disruptive innovations are defined and disruption process more in detail. The critique the theory has received is also reviewed in the end of this chapter.

The fifth chapter describes the empirical research design and methodology as well as gathering and validity of the data. After this the results of the empirical research are presented. The subchapters are divided into the Delphi researches main themes and the last subchapter concentrate on effects to banking sector in more detail. Consequently, the results are discussed in the seventh chapter and the most important finding are highlighted and reliability and validity of the results are discussed and research questions are addressed. In the final chapter the conclusion of the research is presented and implications of further research are suggested.

2 BANKING SECTOR IN FINLAND

The operating environment for financial services in Europe has been in a constant change for a last decade. Since the 2008 financial crises and Euro crises the regulatory environment has steadily evolved and became stricter while economic situation has been challenging due declining and negative interest rates. Together with fast developing technologies, digitalization and globalization the banking sector in Finland has been undergoing a constant transformation which has forced banks to rethink their business and revenue models meanwhile new business have evolved and entered to disrupt the market. (PwC, 2014)

Since the liberalization of banking sector and financial markets in Finland the structure of the banking sector has changed essentially. Despite the structural changes, the market form of banking sector has remained as oligopoly over last decades including three parties: OP Bank, Nordea and Danske Bank. The competitive environment on banking sector has changed completely over time even though the majority of the market share is concentrated to a few banking groups (Kuusterä, 2002). During last years the changes of the competitive environment in Finnish banking sector has been particularly influenced reformed regulations, digitalization and globalization as well as changes in customer expectations. (PwC, 2014)

To gain better understanding of these changes and how earlier technology innovations have influenced to banking sector the study describes Finnish banking sectors development over time and how the technology and changes in competitive environment has evolved during last decades in Finnish banking sector.

2.1 Development of banking sector in Finland

At 1950 when Finnish banking sector’s deregulations started, the competition and operating environment was very different. Banking sector and monetary movements were highly regulated and government determined the interests for both deposits

and loan. Therefore, there were no price competition, and competition for customers in overall was very low if not non-existent. Due to scarcity of money, banks had a pronounced dominance over other actors in the society and therefore banking sector over all had no particular need to adapt operations to meet market expectations. (Kuusterä, 2002, p. 365-367)

During the eighties, deregulation of banking sector started and 1983 first foreign banks opened subsidiaries started operating in Finland (Nyberg & Virhiälä, 1994, p. 10-11). In the 1980s The Bank of Finland liberalized credit market in Finland which led to companies applying loans from abroad due considerably cheaper interests. For the same reason banking sectors lending for individuals and households grew rapidly. Due to liberalization of the financial markets competition for market share and customers began to take a shape. (Hyvärinen & Laine, 2000; Kiander & Vartia, 1998) The banking crisis and recession of the early 1990s reshaped the structures of the financial system and banking sector in Finland, as it led to thousands of bankruptcies and contraction of the banking sector (Kangas, 2006). Bordes (1993) pointed out, even though liberalization was executed according to general principles it increased speculative and hazard activities. Crisis resulted from banking sectors over reaction to liberalization as excessive risk-taking and lending. (Currie, 1993). Consequently banking sectors reliability and credibility deteriorated at the societal level (Kangas, 2006).

After financial crises customers pay more attention also to corporate social responsibility (Mulki & Jaramillo 2011). As a result of the banking crises of the 1990s, corporate social responsibility issues came to prominence in Finnish banking sector and this trend continued forward (Autio, 2005; Kallonen, 2002). The beginning of the 2000s was time of strong economic growth which reflected also to banking sector. The importance of networks was emphasized while banking and insurance business converged and banking sector introduced new operating models and financial instruments (Kangas, 2006; Kallonen, 2002). Along with economic growth this caused increase of the market size and competition in Finnish banking sector in general. Technological development and liberalization of financial markets contributed to increased competition, which reflected especially to loans interest

margins. As financial profits from lending deteriorated, competition changed and intensified significantly which led to need to improve cost efficiency and find new earning model. As a result of banking sectors structural transition emerged new forms of cooperation and mergers (Ruuskanen, 2009). Banks had to react to changes in operating environment and rethink business models and strategy.

Subprime crises in 2007-2008 broke of the booming period of financial market and economic growth (Fungáčová et al., 2015). It started the process of reformation of banking sectors regulation which Euro crisis in 2012 nourished further (EBA, 2015). Fungáčová et al. (2015) argued that banking crises cumulated trends of specialization and outsourcing. Despite structural changes and the liberalization of the Finnish financial markets large banks continue to dominate Finnish banking sector. The market shares in Finnish Banking sector in 2018 within loans and deposits are illustrated in the table 1.

Table 1 Market shares of Banking sector in Finland for loans and deposits (Bank of Finland***)***

	Loans in Finland (To others than Financial institutions)		Deposits and savings in Finland (To other than financial institutions)	
	Million of euros	**Market share %**	**Million of euros**	**Market share %**
Financial institutions in total	213 014	100	158 060	100
OP Group	83 857	39	60 701	38
Nordea	60 890	29	42 850	27
Danske Bank	22 394	11	19 260	12
Handelsbanken	13 507	6	4 510	3
Säästöpankki group	8 472	4	6 499	4
Aktia Bank	6 055	3	4 065	3
S-Pankki	4 182	2	5 818	4
Others	10 187	5	143 58	9

2.2 Development of competitive environment and technology on banking sector in Finland

One of the biggest technological development steps during last decades has been arguably the rise of the internet. It has enabled a broad coming of remote banking services and has since been the cornerstone of technological development in banking sector (European Central Bank, 1999). Technological development has

been fast during last decades and banking sector in Finland has been forerunners of technological development on a global scale especially during 1980's and 1990's (Karhinen & Korkeala, 2017). Although in consumers point of view payment methods started to revolutionize already during 1960's as card payments became available in Finland (Tala, 2015). The history of reaches far out but this chapter concentrates on biggest development steps since online banking started in 1990's.

Remote banking services and further liberalized competition significantly changed the consumer behaviour thus shaping the competitive environment significantly (Karhinen & Korkeela, 2017). Vesala (2000) made the same suggestion and argued that more aggressive competition for customers started due remote access-technologies. As mentioned earlier obtaining the mortgage or loans in general had previously been very challenging due the limited markets and typically required a long good relationship with bank which guides the consumer behaviour still strongly (Hyvärinen & Laine, 2000; Kiander & Vartia, 1998). However the technological development with liberalized markets contributed to consumers to tender out banking services more. (Vesala, 2000)

Karlo Kauko (2003) described the competition of banking sector in Finland and argued that the competitive environment has changed during the decades and compering the degree of competition to earlier decades is therefore difficult. He also mentions the relativeness of competition and as an example emphasises that competitor usually interprets decreased pricing as intensified competition. In his discussion paper Kauko (2003) predicted that competition will continue to evolve as a consequence to technological and business models development where especially service channels will be a big part of the competition. Economic downturns and upturns will also have significant impact on the competition environment on banking sector. Depression or economic downturn is also likely to impact as catalyst to regulatory intervention which could change the competitive environment significantly. (Kauko, 2003)

Flower et al. (2012) considered mobile banking and multichannel service models to be the next big thing in banking sector. They studied also how consumers are using

banking services and concluded that at the time consumers were not ready to move heavily on remote services and branches are still preferred channel for consumers. The remote online meetings with bank for personal customers via internet services began in Finland in early 2010s adaptation of online meetings have progressed slowly, confirming the same trend for branch services (Finanssiala Ry, 2017). Karhinen & Korkeela (2017) illustrated the stages of digitalization in Finnish banking sector the representation of the development is presented in the figure 1.

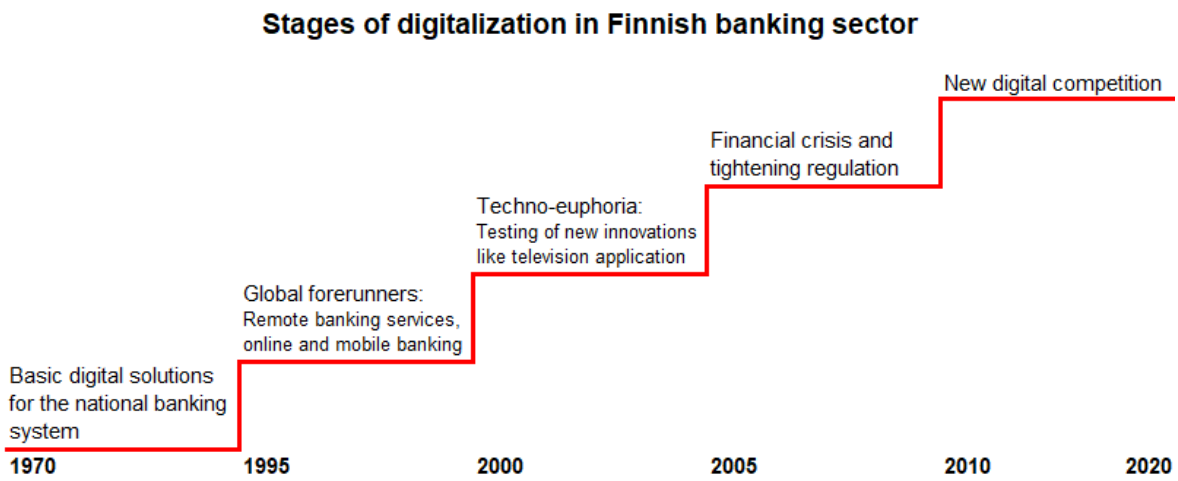

Figure 1. Representation of Stages of digitalization in Finnish banking sector (Karhinen & Korkeela, 2017,p. 2)

Finance Finland association commissioned research (Finanssiala Ry, 2017) which suggested that the trend of mobile banking is growing fast among 18-44 year old users and the use of improved technological solutions has been increasing during last years. Even though majority of Finnish consumers (76%) still prefer branch services the demand for services outside off traditional banking sectors opening hours has increased especially in capital area. This trend is also shaping the competitive environment. (Finanssiala Ry, 2017)

Availability of different credit options and loans has increased the competition. New finance companies has entered to the market. The same change of competitive environment has taken place for savings and investment services. (Finanssiala Ry, 2017)

The technological development has enabled new competition to enter to banking sectors traditional market thus shaping the environment. New entrants have the advantage of shaping the services according to new technologies and are able to provide faster and better services. The regulatory environment is just catching up with this development but it is clear this has impacted to competitive environment as consumer demand and expectations are increasing for more flexible and affordable services. (PwC, 2014) These trends are likely to guide the future development of services as well.

3 DISTRIBUTED LEDGER TECHNOLOGY

Distributed ledger technology (DLT) is one of the latest new innovations which has been said to be the most disruptive innovation across different business fields since the internet (Hiesboeck, 2016). In 2008 unidentified person or group of people using pseudonym Sathosi Nakamoto published a white paper “Bitcoin: A Peer-to-Peer Electronic Cash System” which described a novel approach for organizing and storing information and transactions and offered solution for the double spending problem. Thus starting an extensive communication and studies over the topic of DLT (Mattila, 2016).

There has been a lot of hype around DLT and especially with word blockchain which is often used as a synonym for DLT. As a result, this has formed a number of different perceptions of the technology’s potential some of which, on the basis of the current research, appear to be unlikely or even incorrect (Mattila et al., 2019). Additionally at the moment there are no universal common definition for DLT and the use of the terminology is not always consistent across studies or in media (Mattila et al., 2019). This is influenced by the fact that the technology is still largely in the development stage and is taking shape as new technological DLT solutions and new applications are invented (Tasca & Tessone, 2018).

In this chapter the main features of DLT are first briefly described, after which the definition for DLT is presented which is used in this study, followed by introduction to various definitions which are used in current researches. The end of the chapter introduces current properties and benefits of DLT for financial and banking sectors.

3.1 Main features of the DLT

Essentially DLT is a database or record of information which is shared across a network. It is built as a series of networks of databases which allow participants create and store information in an efficient and secure way (Davidson et al., 2016). It differentiates from traditional centralized databased architecture, as it provides

configuration where the database is spread across the network at multiple different physical locations. On the other hand, in traditional centralized database information is controlled by a central administrator and it is located, maintained and stored in one location. There are different options for administrative solutions for DLT systems and some of them (Bitcoin Blockchain) do not require a central administration at all though usually the control and administration is centralized at least on some degree. Decentralized databased on the other hand does not involve a central storage as the data is stored on servers which provide the information to connected participants (Mills et al., 2016). The difference between centralized, decentralized and distributed databases is illustrated in the figure 2.

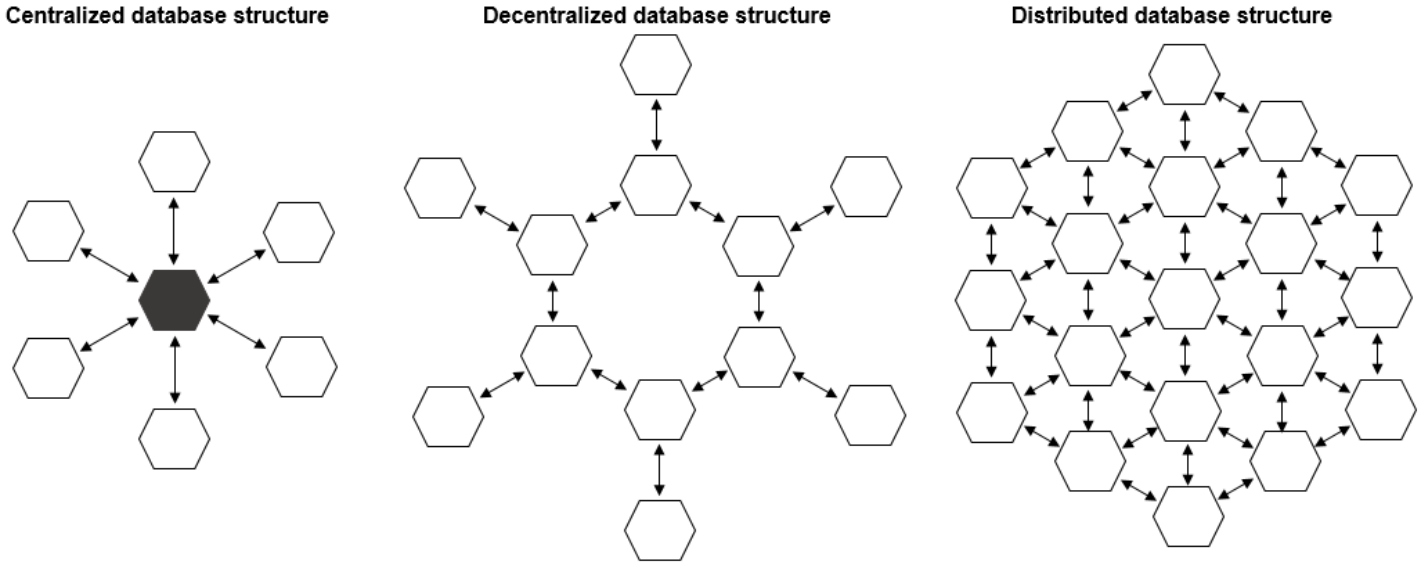

Figure 2. Representation of database architectures (Mills et al., 2016)

DLT system could be described as a distributed database in which the participants of the system reach an agreement by certain consensus mechanism of every update in the system. Generally DLT system dictates how a set of data structures are connected and distributed between users of a system that creates a distributed database (Mills et al., 2016). To gain a better understanding of functions DLT offer it is good to understand the basic working principal behind it. As defined earlier the architecture of DLT is distributed with in the network, the distribution is implemented in form of nodes. The logic behind is that consensus mechanism ensure the integrity of the nodes within DLT system and validate all the transactions. These nodes are stored in the ledger which forms a database that contains all the transactions (Pinna

& Ruttenberg, 2016). The distributed nature of DLT enables it to differ from other database value transfer services as it does not have to rely on central trusted authority (Mattila, 2016).

3.2 Classifications - Access and validation of DLT systems

DLT systems can be categorized or classified according access and validation rights as well as the type of the consensus process used to ensure the integrity of the ledger (Mattila, 2016). Accessibility of the DLT system can be divided to either public or private. DLT system is considered to be public if any user is allowed to view the ledger whereas access to view data of the private ledger is restricted to only approved participants. The validation rights for the ledger can be similarly divided to permission-less and permissioned ledgers. In permission-less DLT systems no central authority or administration is needed for validation as anyone can build and verify the ledgers. Contrary in permissioned DLT system the ability to verify or modify entries to the ledger is allowed only to a trusted and specifically defined group or participants. (Natarajan et al., 2017) There are also so called Hybrid DLT systems which seek to combine the benefits of permissioned and permission-less systems to create more flexibility for businesses. It enables the privacy of permissioned system with the transparency and security benefits that permission-less DLT system offers. (Glaser, 2017) The relation between accessibility and validation options are illustrated in the figure 3.

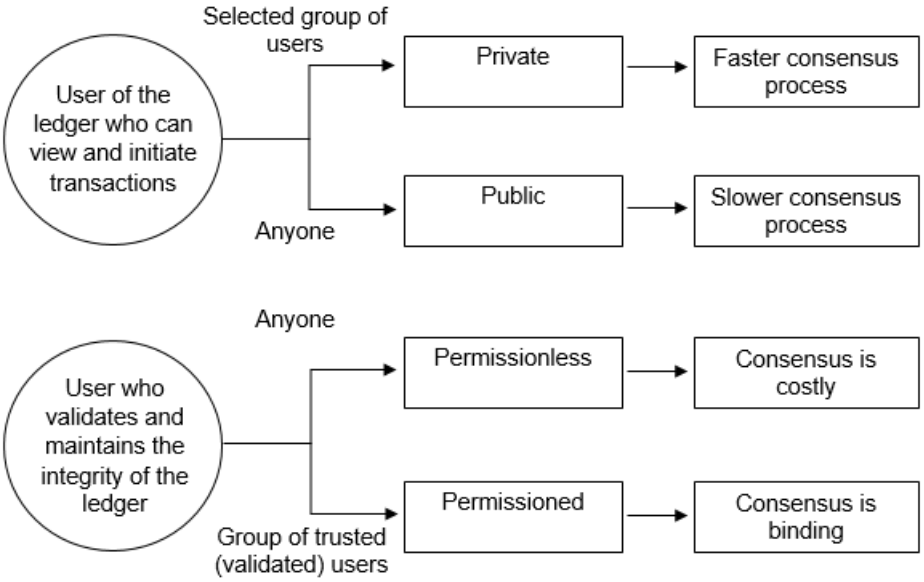

Figure 3 Relation between accessibility and validation

The integrity of a database is an important factor which is why the third important dimension for DLT is the consensus mechanism it uses. It ensures the integrity of a database whereas centralized or decentralized systems usually rely on central authority to validate the information and to prevent for example double spending. DLT systems use different consensus mechanisms to solve this problem. Consensus mechanisms are basically the rules and procedures how DLT system validate executed transactions (Glaser, 2017). There are multiple different consensus mechanisms but the three most common are Proof of Work (PoW), Proof of Stake (PoS) and Byzantin Fault Tolerant-based consensus algorithm (BFT). The consensus mechanism of DLT system is strongly dependent on the validation classification of the system. (Lemieux, 2017)

The strong level of anonymity is one of the benefits of permission-less DLT systems. Although it creates issue of trust between participants Nakamoto (2008) initially solved this problem with PoW consensus protocol which was original solution used on Bitcoin's blockchain. PoW is based on solving computationally –intensive mathematical problem by which the "proof" is obtained by means of "Work". (Lemieux, 2017)

The PoS is another type of consensus process. This is not as energy intensive process as PoW and it uses existing stakes of participants of DLT system to reach the consensus. The basic idea is that participants of DLT system has to invest directly into the system to have “Stake” in the validation process. The stake could be measured for example either as a crypto currency asset or as an off-ledger asset which has been pledged as a collateral. On ideological level the participants of the DLT system and its validation process should be more likely to want DLT system to succeed than be destabilized or subverted by them as participating to the validation requires personal “stake”. (Lemieux, 2017)

BFT-based consensus algorithms is designed to solve Byzantine faults that may occur in the DLT system if some of the nodes in the system behave abnormally. BFT-based consensus requires all the nodes of the DLT system to participate for the validation process. It may include communication and multiple voting rounds to reach the consensus. DLT system using BFT also requires all the participants to agree each other. Due to the heavy nature of this consensus process BFT-based consensus is more compatible with smaller systems with a limited number of nodes. Therefore BFT-based consensus algorithm is usually only used in permissioned DLT systems. (Lemieux, 2017)

3.3 Definitions of Distributed Ledger Technology

In the existing literature there is no common definition for DLT systems and therefore many different researches present their own unique definition. There is wide variation between some of the definitions which in addition are partly contradictory. In this chapter is presented a few different definitions from current literature which show the variety of the terminology and definitions. This research uses an adaptation of Mattila’s (2016) definition for DLT:

DLT is “*a method which allows multiple different actors to maintain common database”* which uses distributed database structure, “*in a more coherent and transparent way between the parties involved in the system.” (Mattila’s (2016) original definition in italics)*

Defining the technology is difficult as DLT is developing and there are multiple different approach methods for defining the technology. Some definitions concentrate more on technological features while others look primarily the working method. At the same time similar technological innovations are developed which are considered to work under same principals which hampers the creation of universal definition. Some authors use DLT as an umbrella term for technology systems which are using distributed methods while some are strict and narrow. Due to inconsistencies in the terminology DLT and blockchain are occasionally used as synonyms (Mills et al., 2016). Some definitions refer exclusively to blockchain technology which started the current development of different DLT systems in 2008 (Nakamoto, 2008).

Nakamoto (2008) introduced decentralized approach for transactions using peer-to-peer network which timestamps transactions by hashing them into a chain of hash-based proof of work. This creates a record which cannot be altered without redoing the proof of work. Which was later named as block chain as it stores each “block” in a chain. Blockchain was later described as “irreversible and tamper-proof public records repository for documents, contracts, properties, and assets [that] can be used to embed information and instructions, with a wide range of applications” by Atzori (2015). Cong & He (2018) on the other hand use definition “distributed database that autonomously maintains a continuously growing list of public records in unit of “blocks”, secured from tampering and revision”.

Mills et al. (2016) use two definitions to differentiate between a strict and a very board definition. The board definition is “combination of components, including peer-to-peer networking, distributed data storage, and cryptography that, among other things, can potentially change the way in which the storage, recordkeeping, and transfer of a digital asset is done. The composition of these combinations is dictated by the particular friction or inefficiency a particular implementation of DLT is designed to solve.”, while strict definition is “a distributed ledger is a type of database that is shared across nodes in a network” (Mills et al., 2016).

Similarly, Davidson et al. (2016), on the other hand, provide a more boarder definition “distributed, cryptographically secure, and cryptoeconomically incentivised consensus engine”. Pinna and Ruttenberg (2016) describe DLT in more detail and defines that it “allow their users to store and access information relating to a given set of assets and their holders in a shared database of either transactions or account balances. This information is distributed among users, who could then use it to settle their transfers of, e.g. securities and cash, without needing to rely on a trusted central validation system”.

Other definitions concentrate more for a key features that are typical for DLT. For instance, Tasca & Tessone (2018) describes DLT systems with a list of unique key features for the technology “A DLT system is a community consensus based distributed ledger where the storage of data is not based on chains of blocks whose principles are (a.) decentralisation of consensus, (b.) transparency, (c.) security and immutability”.

The Bank of England (2017) describe DLT as “a database architecture which enables the keeping and sharing of records in a distributed and decentralized way, while ensuring its integrity through the use of consensus-based validation protocols and cryptographic signatures”. Correspondingly to Tasca and Tessone the Bank of England (2017) also use architectural characteristics to define the technology as “A DLT system is a community consensus based distributed ledger where the storage of data is not based on chains of blocks whose principles are (a.) decentralization of consensus, (b.) transparency, (c.) security and immutability”.

Mattila et al. (2018) refer DLT as a method which allows multiple different actors to maintain common database in a more coherent and transparent way between the parties involved in the system. The potential of DLT is based on the efficiency gains which common database offers for various operations and processes. (Mattila et al., 2018)

As demonstrated in this chapter, there is no universal definition for DLT. Many authors (Mattila et al. 2018, Mills et al. 2016, Pinna & Ruttenberg, 2016) point out that due to the lack of a consistent definition and terminology has occurred

misconceptions and unrealistic expectations towards the technology. It is also highlighted that a genuine and universal definition and terminology would enable better development and improve the targeting of DLT future research. (Mattila et al., 2019)

3.4 Potential benefits and challenges of DLT for banking sector

Due to the expected regenerative nature of DLT it is believed to bring many efficiency benefits on variety of industries. On ideological level DLT could reduce the need of trusted third-party, streamline business processes across multiple entities and increase record transparency and auditability while reducing costs. These attributes offer many potential uses cases for financial industry in general while some of the properties are suspected to be disruptive for banking sector in its current form. (Accenture, 2017)

At a broad level the utilization and use cases of DLT in banking sector can be divided into three different categories on a basis of the information type. These categories are value ledgers, information ledgers and Timestamp ledgers. Value ledgers are used for value transferring services including the transfers and storage of valuable assets such as money transfers. Information ledgers on the other hand, may contain information of business and other important information which could be utilized for example in trade finance. Whereas the timestamp ledger name describes its activities well as it is used to store an immutable audit information of who has transferred what and when. (Oates & Samudrala, 2017)

The benefits value ledgers may provide is efficiency and speed. Traditionally banks use siloed ledgers to complete financial transactions. As with siloed ledgers the issue is that the data is spread across different financial institutions which all have to verify and validate transactions separately making it time consuming and inefficient. The siloed ledgers slow down the data movements as DLT enables elimination of the siloed ledger architecture this property is the biggest reason DLT is considered to have significant potential to be the next biggest thing for banking

sector after the rise of internet (Oates & Samudrala, 2017). However, exploiting and implementing new structures will be challenging if it is possible as the current structures of the banking sector, businesses in general and the competition support the existence of these silos (Oates & Samudrala, 2017).

Information ledgers may also provide improved efficiency as well as cost savings and improve the quality of the data across the process as it can be enriched by different parties of the process. For well-defined business processes like trade finance and proxy voting for example. DLT is able to provide a connected platform which supports multiple service providers and as it creates an entity which initiates the business processes and allows participants to access and enrich the information during the process until it is fully completed. The shared infrastructure and utility models would create enhanced customer experience and help businesses to reduce the processing costs. (Oates & Samudrala, 2017)

The timestamp ledgers store information in immutable matter and is used to capture the exact time of an event with the identity of participants. Therefore the uses cases for it will be included in digital signing processes and digital contracts, settlement instructions, Know-Your-Customer (KYC) processes and corporation action announcements (Natarajan et al., 2017). The key benefit is that information is stored in immutable ledger and thus can be trusted and validated even if it is not directly received from the initial custodian. (Oates & Samudrala, 2017)

In the current studies the biggest potential use cases and the main benefits for banking sector has been evaluated to form in three parts of banking sector: Payments, settlement and clearing on global scale, Trade finance and Investments and securities processing (Guo & Liang, 2016; McLean & Deane-Johns, 2016). Mills et al. (2016) suggested that DLT will enable more efficient and cost effective way for maintaining data accuracy and data storing across multiple locations which would reduce overall operational risks. Otherwise many authors (Guo & Liang, 2016; McLean & Deane-Johns, 2016; Tapscot & Tapscot, 2016; Mills et al., 2016; Pinna & Ruttenberg, 2016; Natarajan et al., 2017) have suggested similar key features and main benefits on banking sector to be:

- Increase of efficiency
- Greater transparency and easier auditability
- Automation and programmability
- Immutability and verification
- Cost reductions
- Enhanced cybersecurity resilience

The benefits are formed compared to centralized and siloed ledgers which are shared between the networks in traditional way. The most emphasized benefit is increase of efficiency which is argued to improve in general on multiple levels and especially improve the speed of different transactions. Efficiency gains are closely related to all the other benefits and notably the increasing level of automation and programmability which would further more improve the efficiency. (Guo & Liang, 2016; McLean & Deane-Johns, 2016) Enhanced cybersecurity resilience will help also with compliance, Anti-Money Laundring (AML) and KYC process and it will help preventing frauds. A form of a DLT will help to improve the data as well as store, track and validate it (Natarajan et al., 2017). The cost reductions will form from improved automation and enhanced processes (Tapscot & Tapscot, 2016).

Even though the benefits and potential is expected to be major for banking sector there are it is pointed out in the researches that generalization is difficult because of the variety of technology's formation and its actual use cases which have not been yet established (Pinna & Ruttenberg, 2016). The benefits are expected to occur incrementally due to risks and challenges related to implementation of DLT (Natarajan et al., 2017). According to McLean & Deane-Johns (2016) DLT has great transformation potential for several business sectors and especially for banking but emphasize the unsolved challenges and issues relating to technology. The conclusion they make is that many centralized intermediary functions cannot simply be replaced by DLT solutions even though in some scenarios it could be beneficial. The challenges are also pointed out by other authors.

The main challenges and problems related to DLT and its implementation are very similar between different authors. For example, Pinna & Ruttenberg (2016) conclude

that DLT offers improvements in post trading of securities but it is yet too early to suggest whether it will disrupt and reshape the market or remain in limited niche segment. Natarajan el al. (2017) concluded similarly, and argued it to remains unclear if DLT could generate benefits and advantages which are able to replace current systems and procedures. Over all the main challenges suggested by authors (Guo & Liang, 2016; McLean & Deane-Johns, 2016; Tapscot & Tapscot, 2016; Mills et al., 2016; Pinna & Ruttenberg, 2016; Natarajan et al., 2017) are listed below:

- Lack of mainstream understanding of the technology and identification of actual use cases
- Limitation in scalability
- The need to increase cooperation between competitors and other stakeholders
- Lack of maturity of the technology
- Lack of standardization
- Interoperability and integration between different DLT systems and current systems
- A governance structure regarding DLT has to be formed and regulatory framework updated

4 DISRUPTIVE INNOVATIONS

This chapter describes disruptive innovations on a basis to Christensen's theory of Disruptive innovations. First it shortly introduce the theory followed by Christensen's definition for disruptive innovation and a board description of how disruption arise and progress as a process in the market. In the end is also introduction to technology s-curve which has been used to explain technological development in stages.

4.1 Introduction to Disruptive Innovation Theory

The disruptive theory was introduced by Clayton M. Christensen and Joseph L. Bower in Harward Business review 1995. Christensen started to further develop new theory forward from discontinuous innovations in a series of articles (e.g. Bower & Christensen, 1995 and 1996; Christensen and Rosenbloom, 1995; Christensen et al., 1998) which sought to observe closer the role of market as literature on discontinuous innovation and incumbent failure often concentrate on companies capabilities and resources rather than external factors. Christensen and Rosenbloom emphasized the concept of value networks which they defined as "the context within which the firm identifies and responds to customer's needs, procedures inputs and reacts to competitors" (Christensen and Rosenbloom, 1995, p. 234).

The innovations are categorized to sustaining and disruptive innovations. Majority of new innovations are categorized as sustaining as they are defined to improve already established product or service and make it better. Sustaining innovations are emphasized to be typically the most important and profitable (Christensen et al., 2004). Christensen & Raynor (2003) further developed the description of Disruptive innovation and argued it does not attempt to create a better product or service to existing market but rather introduce new simpler, more convenient or more affordable products which disrupt the market by redefining new performance attributes and appeal to new or less demanding customers. Additionally they found a new approach and divided disruptive innovations to Low-end disruptions and new-market disruptions.

Christensen (2000) suggests that the theory of disruptive innovations describes a process of disruptive innovation entering to the market and explains how it happens. He argues that the nature of disruptive innovations are process starts with new innovation entering to the market with inferior product or service compared to incumbent business solution. The competitive advantage is typically price and the performance of innovation would be only on sufficient level at first to satisfy the needs of the lowest customer segment. Whereas incumbent's product would already exceed customers' expectations and needs in primary performance attributes. New entrant's product would also typically appeal to secondary performance attributes which may satisfy only niche of the market. As the new innovation develops and eventually improves on the primary performance attributes it starts to attract the higher customer segments. He suggested that incumbent is tempted to move to higher margin customer segments while new entrant attract lower market segments which are overlooked by incumbent. (Christensen, 2000)

An important observation to disruptive innovations is that they are usually built on existing technologies which use application has been changed to offer a novel product architecture changing the functional aspect of the product. The importance of performance attributes may change the competition and former secondary attributes become primary performance attributes for customers. (Christensen, 2000). The disruptive innovation model is illustrated in the figure 4.

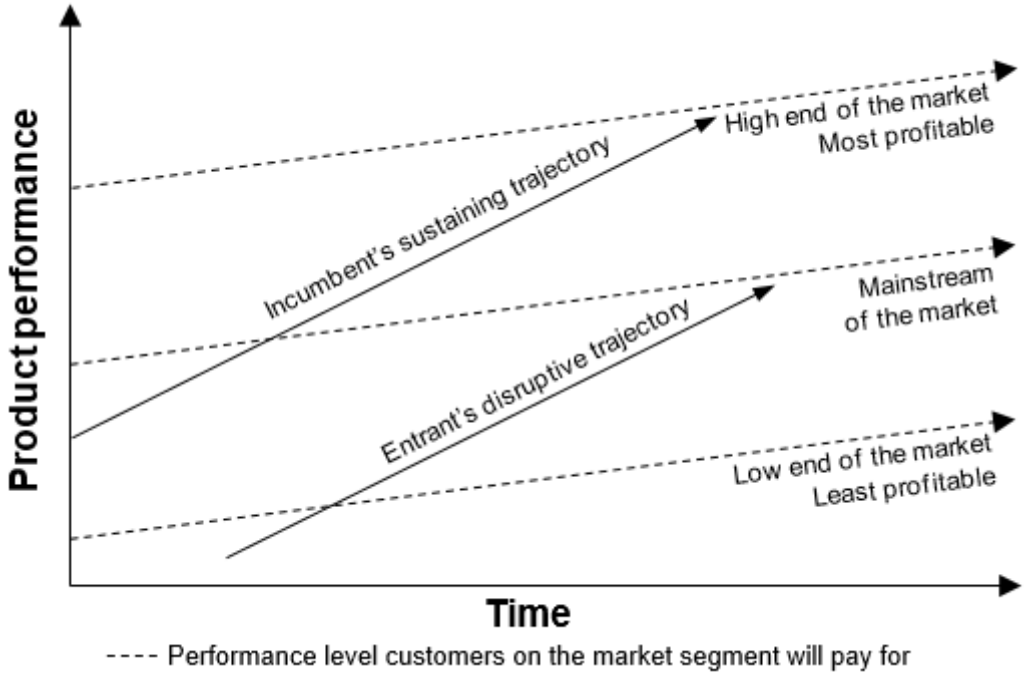

Figure 4. The Disruptive innovation model – mainstream market involved (Christensen, 2015)

The entrant has to always fight for existence as there are competition also for the bottom of the market. Not all the disruptive innovations succeed. Theory predicts the patterns how disruptive innovations evolve and help corporations to dictate whether it is better to join the disruption or continue with current sustaining products and innovations. (Christensen, 2015) The figure 4 presents the disruptive innovation model and illustrates the trajectories of sustaining and disruptive products and demonstrate that the development of disruptor typically develops as the sustaining trajectory.

4.2 Definition of disruptive innovation and disruption process

Christensen (2015) considers the term ”Disruptive” to be misleading and it often causes misunderstanding because all the innovations which are creating major impact are considered as disruptive. Still majority of the innovations are actually sustaining innovations and it is important to acknowledge that initially almost all innovations are experimental in the beginning and started in a small-scale. The differentiating part is that in the beginning disruptive innovation do not try to target

incumbents existing mainstream market and large segment of customers but rather focus on the fringe of the market and concentrates more on the business model (Christensen, 2015).

Christensen (2015) emphasize two main characteristics of Disruptive Innovation in his definition:

- Disruptive innovations originate either from low-end market or it will create a new-market.
- Disruptive innovation does not attract mainstream markets before performance level has reached sufficient level.

Additionally it important to understand that disruption process is usually time consuming and does not happen overnight as it usually requires also change in customer needs and demand. The process may take years or decades before disruptiveness is significant and notable. As the disruption is likely to occur as the market behaviour and demand changes it usually requires a unique business model rather than following standardized processes to meet demand of the market. (Christensen, 2015)

Understanding what disruptive innovation means is important as the theory is easily misinterpreted and the benefits of it are not recognized. Not all the low-end market attracted companies are disruptive nor new market creating companies are threat to incumbent's business. Additionally all the disruptive entrants won't succeed thus majority can be ignored by the incumbent. The key is to recognize if the trajectory is on disruptive path and for this the understanding of the disruptive process is important. (Christensen, 2015)

4.2.1 Basic model and performance over supply

Disruption process was originally illustrated by Christensen (2000) by comparing the performance development trajectories of an incumbent technology and the disruptive entrant technology. Christensen assumed in the early version of the

model that the performance of both the incumbent and the entrant product improves over time explaining the ascending solid lines (Christensen et al., 2004)

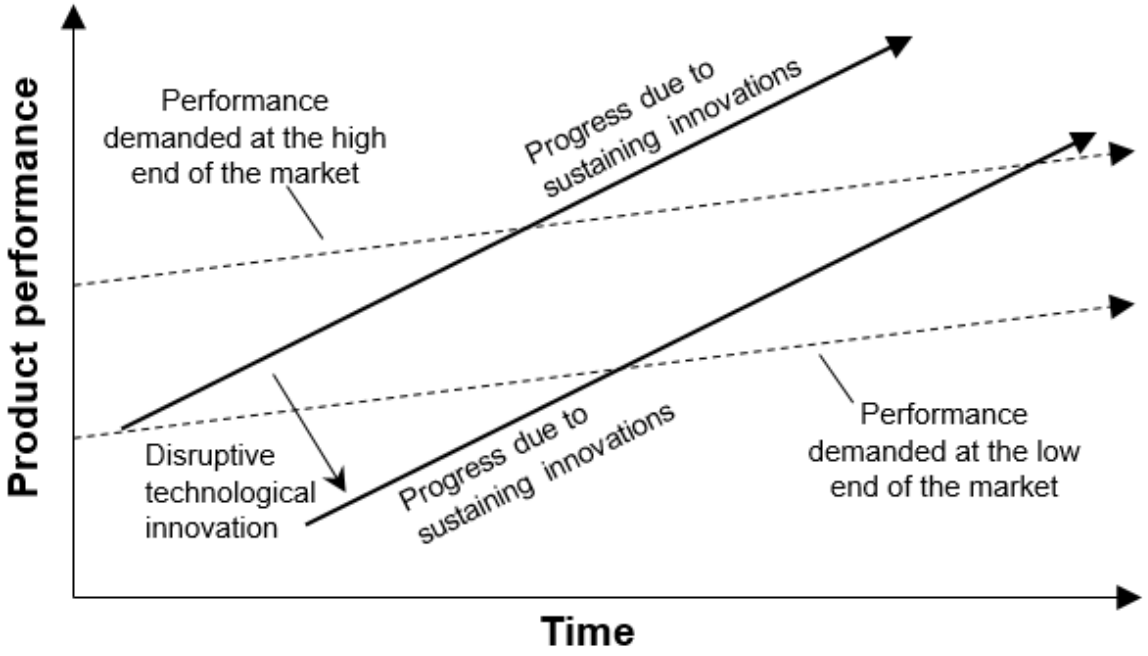

Figure 5 Representation of The impact of sustaining and Disruptive Technological Change (Christensen, 2004)

The incumbent's offering is illustrated in the figure 5 on left side and the right side ascending trajectory is illustrating the new entrant offering. Slightly ascending dotted lines are demonstrating low and high end product demands of the market. (Christensen et al., 2004). Market demand lines are created for demonstrating different standards of customers as in most industries the market is divided to many different customer groups which can be classified by how demanding they are. The most demanding customers, at the high end of the market, have more difficult demands to solve and higher amount of requirements. Whereas the low end have fewer and less complex demands to be satisfied. The gap between dotted lines illustrates the majority of the customers who are in between of these classified demand groups. This majority of group is termed the core of the market or the mainstream customer. (Christensen et al., 2004) The concept of mainstream customers or focus group plays an important role in the process of disruption.

The mainstream market breakthrough is visualized on Figure 6 as the development of entrant reaches sufficient level for the mainstream customers. At this point entrant starts to gain market share and becomes a threat to the incumbent. It is important to note that the disruption does not occur with the introduction of the disruptive innovation. Disruption starts when trajectory of performance development intersects the mainstream market demand line which is marked in the Figure 6 with a star. (see e.g. Adner, 2002; Yu & Hang, 2010).

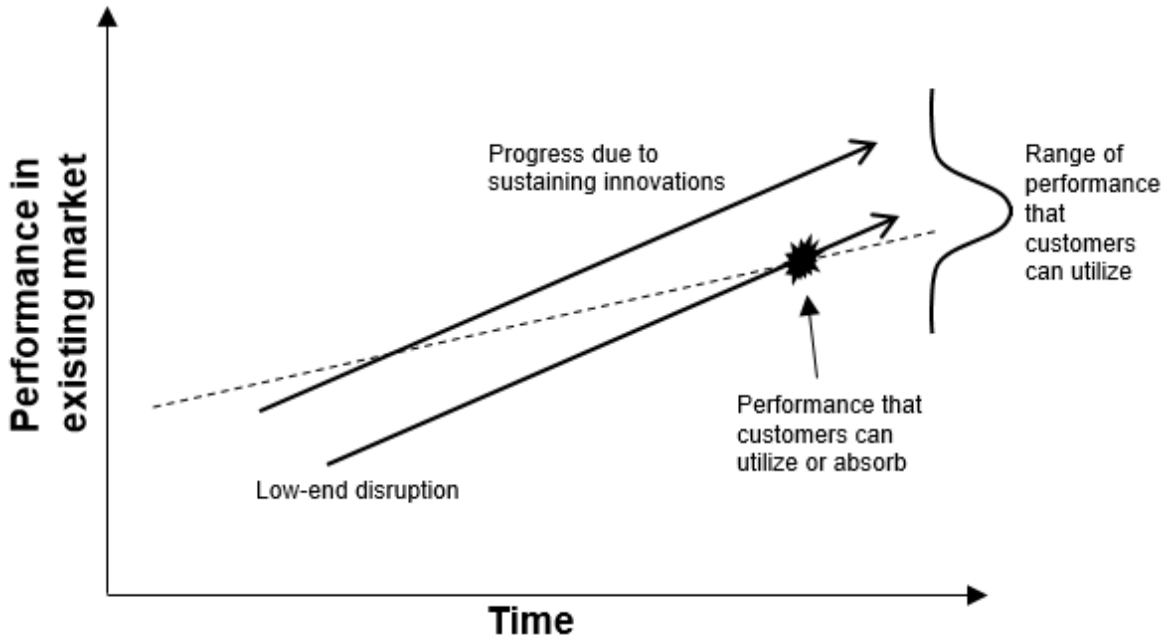

Figure 6 Representation of The Disruptive innovation Model (Yu& Hang, 2010; Christensen, 1997)

After intersecting the mainstream market line entrant start to become disruptive and begins to gain more attention and market share. The disruptive process though is a constantly evolving and the process could take years or decades before it actually becomes disruptive, for example mobile phones were established 25 years ago before starting to erode landline business (Christensen et al., 2004). Other good example is computer business where it took well over 30 years for minicomputer makers to develop a sustaining lead in revenues in relation to incumbent mainframe computer manufacturers. As discussed before disruption is generally not a sudden process. Rather it is likely to take years or decades before new innovation encroaches big share on the established market. (Gilbert, 2003 p. 29, 27)

The role of market dynamics play important role in the disruption process. The mainstream markets may adopt the new innovation despite of superiority of the performance of incumbent's product on the market (Adner, 2002). Christensen (2000) introduced this phenomena as performance oversupply and explained the main principal to be change in market dynamics as when customers' primary performance attributes are met the emphasis for other performance attributes increases thus shaping the market dynamics. Technological development is faster than mainstream market's ability to exploit and utilize it. When this happens and the performance level of mainstream solution overshoots the market demand offering unnecessary features which customers are not able to fully utilize leading to performance oversupply. (Christensen et al., 2004)

Adner (2002) argues that when performance overshoots customers' expectations and ability to utilize it the willingness to pay for improvements decreases. In other words performance oversupply lowers the expected price/performance ratio which creates an opportunity for disruptive innovations to emerge. Christensen (2000) points out that historically performance oversupply has enabled cheaper, simpler and more convenient disruptive innovations to enter the established low-end market. The change in market dynamics provided by performance oversupply starts from the bottom of the market and triggers a fundamental change in the basis of the competition which is one of the key characteristics of a disruptive innovation (Christensen, 2000)

Christensen argues the initial disruption process starts from low-end or new-market segments. Other authors use also more specific description for the initial market segment and call it a niche market thus agreeing the disruption process starts from the bottom of the market as well. (see Carayannopoulos, 2009; Sood & Tellis, 2011; Yu & Hang, 2010) To understand how disruptive innovation progress to mainstream markets it is essential to understand the markets dynamics. Even though the principal demand and need in these segments are similar the preferences in performance attributes distinguish them. (Sood & Tellis, 2011; Schmidt & Druehl, 2008) Primary performance attributes attract mainstream market and secondary

attributes the niche market though these attributes has to be defined case by case secondary attributes usually consists of easier usability and more affordable price. When disruptor's performance reaches sufficient level on primary attributes and begins to progress upwards the market the incumbent is forced to tighten competition also in secondary attributes or to move further upwards the market as well (Christensen et al., 2004).

Usually the development of disruptive technologies improves in parallel pace with prior technologies. This implies that the performance trajectories do not typically intersect meaning disruptive technology is unlikely to surpass established technologies in performance (Christensen, 2000). Christensen et al (2004) define the disruptive innovation's improvement trajectory to be sustaining in relation to its earlier market position. However, Christensen (2006) does not determined whether disruptive innovation should surpass incumbent's technology or not. Sood & Tellis (2011) on the other hand define also a technology disruption process where new disruptive innovation surpasses the primary performance of incumbent's thus making it possible. The improvement cycle of market position and performance begins after it has gained a foothold in new or low-end markets. As the cycle continues and performance level improve enough for disruptor to intersect in the mainstream market they will seriously challenge the incumbent (Christensen & Raynor, 2003).

4.2.2 Asymmetry of motivation

Asymmetry of motivation is an important factor for disruption. It is formed due leading corporations in the industry are motivated to go up the market rather than defend low-end or new markets. The disruptor on the other hand are often interested in these markets. Christensen and Reynor call this phenomenon asymmetry of motivation (Christensen & Raynor, 2003). In other words, asymmetry of motivation refers to a situation where companies have different intentions and one wants to do something other does not want to do. Therefore, disruptive innovations are able to take advantage of asymmetry of motivation. (Christensen et al., 2004)

Competition between companies differs and different focus groups are targeted but as stated earlier whereas incumbents are likely to target more profitable end of market new entrants are motivated to focus to serve customers from lower market tiers or from newly created market. Thus motivations are asymmetric entrant may be able to gain market share with only a little interference from incumbents which do not see new market or lower tiers of a market as attractive opportunities. (Christensen et al., 2004) Asymmetry of motivation can be seen also with existing companies. If two companies on the same industry make different actions and parts of business may be unprofitable to the other company but important part of the other company's business. Of course the size and market position matters when evaluating growth opportunities which are likely to be different even between a start-up and single entrepreneur or not even compare growth opportunities to listed companies. (Christensen et al., 2004)

For disruptive entrant's asymmetry applies when initial market is either too small or undesirable for incumbent companies. Therefore different business models and strategies defend entrants from competitive response. A highly attractive opportunity to entrant is not attractive for incumbent thus they do not see necessary to defend that market share. According to Christensen et al (2004) differences in business models and target customers are key creators for asymmetry of motivation. Even though same customer group would seem attractive to incumbent later, asymmetry of motivation would still hinder the response and competition because at that point reaching for the customers would most probably require adapting incumbents business model and ability to acquire necessary knowledge in fast pace. (Christensen et al., 2004)

Adner's (2002) research on hard disk drive industry identifies demand conditions which enable and support disruptive dynamics to occur at the market. He introduces two new concepts, preference overlap and preference symmetry to explain the relationship between preferences of different market segments. Confirming Christensen's findings Adner (2002) argue asymmetries to be one of the driving forces of disruption and emphasizes the significance of market segments demand

preferences which shape the competitive dynamics. Preference overlap describes the extent of two different market segments preferring the same development and thus market segments overlap with each other. Preference symmetry on the other hand refers to the symmetry of this overlapping section in relation to the size of these market segments and their overlapping part. If this overlap is asymmetric company which covers relatively larger part of its competitors market has higher incentive to compete for the new market. Company with relatively smaller customer potential is likely to concentrate rather on its existing opportunities in old uncontested part of its market than start to compete with price and impair the profitability. Therefore competitive disruption occurs when segment preferences are asymmetric. (Adner, 2002)

Christensen (2006 p.44-45) considered Adner's (2002) research to present a clearer description of the underlying causal mechanism of disruption process. It provided deeper insight on the disk drive industry example of how incumbent was subsequently forced higher up the market because of competition and market incentives. The relation between preference overlap and preference symmetry of market segments explains competition incentives of companies and their willingness to invade new market segments. (Adner, 2002) Carayannopoulos (2009) suggested that incumbent is likely to overlook competition if the preference overlap is limited between markets at first. Even though the overlap could grow as preferences evolve over time the disruptor is likely to be ignored due to asymmetry of preferences in which case disruptor is not perceived as a threat in time (Carayannopoulos 2009). On the other hand, if the overlap of market segments is substantial right from the beginning the disruptor is much more likely to be categorized as a competitor making the competition for new market fiercer and more difficult for the disruptor (Chen, 1996; Porac et al., 1995; see Carayannopoulos, 2009).

4.2.3 New-market disruption process

Christensen and Raynor (2003) added later a third dimension to the original Disruptive Innovation Model to describe new-market disruption. The third dimension

consist of new customers and new contexts of consumption. These form new value networks providing improvements to product costs, portability or simplicity and therefore attracts customers who previously lacked money or skills to buy or use the product. The new value networks therefore may attract new and old customer segments. (Christensen & Raynor, 2003)

When existing products characteristics are limiting the number of potential customers or use of the product is not user friendly or otherwise inconvenient new-market disruptive innovation are possible to occur. These disruptive innovations focus on customers who are not incumbent's active customers at the moment and are not typically users of the product yet. Also the product might not be similar existing product in the markets. (Christensen et al., 2004).

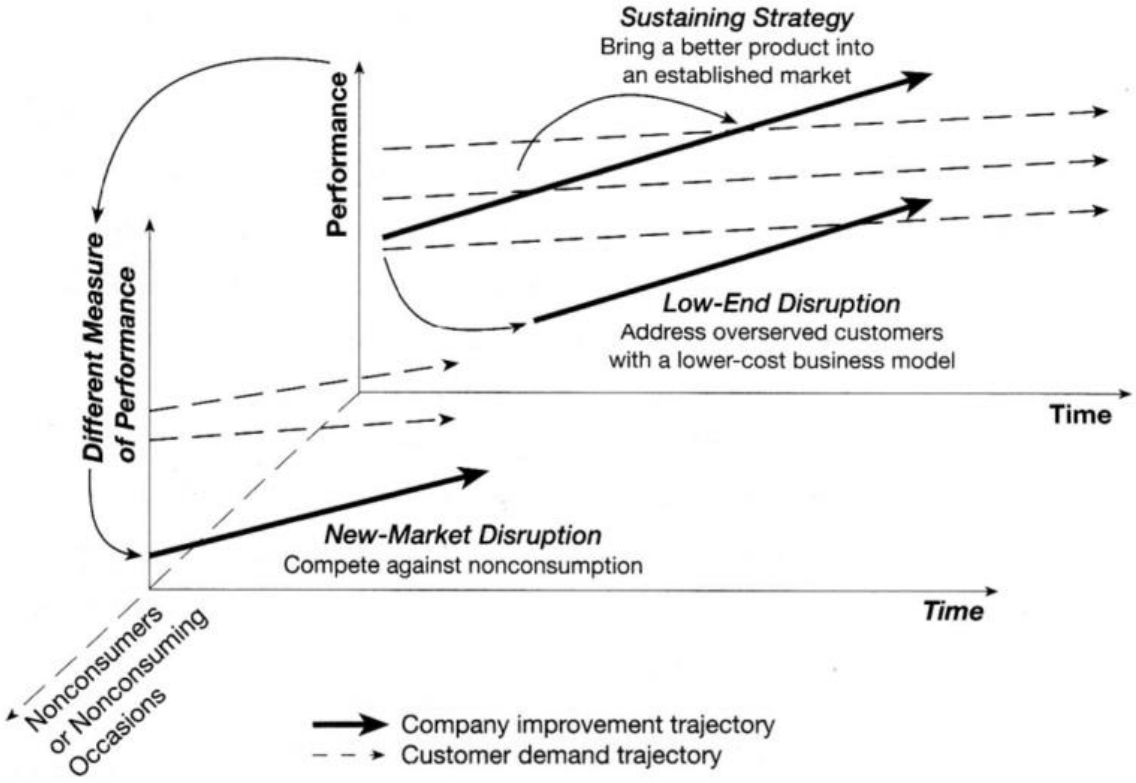

Figure 7 The Third Dimension of the Disruptive Innovation Model (Christensen, 2004 p.44)

The third dimension of the disruptive innovation model adds non-consumers and non-consuming occasions to the model to explain new-market disruption better

(Christensen & Raynor, 2003). The product performance attribute differs from original performance as non-consuming customers may have different performance preference they value. This creates different value networks which can emerge along with new-market disruption dimension at differing distances from the original. (Christensen & Raynor, 2003).

Where the basic model of disruption process explained earlier focuses only on primary performance attributes new-market disruption dimension emphasizes secondary performance attributes. Christensen & Raynor (2003) state that even though new-market disruptions compete at first against non-consumption in their own value network it starts to pull customers from incumbents original value network as their performance improves. Typically this phenomena initially starts from least demanding customer groups. Schmidt & Druehl (2008) came to same conclusion and explain that eventually when performance of entrant improves it start to gain incumbents customers groups. The process, in other words, of new market disruption generally starts with non-consuming customers and after performance has improved and value network expanded also incumbents consuming customers are reached. The process itself is likely to take considerable amount of time and incumbents are likely to defend their market share to slow the process down. (Gilbert, 2003; Schmidt & Druehl, 2008)

As new-market disruptions typically reaches in the beginning for non-consuming customer groups they do not create immediate threat to market leaders nor other companies in the industry. Actually according to Christensen & Raynor (2003, p.46) in the first states of disruption process as entrant start to reach low-end customer groups from the original value network it creates a false feeling of success for leading companies as it easily seems they are moving up the market and replacing less profitable customer segment with more profitable one. Only during final states of disruption process when also higher-margin customer segment is fleeing to disruptor market leaders are able to understand better the disrupting force. (Christensen & Raynor, 2003 p.46) Therefore successful new-market disruption which creates new value networks can be far more hazardous for incumbents than original models low end disruption. Low-end disruption typically starts to gain

already consuming customers from incumbent whereas new-market disruption does not take initially takes sales away from the old product (Schmidt & Druehl, 2008, p.350). And even if it affects to part of sales, the new product is likely to sell to low-end customers who are not that highly valued with in incumbents customer groups as they have low willingness to pay (Schmidt & Druehl, 2008 p.351).

Christensen et al (2004) argue that competing against non-consumption is one of the easiest options due to the fact that as there might be no current product option for many customers and therefore there is a lower threshold for trying it as well as competitive response is likely to be insignificant. Because creating new-market and new value networks differs from the industry's current operating models, Christensen et al (2004 p.8) claim new-market disruptive innovations have the greatest potential to change the industry in long-term.

4.2.4 Trajectories of performance

Danneels (2004) underline that understanding how disruption works requires understanding of the trajectories of performance for the demand and performance level of the new and established technologies together. Trajectory mapping has been employed multiple studies, one of the most famous is Christensen's (1993) work on hard disk drive industry. Christensen (2000) builds his theory on trajectories of performance demanded and performance improvements and states that linear trajectory charts for performance are the best method he know for identifying disruptive technologies.

Christensen (1993) first examined the disk drive industry and mapped the technological performance and capacity demanded in the markets and interpreted the dynamics of industry that smaller sized disks replaced larger disks as their capacity improved. The figure 8 follows Christensens (1995) linear trajectory charts for technology performance in disk-drive industry demonstrating mainframe-computers (A), minicomputers (B), personal computers (C) and portable-computers (D).

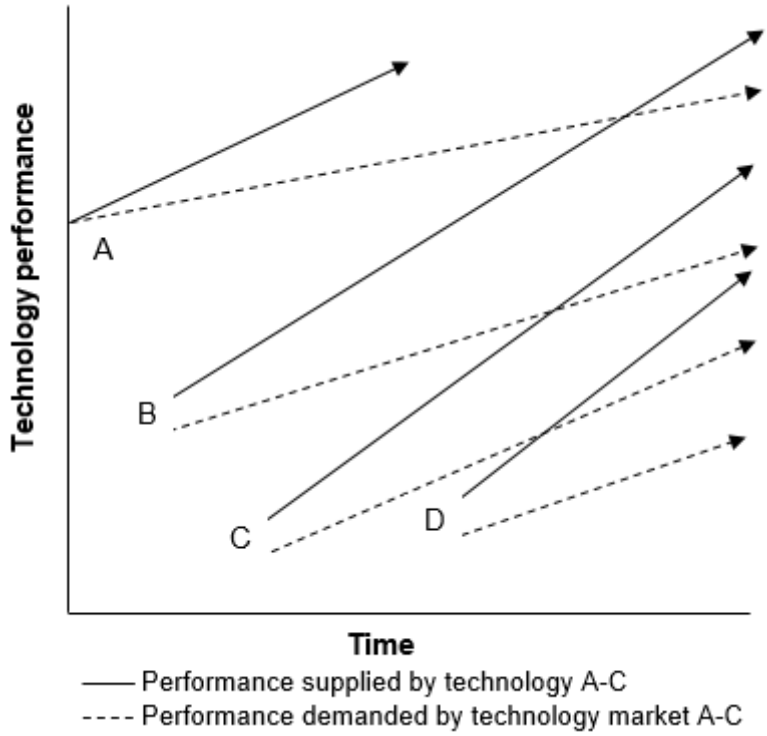

Figure 8 Representation of How Disk-Drive Performance Met Market Needs *(Christensen 1995)*

In a disk drive industry, as presented in a figure 8, three waves of entrant companies led the revolution. Though the innovation was not ready different market sectors technology developed over time and finally addressed end users' needs and disrupted the markets as the supplied and demanded performance lines intersects (Christensen, 1995). It presents how new innovation can proceed from new markets and eventually threaten the incumbent companies and their business.

A trajectory of performance chart should take multiple perspectives into account as potential disruptive innovations could use a different metrics for performance and may therefore be disregarded. Accordingly predicting markets future demand in performance in various dimensions and what might the levels of performance be is important to ensure that potential disruptive innovations are not ignored (Danneels, 2004). It is often recognized that in the beginning new technologies are usually not superior to prior technologies and performance disruption could also occur with already known technologies as they develop further (Sood and Tellis, 2005).

It is important to predict how the market evolves and what performance aspects and levels will be preferred and demanded along various dimensions as well as what this performance is able to supply (Danneels, 2004). The performance disruption is may not be stable especially if new technology is not superior compared to the previous one as the development will still continue (Sood and Tellis, 2005). In other words even though the technology has been passed earlier the trajectories may intersect again. Several studies have indicated (Christensen 1993, Sood and Tellis, 2011, Danneels 2004) that disruption have occurred due to an entirely new type of performance measure which had not been considered threat by incumbent earlier. This implies that performance measures may develop over time and current measures might not be capable of capturing advancement as it should. Therefore, it is crucial to examine new alternate technologies with disruptive potential and performance measures they use as well as major performance measures in current progress.

4.2.5 Diffusion of disruptive innovation

Schmidt & Druehl (2008 p.348) introduced a complementary framework to Christensen & Raynor's (2003) work. Their model suggests that incumbent may overlook new innovations potential impact when it diffuses from low end market toward the high end market. Schmidt & Druehl (2008) propose that low end disruption can be divided into three different types of patterns which they describe as low-end encroachment. They call these patterns fringe-market low-end encroachment, a detached -market low-end encroachment and immediate low-end encroachment. In contrast, pattern called high-end encroachment was considered to occur only for sustaining innovations. (Schmidt & Druehl, 2008) They also introduced a table which presents mapping of type of innovation with type of diffusion below presented in table 2.

Table 2 Representation of Mapping of the Type of Innovation to the Type of Diffusion (Schmidt & Druehl, 2008)

Type of Innovation	Type of Diffusion to which it maps	Description
Sustaining innovation	**High-end encroachment**	The new product first encroaches on the high end of the existing market, and then diffuses downward.
Disruptive innovation	**Low-end enchroachment**	The new product first encroaches on the low end of the existing market, and then diffuses upward.
New-market disruption	Fringe-market low-end enchroachment	Before encroachment begins, the new product opens up a fringe market (where customer needs are incrementally different from those of current low-end customers).
	Detached-market low-end encroachment	Before encroachment begins, the new product opens up a detached market (where customer needs are dramatically different than those of current low-end customers).
Low-end disruption	Immediate low-end encroachment	Low-end encroachment begins immediately upon introduction of the new product.

The fringe-market low-end encroachment scenario refers to new market disruption situation where market segment the innovation opens is only incrementally different from the incumbent's market and immediately attracts a small portion of incumbent's customers. This new market is defined to be on the fringe of the incumbent's old market and the purchasing behaviour of its customers is connected with the decision to choose a more affordable product which offers sufficient performance. Thus if incumbent's product would have been less expensive customers would most likely have chosen it. (Schmidt & Druehl, 2008 p. 351) After the innovation opens this fringe new market, which is considered to be adjacent with the old market, it begins encroaching and the diffusion starts from low end of the market moving upwards to the high end of the market. As described in this scenario incumbent has priced the old product out of the lower market segments while maintaining higher market segments. (Schmidt & Druehl, 2008 p.363)

The detached-market low-end encroachment scenario also starts with the new-market disruption and new innovation first opens up a detached market but in contrast to fringe-market it attracts customers with dramatically different preferences

and need than existing market segments low-end customers. Although the new innovation first encroaches the low-end of the markets before it starts to diffuse to higher end of the incumbent's market. In this scenario the customers of the new detached market highly value the new alternative performance attribute and are willing to accept higher price for a special feature. Though the new alternative attribute only attracts niche of the market and the primary performance attributes of incumbent's product are inferior for majority. The preferences between customers of the new detached market and the remaining market segment are negatively correlated. The need of customers are dramatically different so the prices and volumes of the products on the opposite ends have no impact on each other. The new innovation has to develop further before it will encroach for boarder segment of low-end customers and diffuse to high-end segments. (Schmidt & Druehl, 2008)

Schmidt & Druehl (2008) point out that the detached-market encroachment enables higher asking price in the beginning for the new innovation. They found this pattern for example with portable transistor radios and TVs as well as miniature disk drive and mobile phones which all were initially expensive. In their examples innovations price become considerable cheaper before attracting the boarder part of incumbents market segment (Schmidt & Druehl, 2008 p.361, 369).

The pattern where the innovation immediately attracts incumbent's low-end customer segments is called immediate low-end encroachment scenario. From the beginning there are no negative correlation between the customers' preferences and the performance trajectories or preference attributes are more apparent from the beginning. (Schmidt & Druehl, 2008)

In their research Schmidt & Druehl (2008) discovered that the diffusion process of disruptive innovation is initially less disruptive than a sustaining innovations diffusion process and therefore in the beginning of the diffusion process will not have significant impact to incumbent's sales. For sustaining innovations Schmidt & Druehl (2008) use calculator and fuel injection as examples for high-end encroachment. In this scenario a higher performing innovation with premium price diffuse from established high-end market segments downwards to the low-end market

segments. Electronic calculators with premium price and performance were at first used by scientist where as fuel injection served luxury and sports car segments. This diffuse process pattern followed the Utterback and Acee (2005) description of innovations disruptive attack from above. In their pattern high performing and premium priced innovation enters immediately to established high-end market segments and diffuse over time to low-end markets when price has decreased and usability and performance improved further more. For sustaining innovations it seems that the high-end disruption processes pattern is opposite to low-end disruptions. (Utterback & Acee, 2005)

Sood & Tellis (2011) illustrated disruption process, similarly to Utterback & Acee (2015), with lower and upper attacks. Upper attack refers to situation where at the introduction of new technology it immediately performs better on primary performance attributes compared to incumbent's technology. Lower attack, on the other hand, describes a situation when disrupting innovations performance on primary attributes is weaker than incumbent's technology at the time of introduction and they call this a "potentially disruptive technology". They also argue that a lower attack rarely disrupts firms and it would actually reduce the risk of disruption. It is worth to note that the price was not considered as a factor in definitions of the lower and upper attack (Sood & Tellis, 2011). Schmidt & Druehl (2008) associated a high-end encroachments with higher price and low-end encroachments with lower price level which was similar to Govindarajan & Kopalle (2006) distinction between price level of high-end and low-end disruption.

The diffuse process of disruptive innovation affects the market as a whole and is often described to be fatal for incumbent's business in the end if incumbent does not react correctly on time. According to Gilbert (2003, p. 29) incumbents established business is able to coexist with disruptor but the growth of the old market is likely to slow down or even cease and finally reduce in size as disruptors new market continue to expand and attracts old markets customers. Gilbert (2003, p. 28) defined the disruption process to proceed in three specific phases:

1) Innovation creates a new, non-competitive market independent of the established business.
2) The new market expands and slows the growth of the established business.
3) Having greatly improved over time, the disruptive innovation significantly reduces the size of the old market.

From the perspective of market dynamics during the first phase disruptive business creates larger net growth of the market as whole. This growth is formed due new customers who initially were not present in the established market as their performance requirements and way to use the innovation are different. Even though the disruptor will displace parts of established market the net outcome for growth will always be positive. This growth and market dynamic change is driven by the demand and needs of new customers. (Gilbert, 2003)

Sood & Tellis (2011) agreed that coexisting of competing technologies is possible but it requires market growth and new innovations to create new niche market. Yu & Hang (2010) also found that an incumbent business is able to survive and coexist if it concentrates satisfying its most demanding but least price sensitive customers. A general view of a new-market disruptive innovation process is that it has to first gain momentum in the market it has created before attacking to the low-end of incumbent's established market (Christensen et al., 2004; Schmidt & Druehl, 2008; Danneels 2006). The figure 9 illustrates Gilberts (2003) view of disruption process and how it diffuse to incumbent's market.

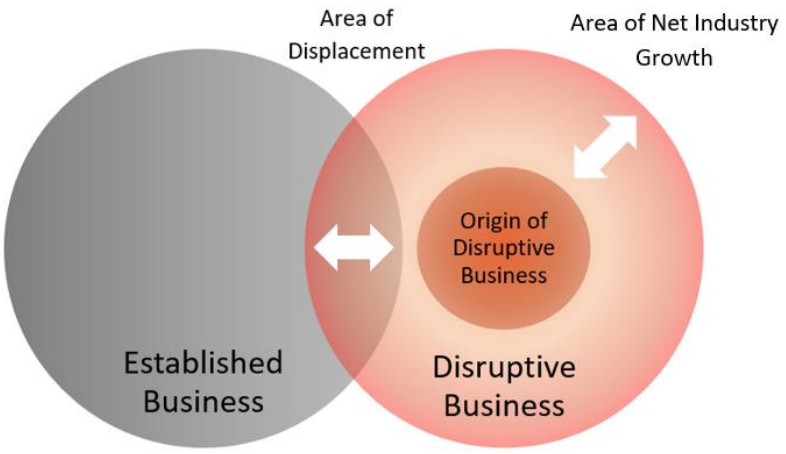

Figure 9 Pattern of disruption process and market (Gilbert, 2003)

Though, market expansion with new market disruptive innovations is supported phenomenon among different authors, Christensen have not accounted net growth of the market as a phenomenon in his works. Instead his focus has been on other effects of disruption. Christensen & Raynor (2003, p. 111) argued that demand on mainstream market is actually not significantly affected in the beginning of the disruption process. However this view does not contradict with others, the emphasis is just on different focus points.

The disruption process for disruptive innovation is initially often less disruptive than diffuse process of sustaining innovations. Disruptive innovations diffuse process moves forward in distinct phases which usually follow certain patterns. Low-end disruption process starts immediately as entrant is introduced to the market and it diffuse right away to the established low-end market gaining market share from incumbent. It progress with similar patterns to new-market innovation but it does not necessarily lead to market expansion in the same way. The new-market disruption on the other hand creates greater market expansion. It first creates a fringe or detached new-market segment from where it continues to expand as its performance incrementally improves. As the innovation matures and improves in performance it starts to attract more new customers and incumbents old customers and diffuse upwards the market. This process starts slower and may take considerable amount of time before disruptive effects are significant.

4.2.6 Technology S-Curve

The technology S-curve can be considered as the centerpiece of thinking about technology strategy. The main principle of the model is that “the magnitude of a product’s performance improvement in a given time period or due to a given amount of engineering effort is likely to differ as technologies mature”. The basic assumption is that in the early stages of a technology the progress rate will be rather slow. The pace of technological improvement will accelerate while the technology becomes better understood, controlled and diffused. However, in the later mature stages the technology will start to approach asymptotically a natural or physical limit. Greater

and greater periods of time or input of engineering effort are required to achieve enhancement. This is shown in the Figure 10 (Christensen 2003, pp. 44)

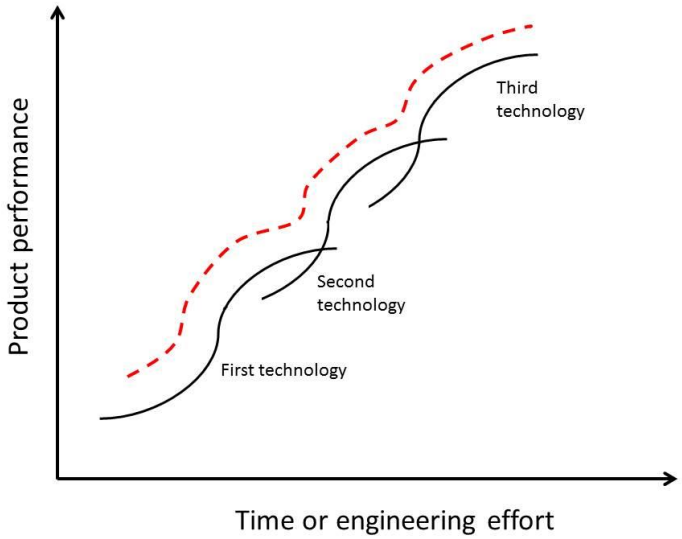

Figure 10 Representation of Technology S-Curve (Christensen, 2003, p. 44)

Myriad of scholars argue that the core of the strategic technology management is to understand when "the point of inflection on the present technology's S-curve has been passed, and to identify and develop whatever successor technology rising from below will eventually supplant the present approach." Therefore the challenge is to understand when to change from the old technology to new technology. Many firms have failed this and the consequences have been dramatic. (Christensen, 2003, p. 44)

S-curve can be divided in three stages. These sections are 1. Introduction stage 2. Growth stage and 3. Maturity stage. In introduction stage development is slow. There are two major reasons for this. The technology is now well known and therefore it does not attract the attention of researchers. The other reason is that important bottlenecks need to be tackled before the technology can be converted into practical and meaningful improvement in product performance. Introduction stage is followed by growth stage. When development continues technology will cross a threshold and after passing by the threshold the pace of development will increase dramatically. Typically this stage begins when there is a dominant standard. This consensus encourages to research this technology which speed ups

the technology development pace. This will attract more researchers. Researchers' cumulative and interactive efforts increase even more the pace of development. This will lead to increases in sales and due to this there are more money to support R&D. The final stage is maturity stage. In maturity stage the rapid improvement stops and the technology occurs slowly or reaches a ceiling. (Sood & Tellis, 2005)

4.3 Criticism of Disruptive Innovation Theory

Disruptive innovation theory, even though it is prominent and widely recognized, has also received much criticism from several scholars. The critique of the theory focuses mainly on three issues, the vague definition of disruptive innovation, the choice of empirical examples to match the theory in Christensen's existing researches, and whether the theory can be used in predictive manner.

Christensen's theory has received the most criticism for failing to provide a sufficiently clear definition of disruptive innovation. Many scholars have argued that the term disruptive innovation is misleading and the lack of coherent and precise definition has led to misconstructions. (see e.g. Danneels, 2004; Tellis, 2006; Schmidt & Druehl, 2008; Yu & Hang, 2009; Sood & Tellis, 2011) Danneels (2004, p. 247) stated that the definition that Christensen provides is too loose and does not allow a clear decision to be made whether innovation can be considered Disruptive or not. Tellis (2006, p. 35) addressed the same criticism and suggested that the problem was in the terminology as same word is used to describe the cause and the effect.

Christensen (2006) addressed the problem and continued refine the definition, but refinements have not been considered fully adequate. Schmidt & Druehl (2008) argued that due inadequate definition and overall terminology leads easily to misconstruction. They pointed out that that as disruptive innovation may also be less disruptive than sustaining innovation it creates confusion over the subject (Schmidt & Druehl, 2008). Additionally Sood & Tellis (2011, p. 340) emphasized ambiguity of the terminology to be the major problem as definition for disruptive innovation is

unclear and term “disruption” is still used to describe the cause and the effect of the theory.

Christensen has been caused to pick cases to match his theory, therefore the empirical evidence has been under debate. Danneels (2004) pointed out that in all the examples Christensen has used the Disruptor always succeeded and accused Christensen of selecting only examples which supported his framework. Tellis (2006) made similar conclusions and alluded that sampling could be biased. Lepore (2014) argued that Christensen tend to ignore conditions which do not fit into his framework and noted that using highly unusual industry of disk drives as foundation for a model creates weak footing to it. Accordingly, Sood & Tellis (2011) argued that the empirical evidence is inadequate which deteriorates the theory which suffers also from the lack of predictive modelling.

The predictive use of disruptive innovation theory has been debated and challenged between scholars. Danneels (2004) pointed out that the model Christensen created is only historical data and pondered whether it is actually possible to identify disruptive innovation in advance. Yu & Hang (2010) stated that many authors have debated whether historical observations of disruptive innovations can support the future predictions. Sood & Tellis (2011) stated that a model capable of predicting disruption has not yet been presented. Additionally, Utterback & Acee (2005) argue that current models is too narrow and does not accept innovations of high performance. Yu & Hang (2010) noted as well that the scope of disruptive innovations has been debated.

5 METHODOLOGY

A key decision in any research project is the careful selection of an appropriate research methodology. Future study is interdisciplinary in nature and it can be referred to as systematic approach to describe, elucidate and understand possible future views or scenarios. (Kuusi, 2002) This study utilizes Delphi method due to nature of the research questions. Linestone & Turoff (1975) defined a list of seven situations in which the Delphi is usually justified research method.

Table 3. Properties of the applications which may lead to the need of employing Delphi. (Linestone & Turoff, 1975, 4)

1. The problem does not lend itself to precise analytical techniques but cart benefit from subjective judgments on a collective basis
2. The individuals needed to contribute to the examination of a broad or complex problem have no history of adequate communication and may represent diverse backgrounds with respect to experience or expertise
3. More individuals are needed than can effectively interact in a face-to-face exchange
4. Time and cost make frequent group meetings infeasible
5. The efficiency of face-to-face meetings can be increased by a supplemental group communication process
6. Disagreements among individuals are so severe or politically unpalatable that the communication process must be refereed and/or anonymity assured
7. The heterogeneity of the participants must be preserved to assure validity of the results, i.e., avoidance of domination by quantity or by strength of personality ("bandwagon effect")

If the conditions of one or more of these situations, listed above, are met it usually leads to the need of employing Delphi method (Linestone & Turoff, 1975). Also the Delphi is suitable for situations where descriptive future research can be found to produce useful information (Mannermaa, 1991). From the list above criteria's one, two and seven apply to this research and Delphi has been widely used for business

forecasting (Koponen, 2010) Therefore it has been chosen as the methodology of the study.

5.1 Delphi method

The Delphi technique was originally developed by Rand Corporation in the 1950's and named it after the ancient Greek temple of Delphi where oracle predicted the future. It was originally developed to improve the accuracy of predictions for military purposes (Woudenberg, 1991). The method was popularized during the 1960's but during 1970´s it received a lot of criticism which led to a decrease in use of Delphi method in scientific research (Kuusi, 2002).

The Delphi technique is a qualitative research method that seeks to predict future prospects and changes, as well as, to elucidate unclear and unpredictable things. It is a multistage process which is designed to combine opinion of various experts into group consensus (McKenna, 1994). Rikkonen et al. (2006) define Delphi as structured group communication process which effectively allows a group of individuals to address and process complex issues. Delphi is often used method in future studies to perceive and predict the future over the long term (Kuusi, 2002). Delphi has been found to be the preferred research method when the views of experts in the field differ greatly and further dialogue is needed and the research questions or problem has to be answered more by intuitive judgement rather than concrete measurement and precise analytical techniques are not suitable for solving the problem (Pill, 1971; Linestone and Turoff, 1975).

According to Woudenberg (1991) there are many different ways to carry out Delphi research but the most common method for data collection is the use of survey rounds in various forms. The number of survey rounds varies depending on the study and though most commonly rounds are from three to ten. The selection of experts is a critical stage in the research and the panelists must have the necessary knowledge and experience of the research topic in order for the research results to be reliable (Chang et al., 2002, 784).

Linstone and Turoff (2002) refer to the use of the Delphi method as a substitute or complement to the work of expert working groups. The Delphi method can be seen to have three key features which are anonymity, iteration, and controlled feedback. (Chang et al., 2002; Woudenberg, 1991; Landeta, 2006) Anonymity is considered to be one of the most important features of Delphi research. Anonymity means that individual responses cannot be associated with the respondent. The aim of anonymity is to achieve the most authentic opinions and views as possible (Landeta, 2006).

Delphi study consist of multiple rounds, in which expert panelists have possibility to change, adjust or re-argument their own opinions. The second key feature, iteration of results refers to this possibility to review and re-argue own opinions. (Kuusi, 2002) Iteration of results is strongly linked with the controlled feedback which is the third key feature. With controlled feedback expert panelists gain insight into the opinions and views of other respondents. (Woudenberg, 1991; Landetta, 2006; Kuusi, 2002)

Due to nature of Delphi method it enables collection of views and opinions independent from other expert panelists and also enables the gathering of tacit knowledge to predict the future. (Nonaka and Takeuchi, 1995, 284) Anonymity, iteration of results and controlled feedback help to avoid the discussion bias and enables testing of more radical or otherwise different as well as supports communication and idea sharing between experts of relative fields. (Bell 1997)

5.2 Implementation of Delphi method

The empirical research was conducted using the Delphi research method. The Delphi method was used to gather information of DLT and its effects on banking sector's future from diverse experts with legal, banking and technology background in order to gain the most comprehensive outlook on the novel subject. The primary aim of the Delphi study is to understand the future effects of the new technology to the banking sector and its operating environment and development in Finland. The

secondary aim is to understand what might be the future applications on the banking sector.

5.2.1 Data collection and analysis

This study utilized a three-round Delphi study for data collection. The first interview round was conducted as a semi-structured interview either in person, by phone or via skype. The second and third rounds were carried out with anonymous surveys and were based on earlier rounds results. The latter surveys consisted of statements, multiple choice questions, matrix questions and open ended questions and offered a possibility to add addition information or arguments.

All the expert panelists who attended to the Delphi study were initially contacted either by e-mail or telephone to ensure willingness to participate. With willing participants the first rounds interviews were executed in spring 2017. Before the first interview, all the participants were provided a short description of the study and an estimation how much time they would be expected to contribute to the project. Also in the beginning of each interview terminology and willingness to participate were confirmed as well as the questions for the semi-structured interview (Appendix 1)

As explained in the beginning, the second and third survey rounds questions were based on the earlier rounds' responses. For these following survey rounds the Likert 5-point scale questions and rating scale questions were used and after each question there was a possibility to argue the opinion to free text field or add other relevant information. The survey questions for second and third round can be found from appendix 2 and 3. The mid-reports were provided for panelists approximately one week earlier than the next survey round was started via email. The latter survey questionnaires were conducted with Webropol, an online based survey tool, and expert panelists had approximately ten days to reply for the survey. These rounds were conducted during May and June 2019 and six participants answered to both of these latter survey rounds.

The figure 11 presents the steps of the Delphi research. It was divided into six different phases from which the first was planning the research and setting the goals for the research. Followed by finding the participating experts and study was conducted with three interview rounds and the final step is presentation of the study which is informed to the participants.

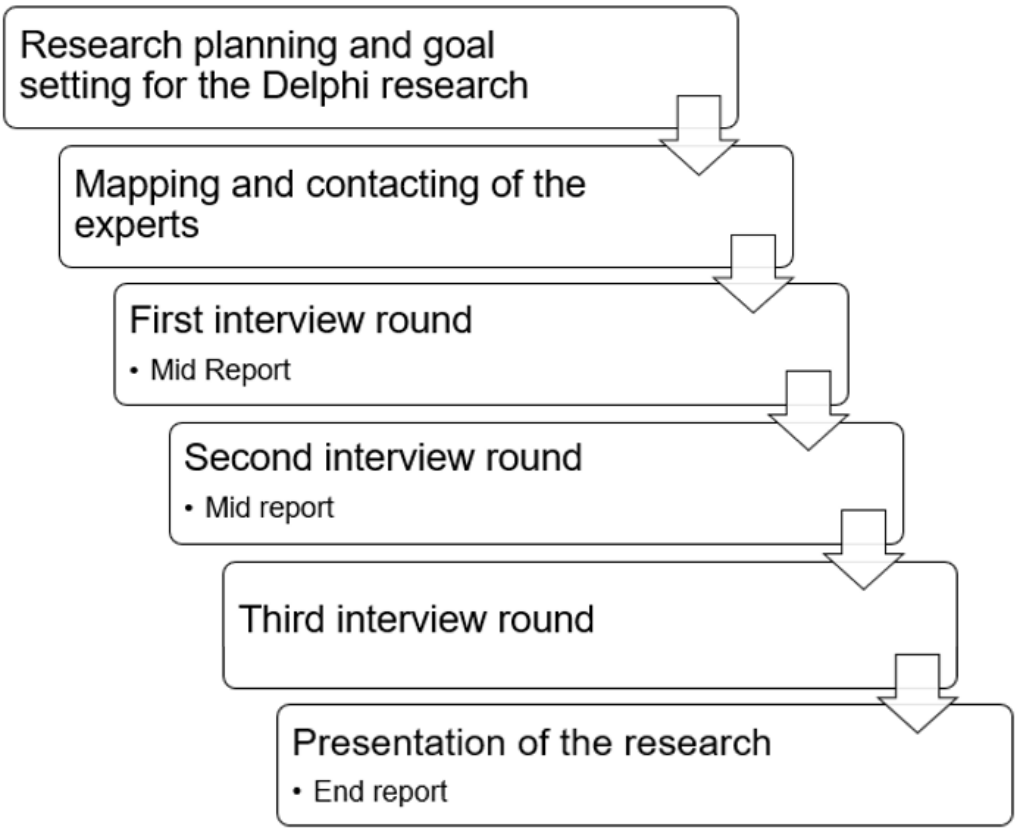

Figure 11. Research steps of the Delphi study

The qualitative method, grounded theory, is used to analyze interviews to find main themes and interdependence between the themes. Grounded theory is a data-driven analytical method that seeks explain and describe phenomenon under study and to provide a concise explanation of it (Glaser & Strauss, 1967). In total twelve themes are found during the first interview round, which are divided to three main themes:

- Opportunities
- Challenges
- Other focus points

Themes are introduced in more detail in the results in chapter 6. To find the themes, interviews were categorized to bring up the most emphasized aspects as well as to recognize the differentiated minor opinions. The grounded theory is used also to further analyze the following second and third round and the answers between different rounds are compared together during the process.

The main characteristics of the Delphi research method were carefully taken into account in the implementation of the study. All the answers were processed anonymously and responses cannot be connected to the single respondent. All the expert panelists had possibility to iteration and equal argumentation. The controlled feedback, mid-reports, was provided via email during the process between the survey rounds enabling re-argumentation and iteration. All the different views were taken into account in mid reports and in final results.

5.2.2 Experts of delphi study

The expert panel for this study consists of 22 international experts which expertise varied from banking to technology and law. The experts were carefully selected between business-oriented and research oriented experts available. The division between main expertise backround was important selection factor and it was ensured that the balance between banking experts and technology experts remained. Regardless of the background, all the experts were required to have prior knowledge of the DLT and understanding for it under their own expertise field. The work places and fields varied from specialists and executive level managers in banking to IT and cryptocurrency consultants, economics, researchers and IT-specialists as well as laywers with technology or banking understanding. Social networks, expert contacts and internet were used to find and select the participating experts. Additionally potential experts were found by inquiring recommendations of potential persons from other experts from the field.

The Delphi research involved experts from five different countries. Clear majority of the panelists are from Finland as the focus is in Finnish banking sector. But for novel

topic international experience was was also necessary to gain a comprehencive knowledge. Other nationalities are Swedish, Norwegian, American and Italian. The distribution of the nationalities of the experts is shown in the table 3.

Table 3 Nationality distribution of panelists of the Delphi study

Nationality	%	number
Finland	81,8 %	18
Italy	4,5 %	1
Norway	4,5 %	1
Sweden	4,5 %	1
USA	4,5 %	1

The distribution of main expetiese of the panlists are demonstrated on table 4. On the top part of the list orientation and main expertise field are illustrated. In general 22 expert panelists participated on first round from which five have research backround and the rest have business oriented backround. Main experties field divided closely between banking and technology backrounds. As eight of the panelists expertise cover two of the expertise fields the there are presented list with all the expetiese considered and with only current primary expertise based on the current work.

Table 4. Background distribution of panelists of the Delphi study

Orientation:	%	Number
Research oriented	22,7 %	5
Business oriented	77,3 %	17

All expertise concidered	%	Number
Banking sector	40,0 %	12
Technology	46,7 %	14
Law&regulations	13,3 %	4

Main expertise considered	%	Number
Banking sector	36,4 %	8
Technology	45,5 %	10
Law&regulations	18,2 %	4

6 RESULTS

This section presents the research results of the Delphi study. As mentioned earlier in chapter 5, the research results were divided into three different main themes and as a whole, twelve different themes were identified. The themes are presented in the table 5.

Table 5. Themes of the Delphi research

OPPORTUNITIES	CHALLENGES

• Increased efficiency and cost reductions
• Improved transparency and traceability
• New applications
  ○ Digital identity
  ○ Smart contracts
• New business models
	• Immaturity of the technology
	• Incoherent terminology and lack of experts
	• Governance problems
	• Legal and regulative problems
	• Financial risk and integration risk

	OTHER FOCUS POINTS • Cryptocurrencies • Structural change in competition • New Innovations

Results are presented thematically and the last subchapter presents panelists' views of strategic effects of DLT to Finnish banking sector. All the results are presented but the most important ones can be divided into three strategic impacts and two applications which are considered to have most potential to create new market segments and business models, which is why banks should have extra focus on these DLT applications and businesses utilizing them.

Strategic effects to banking sector:

1) The market structure and competitive environment will change
2) Banks will have to review revenue streams and business models
3) Banks efficiency increases and cost structure changes.

The most potential applications:

1) Digital identity
2) Smart contracts

The research results are presented objectively and the responses of all expert panelists have been taken into account in the research results. The presentation of the research results is supported by direct quotations from the panelists' answers. The interviews were conducted in either Finnish or English, so some of the quotations have been freely translated into English.

6.1 Opportunities of DLT

Majority of expert panelists believe that DLT will become important technological solution for multiple business fields. The potential solutions it offers are extensive though it is generally agreed among panelists that the technology needs to be understood better to unveil the true potential. Additionally it is generally agreed that banking sectors ecosystem is evolving and there are multiple other factors which are simultaneously effecting to banking sector and supporting these opportunities. The responses of the main opportunities of DLT are partly scattered all the different views argumentations are presented in the results. The opportunities that expert panelists most believe in can be divided to four categories:

1. Increased efficiency and speed with reduced costs
2. Greater transparency and improved traceability
3. New applications: Digital identity and smart contracts
4. New business models

6.1.1 Increased efficiency and reduced costs

18 expert panelists name the potential to increase efficiency as one of the biggest opportunities DLT offer. Improving efficiency is linked closely to cost reductions and faster services in all these answers. Panelists see that the DLT offers extensive possibilities for increasing level of automation, 14 panelists mention the transfers as an example. The level of complexity of the bank transfer and cross boarder payments processes are high. DLT enables banks to simplify the process by

improving the efficiency and transaction speed as how fast money is transferred to other bank as well as reduce the costs as the process can be more automated.

> *"Well the main opportunities can be divided in two categories. First of all quite a number of things have been done in a very complex way in the banking sector. If you for example look at such a basic banking operation as transfer to another bank, the degree of complexity is pretty staggering...*
> *Improving efficiency is the first opportunity, doing things, the current operations the way they should be done so that they would be efficient, trustworthy and fast."*

> *"Banks' current processes are cumbersome and slow, especially for bank transfers, for which DLT could offer a lot of relief. When the system can validate the data automatically and no manual work is required, efficiency is improved, costs are reduced and transfers could possibly be made even in real time."*

DLT can diminish or even remove the need for data synchronization and concurrency control by a trusted third party. Opinions of panelists scattered with the statement of DLT's ability to remove the need for the central authority. Six of the panelists argued for it because it is the new groundbreaking change that the DLT offers while seven of the panelists argued that on banking sector a dispute solver will be needed which also come up in the chapter 6.1.2. Additionally, the problem of governance was raised, which is presented in chapter 6.2.2 in more detail. Panelists stated that due decentralized data speed of for example transaction settlements is expected to improve. Also its distributed nature will allow to reduce other connectivity bottlenecks.

None of the panelists directly denied the potential efficiency gains but cost savings and view of distributed database as superior or even incrementally better infrastructure solution is questioned. Nine of the panelists bring out these views from which six of them take either neutral approach or consider benefits to be more likely.

Panelists agree that DLT is not likely to be the main architecture or system for banks but it is likely to be very good option for some parts of the business.

> *"So far, blockchain or DLT technology has not proven to be a better and more efficient system for banks or especially for other industries. It has potential but the same development solutions can also be implemented with existing technological solutions and database structures. Because new technology also requests big investments and benefits are uncertain it is too early to suggest will it offer cost savings."*

> *"Yet there is no actual use cases which would proof efficiency benefits of distributed database structure, sure there is a lot of potential but could decentralized databases offer same or even better level of efficiency is uncertain. The only thing that is certain is that more efficient solutions than current systems can be achieved."*

6.1.2 Greater transparency and improved traceability

Transparency and traceability are essential part of banking and the need to improve them is also growing. The present role of central authority or a trusted third party which bank possess emphasizes in particular the need for transparency according to panelists. The implementation of DLT and chosen DLT system will indicate how these can be improved. In general panelists agree that banks are more likely to use rather private than public DLT systems. Private DLT systems do not offer radical changes to present systems but it is likely to improve auditability and recordkeeping in general which would ultimately improve both transparency and traceability. Even though private DLT system does not provide extensive improvements to traceability and transparency these are very important aspect in banking sector and incremental improvements it can offer according to panelists are significant.

> *“Financial operations which have low transparency and limited traceability are vulnerable to disruption by DLT solutions because these aspects are very important for banks business.”*

> *“In general public DLT system is not ideal for banks and will not be at least for a long time. Private systems could still offer better transparency and traceability within DLT platform especially if it is common with several banks and other actors.”*

Panelists pointed out that DLT may provide traceability over how, when and by whom the user’s identity is being used and thus improves overall transparency. They conclude that increased transparency is likely to lead towards better consumer trust and security. Five of the panelists believe that this is likely to lead to more responsible interaction between companies and consumers. It is pointed out that improved transparency and traceability is important enabler with some of the applications DLT can offer.

DLT improves traceability as it provides an immutable ledger and it is possible to audit all the events in the ledger. Successfully authenticated changes to the ledger cannot be deleted or modified which ensures accuracy and security of the record. The immutability is questioned by six panelists as the technology is not mature enough to prove immutability thus it cannot be stated as a fact.

> *“There are known fork situations like DAO attack that threatens the immutability, also practically one instance could obtain, at least in theory, enough mining power to take control over a public blockchain. Due to immaturity of the technology and unsolved problems the immutability is questionable.”*

6.1.3 New Applications

Panelists point out that DLT enables many new applications from which by common consent smart contracts and digital identity are most promising for banking sector. Smart contracts enable even higher level of automation and significantly reduce counterparty risk and costs of transacting as it can minimize the human errors from the process. Smart contracts can offer lower contracting and compliance costs as well as easy enforcement. Smart contracts would enable economy to work in totally new ways. Other technology solution like Internet of things or artificial intelligence combined with smart contracts could provide useful and interesting new beneficial solutions and multiple new business models.

Panelists point out that digital identity will be a huge business which will grow in the future. In practice, banks dominate authentication services in Finland for now. Though it is noted that their market position started to change as new operators have entered to the market. Nevertheless many of them make use of banks identification channels. The digital identity is stated to become a massive business which has not yet been utilized nor capitalized as well as it could. Additionally panelists point out that there are companies with DLT-based solutions being developed for both digital identity and personal data management and they see these as potential and interesting especially for banking sector.

> *"Blockchain or DLT based solution for digital identity can provide a legitimate audit trail with immutability and security. It could be structured with easy access and easy manageability. This would also enable easier data management for everyone's own private information. If you wish you can grant access to all or part of your information which if realized, would be revolutionizing change."*

> *"There are currently companies developing digital identity solutions which could revolutionize how digital identity and data could be managed. Imagine what the competition could be like if you could*

provide the company with all your financial information, credit rating and payment history at the touch of a button."

DLT offers better trust and security for consumer data which makes it possible to have ownership of your own data and even a digital identity. This would allow one to freely choose who can gain access and to what part of the data. Consumers or other data owners would be able to grant temporarily or permanent access to their identity or data while retaining the ownership. This would also allow huge cost savings for financial institutions for KYC -process as well as any other company who needs to identify other customer or contract party.

"The KYC and AML processes are very cumbersome for banks. DLT could allow for a common KYC data repository which would alleviate this. However, consent must always be obtained from customers, so for the time being the solution could require a system through which the customer can authorize himself if he so wishes."

6.1.4 New Business models

Panelists give coherent opinion over potential possibilities of DLT. The level of automation, transparency and data ownership rights are likely to improve and there are significant possibilities to improve efficiency. Though eleven panelists point out that technological disruption is likely to cut down some work tasks at first they believe more opportunities will raise up from new business models. Though net labor effect is too early to predict for now. Panelist commonly agree that banks will have to rethink their business models because of DLT and legislative changes (e.g. PSD2) which will change the competitive environment. Even though panelist commonly agree that new revenue streams and business models are huge opportunity the main focus areas vary in responses.

"The whole ecosystem of banking sector is going through a transition period. The winners of this will have to understand from what

components the new business and revenue streams are formed as for now, money transfers have created secure revenue stream and this might change in the future"

"Cryptocurrencies and crypto assets offer completely new opportunities for banks which, at least so far, they have not been willing to explore and take advantage of"

"New DLT platforms offer interesting possibilities for banks, the trend for business models utilizing platform economy has been rising and banks could use these as example"

"Most important part is to understand what creates the added value and which services and functions provide it the most. Banks are generally seen as reliable party in Finland which could be the key factor in competition with new small actors. I believe simple and easy to use and reach solutions are will be the driving force for business model development"

"The technology is likely to form new ways to do business and create new business models – Which is another big opportunity category."

Panelists argue that the current economic situation also affects to banks revenue streams as the operating environment is re-forms. This market level change is also expected to guide banks to review their business models. Six panelists emphasize the new business opportunities that smart contracts and digital identity solutions could offer. They also suggest that the most interesting business models are likely to rise from smaller banks or new market entrant's as the banking business is well established and recent innovations has mainly been product or solution based which competitors have been able to copy rather easily.

"Account transfers have created secure revenue stream banks. DLT could change this. Even though the price competition has already been

> *high it could become even fiercer. I consider it possible that new players will also enter the industry who offer transfers to companies free of charge but seek income through something else and these kind of entirely different business models may be hard to copy – banks might would have to compete at the expense of profitability"*

Experts point out that new business models are one of the biggest opportunities that DLT poses. New technology is able to change the market structure and competitive environment the change brings new perspectives to the existing market and new operating opportunities enable the development of a new business model. The level of complexity is high on many operations on banking sector. Simplifying operations and changing own operational logic is likely to help new business models to occur.

6.2 Challenges of DLT

6.2.1 Technological point of view: Immaturity of technology & incoherent terminology and lack of experts

All the experts addressed real issues behind DLT starts with shortage of real experts and true understanding what it is and for what it could and should be used for. Big hype around DLT and especially Blockchain, wide misuse of terminology and mixing of concepts are complicating and slowing development process of technology.

> *"The hype created around DLT and especially to blockchain have led to its use also in situations where it was not sensible option in any aspect but rather used only for the hype."*

> *"Even specialist mix the terminology, when things are developed in a network and there is no common terminology it complicates and slows down the development process although in cooperation these are usually agreed in the beginning"*

In technical point of view it is a novel technology and still in immature phase of its development. Nine experts estimate that DLT has peaked over the top of the first s-curve and is evolving forward. Though they note at the same time that DLT is still generally too immature to move forward as a mainstream solution. Banks cannot rely on technology that has not been tested long and accurately enough.

> *"In the end customers do not care what technology is used as long as it works. Every time banks systems go down for even for a day it creates a lot of bad publicity. I'm sure banks will not introduce DLT at consumer business interfaces in the near future to avoid reputational risk as it is still in too immature phase"*

Technological issues DLT has to solve are affiliated according to expert panelists with security, privacy and integrity of data solutions as well as scaling problems and energy intensive nature of the technology. While technology is offering security and privacy benefits organizations will need to ensure that only those with appropriate permission are allowed to access the data. These issues are partly linked to different DLT platforms and infrastructures. Apart of different technical solutions in general ensuring the security and integrity of system is the biggest problem technology wise as this affects to implementation and adaptation of the technology solutions. The issue of trust in the system, ascertaining integrity of other users in the distributed ledger, and carrying out transactions in a consistently secure manner are thus key challenges to wider DLT adoption.

6.2.2 Governance problem

Panelists agree that ideologically one of the biggest expectations of the DLT is to obviate conventional third-party enforcers and creating impartial rule enforcement system which e.g. gives enforcement power to network of users. Though five of the panelists strongly believe this can fundamentally change the power relations generally and possibly in the banking sector, six of the panelists do not believe that this will have any fundamental impacts.

> *“The third party will not be removed and the central authority is needed in banking sector also in the future. Whenever a dispute between two parties occur a third one is required to resolve the situation. That won’t change.*”

Two of the panelists point out that even with bitcoin there is a central actor who creates the rules even though the rules are enforced more or less in cooperation. As long as there is an instance which operates as board of directors or similar the ideological change has not really happened it is just disguised as creator of the rules still exists and is the actual central authority.

> *“The ideological change is ambitious but the governance is a fundamental problem and if the only reason to use DLT is to obviate conventional third-party enforcers it can’t do it because in the end there are no difference between rule maker and enforcer. Therefore the power relations are not fundamentally changed and this governance problem makes DLT useless in that sense.”*

The two panelists address the governance problem to be fundamental and argue that DLT does not solve the problem of governance nor can ignore it. Therefore the power relations remain and banks will continue to serve as trusted third party also in the future.

> *“This leads to the conclusion; as it does not differentiate whether you trust someone to make the rules or enforce them, the power relations would not be fundamentally change. Current DLT solutions also seem to use trusted third-party enforcers. As the power relations are not changed DLT does not offer fundamental change to economics.”*

6.2.3 Legal problems and uncertainty of regulations

All the panelists did not take a position on legal and regulative issues. Most of the panelists addressed legal perspective but only eight panelists in total addressed these problems. Liability, damage and evidence issues arise in legal perspective, the dispersion of responses are related to how easily the regulative problems could be solved and how fundamental these problems are. All together unanimous opinion is that legal and regulative challenges are very important to solve before DLT can be widely adopted.

How DLTs interact with current laws and regulations governing specific sectors and what exactly should be regulated seems to be problematic. One of the biggest questions is jurisdiction. Because of the decentralized system raising issues are determining the appropriate governing law and determining the location where erroneous action took place. Also different follow up questions rise if the issue is transactional or contentious in nature. One example of jurisdiction concern is for digital identity, can identities registered under one jurisdiction be used for authentication under another jurisdiction.

Panelist also address that as DLT has gain more attention it has also attracted illegal activities for example due cryptocurrencies transaction anonymity. Therefore, regulatory field is likely to become more heavily regulated and currently regulatory field for DLT is just developing which creates uncertainty over technology.

> *“Regulative and legislative support is needed before DLT can become a mainstream technological solution”*

> *“Biggest problem is which court has jurisdiction and which law is applicable especially when the situation happens in international and digital environment”*

“The application of the laws has not been resolved but possibly applicable laws do exist. Whether it is necessary to create new laws for blockchain or not, it is too early to say, but so far I do not consider it necessary”

“Contract law faces a challenge when examining its applicability to the digital world”

“Regulation cannot be technology-driven and must follow existing frameworks. The formation of regulation eventually occurs based on use cases.”

6.2.4 Financial risk and integration risk

Adapting to new technology and being the first mover is a big financial risk for any company. Within fields where sensitive data is handled the risk increases tremendously. Panelists’ state that financial and integration risks are related to all technology development and deployment situations especially considering new technological innovation which require big investments to be further developed. Panelists pointed out that DLT is still in too immature phase for banks to implement it for consumer use but banks have introduced pilots and actual use have already started for internal operations and for interbank operations.

“The research and development process for a new technology requires large investments. There are very high expectations for DLT which it possibly may not be able to meet. Due to lack of understanding there are a lot of projects which only use DLT because it is hot right now not because it is the best solution for the particular issue.”

“Because of the hype over DLT and lack of technological understanding of the novel solution architecture and its potential use cases financial and integration risks become larger.”

> *“Integration risk is also closely associated with reputational risk. The failure of banking services, especially if issues last for long, has far reaching implications for the bank’s reputation.”*

The expert panelists address financial and integration risks but do no emphasize them as these are considered more like a secondary risk. Due to the existence of these risks, the actual deployment is expected to be slower than it could be if the technology is able to meet the expectations associated with it. Therefore seven panelists believed it will slow down the adaptation and development of DLT for banking sector in Finland.

6.3 Other focus points

6.3.1 Cryptocurrencies

Several panelists have sharp opinions and views regarding cryptocurrencies and the subject divide nine of the panelists to different extremes while rest have rather neutral approach. Four of the panelists strongly believe that cryptocurrencies and crypto assets have strong disruptive potential over banking sector and are therefore able to change the industry when the technology has developed enough. Some of the cryptocurrencies are also referred as “digital gold” by three panelists because of computational scarcity which is involved to them. On the other extreme five panelists do not believe that cryptocurrencies will have any notable impact for banking sector in general. Fundamental problem with cryptocurrencies is that commonly treated as an investment rather than an instrument of exchange and its value in many cases is purely speculative.

> *“long existence and proven concepts of major virtual currencies prove cryptos work and should therefore be recognized as possible mainstream instrument of exchange”*

> *“If the value is speculative and currency is actually seen and used as investment it will not pursue the ultimate purpose of the currency as an instrument of exchange”*

Panelists describe that ideologically cryptocurrencies could offer a worldwide currency, free from government’s regulatory influences. The organic nature of bitcoin for example is profounding as it is not issued by any central authority and on theoretical level it is immune to manipulation. Other benefits cryptocurrencies are seen to offer are fraud prevention, transaction anonymity or better identity and data protection, immediate settlement especially for cross boarder payments and low operating costs. The challenges cryptocurrencies are stated to face are increased regulations, lack of applications, limited scaling, consumer safety and security problems as human error or technical glitches. Additionally, due to its anonymity, it has also been used for money laundering and other criminal activities.

Five of the panelists argue that cryptocurrencies would have to be issued by central authority and the value should be tied to fiat currency or something else in order for it to become mainstream or even trusted instrument of exchange.

> *“As long as crypto currencies value is purely speculative mainstream markets will not be ready for them.”*

6.3.2 Structural change in competition

Panelists see that the business ecosystem is evolving and changing the competitive environment. With the changing regulative field DLT offers opportunities for new competition as the banks “walls and silos” are dismantled which especially creates opportunities for fintech companies which are likely to diversify competition. Panelists also agree that DLT is not likely to meet the hype that has been over the technology. It is pointed out that banks have compete in the same environment for a long time and thus are able to have some degree of cooperation which can be seen for example with R3 the banking consortium which develops one DLT system

for banking sector. It is also commonly agreed that the competitive power relations are hard to change due the regulations and already fierce price competition. DLT is seen as enabler rather than driving force of structural change as regulative changes are currently creating the biggest impact.

> *"The structural change technological development and regulative changes like PSD2 provide will intensify the competition as new innovative companies can easier enter to the market."*

> *"The degree of competition will increase. DLT enables new entrants to attack to the market with new innovative solutions. As lot of capital is required I would not be surprised if this would lead to acquisition when banks find new interesting concepts form new entrants."*

Expert panelists see that rapid rise to become a mainstream technology solution for banking sector is unlikely and deployment of the technology is more likely to happen at a slow pace in one business part at the time and may take years before it become mainstream solution if ever. Increasing level of automation will also impact on competitive environment and increase the price competition. Despite of majority view four of the panelists believe that the competitive environment can change faster as new companies enter the market and offer new types of solutions. Speed of these service solutions are believed to be the competitive advantage. They also note that due to high level of regulations structural change of competitive environment is likely to take at least couple of years but if the technological development is fast and good solutions are found it is possible.

> *"The change can happen fast if proven use cases are found as the technology has been proven to work "*

> *"customers have become more impatient than before due to new digital solutions. With mobile phones we are use to attain information or service fast and therefore services are expected to easily attained and*

> *fast – many manual actions are believed to occur automatically in banks although the degree of manual work is still huge."*

Panelists agree that in the beginning the change will start with internal systems and from there it is likely to evolve to interbank systems and move over to companies operating in the same ecosystem. Although beliefs about the potential for real use cases of technology for banking sector differ somewhat between experts, all panelists still express that from a technological point of view there are still many uncertainties associated with the change but even though technology would not meet the expectations the competitive environment will change due to evolving regulative field.

6.3.3 New innovations

Panelists believe that the true potential of the technology may not yet have emerged. There are not justified actual use cases found for banking sector yet and the technological development and understanding might bring them up later on. The potential is emphasized and new solutions are expected to be found.

> *"What new innovations related to DLT could be is impossible to address but if similar new innovations as smart contracts will be established in the future."*

Two of the panelists do not believe that DLT will offer fundamental improvements over present technology architectures. They do not deny that the technology would not develop but in their opinion it seems that decentralized systems should be able to offer similar level of performance as long as the central authority is required and there are no credible solution for problem of governance. They note that if actual use cases are found and technological concepts can be proven to work the situation may change. Nonetheless they admit that with the attention DLT has gained over banking sectors development new innovations are more likely to occur than without the attention.

6.4 DLTs strategic effects on banking sector

The banking sector in Finland is undergoing a transformation, which is strongly influenced by both regulatory changes and the development of competition as well as the development of technology. Regulatory changes are expected to have the biggest effect to banking sector in general as it have direct impact on competitive environment. Panelist believe that DLT is enabler which accelerates this change.

Panelists were asked to assess the possible effects of DLT on the banking sector in Finland. The market is expected to change as a whole and this structural change is expected to have an impact on banks' strategic choices and decisions. DLT is described as disruptive technology which has the potential to make fundamental changes to the banking sector and how banks operate. One disruptive aspect is transfers in general and especially interbank and cross boarder transfers. Banks have got a secure revenue stream from transfers and DLT system could increase competition and cut the prices which would directly affect to banks' results. Therefore the understanding where new revenue streams could be found and how to adapt the business model accordingly is important strategic decision in the future. The competition is increasing and it is expected to further diversify in the future as regulative changes has opened banks payment interfaces to third parties and enabled new fintech companies to enter the market more easily. The concept of open banking is changing the competitive environment as well as the opened interfaces as the silos are driven down and banks have to observe the challenges and opportunities even further to remain in the top of the competition.

> *"The structural change it causes to the banking sector is likely to be the biggest change that will happen on the market"*

> *"it is quite a big revolution for banking sector that the thick walls of silos may no longer protect your business in the future, the banking sector will have to learn to share things with each other so that competition can continue in the future. What it will require from a strategic point of*

> *view is the right kind of networking with competitors as well as other players."*
>
> *"the entire operating environment is evolving rapidly and is influenced by several parties and factors which affect to the whole banking sector. This will create new ways to operate, new business models"*
>
> *"it is always the case that first the old disappears and when "hunger" comes and increases enough, the imagination also increases, creating new innovations, new business models and different new ways to do things"*

Panelists make notion of platform economy which has been a rising trend. They point out that economic structures could continue to develop more towards platform economy especially on banking sector because on banking sector it is likely to emerge one or a few DLT platforms which come into common use. Provider of the platform will greatly benefit and banks or third parties who are able to make the best use of the platform will gain competitive advantage. Though panelists do agree that the banks themselves will not act as a platform provider, but may otherwise be associated with it, either through an ownership base or a similar solution to secure their own position in the market.

> "It will be interesting to follow how DLT platforms are selected for use in the banking industry. The integration of different platforms is difficult so this has a significant impact on the operating environment. It would also be particularly interesting if one of the providers of a platform were to join the competition in much the same way as Amazon has created a business model based heavily on offering and managing the platform."

During interviews panelists were asked to assess how DLT could progress in the banking sector and what kind of direct impacts it could cause to banks. There are many uncertainties according to the technological development and will appropriate

use cases be found. The technology has reached the first s-curve peak as is going through the second development phase. It has been taken in use and banks are going through testing but for DLT solutions to become mainstream or the most significant system solutions is likely to take time years. Panelists conclude that fore banking sector for DLT to become widely adopted solution it is likely to take 5-10 years but it might also not happen in foreseeable future. DLT adaptation is also happening in smaller scale and DLT systems are likely to increase in banks internal operations during next couple of years.

> *"Technology has matured over first cycle of its development and the pace of development is likely to get on other development burst within a year"*

> *"Estimating the actual timetable for DLT to become mainstream is difficult it is likely to still take a decade as these things take time but it could also be still in unforeseeable future as well"*

The deployment of DLT based systems is likely simultaneously increase the level of automation. It is expected to start from back office operations which are usually more easily automated. According to panelists it is still too early to estimate how it might impact to the number of employees. It is noted that due evolving regulative environment employees are needed for KYC operations as well as technology is also likely to create new jobs. Net effect to employees is concluded to be impossible to estimate.

> *"The question remains whether it creates more new than disrupts old - but to be honest the level of automation will increase significantly which will happen with or without this technology."*

> *"Automation benefits it creates are significant for KYC and AML processes alone, though the automation is likely to increase even though DLT would not be happening"*

The trend for banking services is argued to be personalized solutions and growth in the supply of digital services and especially mobile services. Because banks already have a good knowledge of big customer pool and banks offer identifying services it is expected to become a bigger part of banks business in the future. Though it is noted that banks have to recognize emerging competition and revise their own services and business models of it. The digital identity and ability to manage your own data creates great opportunities for different businesses and enables things that previously had to be taken care of in person. It improves online security and transparency as well as strengthen reliability as many services are digitalized and online. Panelists also identify trend of fast and simple services. Even though the technology becomes more complex services has to be easily accessed and used. Information should be easily and quickly transferable and accessible. Banks should explore the possibilities of DLT and try to simplify services as well to meet the market demand.

> *"Demand is strongly influenced by market trends and changes in consumer demand. These typically change in rather slow pace. However, a clear trend in the banking sector is more personalized services, a more cohesive multi-channel or "Omni-channel" service package providing better service experience and everything is becoming more digital. The trend in the digitalization on the other hand is mobile services as phones has become major part of our lives."*

Panelists name smart contracts and digital identity as most interesting applications of DLT for banks at the moment. Although the basic functions of DLT are expected to be more disruptive in the short term these are expected to create new market segments which will also diversify the competition to which banks may be more difficult to answer because they do not relate directly to the their core business. Two of the panelists also emphasize the importance of cryptocurrencies but the disruptive nature was addressed more towards central banks and is not within limitations of the research and is therefore left out from the results.

Additionally, panelists described what banks should be doing with DLT. As mentioned earlier banks should follow the development closely and have internal research and development projects to explore the technology and how it should be used. It is also advisable to research market trends and revise business models and strategies accordingly. In general panelists see that banks operating in Finland have acted prudently to explore DLT but on too small scale.

To summarize the strategic effects which DLT is expected to have on Finnish banking industry within next ten years. The market structure will change and DLT is one of the strongly influencing forces to drive this change. As the market structure change so will the competitive environment. The technological development along with regulative changes will diversify and intensify the competition as new companies will enter the market. Banks will have to review their strategies as some of the current revenue stream will reduce which will ultimately lead for new business models to occur. The efficiency DLT is able to provide will cost savings the entire cost structure is likely to change especially due evolving regulations. It is not yet possible to say whether the net effect of the changes on the cost structure is negative or positive but banks should prepare for this change. Panelists conclude that most interesting applications are digital identity and smart contracts because there are multiple different business model opportunities and new market opportunities that these may create. Other applications are thought to be more directly related to the bank’s current main business and therefore are less likely to any big surprises for the banking sector. According to unanimous opinion banks should continue to follow the development and especially proven use cases of DLT closely. As digital identity with concept of ownership of your data, and smart contracts are expected to provide the most new business model opportunities it is particularly important to monitor their development.

7 DISCUSSION

This is a qualitative study that aims to open up the effects of DLT on the banking sector in Finland. The research consisted of both a theoretical and an empirical part. The purpose of the theoretical part was to form an overview of Finnish banking sector and its development, DLT as a technology and how it might be deployed on banking sector as well as how disruptive innovations evolve and disrupt the markets. This theory base helps to outline which things have affected and could affect the development of the banking sector in Finland in the future as well as how disruptive innovations typically behave and affect to the market and how the disruption process progress. It helps to create understanding of what DLT is, why it is considered to be disruptive and what are potential benefits for banking sector.

The purpose of the empirical part of the study was to find out the impact of technology on the banking sector in Finland and how it is likely to develop and disrupt the industry. The empirical part focused on gathering the views of banking and technology experts on what opportunities and challenges DLT creates especially for the banking industry and how it affects the development and the future of the banking sector in Finland. The main themes of empirical study were the opportunities, challenges and future outlook impact of DLT for banking sector. In more detail what is the current state of the banking sector and what opportunities and threats does DLT create for it. How will DLT change the banking industry in the future and how big will the changes be. What are the most potential benefits and applications for the banking industry as well as what things affect the adoption of DLT and at what pace the deployment is likely to progress.

The objective of the research is to gain understanding of how DLT effects to the banking sector in Finland. To answer the objective it was divided into one main research question and one sub-research question.

- How distributed ledger technologies will change the banking sector in Finland?

- Can Distributed Ledger Technology be classified as disruptive innovation for the banking sector?

The results indicate that this technology has significant disruptive potential but future development will determine the degree of disruptiveness in the banking sector and there is no certainty about this yet. Deriving from the results DLT will have impact on three major areas of Finnish banking sectors which will influence strategic decision making and guide bank's actions: 1) The market structure and competitive environment will change 2) Banks will have to review revenue streams and business models 3) Banks efficiency increases and cost structure changes. In addition to the main impact areas two DLT applications are considered most interesting for banking sector which are Digital identity and Smart contracts. Therefore banks should have extra focus on these DLT solutions. The implementation process of these changes has started and some DLT solutions will be deployed within next couple of years though the overall process is likely to take several years and it was expected to take decade before DLT can become mainstream solution.

Based on the results all the three major areas of impact are influencing each other and effecting to the whole process. This was expected result as the process of disruption is described to progress in phases, as the market demand start to develop the disruption process progresses in cause consequence sequences (See e.g. Christensen & Raynor, 2003; Gilbert, 2003; Schmidt & Druehl, 2008; Christensen, 2015). Because the current research does not sample failed disruptive innovations and it is stated that models are still inadequate, evaluating the process and its phase is more difficult.

Delphi results also indicate that the drivers of the change are interlinked and thus influence to each other. The results indicate that DLT will be the secondary driving force for change of the market structure which influence to the reshaping of the competitive environment of banking sector in Finland. Because the regulative change will be the primary driving force for both, change of market structure and competitive environment it is challenging to estimate the magnitude of the effect of DLT. This was probably part of the reason why the results of Delphi study did not

address the magnitude. In part this is due to the fact that it is difficult to identify disruptive innovation and assess its impact and there are not good model for it yet (Sood & Tellis, 2011).

Basing on the results, DLT is not expected to decrease the banking sectors entire market significantly at least in the beginning. It is expected to create multiple new market segments on the fringe of initial market. Banking sector market already consist of smaller market segment parts. Some of these smaller parts of banking sectors market segments are likely to be more strongly disrupted. The results do not directly indicate which segments are more likely to be disrupted and it does not address these specific market segments. Identifying these smaller market segments and how DLT affects to them in detail would therefore be an interesting study topic in the future. In general results indicate that overall market segment is likely to decrease moderately as new market segments formed on a fringe of banking sectors established market are likely to draw customers also from commercial banks as the innovation matures. I believe this will influence in demand and the development of the established and new market segment which enables the emergence of new innovative services and business models. In my opinion the notation in the Delphi results that current revenue stream are changing and have to be revised is highly important consideration for the business models development and has to be emphasized.

Interestingly, this previously illustrated future view of development follows partly Schimdt & Druehl's (2008) view of the diffusion process of disruptive innovations. Gilberts (2003) take on disruption process can as well be identified with this outlook for the first two phases but it is too early to say whether the development also follows the third stage. According to the results the change and disruption processes are expected to progress more slowly due to heavy regulations of the banking sector which enabling incumbent actors to better prepare and respond to the change. Assuming incumbent consciously or not, is able to identify the disruption and understands not to ignore it. The high level of regulation on the banking sector entire initial market was not expected to reduce significantly although the impact on some of the smaller market segments was believed to be significant. Interestingly this

result differs partly from the theory. Gilbert (2003) suggested that the initial market will reduce significantly in the phase three of the diffusion process. Though the results did not take strong position on the matter.

The third area derived from results is the efficiency and cost structure. In the literature in describing the development of the banking sector, cost structure was described more as a consequence and not as a cause. Fungáčová et al. (2015) emphasized increasing trends of specialization and outsourcing which are used to influence the cost structure and competition. On the other hand, Kauko (2003) stated that impaired cost-income ratio is often interpreted as consequence of intensified competition. Interestingly the results of the study indicate it may be the causal factor instead of consequence. Therefore, it was difficult to assess the extent of the change in the cost structure and its impact on the banking sector and compare it to earlier development within this study. This could be interesting topic to continue future studies.

The view of DLTs disruptive potential on different parts of banking sector varied in the Delphi results even though majority still believed it to have significant disruptive potential. This can be explained by differences in the backgrounds of experts but also by individual perception of the term disruptive. Similarly in the literature the term disruptive is concluded to be understandable in several different ways (Yu & Hang, 2009). The parallel responses were mutually supportive even though many participants expressed the predictions to be very speculative and uncertain. Delphi method is considered tackle this problem and provide reliable results and future predictions if experts have the necessary knowledge and experience of the topic (Chang et al., 2002, 784). The Delphi method is used for long term future predictions as it provides as accurate predictions that are possible to attain over complex issues (Kuusi, 2002). Therefore the prediction can be assumed to be reliable, but in my opinion the accuracy is difficult to demonstrate and determine.

The change in banking sectors market structure and competitive environment will direct banks to review their business models and strategies as some of the current revenue streams are likely to reduce. Even though the competition is diversifying

the competitive position and market shares are expected to remain for the largest market players even though the disruption enables new entrants to attack to the market. Interestingly, this did not follow the theory of disruptive innovations but this could be an anomaly which occurs due highly regulated environment. Additionally it could be that the decline of the market is still so far away it cannot yet be predicted. In terms of new business models digital identity and smart contracts are believed to be the most promising DLT based applications while in general DLT is expected to increase the level of efficiency and automation. Disruptiveness and mainstream deployment are still going to take for a long time as technology needs to develop and understanding of potential use cases needs to be improved in order to develop the performance to a sufficient level.

Earlier studies over Finnish banking sector and literature for how it has developed are comparable to Delphi research results. Regulations and digitalization has reformed the banking sector in Finland and the entire banking sector has been going through transition period. (PwC, 2014)

Interestingly, the change in competitive environment caused by increasing regulations is expected increase the competition which is completely opposite reaction than earlier studies demonstrate. Currently the competition is expected to get fiercer contrary to earlier deregulations which have had the same impact. (Hyvärinen & laine, 2000; 3-4, Nyberg & Virhiälä, 1994, p. 10-11) Although it can be described that information and access to information is liberated by the regulation increases this time and in that sense it liberalize competition. Kauko (2003) suggested the comparison between competition level of earlier decades is difficult as the environment has changed and he mentioned that technological development and business models will have significant role on banking sectors competition. The Delphi study confirms this statement to be still valid. As Kauko (2003) additionally argued economic downturn is also likely to impact as catalyst to regulatory growth and change the competitive environment significantly and this statement is also true with present regulatory changes which impact to the competition. I think that Kauko’s (2003) statement, of non-comparable competitive environments over decades is

accurate which challenges the interpretation of the Delphi results compared to earlier development of Finnish banking sector.

Based on results primary attribute for change is increase in regulations which makes it challenging to assess the extent of the impact of DLT to overall development and evolvement of banking sector. In my opinion, the uncertainty in the answers reflected to the complexity of the subject and emphasize how many different causal factors are relative to each other and direct the development. However the results strongly indicate that DLT will have an influence though it could stay on moderate level. The technological development in general will have a major role in the process. Nonetheless the lack of actual use cases of DLT impairs the accuracy of the results.

The results of the Delphi study follow the theory of disruptive innovation. Based on the Delphi study DLT is a disruptive innovation and Christensen's (2015) definition of Disruptive Innovation supports this conclusion. One of the greatest benefits of DLT is the new business opportunities and operating models it enables which is expected to start from smaller segments of the financial market. Based on the future views of the expert panelists the new business opportunities are created with more simple and efficient solutions which are likely to change the present operating models of small specific parts of the business creating new markets with new kind of services.

The second part of Christensen's (2015) definition is that innovation will not attract mainstream market before performance has reach sufficient level. This part can be viewed in different ways because disruption is always relative to another product, company or industry and more detailed research could come to another conclusion from more limited perspective. In this research none of these perspectives are excluded as DLT is defined as a broad concept. It is noted that disruption is likely to occur at all of the different levels and it will effect to the entire banking sector. The study indicated that product level disruption could occur with smart contracts and industry level disruption could occur with digital identity and ownership of the data. The company level disruption on the other hand is more likely to occur with new

business models. On technological level DLT could disrupt other database structures and become a mainstream solution but that was stated to be unlikely. Experts concluded DLT will not become mainstream solution nor attract mainstream markets for a long time as it is not yet able to provide sufficient performance and it still lacks the actual use cases. Thus results support the conclusion that DLT is disruptive innovation. On theory point of view DLT is likely to be a low-end fringe market innovation, according to the future view of the Delphi experts it is likely to create multiple new fringe market segments around banking sector and create disruption through them.

Although I interpret, based on Delphi results, DLT to fit in Christensen's (2015) definition of disruptive innovation, I acknowledge that the lack of a precise definition of DLT which increase the speculative aspect. The refinement of the definition of DLT and the actual proven use cases found in the future may affect to the categorization of DLT as innovation.

7.1 Limitation, reliability and contribution

The study is limited to Finnish banking sector and commercial banks operating in it. Therefore the generalizability of the results are limited to Finnish banking sector and even though the regulations effecting to the change are increasing on EU level no direct conclusions cannot be drawn to the banking sectors of other countries. Additionally the study does not address the impacts to central bank and its operations as the study is limited to commercial banks operating in Finland.

The empirical data contributes a clearer understanding to the future development of banking sector in Finland. While previous researches has focused on potential and actual use cases for banking sector they have not taken a position on market developments as a whole, which gives the industry a better understanding of future changes. The research builds on the disruptive innovation theory and provides improved outlook on DLTs effects on banking sector and indicates the main changes of the market which can be further exploited by operators in Finnish banking sector.

The research method was qualitative and the source of empirical research was Delphi research. The Delphi study gathered information from experts with a prior understanding and knowledge of DLT and background in banking, technology or law and the data consisted of the views and opinions of experts. The study included three rounds of questionnaires and considered the main features of the Delphi method and it has been shown to be well suited for future studies. Most importantly the anonymity was sought to ensure the collection of genuine opinions and views.

In general research results in qualitative study are influenced by the selected experts which is why the aboard and diversified group of experts were selected to minimize the impact of an individual experts opinion to shape the entire study results. A comprehensive number of experts also ensured that the material was large enough to draw sufficiently reliable conclusions. The response rate of the experts who participated in the study decreased significantly for the last two rounds of the survey, which also affects the reliability of the results at a general level. Overall, the results remained in line with first interview round and the number of responding experts was at sufficient level throughout the study despite the decline in response rate. Therefore the effect of the decrease in response rate is estimated to be either moderate or negligible. Over all the reliability and validity of the study are on a good level. If the research would be re-conducted the timing could affect the change in results because the subject is still novel and the technology is developing fast. Though similar results would be expected.

8 CONCLUSION

This qualitative study addressed the effects of DLT on the banking sector in Finland. The aim of the study was to outline how the new technology DLT which is described as disruptive affects the development of the banking sector, which is already undergoing a transformation period with empirical research and current literature. The empirical part of the study consisted of Delphi research utilizing the comprehensive views of experts with understanding of DLT, banking sector and its development as well as regulative knowledge of banking sector. While the theoretical part of the research created an overview of Finnish banking sectors current state and historical development, DLT and its potential for banking sector as well as understanding of disruptive innovations as a process and how the process progresses to disrupt the market.

The main research question was how distributed ledger technologies will change the banking sector in Finland. Based on the study, it can be stated that DLT is a very potential technology which, if able to meet some of the expectations and become more widespread, will cause disruption to the banking sector in Finland. The main effects of the technology will be change of the market structure and competitive environment. The change in banking sectors market structure and competitive environment will direct banks to review their business models and strategies as some of the current revenue streams are likely to reduce but overall cost structure net change cannot yet be estimated. Technology is developing on fast phase and first solutions have already been tested in banks and the implementation of the solutions is estimated to happen within next couple of years. Even though the initial implementation will be small the adaptation is expected to increase over time though it may take several years or a decade before DLT becomes widely adopted or becomes a mainstream solution. Therefore the disruption process is expected to be slow. Additionally the degree of disruptiveness is not clear yet as the technology is immature and the actual use cases for banking sector are still not sufficiently identified. The major strategic effects can be summarized in three impacts and two potential applications of which new markets and business models will emerge the

most. The answer to main research question can be summarized to these five points:

Strategic effects to banking sector:

1) The market structure and competitive environment will change increasing the importance of networks even further
2) Banks will have to review revenue streams and business models
3) Banks efficiency increases and cost structure changes.

The most potential applications for new market segments and business models:

1) Digital identity
2) Smart contracts

The sub research question asked can distributed ledger technology be classified as disruptive innovation for the banking sector. The categorization of DLT is difficult for two main reasons the technology is not defined well enough and there are multiple different definitions for it which may affect to categorization and if it is studied in more detailed concept the categorization could be different. Based on the study DLT can be categorized as a disruptive innovation. More specifically DLT can be categorized as new-market disruptive innovation and it is likely to follow fridge low-market encroachment as it develops and the disruption process progress. However there is a lot of uncertainty associated with disruptive innovations and DLT which may affect to the disruptiveness of the technology.

The research offers a comprehensive view of the impact of technology on the development of the Finnish banking sector and a view of how new disruptive technology affects the operations of banks operating in Finland. This study provides important insight to understand how development of Finnish banking sector is likely to progress in the future and what strategic decisions bank will have to review in following years regarding to DLT.

As the topic DLT is still relatively new, future research is needed in a number of different areas. From a banking sectors perspective the future research should

continue through disruptive innovation theory and focus on identifying new performance trajectory attributes and how the market demand changes. This would help to understand the process of change and offer important insight for new business model innovations. Further studies are also needed to understand the use of the technology to establish actual use cases. After the actual use cases have been recognized the performance trajectories could be researched to gain better understanding of the disruptive nature of the technology.

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APPENDICES

APPENDIX 1: Delphi first round interview frame

INTERVIEW FRAME

English:

POSSIBILITIES

- How distributed ledger technology will change banking industry?
- How big will the change be?
- What are the potential applications of distributed ledger technology in financial services?

WEAKNESSES AND PROBLEMS

- How complete is the distributed ledger technology?
- What might prevent distributed ledger from going mainstream in financial services?
- Over what timeframe distributed ledger technology is likely to go mainstream in financial services?

MOST IMPORTANT RIGHT NOW

- What should financial institutions be doing about the technology?

Finnish:

MAHDOLLISUUDET

- Miten DLT tulee muuttamaan pankkialaa?
- Kuinka suuria muutokset tulevat olemaan?
- Mitä potentiaalisia applikaatioita DLT tuo pankkialalle?

HEIKKOUDET JA ONGELMAT

- Kuinka valmis DLT on?
- Mitkä asiat voivat estää DLT laajemman kaupallistumisen?
- Millä aikajänteellä DLT tulee todennäköisetsi nousemaan valtavirtaan / kaupallistumaan?

TÄRKEINTÄ JUURI NYT

- Mihin Pankkien ja finanssilaitosten tulisi keskittyä DLT osalta tällä hetkellä?

APPENDIX 2: Delphi second round questionnaire

Future study: Distributed Ledger Technology on Finnish Banking sector

Delphi second round:

1. Distributed Ledger technology challenges

	1	2	3	4	5	
DLT is immature technology	○	○	○	○	○	DLT is mature technology
Lack of experts	○	○	○	○	○	No lack of experts
Legal issues are big	○	○	○	○	○	Legal issues are small
Security risks are big (i.e. hacking)	○	○	○	○	○	There are no security issues
Governance problem is fundamental	○	○	○	○	○	Governance is not problematic
Scalability is big problem	○	○	○	○	○	Scalability is not problem at all

1. Free text field for question 1 for comments and additional argumentation (Optional)

2. How promising applications and opportunities of DLT are

1 = not promising - 5 = very promising

	1	2	3	4	5
Digital identity	○	○	○	○	○
Ownership of your data	○	○	○	○	○
Reduced need for third-party enforces	○	○	○	○	○
Smart contracts	○	○	○	○	○
Smart auditing	○	○	○	○	○
Immutability of transactions	○	○	○	○	○
Decentralization of data	○	○	○	○	○
Capability to increase level of automation	○	○	○	○	○
Cryptocurrencies	○	○	○	○	○

2. Free text field for question 2 for comments and additional argumentation (Optional)

3. DLT impacts to business

1 = will not - 5 = will have strong impact

	1	2	3	4	5
Overall economics	◯	◯	◯	◯	◯
Banking sectors ecosystem	◯	◯	◯	◯	◯
Banks business models	◯	◯	◯	◯	◯
Banks current revenue streams	◯	◯	◯	◯	◯
Banking sectors market structure	◯	◯	◯	◯	◯
Banking sectors market shares	◯	◯	◯	◯	◯

3. Free text field for question 3 for comments and additional argumentation (Optional)

4. Future competition

	Not likely / 0%	5% or less	10%	15%	20% or more
Fintech companies are likely to gain market share in transaction banking	◯	◯	◯	◯	◯
Fintech companies are likely to gain market share in credits and loans	◯	◯	◯	◯	◯
Fintech companies are likely to gain market share in investments	◯	◯	◯	◯	◯
New companies are likely to gain market share deposits and savings	◯	◯	◯	◯	◯
New companies are likely to gain market share in transaction banking	◯	◯	◯	◯	◯
New companies are likely to gain market share in credits and loans	◯	◯	◯	◯	◯
New companies are likely to gain market share in investments	◯	◯	◯	◯	◯

4. Free text field for question 4 for comments and additional argumentation (Optional)

6. Level of automation will

1 Will not increase - 5 Will increase strongly

	1	2	3	4	5
Credits and loans	○	○	○	○	○
Deposits and savings	○	○	○	○	○
Transfers	○	○	○	○	○
Expert services	○	○	○	○	○
Investments	○	○	○	○	○
Cross boarder transfers	○	○	○	○	○
Transaction banking	○	○	○	○	○
Settlements	○	○	○	○	○
Other (Please write below)	○	○	○	○	○
	○	○	○	○	○
	○	○	○	○	○

6. Free text field for question 6 for comments and additional argumentation (Optional)

7. DLT adaptation time scale

	1 year	1-3 year's	3-5 year's	5-10 year's	not in foreseeable future
DLT will become mainstream in banking	○	○	○	○	○
Banks will widely adopt DLT	○	○	○	○	○
Corporations and businesses will widely adopt DLT	○	○	○	○	○
DLT will become mainstream	○	○	○	○	○

7. Free text field for question 7 for comments and additional argumentation (Optional)

APPENDIX 3: Delphi third round questionnaire

Future study: Distributed Ledger Technology on Finnish Banking sector

Delphi third round:

1. DLT adaptation time scale

	1 year	1-3 year's	3-5 year's	5-10 year's	not in foreseeable future
DLT will become mainstream in banking	○	○	○	○	○
Banks will widely adopt DLT	○	○	○	○	○
Corporations and businesses will widely adopt DLT	○	○	○	○	○
DLT will become mainstream	○	○	○	○	○

1. Free text field for question 1 for comments and additional argumentation (Optional)

2. Given that DLT will disrupt and reshape banking sectors ecosystem, please rank which parts of business are the most important for retail banks (in general):

1. The **most** important - 8. The **least** important

- ○ Credits and loans
- ○ Deposits and savings
- ○ Digital identity
- ○ Expert service (advisory)
- ○ Investments
- ○ Smart contracts
- ○ Transaction banking
- ○ Other (Please write below)

2. Free text field for question 2 for comments and additional argumentation (Optional)

3. Given that DLT will disrupt and reshape banking sectors ecosystem, please rank which business areas are the most important for **new market entrants** in the future

1. The **most** important - 8. The **least** important

- ◯ Credits and loans
- ◯ Deposits and savings
- ◯ Digital identity
- ◯ Expert service (advisory)
- ◯ Investments
- ◯ Smart contracts
- ◯ Transaction banking
- ◯ Other (Please write below)

3. Free text field for question 3 for comments and additional argumentation (Optional)

4. How promising applications and opportunities of DLT are

1 = not promising - 5 = very promising

	1	2	3	4	5
Digital identity	◯	◯	◯	◯	◯
Ownership of your data	◯	◯	◯	◯	◯
Reduced need for third-party enforces	◯	◯	◯	◯	◯
Smart contracts	◯	◯	◯	◯	◯
Smart auditing	◯	◯	◯	◯	◯
Immutability of transactions	◯	◯	◯	◯	◯
Decentralization of data	◯	◯	◯	◯	◯
Capability to increase level of automation	◯	◯	◯	◯	◯
Cryptocurrencies	◯	◯	◯	◯	◯

4. Free text field for question 4 for comments and additional argumentation (Optional)

5. Please rank the importance of DLT applications for banking sector

1 is the most important – 9 is the least important.

Digital identity	◯
Ownership of your data	◯
Reduced need for third-party enforces	◯
Smart contracts	◯
Smart auditing	◯
Immutability of transactions	◯
Decentralization of data	◯
Capability to increase level of automation	◯
Cryptocurrencies	◯

5. Free text field for question 5 for comments and additional argumentation (Optional)

6. Given that DLT will become mainstream. Please rank parts of business that are most important for business models for retail banks

1. The **most** important - 7. The **least** important

- ◯ Channels
- ◯ Customer segments
- ◯ Key Activities
- ◯ Key Partners
- ◯ Key Resources
- ◯ Relationships
- ◯ Value Proposition

6. Free text field for question 6 for comments and additional argumentation (Optional)

7. Please rank the importance of DLT applications for banking sector

1 is the most important – 9 is the least important.

- ◯ Digital currencies
- ◯ Digital identity
- ◯ Capital markets (Trading & settlement of securities)
- ◯ Collateral register (Land register other property register or other movable assets register)
- ◯ Payments (authorization, clearance & settlement)
- ◯ Syndicated loans
- ◯ Smart contracts
- ◯ Trade finance
- ◯ Other (Please write below)

7. Free text field for question 7 for comments and additional argumentation (Optional)