Tampereen yliopisto

Samuli Määttä

IMPACT OF BIG DATA ANALYTICS AND FINANCIAL TECHNOLOGY IN FINNISH BANKING SECTOR

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Professor Nina Helander
Assistant Professor Hongxiu Li
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ABSTRACT

Samuli Määttä: Impact of big data analytics and financial technology in Finnish banking sector
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Banking sector has gone through many changes after the recent financial crisis, where the most notable ones are technological leaps in terms of big data analytics and added regulatory pressure towards the banks. Especially in the EU area, the changes to regulation have shaped the banking sector market, in which PSD 2 directive is one key factor. Tightened regulation towards the banks as well as EU's will for more open competition has brought new players into financial industry markets, and Financial Technology (FinTech) companies have especially emerged to these markets. Banks are in the midst of a turning point, and to survive they have needed to digitalize their services and processes in addition to the factors stated above but also because of increased demands from the customers. This research examines the factors that affect Finnish banks from the perspectives of FinTech and big data analytics.

The research has been executed in two parts. In the first part, a literature review is conducted from the subject matters of the research. The purpose of the literature review is to give an understanding to the reader about different themes relating to the research and what have been the most influential factors in the history of banking sector from the FinTech and big data analytics point-of-view. The second part of the research is an empirical study, in which Finnish experts in banking sector are interviewed. Empirical study is conducted as a qualitative research, where the purpose is to validate the phenomena impacting banking sector gathered from the literature review and to make general conclusions on how Finnish banking sector is aligned with compared to the international comparison coming from the literature review.

The results of the research indicate that changes impacting Finnish banks from the perspectives of FinTech and big data analytics are two-folded. From the big data analytics viewpoint Finnish banks seem to mostly be aligned with the observations made in the literature review. The most influential factors affecting Finnish banks are the rise of big data and its challenges, and also the technological application utilization in banks' own business core functions. Big data analytics applications were identified especially in the fraud and money-laundering prevention. In addition, big data analytics applications have been seen as a way to solve the increased customer centricity among Finnish banks. It was identified that in the Finnish banking landscape the banks are relatively capable in terms of data analytics when compared to international landscape, and especially the capabilities in terms of digitalization are above average in the international comparison. Finnish consumers were also seen as more demanding, as they have been used to digital services such as mobile banking for years now.

From FinTech point-of-view, the results were somewhat contradictory when comparing the literature review to the empirical study. The results of the literature review showed that the focus of academic literature is pointed towards the competition between the FinTech companies and banks, while in the empirical study it was evident that Finnish banks see the FinTech more as partnerships and a way to collaborate. Also, Finnish FinTech companies were seen relatively positively by the banks.

Key words: big data, analytics, FinTech, banking sector, regulation, PSD 2, Open Banking

The originality of this thesis has been checked using the Turnitin OriginalityCheck service.

TIIVISTELMÄ

Samuli Määttä: Big data analytiikan ja finanssiteknologian vaikutukset suomalaiseen pankkisektoriin
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Pankkisektori on kokenut viime finanssialan kriisin jälkeen monia muutoksia, mistä suurimmat ovat teknologiset harppaukset erityisesti big data analytiikan alueella sekä pankkeihin kohdistunut kiristynyt regulaatio. Varsinkin EU:n alueella finanssikriisin jälkeiset muutokset regulaatioon ovat olleet markkinoita mullistavia, josta PSD 2 -direktiivi on yksi suuri tekijä. Kiristynyt regulaatio pankkeja kohtaan sekä EU:n regulaation myötä noussut avoimempi kilpailu on myös tuonut uusia toimijoita finanssialan markkinoille, ja erityisesti finanssiteknologiayritykset ovat nousseet näille markkinoille. Pankit ovat olleet murroksen keskellä, ja selvitäkseen niiden on pitänyt digitalisoida palvelunsa ja prosessinsa. Edellä mainittujen asioiden lisäksi myös lisääntyneet asiakasvaatimukset ovat pakottaneet pankkeja aloittamaan kehittämään digitaalisia palveluita. Tämä tutkimus tutkii suomalaisiin pankkeihin vaikuttavia asioita erityisesti finanssiteknologian ja big data analytiikan perspektiiveistä.

Tutkimus on toteutettu kahdessa osassa. Ensimmäisessä osassa on tehty kirjallisuuskatsaus tutkimuksen aihepiireistä. Kirjallisuuskatsauksen tavoitteena on antaa lukijalle käsitys tutkimukseen liittyvistä teemoista, ja selvittää suurimmat tekijät pankkisektorin historiassa erityisesti big data analytiikan ja finanssiteknologian aihepiireistä. Tutkimuksen toinen osa on empiirinen tutkimus, jossa haastatellaan suomalaisia pankkisektorin asiantuntijoita. Empiirinen osa toteutetaan laadullisena tutkimuksena, jonka tarkoituksena on validoida kirjallisuuskatsauksessa tunnistetut ilmiöt sekä tuottaa johtopäätökset siitä, miten suomalainen pankkisektori sijoittuu kirjallisuuskatsauksessa tehtyyn kansainväliseen analyysiin.

Tutkimuksen tulokset osoittavat, että suomalaisiin pankkeihin kohdistuvat muutokset finanssiteknologian ja big data analytiikan perspektiiviestä ovat kaksijakoisia. Big data analytiikan näkökulmasta suomalaiset pankit vaikuttavat olevan suurimmaksi osin linjassa kirjallisuuskatsauksessa tehtyihin huomioihin nähden. Suurimpia suomalaisiin pankkeihin vaikuttavia yksittäisiä tekijöitä ovat suuren datamäärän sisältämät haasteet ja niihin liittyvien teknologisten sovellusten hyödyntäminen pankin omissa liiketoiminnan ydinprosesseissaan. Big data analytiikan käyttökohteita tunnistettiin erityisesti rahanpesun sekä petosten vastaisessa toiminnassa. Lisäksi pankkien toiminnassa tunnistettua lisääntynyttä asiakaslähtöisyyttä pyrittiin kehittämään suomalaisissa pankeissa myös big data analytiikan sovellusten avulla. Suomalaisten pankkien data-analytiikkavalmiudet huomattiin olevan suhteellisen hyvällä tasolla verrattuna muiden maiden pankkeihin, ja erityisesti suomalaisten pankkien digitaalisaatiokyvykyydet nähtiin paremmalla tasolla verrattuna kansainväliseen pankkisektoriin. Suomalaiset kuluttajat nähtiin myös keskimääräistä vaativampina, jotka ovat tottuneet digitaalisiin palveluihin kuten mobiilipankkiin jo vuosien ajan.

Finanssiteknologian näkökulmasta tutkimuksen tulokset olivat ristiriitaiset, kun kirjallisuuskatsausta verrattiin empiiriseen osaan. Kirjallisuuskatsauksen tuloksena oli tunnistettavissa jokseenkin vinoutunutta tutkimuksen painopistettä finanssiteknologia-alan yritysten ja pankkien keskinäiseen kilpailuun, kun taas empiriaosuudessa huomattiin suomalaisien pankkien näkevän suhteen finanssiteknologia-alaan enemmän yhteistyönä ja kumppanuutena. Myös suomalaiset finanssiteknologia-alan yritykset nähtiin positiivisessa valossa.

Avainsanat: big data, analytiikka, FinTech, pankkisektori, regulaatio, PSD 2, Open Banking

Tämän julkaisun alkuperäisyys on tarkastettu Turnitin OriginalityCheck –ohjelmalla.

PREFACE

It is quite the coincidence that I am writing this just before 1st of May as it is the most important event in student festivities. Five years ago, there was a young freshman eagerly waiting for Teekkari Dipping. During and after that time, I have had an abundance of memorable moments together with my fellow friends from TUT. The time I have spent in different events and student organizations is surely unforgettable.

I would like to thank Professor Nina Helander for her being positive-minded and flexible when guiding through the process. Thank you also Assistant Professor Hongxiu Li for your valuable comments during the writing process. In addition, I would also like to thank Jani Ristimäki for being a sponsor of the research and providing plenty of insightful ideas as well as interviewees for them sharing their expertise.

I want to also thank my family for always being supportive about my education path and a special thank you for my brother Tuomas for proofreading and providing helpful tips throughout the writing.

Ultimately, I want to show my gratification towards Jasmin. She has been there for me, supporting and encouraging throughout the process.

Helsinki, 30 April 2020

Samuli Määttä

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LIST OF ABBREVIATIONS

AISP	Account Information Service Provider, third party providers in the financial industry, which provide aggregated account information from multiple sources. Result of PSD 2 regulation.
AML	Anti-Money Laundering, data mining method, where the purpose is to find money laundering transactions among the whole transaction data set
API	Application Programming Interface, a software protocol for computers to interact primarily in internet. Provides data with a set structure for other services to be easily used.
BankTech	Banking Technology, refers generally technology and digital services used in banking sector.
Big data	A term used to describe data with modern challenges, for example, large data volumes that single computer cannot handle and complexity that requires processing and data engineering.
CRM	Customer Relationship Management, the process of managing all existing and possible new customers' data and interaction with them. Usually requires a separate IT system.
FinTech	Financial Technology, a broad term for companies and start-ups that are in financial industry. Can also reference to technology relating to financial industry.
KYC	Know-Your-Customer, a process in banks in order to know the customer better for regulatory compliance as well as generating more revenue by better serving the customer better.
Open Banking	A concept within banking sector, where the purpose is to open data from banks to others in the financial industry and add transparency within the banking sector. Is heavily connected to APIs.
PISP	Payment Initiation Service Provider, third party providers in the financial industry, which provide ease of use payment transactions for the customer. Result of PSD 2 regulation.
PSD 2	Payment Services Directive 2, EU directive which aim is to open the competition and increase innovation in the banking sector.
RegTech	Regulatory Technology, technologies used for regulatory processes in the banking sector.

1. INTRODUCTION

This chapter will introduce the research and its purpose by explaining the background and motivation and introducing the research objectives, research problem and research questions. The research problem and questions are justified on why they were chosen. The process of the research is also defined, with both limitation and scope also discussed.

1.1 Background and motivation

The exponential rise of digitalization has disrupted essentially all fields of economy. Banking sector and finance industry in general are no exceptions to this. In addition, recent advances in big data technology and data analytics have had a significant effect on banking sector. These have influenced regulation too, where PSD 2 and Open Banking are just two examples of this. Banking is indeed in a new digital era, where together the latest big data analytics technologies, government and EU regulation and Financial Technology (FinTech) boom have created whole new ways of banks to develop their business and create meaningful added value to the customers (Simonson & Jain 2014; Dapp et al. 2014).

Development of data economy has also had a concrete effect in financial industry. The traditional straightforward relationship between manufacturers and consumers have been scattered to a mesh of partners which include in addition to manufacturers different upstream or downstream partners. In traditional industry this has led to scattering ecosystem of suppliers, distributors, retailers and of course manufacturers. (Opher et al. 2016) In financial industry, the same phenomenon has occurred, and there has evolved this broad ecosystem, where also FinTech is located. While in the past banks have been in the center of the financial industry, today banks must evolve and adopt new kind of collaboration and communication between other operators in the industry. This has evidently led to an increase in competitiveness, and banks must find new business and added value in the midst all the data and operators in financial industry (Lee & Shin 2018).

One challenge traditional banks are facing is the rise of technology giants, and their interest in becoming also involved in financial services. This has been the case already

with Apple credit card. Also, one third of Amazon customers would consider opening a banking account in Amazon ecosystem according to a survey made in the United States (Marous 2019). Traditional banks have not been shown as flexible whereas the competition both in small FinTech companies as well as the technology giants are proved themselves to create business out of agile way of integrating technology into traditional banking sector. Now banks are also forced to re-create their business models and make use of new technologies in banks' own core functions (Dapp et al. 2014).

This research studies the different aspects of financial industry, mainly the banking sector and FinTech, where data and analytics have significant roles in creating value. The study will be done by first shedding light to the background of digital transformation of banking sector as well as different big data analytics applications that are used in banks. Empirical part of the research will be conducted by interviewing Finnish banking experts. Lastly, these interviews are reflected on the theory and analyzed for insights.

1.2 Research problem, research questions and objectives

The main research problem is as follows:

Research problem: How big data analytics and FinTech impact traditional Finnish banks?

Answering the main research problem is done by creating sub-questions to support the process of the main research problem. Sub-questions are first answered separately, and after that the answers are combined so that the main research problem can be answered. The sub-questions for the main research problem are:

> ***Question 1: What are global trends in digital banking and how they affect the digital banking transformation?***
>
> ***Question 2: What is the role of big data and big data analytics in banking sector?***
>
> ***Question 3: What is the maturity level of Finnish banks with regard to big data analytics capabilities?***

First two sub-questions will be answered by using mainly literature review as well as partly in the semi-structured interviews. The third sub-question is answered by using the insights gathered in the literature review and reflecting the insights in the interviews.

In the first sub-question, literature review is done in order to understand and define the terms used in the sub-question as well as in the main research problem. The purpose of the sub-question is to define the landscape where traditional Finnish banks are and identify key drivers that affect digital banking transformation. This is done in the literature

review part. In the empirical study part, semi-structured interviews are used for validating the findings gathered in the literature review part.

Second sub-question is about describing the technological landscape of banking sector and how big data and big data analytics relate to this. Literature review is done so that the most used methods for big data analytics and use cases are identified. The role of big data is also discussed with also emphasis on cloud computing.

Last sub-question is limited to Finnish banks as the interviews are also done on Finnish level. Answering this question is done by cross-examining the answers from the semi-structured interviews and comparing answers to findings gathered from the literature review.

1.3 Research limitations and scope

This research is done in collaboration with case company which guides the research. Academic requirements are also fulfilled. From case company's perspective, the main result from this research is to investigate how banks are utilizing their data and analytics, and how it could be improved. Also, new trends such as effect of accelerated regulation on banking is a primary topic to be covered.

The geographical scope of the research is from the European financial industry point-of-view. The focal point is on Finnish banks, but broader European financial landscape is investigated and researched, too. This is due to the fact that common European regulation is shaping strongly also the Finnish financial industry. Global events, such as the financial crisis in mid-2000s, are also considered in this research to attach this research to the real world and provide background and motivation also for the more local events such as strong shift in regulation to Open Banking.

Some terms are to be clarified for the context of this research. The term FinTech, abbreviated from words Financial Technology, is a rather ambiguous term used in the academic field as well as in the business industry. Many of the reference articles used in this research use FinTech synonymously with both the actual financial technology and FinTech start-ups. Using FinTech term for start-ups is a rather restricted use of the term, so in this regard the term FinTech will imply the actual financial technology, not just start-ups. According to an article by Zavolokina et al. (2016), the term FinTech can be seen as two-dimensional definition. This is due to the fact that the public media has adopted FinTech quite actively to fit to social needs, being a common term for technology entrepreneurs joining FinTech scene. First, FinTech is identified as term to describe financial services which takes use of innovative technologies to satisfy future

requirements. Secondly, Zavolokina et al. (2016) point out FinTech start-ups being synonymous with the previously mentioned definitions and that the suffix start-up is not used when talking about the newly founded companies.

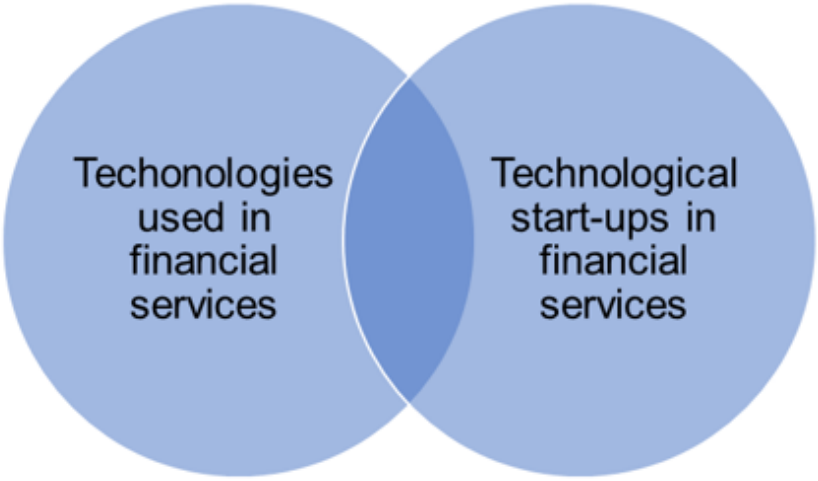

Figure 1. *Use of the term FinTech in this research*

FinTech has also a whole different domain, which shows the multidimensionality of the term. According to Alt et al. (2018), FinTech consists of three different subdomains, which are BankTech, InsurTech and RegTech. In this research,

FinTech is being referenced to BankTech, where the focus is on the consumer and how to holistically improve banking (e.g. KYC, Know Your Customer), and RegTech, which provide means for regulatory compliance (e.g. AML, Anti-Money Laundering).

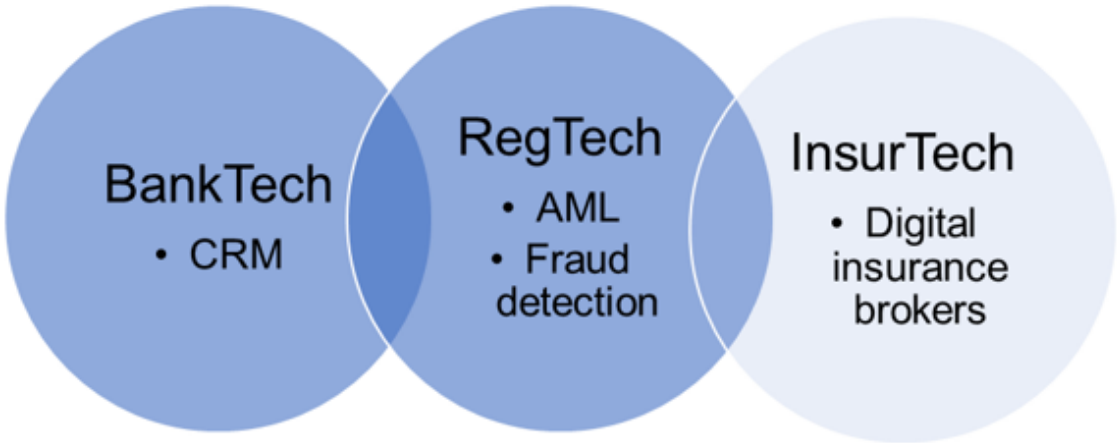

Figure 2. *Scope definition for FinTech (adapted from Alt et al. 2018; Stoeckli et al. 2018)*

The scope of this research is focused on Banking Technology (BankTech) and Regulatory Technology (RegTech) applications. The vast majority of analytics

applications that the banks are investing in are around BankTech, where the purpose is to enhance the internal core capabilities of the bank. RegTech is also covered in this research, which aims for better efficiency in regulatory compliance.

In this research, banking sector stands for a common landscape, where different traditional banks are competing in. Financial services on the other hand, is a more general ecosystem of all players that provide or assists on any financial services. For example, Financial Technology (FinTech) companies are in financial services but not directly in banking sector. Figure 3 defines the use of different financial terms used in this research.

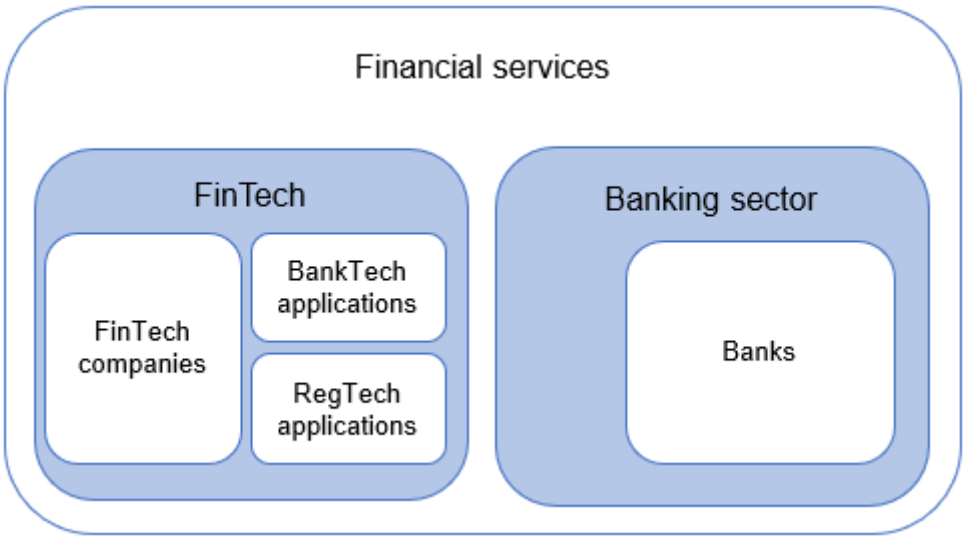

Figure 3. *Definition of financial terms used in this research*

In this research, the term FinTech is used for both BankTech and RegTech applications, as they bear resemblance to one another. Companies in FinTech area are described as FinTech companies, without startup suffix if not deliberately needed.

1.4 Research structure

This research consists of a literature review part and empirical study part. The literature review is done in order to lay the foundation of the research by examining current status of the research topic, finding relevant trends and linking the main topics into together, which are in this case financial technology (FinTech) and big data and big data analytics in financial industry.

The empirical study will be done by interviewing professionals in the area of the research topic. Interview body is made from the insights gathered in theoretical background part and will be modified according to feedback from the pilot interview. The research structure is shown in the picture below.

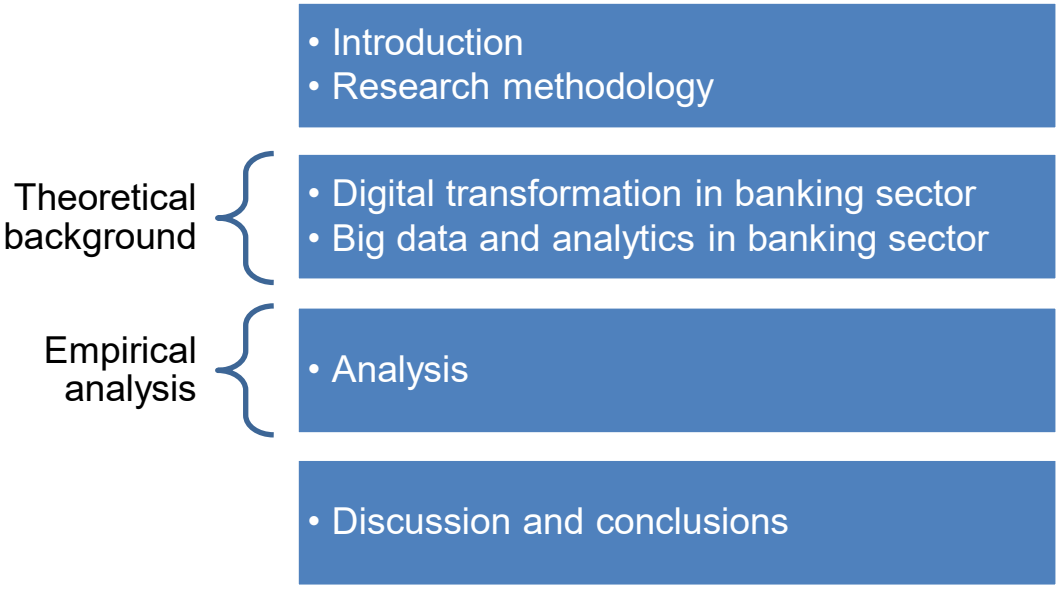

Figure 4. *Research structure for the thesis*

In the first chapter, an introduction to the research topic and motivation are given. This chapter will answer the questions on why and how to research this given topic. Introductory chapter will also present the main research problem and the sub-questions for the research problem. Limitation and scope are also introduced in this chapter as they will impact the focus areas of the research.

Second chapter will introduce the methodology used in this research. In this research, literature review and semi-structured interviews are conducted. Research methodology is described more in-depth, where Saunders et al. (2009) is used as the main reference. Third and fourth chapter will consist of the literature review on the main two topics of this research, digital transformation in banking sector and big data and analytics in financial industry. In the empirical analysis part, interviews are conducted, and analysis is performed. Theory is validated and reflected in the interviews. The last chapter consists of discussion about the results as well as the impact of the research in general. The findings gathered from the interviews are introduced, and lastly the reflection of the research is conducted.

2. RESEARCH METHODOLOGY

This chapter will define the research methodology used in this research. The goal of the research is discussed and how to reach it with the selected methodology. The components of the research methodology are introduced and details on conducting both literature review and empirical study are listed.

2.1 Methodology

The goal for this research is to identify the impact of digital banking transformation in terms of big data analytics to traditional banks. To achieve the goal of the research, a research methodology is constructed. This methodology closely follows Saunders et al. (2009) research onion framework. This framework consists of six layers, going from generalities to more tangible techniques and procedures. The layers are

- Research philosophy
- Research approach
- Research strategy
- Research choice
- Research time horizon
- Research techniques and procedures

First, Saunders et al. (2009) introduce four distinct philosophies relating to research methodology: interpretivism, realism, positivism and pragmatism. Defining a research methodology is important as it portrays what is the relationship between researcher and research. Saunders et al. (2009) state that choosing a research philosophy rarely usually derived from the practical considerations that happen on the research. Still, it is useful to understand what research philosophy is the closest to the research as it will lay the foundation of what type of research outcomes are to be expected. (Saunders et al. 2009) Research philosophy chosen for this research is realism, as the ambition of the research is to find holistic views on the research topic by cross-examining theory and qualitative empirical study.

Research approach chosen to this research is abductive approach. According to Haig (2018), abductive approach is about detecting observations and phenomena, and creating plausible reasoning to those observations and phenomena. Models that explain

the observations or phenomena are constructed, which aim is to provide the best possible explanation, not the absolute truth, in cases where no absolute truth may be feasible to achieve. (Haig 2018) Timmermans & Tavory (2012) state that abductive analyses are about conducting qualitative data analyses in order to construct theories. In this research, a theoretical framework is defined from the digital banking sector research topic.

A qualitative research strategy of conducting semi-structured interviews is adopted in this research. According to Saunders et al. (2009) qualitative analysis is synonymous for any data collection that is non-numerical in nature. In this research, qualitative analysis is performed by interviewing experienced professionals in the relevant field and gathering insights from the interviews which are then validated from the knowledge gained in the literature review.

For the research choice, mono method was chosen. Saunders et al. (2009) state that mono method is when single quantitative data collection method is chosen together with quantitative data analysis procedures, or qualitative data collection method with qualitative data analysis procedures. In this research, conducting qualitative semi-structured interviews is seen as adequate, since the insights from interviewing experienced professionals is sufficient in order to detect the observations and derive best possible explanations

The research time horizon is cross-sectional, where the research is set on a specific time frame. Cross-sectional research is usually conducted when describing or defining a single research problem, and the studying the development of the research topic is not needed (Saunders et al. 2009).

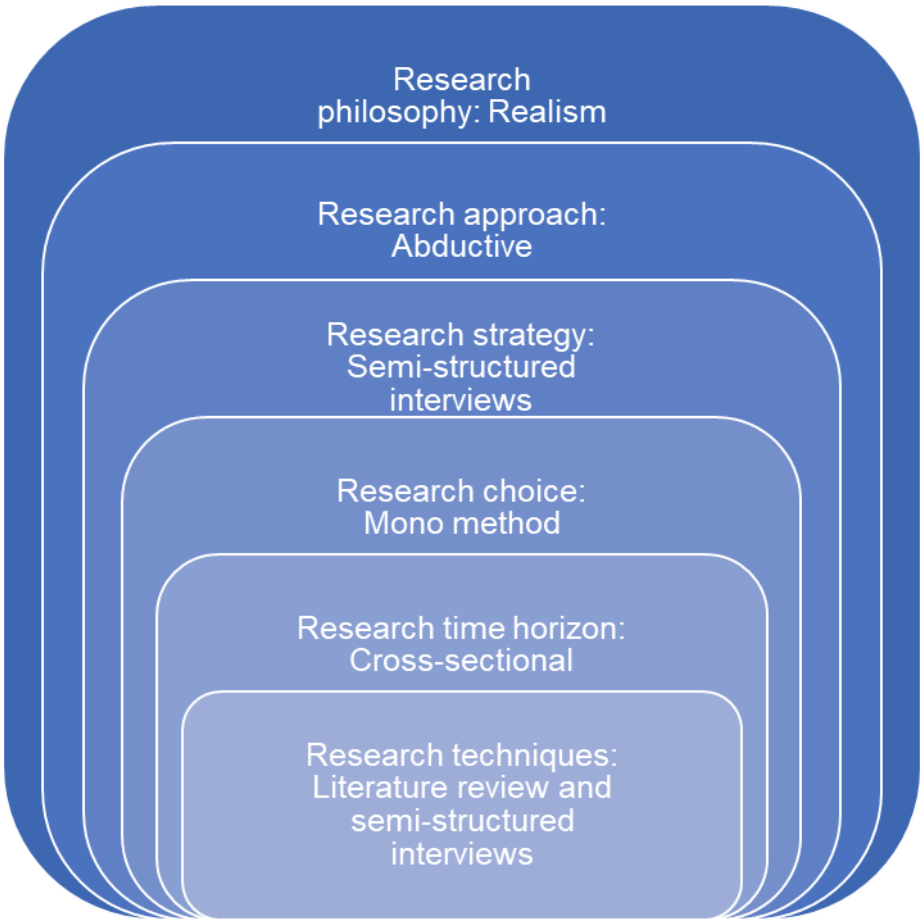

Figure 5. *Research framework for the thesis*

As a result, the research is conducted by first processing the research topic by conducting a literature review around the relevant themes. After the literature review, semi-structured interview template is constructed, and interviews are done. Literature review is then complemented by topics that rise during the interviews. Analysis is then performed on top of the results from literature review and the interviews.

2.2 Literature review

According to Saunders et al. (2009), conducting literature review consists of four different aspects. These include

1. Search parameters
2. Key words and search phrases
3. Databases and search engines used
4. Criteria on relevant search items, what to include and exclude

The following sub-chapters will introduce these in detail and explain, why these were chosen.

2.2.1 Search parameters

Search parameters used in this research is shown in the table 1.

Table 1. *Search parameters used in the research (Bell 2014; Saunders et al. 2009)*

Parameter type	**Parameter value**
Language of publication	English and Finnish
Subject area	Data analytics and technology
Business sector	Banking sector and FinTech
Geographical area	Europe
Publication period	From 2010 to 2020
Literature type	Academic articles and journals, other research and surveys

These search parameters are linked to general limitations and scope of this research. The purpose of search parameters is to start to define the literature review scope and provide first restrictions of literature to include in the literature review. Defining search parameters also assist in examining whether the literature review scope is too narrow or too broad (Saunders et al. 2009). Language of publications has been chosen to be either English or Finnish, where English is the overwhelming majority of the literature used in this research. Subject area is the point-of-view, where the business sector is projected from. In this research, data analytics and technology are chosen as the subject area, because it is the most familiar and interesting topic to the author. Business sector is chosen as banking sector and FinTech, which are related to each other and are both connected to the chosen subject area, too. Finland has been chosen as the focal point in the research, since there is not a lot of research in this scope made purely for Finnish market area. Also, it is a geographical area where author can get relevant contacts for interviews. Therefore, articles pointing to European geographical markets are chosen. Publication period is from 2010 to 2020, which is broad enough period where publications are still relevant. Latest technology trends and methods discussed in this research are from this era, so using earlier publications may contain already expired information. Year 2010 being the starting period is chosen, because this is the time where modern FinTech arose. Some exceptions were included in the literature review, for example for historical analysis, but majority of publications used in the literature review are from this time period. Publications included in this literature review are mainly academic articles and journals, but other research made from business context are included as well.

2.2.2 Key words and search phrases

According to Bell (2014) and Saunders et al. (2009), defining key words used in literature review is the one of the most important part in conducting the review. Key words, and their definition, create the frame on which the resource gathering, and actual review is being done. Key words are generated based on the research questions, limitations and scope as well as search parameters defined in the previous chapter. Main keywords and search phrases are shown in the table 2.

Table 2. *Key words and search phrases used in the research*

Main topic area	**Key words and search phrases**
Data analytics and banking	- analytics AND bank* - “big data” AND bank* - analytics AND (AML OR “anti money laundering” - bank* AND CRM AND analytics - fraud AND bank* - analytics AND KYC - “data mining” AND bank* - “data mining” AND application* and “financial industry”
Banking sector and FinTech	- “Open bank*” AND “regulation” - bank* AND fintech - digital AND bank* - fintech AND “financial industry” - bank* AND “customer cent*” - “digital bank*” AND transformation

Search phrases and key words have been executed in a way that fulfills the search parameters. This means that other filtering in addition to key words and search phrases were utilized also. These include language, time period and literature types. Some of the publications used in this research were found using backwards citation. This means that some of the publications were found indirectly when accessing examining references of another publication (FAU Libraries).

2.2.3 Databases and search engines

The publication gathering used in the literature review was done using tertiary literature sources. According to Saunders et al. (2009), tertiary literature sources are also known as search tools, and are designed to guide towards primary and secondary sources, primary ones being the first research done at a given topic and secondary being journals and books that reference to the original research. (Saunders et al. 2009)

The main databases used in this research are provided by Tampere University. These include ScienceDirect, Scopus and Semantic Scholar. Google Scholar was used as the main search engine as well as Tampere University's proprietary Andor search engine.

2.2.4 Relevancy criteria

According to Saunders et al. (2009), relevant publications gathered from the previous phases in literature review, usually need to be more clarified and structured. Proceeding with previous phases may end up with publications following the definitions, but still being out-of-scope and not relevant to the scope of this research. Therefore, special inclusions and exclusions are to be made. These inclusions and exclusions used in this research are defined in table 3

Table 3. *Inclusions and exclusions on relevancy criteria*

Inclusions	**Exclusions**
- Data mining - Big data - Cloud computing - FinTech - Customer-centricity	- Mobile banking and payment systems - RPA (Robotic Process Automation) - Chatbots and NLP (Natural Language Processing)

From the technological perspective, data mining and big data are included in this scope as they were the overwhelming majority of data analytics applications and methods introduced in the literature review. Cloud computing was also covered, as it is closely connected to big data. FinTech was included as it is an interesting phenomenon closely linked to banking sector and was emerged from same events as digital banking transformation, i.e. new regulation and advances in technology. Customer-centricity was also incorporated as it is one driving force of the digitalization of banking sector.

Mobile banking and mobile payments are also introduced in some academic research relating to analytics and banking sector. This was, however, excluded as it would be

disconnected from the rest of the main topics introduced in this research. RPA (Robotic Process Automation) and chatbots were excluded on the same basis, as the applications of RPA and chatbots are insignificant to this scope of the research.

2.3 Empirical research

The empirical research is conducted using semi-structured interviews. Semi-structured interview is a qualitative research, where the interview has a set theme, usually regarding the research questions. Interviews consist of a template of theme questions made by researcher, on which the actual interview is based upon. These theme questions are derived from the research questions and theoretical background and frameworks. Organizing interviews is not based on strict structure, but a loose structure which some of the interviews may be varying depending on the flow of the conversation. (Saunders et al. 2009) The template for theme questions can be seen in the appendix A.

Semi-structured interviews were chosen from the basis of the research strategy as the abductive research method can be obtained by challenging the theories to be proven in the research. Due to ongoing COVID-19 pandemic during the time of research, later interviews were teleconference calls while the first ones were face-to-face interviews.

According to King (2004), the goal of qualitative interviews is to see the research topic from the perspective of the interviewee and understand why the interviewee has come to that perspective. In this interview, understanding the interviewees' perspectives are validated on the basis of the literature review.

The interviewees used in this research were professionals from Finnish banking sector. The focus was on the two primary topics of this research: FinTech and big data analytics. Therefore, the interviewees had previous knowledge about these topics. Interviews used in this research were anonymized, and only relevant information for the research was gathered. The background information of the interviewees is presented in the table 4.

Table 4. *Interviewees' background information*

Interviewee	**Experience in banking sector**	**Roles**	**Field**
I1	12 years	Manager, Team lead, Consultant	Payment services development
I2	8 years	Operations manager, Team lead, Head of business services	Credit fraud, payment processing development
I3	8 years	Chief specialist, Team lead	Financial crime, AML and terrorism funding, compliance
I4	5 years	CIO	Technology and development
I5	14 years	CDO	Technology and innovation

Interviews lasted approximately an hour, shortest interview being 48 minutes and longest 1 hour 25 minutes. With the consent of the interviewees, the interviews were recorded in order to transcript the interview later and having the ability to be more involved in conversations during the interviews. Short meeting notes were also made during the interviews highlighting interesting observations. Timmermans & Tavory (2012) emphasized the importance of having the ability to revisit the interview, after for example being introduced to new theory. Revisiting the interview may result in more interesting observations being found when reflecting against the new theory. Going back to the interviews and meeting notes also forces the researcher to reevaluate observations that were first taken for granted. (Timmermans & Tavory 2012) After finishing the research, all recordings were deleted, as it was also communicated to the interviewees.

Outcomes of the interviews, derived from the literature review and theoretical frameworks, are critically analyzed in the analysis part. The primary method used in this part is summarizing the interview results in order to gain similarities between interviewees and making generalizations out from the conversations in the interviews.

These summaries and generalizations are then reflected back to the literature and then analyzed for proposed actions for the banks as well as making research conclusions.

3. DIGITAL TRANSFORMATION IN BANKING SECTOR

This chapter will lay the foundation of the banking sector's evolution to a digital industry by inspecting the evolution of banking sector and financial industry on the whole to gather insights about the history and future of banking. The chapter will justify and give insight on how financial regulation especially from after the global financial crisis has had a thorough impact on the development of financial industry overall.

This chapter will join the background and motivation from the financial regulation and the financial technology advancements together to a cohesive entirety. FinTech is also introduced as a key part in digital transformation of banks and show how changed regulation has shaped the development of FinTech and banking sector.

3.1 Digital evolution in banking sector

The financial digitalization era started with the increase of mobile phone and internet users. Since mid-2000s, consumers have started to become more used to interacting with digital media to share information, shop online and access new services, to name a few. All this was made possible together with new mobile network technologies and internet. This has led to consumers wanting more from financial services also, desiring fast and convenient access to financial services as well as better and more personified services. (Munaiah & Krishnamohan 2017; Cuesta et al. 2015; Tornjanski et al. 2015; Bons et al. 2012)

This has happened at the same time of banks being identified as very conservative and resistant to major changes. This is due to banks being such a large organizations and banking landscape being relatively stable in the previous decades. Only the last two decades have showed that even financial services cannot escape the digital disruption that has put banks under stress to continuously evolve. (Tornjanski et al. 2015) In addition to digital disruption, banking sector transformation to face the modern challenges is not only a technological challenge. According to Omarini (2017), digital transformation in banking sector is not purely technological. Author states that in addition to banks adopting new technologies, banks must re-define their business processes to become more agile in a way that the value chain of the bank is more flexible. All business processes, services and products must be digitized in a way that they will create more value to the customer. In addition, banks need not only focus on how to digitalize their

processes, but also holistically examine and re-define the value chain of the financial services (Klimontowicz 2014; Bons et al. 2012).

Banking sector is now in a challenging situation, where banks must continue developing their core business and services while in the same time create new services and strategies to combat increased competition (Guo 2017; Schuchmann & Seufert 2015; Klimontowicz 2014). According to Schuchmann & Seufert (2015), the technological adoption amongst consumers have resulted in consumers demanding more from their banks. Accessibility is one of the main drivers creating this rise of demand within customers. At the same time, the authors state that typical banking services such as fund management and stock dealing are already fulfilled by actors outside the traditional banking sector. (Schuchmann & Seufert, 2015) Lastly, consumers are also less loyal to a financial service provider and will change the provider more frequently (Stoller-Schai 2011, cited by Schuchmann & Seufert, 2015). In addition, multi-bank relationships between customers are increasing which further emphasizes to decrease of retention capabilities within banks (Alt et al. 2018).

Financial services in banking sector have previously been primarily about transactions and asset management. Digital transformation has only recently occurred when ATMs and internet, which in turn evolved into mobile banking, were founded. This has also led to more product-intensive innovation rather than service-oriented. Gaining competitive advantage has been mostly all about operational efficiency. (McLaughlin 2017)

The current value chain in digital banking in the internet and mobile era is becoming more about the customer and customer relationship management and less about financial services products that banks provide. According to Bons et al. (2012), banking has become an information-intensive business, where information technology has a crucial part in all steps of the value chain. Value chain from customer point-of-view is shown in the figure 6.

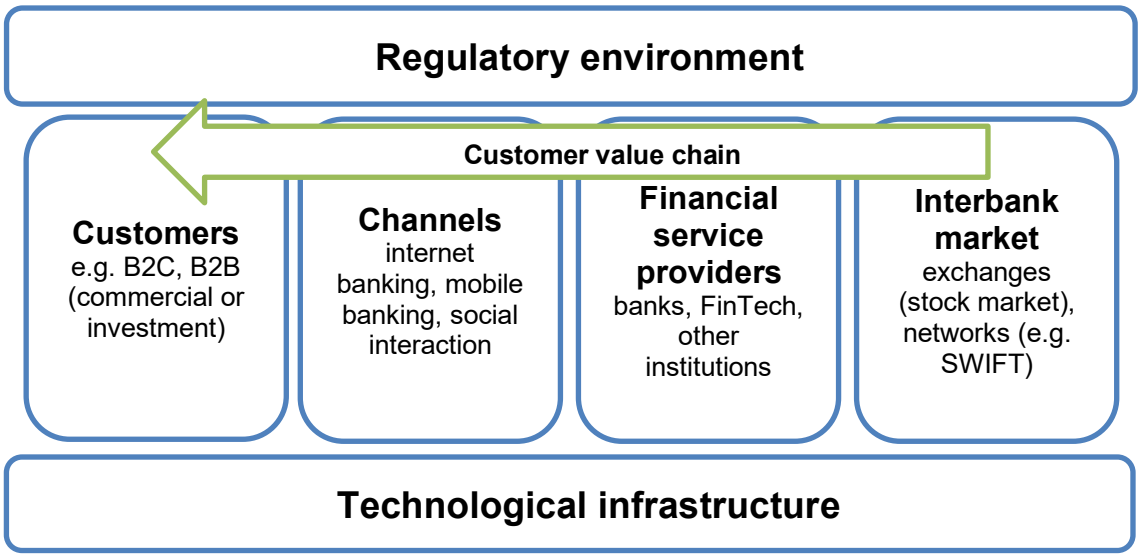

Figure 6. *Value chain of customers in digital banking sector (adapted from Bons et al. 2012)*

Interbank market is a global network of financial institutions that trade currencies. It consists of large private banks as well as trading firms and hedge funds. (Chen 2019) Within interbank markets, there are technological ways of trading funds. An example of these technologies is SWIFT (Society for Worldwide Interbank Financial Telecommunication). SWIFT is a technological communications platform, on which the financial institutions can communicate in the interbank markets. This is where the foundation of financial transactions is. SWIFT is not a transactional payments system, but rather a transport network for all major payment and security infrastructures. SWIFT provides a proprietary channel for all actors, financial services providers and financial institutions. (Scott & Zachariadis 2014)

Financial service providers are a collection of traditional banks, FinTech companies and other relevant institutions. According to Bons et al. (2012), financial service providers are all players that communicate to each other using interbank market described above. Lee & Shin (2018) argue that financial service providers are not only financial institutions, but also supporting services, which of information technology services is the most influential. Therefore, in digital banking value chain there usually is one or more player that is not financially related.

Financial service channels can be multi-dimensional. Customers in the value chain can use channels that include mobile banking, internet banking, social interaction or a multi-channel approach, where some of the services provided are done for example with mobile banking (e.g. paying bills) and other using social interaction (e.g. negotiating a

loan) (Patel & Brown 2016). It is to be noted that technological infrastructure is still needed, even if all services provided to a customer would be social interaction as bank still uses technology in the background.

Value chain of digital banking sector ends with the customers. Bons et al. (2012) argue that certain customers demand for different types of technological infrastructure. For example, digital natives desire more internet-based services and mobile banking, whereas more senior customers still prefer human interaction. According to the authors, even if digital natives are leaning towards more digital interaction, the need for customer interface as well as customer-centric and personalized services. Figure 7 shows the new landscape of digital banking.

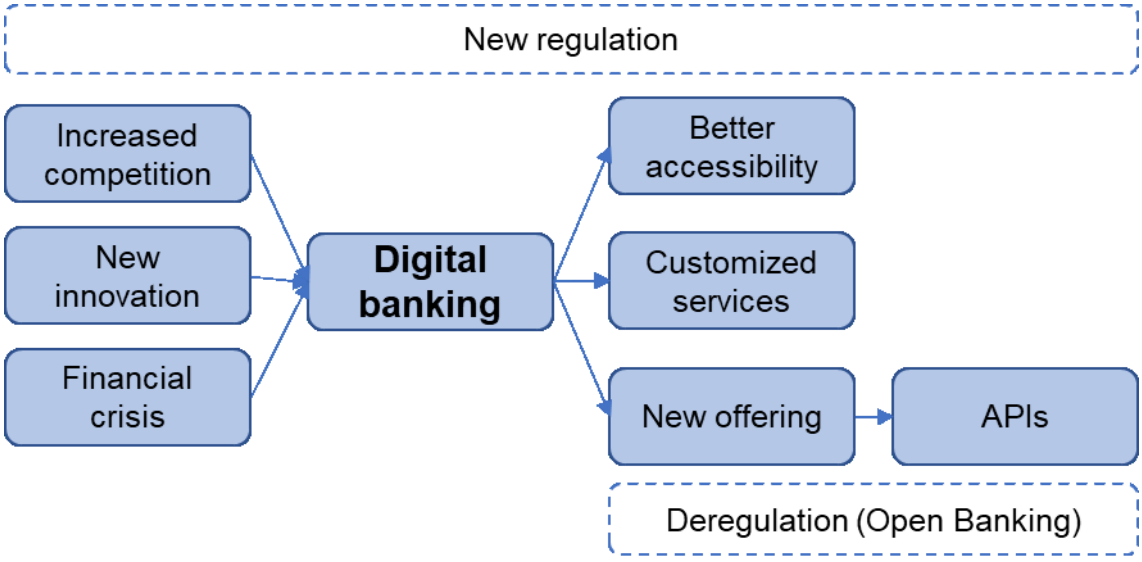

Figure 7. *Digital banking transformation landscape*

Traditional banks are facing a totally new landscape of competition. According to Marous (2019), both huge technology companies as well as smaller challenger banking institutions are stepping up to the traditional financial services landscape, on which no other than traditional banks have gone before. Huge technology companies possess the platform and the ecosystem, including large customer base, and are now also gaining trust among the customers. Marous states that not all technology companies are yet in the trust level of having the ability to attract customers to their financial services, but it is evident that the technology companies are willing to pursue this goal. (Marous 2019)

According to Dietz et al. (2016), increased competition is also coming from magnitudes of smaller companies compared to traditional banks, but in FinTech sector. Dietz et al. raise the concern to banks that most FinTech start-ups and companies only lack one thing, customer base. Other aspects, such as innovative ways of utilizing the potential of data to the fullest, are among the strong suits of the FinTech companies. These

applications are showing for example as new ways of calculating credit-scoring. (Dietz et al. 2016) Big data analytics provide the ways of doing this, which also most FinTech companies possesses the knowledge of.

Open Banking has a clear impact on openness of innovation in banking sector. Open Banking, in essence, is an ecosystem of different players, both financial and non-financial, where the transparency and innovation of services are emphasized (Naukkarinen 2019). The ability to leverage customer data together with third party data or open data, creates a whole new domain of innovation. This must be addressed in banks and choosing the strategy to follow is at the utmost of importance.

According to Gomber et al. (2018), financial services innovation has three key forces: Technology innovation, process disruption and services transformation. These all contribute to the overall innovation of banking sector. Technology innovation is about the methods and tools to use in order to achieve innovative new services and products. The authors state that technology innovation is not purely technological as it ties closely with society and its needs. Process disruption in financial services is figuring out new ways to disrupt traditional processes, in this case financial processes. While FinTech companies truly utilize process disruption, one key issue is still to resolve: How will the customers trust their financial services to be handled by smaller, more unknown companies. In services transformation, technology innovation and process disruption are combined in a way that it results in holistic services transformation. Authors state that financial services transformation is not a new topic per se, but there are plenty of unsuccessful service transformations. What is now different, is abundance of data and technological means to analyze the data. Also, authors argue that collaboration with FinTech companies and traditional banks have become more supportive to each other, which will accelerate financial innovation on the whole.

As stated before, the financial crisis was the third main catalyst that has critically shaped financial services in the recent years. The new uncertainty and brand-loss among traditional banks are something, that banks and financial services generally still bounce back from. It is clear that financial crisis has had an impact on banks, them being now much more careful and cynical.

Hõbe (2015) goes further and states that the last financial crisis has also had an impact on customers, wanting more reliable and secure services but also more tailored to them. This goes in line with previous discussion with customers wanting more from financial services, but Hõbe (2015) argues that the financial crisis is also one key factor in this.

3.2 FinTech

Financial technology (FinTech) can be seen as data driven technologies that are in close relationship with financial industry. The goal of FinTech is to adopt new approaches and methods in financial industry that utilizes latest technology. These new approaches and methods have also managed to re-design traditional banking and other financial processes and therefore created new ways of creating value in financial markets. Key aspects of FinTech companies are focus on personalizing services, making business more transparent and accessible via digital channels and creating new kinds of offering to customers wanting to have alternatives to traditional banking services. (Vasiljeva & Lukanova 2016)

Gimpel et al. (2018) include the usage of digital technologies such as Internet, mobile computing and data analytics to the definition of FinTech. These technologies are used to re-invent and disrupt financial services and have a strong presence of startups. There is a common interest among FinTech companies to deliver personalized and innovative services and products to customers (Temelkov 2018). In other words, there is a strong consensus to become more customer-centric than the direct competitors and traditional banks. According to Gimpel et al. (2018), FinTech is lacking theoretical background and research, despite the exponential investments in this area.

Lee & Shin (2018) state that in addition to FinTech startups, there are several other key operators in financial industry. Zavolokina et al. (2016) have surveyed the presence of FinTech and its definition in scientific and commercial articles. Table 5 shows multi-dimensional ecosystem of FinTech and its key operators and functions.

Table 5. *FinTech ecosystem and operators (adapted from Lee & Shin 2018)*

Name	**Operators**
Government	Financial regulators
FinTech institutions	Traditional banks, insurance companies, venture capitalists
Technology developers	Big data analytics, cloud computing, cryptocurrencies
FinTech startups	Payment, wealth management, lending, capital market and insurance FinTech companies
Financial customers	Individual customers and organizations

Lee & Shin (2018) argue that FinTech is one of the most important innovations in financial industry and is one main driver in the evolution of financial industry overall. FinTech is said to shape the technological developments in infrastructure, big data and data analytics in banking sector. According to Vasiljeva & Lukanova (2016), FinTech activities can be distinguished in three different categories:

Table 6. *FinTech categories in the context of banking sector (adapted from Gomber et al. 2018; Vasiljeva & Lukanova 2016)*

Category	**Key areas**	**Applications**
Service-oriented	Technological development of traditional financial services and alternatives to them	Fund transferring, lending, investment
Data-oriented	Technological solutions to collecting, processing and analyzing information	Anti-Money laundering, fraud detection
Process-oriented	New operating models enabled by the use of new technology	Customer intelligence, customer relationship management

Vasiljeva & Lukanova (2016) point out that data-oriented technologies are not yet gained a lot of attraction among the banks. There are still signs of a growing trend in big data analytics interest. Main focus in this research is on the process-oriented and data-oriented categories as they are the enablers for the service-oriented applications.

3.2.1 Different eras of FinTech

According to Arner et al. (2015), the history of FinTech reaches to 1866 and can be divided into three distinct eras. First FinTech wave started in 1866 to late 1980s, where the first transatlantic transmission cables were constructed, proposing the first opportunity to communicate between continents. (Arner et al. 2015) The technology was primitive in today's standard, but the interconnection of continents was a huge leap in technology at that time.

The second era of FinTech, proposed by Arner et al. (2015), was from late 1980s to 2008, when most banks and other financial services companies started to digitize their business processes. This, however, was limited to mostly internet banking and digitizing banks own processes and did offer only limited services to customers.

The third and last era of FinTech started in 2008. The financial and economic crisis of 2008 had an irreversible impact to public perception and human capital. After the crisis, banks suffered from public image and brand losses, which gave way for new ways of thinking and behavior in financial sector. The financial and economic crisis of 2008 also had a major effect on regulation, which would try to prevent new crises from occurring. Figure 9 shows the main eras of FinTech evolution and characteristics and impacts on financial services.

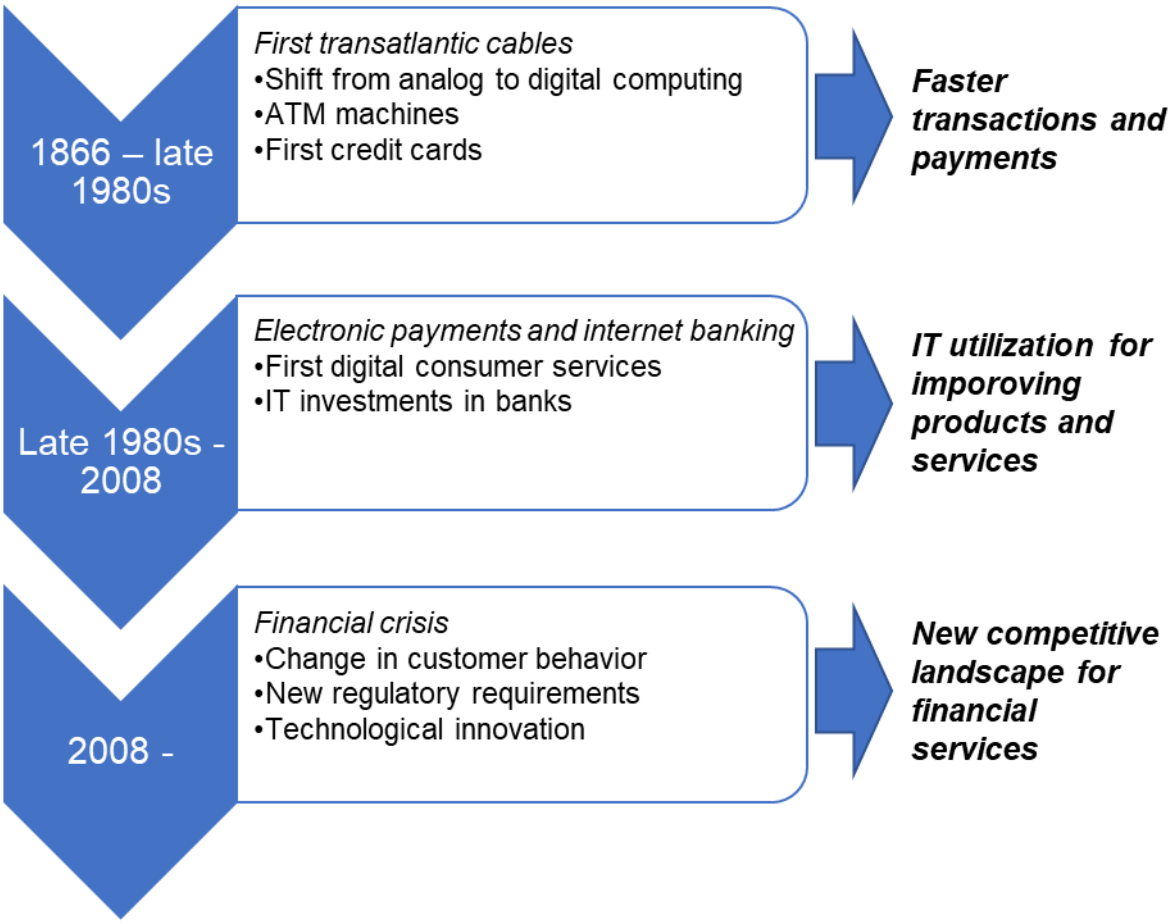

Figure 8. *Characteristics of FinTech eras (adapted from Bates 2017, cited by Thakor 2020; Alt et al. 2018; Schindler 2017; Arner et al. 2015)*

In the third and the most recent wave of FinTech, a larger focus on regulatory aspects have risen. According to Arner et al. (2016), regulators have not yet fully decided on how the regulation affects FinTech companies. The cost of regulatory compliance is considerable, which will ultimately show in the decelerated innovation among the FinTech companies. Therefore, regulators do not want to fully enforce the same compliance requirements for all FinTech companies, but industrywide decisions should be made on when and what to regulate. (Arner et al. 2016) Other meaningful differences when compared to previous FinTech eras are increasing of non-cash payments, larger

networks of partners among banks, higher competition, focus customer-centricity and rise of APIs (Alt et al. 2018).

Gai et al. (2018) argue that FinTech has several different drivers that influence the rise of FinTech. These include technical development, business innovation expectations in the financial market, cost-saving requirements and increased customer demands. Schindler (2017) adds diversified demographics, and especially increased need of mobile banking among the youth. Millennials are used to fast and mobile access to different services, and financial services and banking are not exceptions. (Schindler 2017)

Claessens et al. (2018) state that global market competition and economic growth have also had an effect on the rise of FinTech. The ever-increasing competition have led to lower margins for traditional banks, which in turn have forced banks to look more lucrative business in financial services. In addition, lacking regulation on FinTech has until this point enabled explosive growth in FinTech. (Claessens et al. 2018) According to the survey by Zavolokina et al. (2016), it was only in the year 2013 when FinTech regulation started to emerge to the press and scientific articles.

3.2.2 Impacts of FinTech companies to banks

There is a clear consensus within the academic literature that FinTech phenomenon is generating more competition which in turn results in better services for the customer (Navaretti et al. 2018). However, the changes in the financial industry landscape is not as straightforward as it is shown to the consumer.

It seems that the impact of FinTech to banks is disruptive in nature, as there are a lot of academic research pointing the FinTech companies' ability to affect traditional banks' business processes. In addition, large portion of the academic research seems to define the relationship between FinTech and banks as rivals. (Siek & Sutanto 2019; Anagnostopoulos 2018; Vives 2017) Upon a closer inspection, the disruptive force is focused mainly on a rather small segment in financial services, mainly in services like peer-to-peer lending and payments, where the main idea is to provide lending and payment services without the involvement of traditional bank. Still, general competition against banks' large product and service portfolio is lacking and viewing FinTech and banking landscape more holistically shows the relationship in a much more collaborative nature.

Mills & McCarthy (2017) derive to the conclusion that there are three different areas where FinTech companies still cannot compete with banks, and which is most often overlooked. First, the amount of capital the banks possess is on a different level to

FinTech companies. This will create the natural benefit of cheaper capital costs in lending services. Also, FinTech companies do not have the large, and usually loyal, customer base that the banks have. Lastly, brand image still is relatively unknown among the FinTech companies, while traditional banks have a long and reputable history. (Mills & McCarthy 2017) This is especially apparent in Finland, where the bank loyalty is extremely high. According to a study made by Järvinen (2014), Finland had second-highest trust level in Europe. Zalan & Toufaily (2017) come to the same conclusion that even if there are some FinTech companies willing to compete against the traditional banks, they should see the FinTech landscape more of an opportunity for innovation and bank-FinTech partnerships.

Anagnostopoulos (2018) states that as banking sector is due to a fiercer competition, banks may in fact look for collaboration with FinTech companies and technology developers in order to improve competitive advantage. This will not happen automatically as the digital maturity of the bank must in a level that the FinTech collaboration is possible. Therefore, banks may need to invest heavily on their digital ecosystems before FinTech companies can be seen as partners instead of competitors. (Anagnostopoulos 2018) Zalan & Toufaily (2017) define five different strategies for banks to adapt to the new financial industry landscape with the FinTech companies:

Table 7. *Proposed banks' strategies in relation to FinTech (adapted from Zalan & Toufaily 2017)*

Strategy	**Definition**
Maintain status quo	Continue focusing on the bank's previous strategy
Deepen digitalization capabilities	Add capabilities for innovation within the bank
Set up own FinTech	Develop own FinTech platform for pursuing disruptive opportunities in FinTech sector
Invest in FinTech	Acquire FinTech companies in order to minimize losses to FinTech market penetration
Partner with FinTech	Collaborate with FinTech companies

Zalan & Toufaily (2017) point out that last strategy proposed, partnering with FinTech, was an overwhelming majority. According to the authors, partnering can result in a complementarity of capabilities, where traditional banks can leverage from the FinTech's agility and innovations in technology, and FinTech will have the access to banks' customers.

3.3 Regulations in banking

The common attitude towards financial regulation has been severely affected by the global financial crisis of mid-2000s. Before the crisis, 56 % of the respondents of the survey made by Kevin Young (2013) had positive or neutral attitude towards financial regulation, whereas after the crisis, the same number is only 27 %. This has led to governmental action and especially European Union to impose new regulation to financial services and banking sector. According to Arner et al. (2017), one main reason for this is forcing financial industry to reduce risk. To put this into force, a massive sanctioning system has been created by regulators and as a result, post-crisis fines are over $200 billion, according to Jeff Cox (2015).

From the point-of-view of this research, next is introduced the most influential regulation for banks, PSD 2 (Payment Services Directive 2). PSD 2 is in focus of this research due to its nature in digitalization and being relatively close to big data analytics landscape. Topics relating to PSD 2, namely Payment Initial Services Provider (PISP) and Account Information Services Provider (AISP) are also introduced. Open Banking, which is also a central part of European Union's strategies to enable competition in a fairer way is discussed later.

3.3.1 PSD 2 and Open Banking

PSD 2 is one of the most influential regulations shaping the financial landscape in Europe in recent years. This new regulation was an outcome of the financial crisis as well as political decision. The main purpose of these legislations was to primarily to give personal data access to the customer and secondarily to introduce new, more transparent competition that was previously done in the energy and telecommunication sectors. (Rousseau 2019, European Commission 2015)

PSD was introduced in the EU in 2007, and the updated PSD 2 was first introduced in 2013, and fully implemented in 2018. Briefly, PSD 2 means that any service can handle payments on behalf of the users, and therefore cutting the middleware of the payment service providers. (Mansfield-Devine 2016) The outcome of PSD 2 is that banks are required to offer the customer account data openly to third party providers and vendors.

(European Commission 2015) The main purpose of this is to enable competition and more innovative services by leveraging the banks' infrastructure and data (Gozman et al. 2018).

Overall banks have been quite unsure about the new regulation. A survey made by Sandrock & Firnges, (2016) 68 percent of banks are feeling that they are in a weaker position as a result of PSD 2 and that they are losing the control over customers. Although this has created a defensive attitude from banks towards the new legislations, some banks and FinTech companies are utilizing the possibilities of opened banking data and are now creating strategies to lead this development further. (Sandrock & Firnges 2016). It can be concluded that banks in recent years have become more divided in terms of their position towards changes in the financial and banking landscape. Same conclusion is reached in Enge-Olsen & Pedersen's (2019) research, where the study conducted resulted in larger banks identifying to be more open to FinTech companies and changing their business models whereas smaller and in particular savings banks are more reluctant in applying digital transformation and FinTech collaboration.

3.3.2 PISP and AISP

Concrete implications of new regulation and especially PSD 2 is the desire for modularizing of payments in the EU area. Chiu (2017) states that PSD 2 has resulted in two different types of authorization that previously were not enabled. These are called Payment Initiation Services Provider (PISP) and Accounts Information Services Provider (AISP). Both need the consent of the consumer, but there is no need for requiring approval from the bank, which the consumer has banking services in. (Chiu 2017)

PISP handles the payment between the customer and bank and provides the customer interface for that. PISP has often adopted new payment technologies such as mobile payments and Apple Pay. (Chiu 2017) According to Isac (2019), PISPs are service providers that processes the payment orders that are initiated by consumer and which access the consumer's banking platform. The PISP process develops a communicative bridge between the merchant's services, on which the consumer wants to initiate the payment process, and the bank's underlying payment services. (Isac 2019). Chiu (2017) argues that players in PISP area might not want to fully integrate to the whole payment process, so the need for traditional banks still remain. This is due to PISPs not wanting to invest in heavy infrastructure needed to process the payment end-to-end and that they are by far more interested in connecting into already established infrastructure systems, first developed by traditional banks. Also, PISPs have far less regulatory compliance that they need to deal with when only being the middleman in the payment process. (Chiu

2017) This may create challenges and uneven competition for the banks, which have to carry the burden of strict compliance requirements.

AISP's purpose is to consolidate consumers' all financial services into an integrated solution, meant for easier management by the consumers. According to Eide & Hallum (2018), AISP can perform aggregation from different online sources and for multiple payment accounts and deliver the aggregated information to a single view for the customers to manage their daily finances. Andersson & Wang (2017) state that AISPs can for example give advice and overview of the customer's spending habits and financial situation. AISPs can aggregate information from all banks that are inside the EU. (Andersson & Wang 2017) Guibaud (2015) notes that not only FinTech companies are able to become AISPs, but also traditional banks can serve as the AISP. This would keep the bank in close proximity of the customer, without losing visibility from the customer's point-of-view. This requires a strategic choice by the bank, since banks are not likely to possess the capabilities of being an AISP from the beginning.

3.3.3 Open banking

Open Banking is a general term for the outcomes from PSD 2, mainly Open Banking is related to the broader landscape and ecosystem of financial technology within the European payment markets. The increased competition and innovation that the PSD 2 is encouraging is also closely related to the term Open Banking. (Høgetveit & Thorkildsen 2018; Omarini 2018)

According to Naukkarinen (2019), the term Open Banking can be seen as either narrowly or widely. By the narrower definition, Open Banking is only an interface for the use of payment services and account information services (i.e. PISP and AISP). But on the wider definition, Open Banking can be seen as an ecosystem of different players, banks and FinTech companies, in which the banks' value chain is changed due to new possible ways of creating products and services. In this Open Banking ecosystem, the financial services processes are moving from the hands of the banks to the ecosystems chosen by the customers individually. (Naukkarinen 2019)

Omarini (2018) points out that in addition to customers' ability to choose their preferred ecosystem of financial services, banks can also adapt to the situation by choosing the level of openness they want to provide. Banks do not need to open all their competitive advantages to other players in the market. In addition, banks may integrate their offering into other players' offerings, such as FinTech companies'. (Omarini 2018)

Omarini (2018) states that Open Banking in essence is about enabling banks to diversify their product and service offerings as well as innovate together with other players in the

market landscape. Open Banking landscape and the emerging new business model is further discussed in chapter 4.

3.3.4 Challenges posed by PSD 2 and Open Banking

One major challenge for banks is existing customers and their data. As customer data becomes more open to other parties than only the bank that customers have contracts in, the value of customer data must be rethink and revalued. According to Enge-Olsen & Pedersen (2019), some banks see this as a negative impact of PSD 2, where their information gathered throughout the customer lifecycle is threatened. On the other hand, Enge-Olsen & Pedersen (2019) state that some banks still think that the holistic knowledge about the customer is something that even releasing PSD 2 related customer data will not be threatened. A key distinction about this is that the knowing the customer is much more than just transactional data, and in order for banks to succeed, business processes as well as technological methods must be up to date so that banks keep their advantage in knowing their own customers.

The new regulation sanctions are forcing banks to find ways to stay compliant. These means to stay compliant are not cheap and usually need new business processes as well as IT infrastructure. To solve this, regulatory technology (RegTech) has been growing in recent years. This has been argued by Arner et al. (2017), where previously staying compliant to all regulation has been happening from manual reporting and compliance processes. Only recently RegTech has been seen as a potential solution to create more resource efficient and effective way to stay compliant. Arner et al. (2017) goes even further where RegTech can be seen as key shift from just an efficiency tool to a completely new paradigm in regulation, and that RegTech should be seen as an integral part of financial services sector, not just a compulsory task to prevent receiving sanctions. But in order to achieve this, whole new business processes must be implemented in bank's core functions. This creates a clear challenge when viewing from the IT infrastructure point-of-view as the new business models and technological methods need new IT infrastructure.

3.4 Customer centricity in banking

The best way to create successful financial services business is to know all about the customers and their needs (McLaughlin 2017). This has become more evident in the recent trends in the banking sector, where the competition has risen, and customers have become more demanding.

Shah et al. (2006) define customer-centric approach to be the philosophy of serving customers instead of selling products. Customer-centric organizational structure involves customer segment centers and customer relationship development, usually by utilizing IT for developing sufficient customer relationship management (CRM) platforms. Shah et al. (2006) compare customer centricity to product centricity as being the opposites. According to the authors, it takes considerable amount of resources to shift the organization from product-centric to customer-centric business. (Shah et al. 2006)

In banking sector, customer centricity has become one of the key elements in driving the CRM development. There are several ways of integrating customer centricity into banks' core processes, which will also show in the bottom line. (Munaiah & Krishnamohan 2017) For effective customer-centric approach in banking sector, banks must identify three different ways to improve customer relationship management (Parthiban & Sakthi Priya 2016):

- Identify most valuable customer segments in the market
- Define key drivers and best practices of customer relationships
- Monitor customer relationships and the performance of CRM platforms

According to Marjanovic & Murthy (2016), shifting from product centricity to customer centricity in financial institutions, such as banks, require comprehensive focus on aligning IT strategy and business strategy. The outcome of successful shift towards customer-centric organization will result in improved customer loyalty and satisfaction, which in turn leads to increased competitive advantage.

Guo (2017) argues that the competitive advantages from customer centricity comes within internal and external measures. Internal measures mean to enhance relationship orientation and therefore sharpen the customer focus. By external measures, the bank seeks out for better customer perception and what actions result in better customer loyalty.

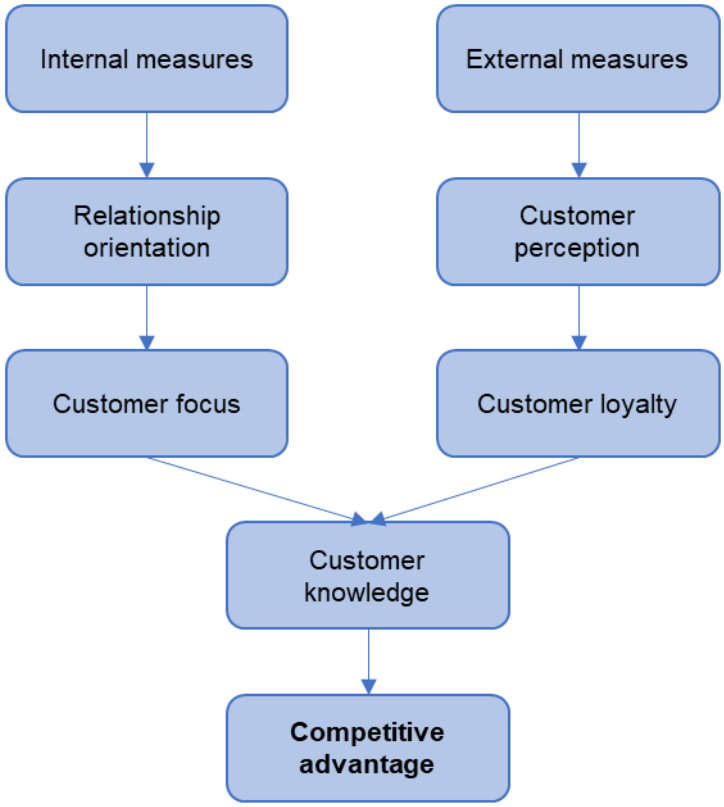

Figure 9. *Internal and external measures in increasing customer knowledge (Guo 2017)*

It is important to note that internal measures are more about refining strategy alignment and cultural transformation whereas external measures demands are fulfilled more with the utilization of CRM systems within the bank. Guo (2017) also states that improving customer relationship orientation, it will also impact positively to CRM performance. For increasing customer perception, big data analytics applications can be used. These applications are introduced later in this research.

3.5 Summary

Boot & Marinč argued in 2008 that financial services industry is in the midst of a revolution. According to the authors, traditional banks are faced with three major areas of change, where previously there was no radical change found:

- Increased competition both from interbank competition as well as from nonbanking financial institutions
- Increased financial innovation through technology and new product innovations
- The financial crisis

Authors also state that financial institutions are no longer domestic business and the increase of foreign banks penetrating national banking sector is imminent. (Boot & Marinč 2008)

The rise of increased competition has mainly been coming from FinTech companies, which try to offer more innovative solutions for replacing the existing, rather traditional and stale services that banks have been used to offer. The rise of FinTech has had two primary drivers: opened regulation for non-banking institutions and technological development in the recent years (Schindler 2017). The impact that FinTech has to Finnish banking sector will be discussed more in depth later.

New regulation has had an impact on banks and their future of digital transformation. Banks may be in a situation where the regulator is pressing from both sides, from regulatory due diligence as well as opening of the ecosystem and innovation. This naturally creates a need for the banks to balance their strategies and define carefully on how to embrace the new possibilities of open innovation while keeping regulatory requirements under control.

From the perspective of regulatory issues in FinTech adoption and digital transformation in banking sector, banks must re-define their strategies and create a balance between doing nothing towards regulatory compliancy and doing everything. According to Zetzsche et al. (2017), costs of doing nothing are significant, but also cost of catching all mandatory requirements is costly as well. Banks must improve their risk assessment management to clarify, what regulatory compliance will be enforced and to which extent.

4. BIG DATA AND ANALYTICS IN BANKING SECTOR

This chapter will introduce big data analytics that is used in the banking sector. The chapter will first go through big data and how it is seen in the financial industry and then different big data analytics applications that are used in banks. Lastly, cloud computing is addressed as it is one key enabler for big data analytics.

Tackling modern challenges in banking sector often need technological tools and methods. Increased competition, new regulation, latest innovation mentioned in the previous chapter all make use of technology and analytics. According to Rajpopat et al. (2017), main challenges that banks face consists of:

- Dispersed data
- Identification of fraudulent activity
- Having unclear view of customers
- Customer analytics
- Governance

Using analytics for big data has shown to have clear benefits. According to Simonson & Jain (2014), utilizing analytics in banking sector will help banks to have a clearer understanding of consumer behavior and the change of that, meet with regulatory requirements posed to banks and have an overall better product portfolio for customers and improved product design.

The rise of big data and analytics in banking sector largely share the drivers that are driving FinTech also. According to Simonson & Jain (2014), the main three drivers are:

- Competitive advantage
    - Having a better product differentiation and utilizing big data to the fullest
- Compliance
    - Passing stricter regulation, lowering the cost of doing compliance, i.e. due diligence
- Profitable growth and solvency
    - Needing new growth from other areas other than traditional retail banking

All challenges and possibilities are data-intensive by nature and require big data methods as well as adequate analytics to solve them. This chapter will go through what kind of data is within the banks' ecosystems and how they can be categorized. This chapter will also shed light to the technologies and methods that are used in these areas. The focus of the technologies and methods is in line with the academic literature. Real-world use cases are examined and validated in the empirical study.

4.1 Big data in banking sector

Big data is data which is in such a large scale that no traditional computing power is capable to handle it. This data is coming from a vast number of sources, which are all linked to a large data model. In financial sector, this big data comes from monetary transaction data as well as other customer, market and trading related data sources. Storing and accessing this big data, let alone performing analytics on big data require new technical architectures, modern analytics and tools. Big data used correctly, however, can offer valuable business insights and competitive advantage. These can in turn affect positively on organizational agility. (Côrte-Real et al. 2017, Trelewicz 2017, Elgendy & Elragal 2014, LaValle et al. 2011)

Big data is characterized by different *V*'s of big data. Trelewicz (2017) define big data to have three *V*'s: *Volume*, *Velocity* and *Variety*. Elgendy & Elragal (2014) add a fourth dimension to big data, *Veracity*. Wamba et al. (2017) added a fifth dimension, *Value*, and Uddin & Gupta (2014) completed big data dimensions to have seven *V*'s, by adding *Validity* and *Volatility* to the mix.

Table 8. *Big data dimensions (adapted from Wamba et al. 2017; Trelewicz 2017; Elgendy & Elragal 2014; Uddin & Gupta 2014)*

Dimension	**Definition**	**Use cases**
Volume	Input data from different sources, data sizes in the range of terabytes or even petabytes.	The New York Stock Exchange (NYSE) produces over a terabyte per day of transactional data
Velocity	New data is coming swiftly, and existing data is changing rapidly	Need for timely stock data
Variety	Data types can be diverse and structured, semi-structured or unstructured, and may include pictures, videos etc.	Credit score for a customer can be calculated from a multiple of different data sources
Veracity	The assumption on how precise and complete the input data is	Bank's customer's nationality can be based on place of birth or passport
Validity	Correct data for intended use	Customer data coming from onboarding can be outdated
Volatility	Data expiration and data retention	All transaction data ever recorded is not possible and not even desired
Value	Insights gained over resources invested	CRM can accurately predict the customer behavior

The purpose of utilizing big data in analytics is to enhance data-driven decision making and create more innovative ways to improve customer relationship management, management of operations risk and enhancing operational efficiency and overall company performance (Wamba et al. 2017). Data types can be either structured, semi-structured or unstructured. According to Shirazi & Mohammadi (2019), structured data is data that is in a set form, either compliant with a standard (e.g. ISO 8583, for financial transaction interchanges) or a data platform specific (such as csv-files). This structured data is usually found in databases and APIs. Semi-structured data is for example data gathered from call centers or emails and other documents which may have some

consistency in the data structure. Unstructured data is found from web logs and social media and are not following any patterns in data types. (Shirazi & Mohammadi 2019)

4.1.1 Leveraging customer data

Banks have shown to understand the importance of customer relationship management (CRM) and its ability to retain and maximize existing customers' lifetime value as well as supporting in acquiring new customers. Utilizing customer data in banking sector requires strong coordination between marketing department and IT department. At full potential, customer data can reveal distinct characteristics of customers and help identify different customer clusters. (Onut et al. 2008) Data mining algorithms are used in order to identify the clusters and analyze customer retention and characteristics. (Moin & Ahmed 2012)

According to Onut et al. (2008) and Elsalamony (2014), there are several different aspects of data that banks are interested in customers:

- Demography (age, sex, cultural level, education, marital status)
- Ownership of bank's products
- Product and services usage (balance, transactions, loans)
- Global variables (profit, cost, risk, assets, liabilities)
- Relationship with the bank (segment, portfolio)

This data may come from a variety of different systems. According to Shirazi & Mohammadi (2019), in addition to data coming from CRM, data may be sourced from transactional database, social media, web log and call centers to name a few. This indeed shows the variety and veracity of the big data within banks.

Open Banking Working Group (2017) categorize customer data in banking to customer transaction data, customer reference data and aggregated data. Table 9 shows different customer data types and their use cases.

Table 9. *Customer data types (adapted from Open Banking Working Group 2017)*

Customer data type	**Use cases**
Transaction data	- Bank balance - Bank transactions
Reference data	- Demography - Ownership of bank's products - Relationship with the bank
Aggregated data	- Global variables, other customers' aggregated data and open data

As seen in the table 9, banks can utilize more data than the customers own data to enrich customer data. This may include for example cash withdrawals per month across a postal area. For instance, open data include open product information and ATM locations. (Open Banking Working Group 2017) The purpose of gathering diverse data from customer is to have a better understanding of the customer and his or her financial needs.

4.1.2 Open Banking and APIs

It is evident that in order to succeed in tomorrow's financial landscape, banks need to also adopt ecosystem data on top of their own data. This ecosystem is largely shaped by recent Open Banking directive coming from the EU. Open Banking can be defined as being an evolution to banking, which is leading to more transparency between financial industry and customers and will leave the customer with having more control over their personal data (Euro Banking Association 2016). Open Banking has major influences for banks. According to Euro Banking Association, Open Banking will challenge traditional assumptions for banks. This will force banks to rethink their strategies regarding data that banks possess. On the flipside, having to publish more data to other players in the financial industry will also lead to having more possibilities to utilize other data in addition to their own. Banks may benefit from Open Banking as it could lead to more innovative product lineup for customers, better industrial partnerships with FinTech community and compliance towards new regulation such as PSD 2 (Payment Services Directive 2). Banks will have to make strategic decisions to which role they want to be in the new Open Banking ecosystem, what kind of value banks want to offer to their customers and also how to collaborate with the FinTech landscape (Euro Banking Association 2016).

Banks are ordered to provide their data by using APIs (Application Programming Interface). API is way of two computer applications loosely communicating with each other primarily over the internet in a structured way where there is no need to know the services behind the interface (Open Banking Working Group 2017, Jacobson et al. 2012). APIs can also communicate by other means than internet, for instance in bank's intranet. This means that the service which uses APIs can be sure of what data is coming, allowing APIs to provide a platform on which new services can use the data. These new services can easily utilize APIs with minimal investment in studying the actual API and can quickly begin the access to that information needed (Open Banking Working Group 2017).

Open Banking business model is radically different from traditional banking business model. Previously, one bank took care of all customers' needs, and was solely responsible for customer data. Now, third party services like FinTech companies and other service developers are intertwined with the bank and customer. Figure 10 shows an example Open Banking business model.

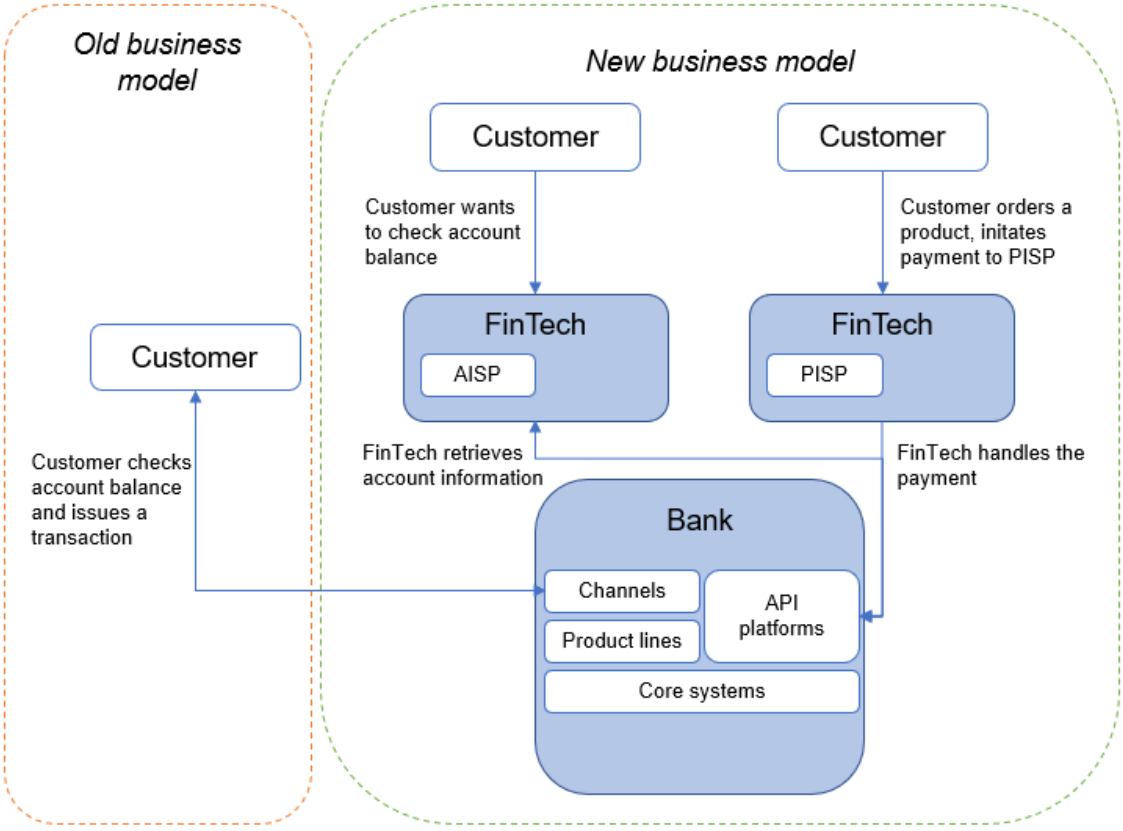

Figure 10. *Open Banking business model (adapted from Enge-Olsen & Pedersen 2019; de Jong et al. 2017; Sandrock & Firnges 2016)*

There is a clear challenge that banks are facing in Open Banking, where the customer will not see the bank but only the FinTech services the customer is using. Guibaud (2015)

states that banks have a risk of disintermediation, where the customer will not have the bank at the front of their mind when using other service than the bank's own. Banks need to co-create in a way that it is also beneficial to the bank. It must be noted that FinTech collaborating with FinTech is also possible (Brandl & Hornuf 2017). This further emphasizes the fragmenting of the traditional and straight-forward banking landscape. Yet, there are also possibilities for banks to gain competitive advantage. By offering partnerships with other FinTech companies, banks can have more market presence and more diverse product lines. Zalan & Toufaily (2017) describe the most important benefits for banks, FinTech companies as well as customers:

Table 10. *Benefits for all parties in Open Banking business model (Zalan & Toufaily 2017)*

Party	**Benefits**
Bank	- Enabling of financial technology - Customer centric approach - Targeting new customers
FinTech	- Gaining trust - Access to customers and their data - Compliance to regulation
Customer	- Access to alternate offerings - Better user experience and customer value

4.2 Big data analytics applications used in banks

Data analytics can be divided into three categories: Descriptive, predictive and prescriptive. Descriptive analytics is the most basic category, which aim is to understand status quo and identifying problems and opportunities within existing functions. Predictive analytics is about trying to predict the outcome of what will happen in the future and why. Prescriptive analytics' goal is to improve business performance by making multi-criteria decision-making, simulation or optimization with high volume and complexity. (Wang et al. 2016, Baesens et al. 2015) In banking sector, utilizing applications of data analytics can lead to sophisticated models of the future behavior of markets which will result in better adaptability and faster decision-making of the bank (Trelewicz 2017).

A general process model of data analytics has been founded by Wirth & Hipp (2000). In this process model, an iterative process is being defined with six different process steps. The process model illustrated by Wirth & Hipp (2000) is also known as CRISP-DM (Cross Industry Standard Process for Data Mining).

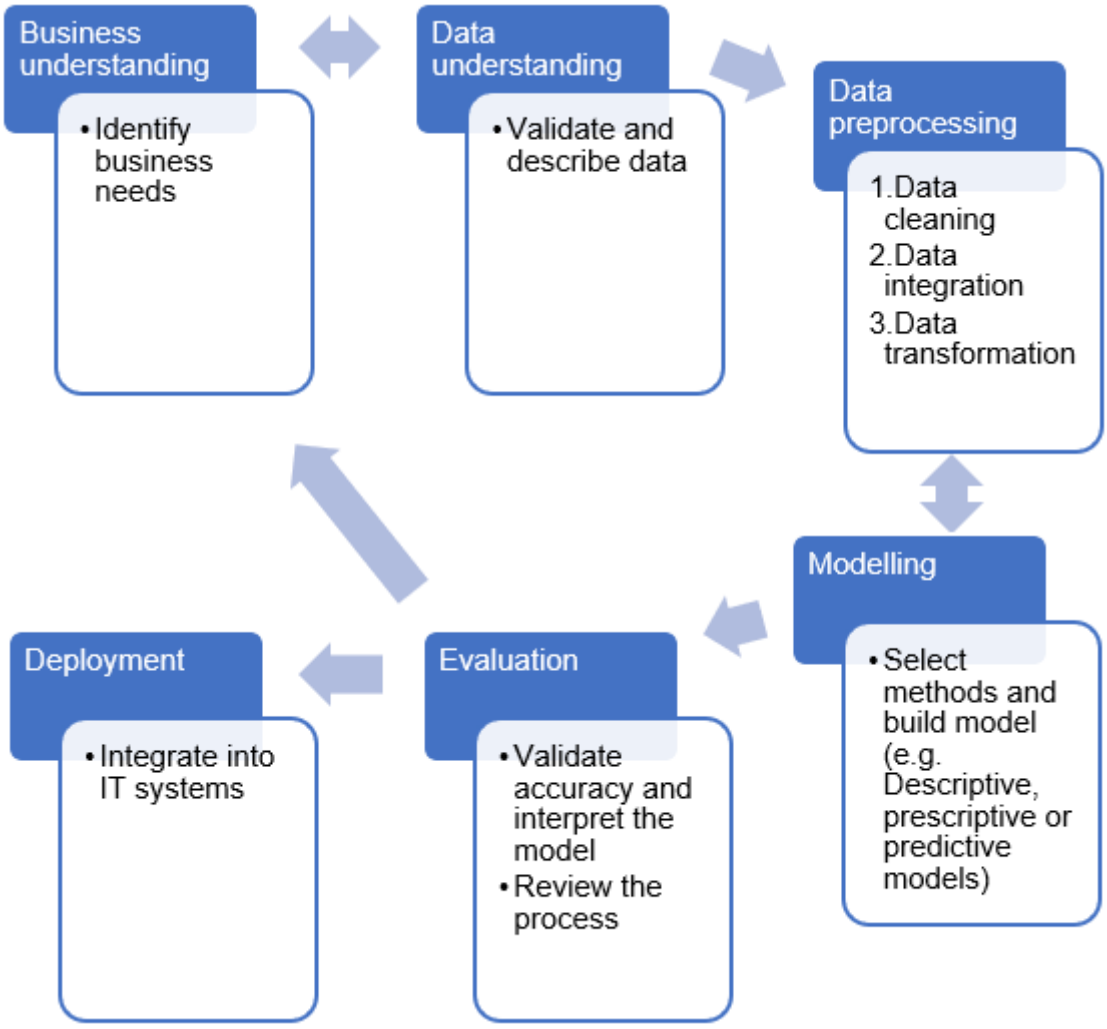

Figure 11. *Data mining process model (adapted from Alasadi & Bhaya 2017; Wirth & Hipp 2000)*

As with all analysis, data analytics also starts with problem formulation. Problem formulation should be done with SMART criteria (Specific, Measurable, Achievable, Relevant and Time-bounded). Problem formulation is proceeded by business understanding, which consists of breaking high-level executive needs into specific analytic goals. Different data sources are also investigated, and the maturity of the data is examined. In the data understanding phase, the collected data is described through a thorough investigation of the data structures, sizes and formats. Collected data is then prepared in the data preparation phase and modelled with selected, applicable modelling technique or techniques. Evaluation is conducted on the basis of the results gained in the modelling phase. This may include test scenarios and communicating results to

stakeholders. Documentation of the process is done in the deployment phase, together with the actual deployment steps needed to be accessed by the relevant users. (Li et al. 2016) This process model is used as a backbone in this research in data mining areas.

According to Simonson & Jain (2014), banks have now become smarter and started to implement analytics in banking sector. Previously, analytics was reporting oriented and descriptive by nature, but now more advanced and prescriptive technologies have been developed within banks. The goal of the more advanced and prescriptive technologies has been to generate more powerful insights about the data that bank possesses, which in turn would result a significant business impact. Authors see, however, that there still is large gap in industry potential and actual outcome. Due to this, third-part analytics businesses have begun penetrating the banking sector markets, and it was projected that adoption of third-party analytics such as machine learning and data mining to banking services have quadrupled from 2014 to 2020. (Simonson & Jain 2014)

Machine learning is about using high computational power and utilize sophisticated algorithms in order to gain insights from data (Bazarbash 2019). Jordan & Mitchell (2015) state that machine learning in essence is about defining a set problem and improving the performance of solving the problem using some kind of training experience. Authors give an example of finding fraudulent credit card transactions by going through the history of all transactions.

Data mining is a similar process to machine learning. In data mining, hidden knowledge is extracted from large volumes of data (Bhambri 2011). In other words, data mining is about discovering meaningful patterns that are repeated in different data sets and is not easily visible by eye. These patterns may include for example important facts, future or historical trends, relationships between data points, anomalies or irregularities. (Miyan, 2017; Bhambri 2011) Knowledge can be gathered from the data using several different techniques. Main applications that are associated to banking sector are presented in table 11.

Table 11. *Relevant data mining applications in banking sector (adapted from Miyan 2017; Jayasree & Balan 2013; Moin & Ahmed 2012; Bhambri 2011; Olson & Delen 2008)*

Application	**Description**	**Business case in banking**
Customer profiling	Identifying customer for their behavior and classifying customers to different categories	• Credit fraud analysis • Anti-Money Laundering
Customer relationship management (CRM)	Finding profitable customers by association and correlation	• Identify customer value • Know-Your-Customer (KYC)

4.2.1 Anti-Money Laundering and fraud detection

Generally, fraud is considered as criminal deception and wrongful action towards financial or personal gain (Cambridge Dictionary). According to Open Banking Working Group (2017), financial fraud costs about £570 million per year to UK consumers only. This is naturally a massive amount, which both the consumers and banks alike want to minimize. In addition, according to research made by Nilson Report (2019), global losses due to credit card fraud reached over $27 billion, which was an increase of 16.2 percent compared to 2017. The rising popularity of credit cards as well as other means of digital payment will evidently lead to rising fraud, too. In addition to credit card fraud, fraudulent activities can occur multiple ways. For example, corporate fraud, mortgage fraud and money laundering are types where financial fraud can occur. (Ngai et al. 2011) Regulation has also been placed to combat this, namely Know Your Customer (KYC) regulatory requirement. Due to the rise of advanced analytics also in the banking sector, technological means such as Anti-Money Laundering (AML) and fraud detection methods are created and developed.

Money laundering is the action where dirty money coming from criminal activities, for example illegal arms trades, smuggling, corruption and bribery, or in some cases, tax evasion, and converting that dirty money into economy and into legal use. Major issues when combating this, for example Anti-Money Laundering is discovering the transactions coming from illicit activities and identifying the receivers and senders, proving the transactions to be illegal and engaging investigative measures. (Palshnikar et al. 2014) According to Lopez-Rojas & Axelsson (2012), countermeasures against money

laundering require statistical analysis, where machine learning can help banks to identify anomalous transactions.

By using machine learning techniques, AML processes can result in several suspicious activities from customers that are suspected to be fraudulent. According to Palshnikar et al. (2014), these suspicious activities can be for example regular ATM withdrawals from an unlikely account, withdrawing cash to deposit it to another bank multiple times and transferring money to offshore bank accounts. Machine learning can be used to detect these types of activities. Anomaly detection or flagging abnormal behavior are examples of machine learning outcomes. (Palshnikar et al. 2014)

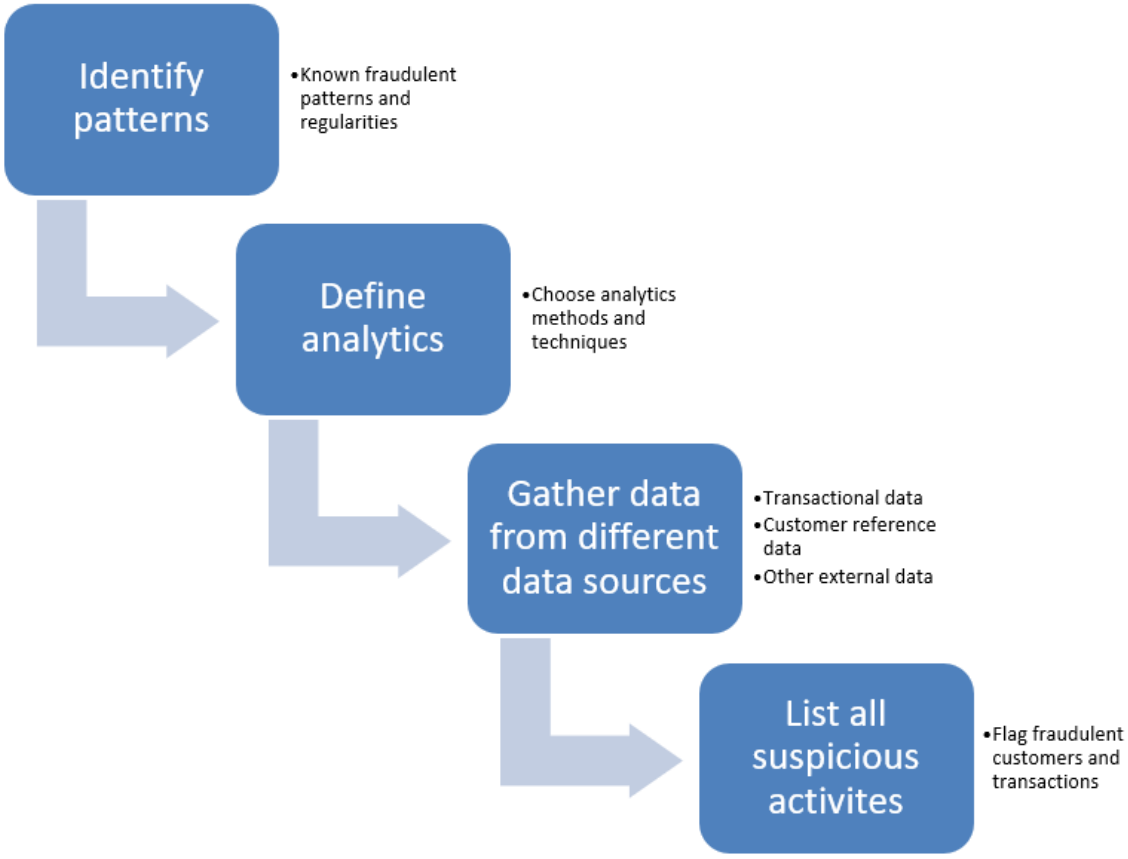

Figure 12. *Anti-Money Laundering process (adapted from Palshnikar et al. 2014)*

Patterns that are identified as fraudulent are usually rule-based, which, without machine learning algorithms, require manual labor and have low efficiency. In addition, rule-based approaches are easily learned by the money launders. (Liu & Zhang 2010) In defining analytics, data mining methods or machine learning algorithms are defined and chosen. John et al. (2016) propose three different categories for data mining:

- Exploratory analysis, where data is explored without a set agenda on what to look for

- Descriptive modelling, where relationships between different variables are analyzed
- Predictive modelling, where one variable's value is predicted from the basis of other variables.

Palshnikar et al. (2014) state that in data gathering part, it is likely to not be able to have complete data from different customers. This is due to bank transactions going or coming from different banks, which limit the visibility of the transaction and hinders the tracing of the transaction. The outcome of the AML process will be a list of suspicious activities, which will get forwarded for further investigation.

In banking fraud, most general methods are credit card fraud, corporate fraud and money laundering. (Ngai et al. 2011) According to Sudjianto et al. (2010), fraud is about criminals trying to unlawfully capitalize on behalf of legitimate customers through some banking transaction channel, usually credit cards or online banking. Most of the fraud detection is about preventing credit card frauds. (Sudjianto et al. 2010) Credit card frauds are by nature a cost-sensitive issue, where the cost to bank with false positive is more costly than the cost of false negative. Therefore, aiming for accuracy is in credit card fraud detection and prevention is very important. (Bahnsen et al. 2016)

Internet has posed another challenge for banks in combating with fraud. Internet banking fraud is in nature similar to normal fraud, but in addition they have some unique characteristics as stated by Wei et al. (2013) and Kovach & Ruggiero (2011):

- Internet banking fraudsters are in general intelligent and very active
- Their behavior is dynamic, and transaction frequency can fluctuate
- Fraudsters can hide their intention with diversified actions, for example one fraudster accessing a large number of bank accounts
- Fraudulent transactions are dispersed, and small transactions are made with many accounts which makes fraud hard to detect real-time

Fraud detection algorithms generally rely on decision tables being generated on possible and likely fraudulent behavior. Decision table is a set of rules, on which fraudulent transactions are analyzed. Decision tables result in flags the transactions as either suspected fraud or non-suspicious activities. (Baesens et al. 2015) Rule-based approach makes the decision table maintenance to be manual labor-intensive, as they will not automatically update based on new fraudulent behavior. Table 12 shows an example of decision tables used in fraud detection.

Table 12. *Example of decision table in fraud detection (adapted from Baesens et al. 2015)*

Suspicious merchant?	Yes				No			
Transaction amount?	≤ 1000		> 1000		≤ 1000		> 1000	
Credit card present?	Yes	No	Yes	No	Yes	No	Yes	No
Fraud?	No fraud	Fraud	Fraud	Fraud	No fraud	Fraud	No fraud	Fraud

In the table 13, rules are shown bold, and the outcome of the suspected fraud is shown italic. As seen above, the rules can be either numeric or categorical. Machine learning algorithms such as time series analysis, where aggregated data is gathered from historical data, can be used if the fraud detection algorithm is sophisticated. (Devaki et al. 2014) Also, more advanced fraud detection applications can use neural networks, where the decision tables are generated and updated by the algorithm (Patidar & Sharma 2011). Neural network consists of input layer, hidden layer and output layer. According to Angelini et al. (2008), neural networks provide a different way of using sophisticated algorithms for banking sector. In contrast to more traditional data analytics methods, neural networks are considered as black-box algorithms, where the exact information about the configuration of the neurons cannot be retrieved. Neural networks perform in a way that provided a set of neurons in the input layer and an output layer, the neural network will generate the non-linear relationships of the input layer neurons and calculates the likely output. According to the authors, neural networks are best suited for classification problems, recognizing patterns in data and finding predictions about the data. (Angelini et al. 2008)

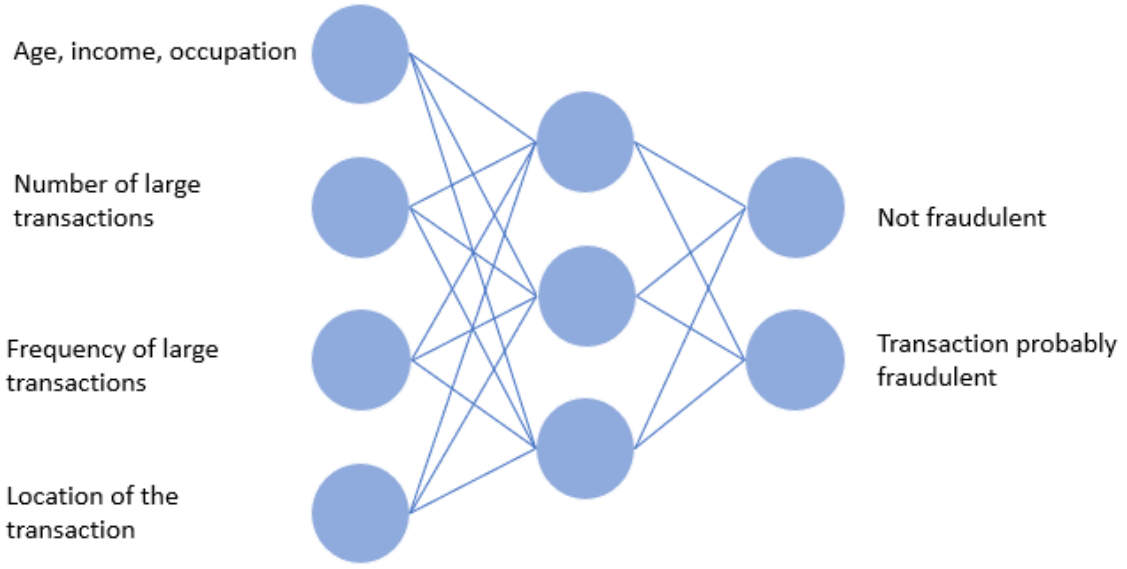

Figure 13. *Example neural network of fraud detection in banking (adapted from Patidar & Sharma 2011)*

In input layer, parameters such as customer data and transactional reference data is defined. Values from input layer are propagated to hidden layer, where the values are processed by the neural network. Decisions on transactions being fraudulent or not are presented in the output layer. (Patidar & Sharma 2011) The output of the neural network cannot be traced, which will make gathering insights more challenging. Therefore, banks need to identify when and where to use neural networks.

4.2.2 Customer relationship management and data mining in banks

According to Elsalamony (2014), banks need to focus more on preserving customers by using more advanced methods like predictive analytics and data mining techniques. Author also states that mass market campaigns have been proven ineffective and banks' need to put more emphasis to personalized marketing and customizing of the market campaigns. (Elsalamony 2014) In banking sector, where the banks possess huge amounts of information and knowledge about their customers, banks do also possess a potential to better harness the knowledge from customers to customer relationship management by using big data analytics methods. This requires more attention to collaboration between IT and marketing departments (Onut et al. 2008).

Customer relationship management (CRM) has been a term that is defined from both marketing and IT strategy point-of-view. From the marketing aspect, CRM can be seen as a combination of business processes that seek knowledge about the company's customers in order to understand their behavior and characteristics. (Onut et al. 2008) From the technological side, CRM is seen as a technology support to outsourcing of

explicit customer knowledge (Toriani & Angeloni 2011). Rababah et al. (2011) propose a holistic definition for CRM, where CRM is defined as improving customer-oriented culture with a set strategy which goal is to enhance profitability of the customers and retaining them. All this is enabled by an IT application. (Rababah et al. 2011)

Kumar & Ravi (2008) argue that utilizing effective CRM decision support system will help banks with predictive modelling on what customers are likely to leave the bank and why. In addition, CRM system can enable new ways of personalizing services to customers and improve product and service offering as well as marketing approaches. According to the authors, an effective CRM system can create better customer experience. (Kumar & Ravi 2008)

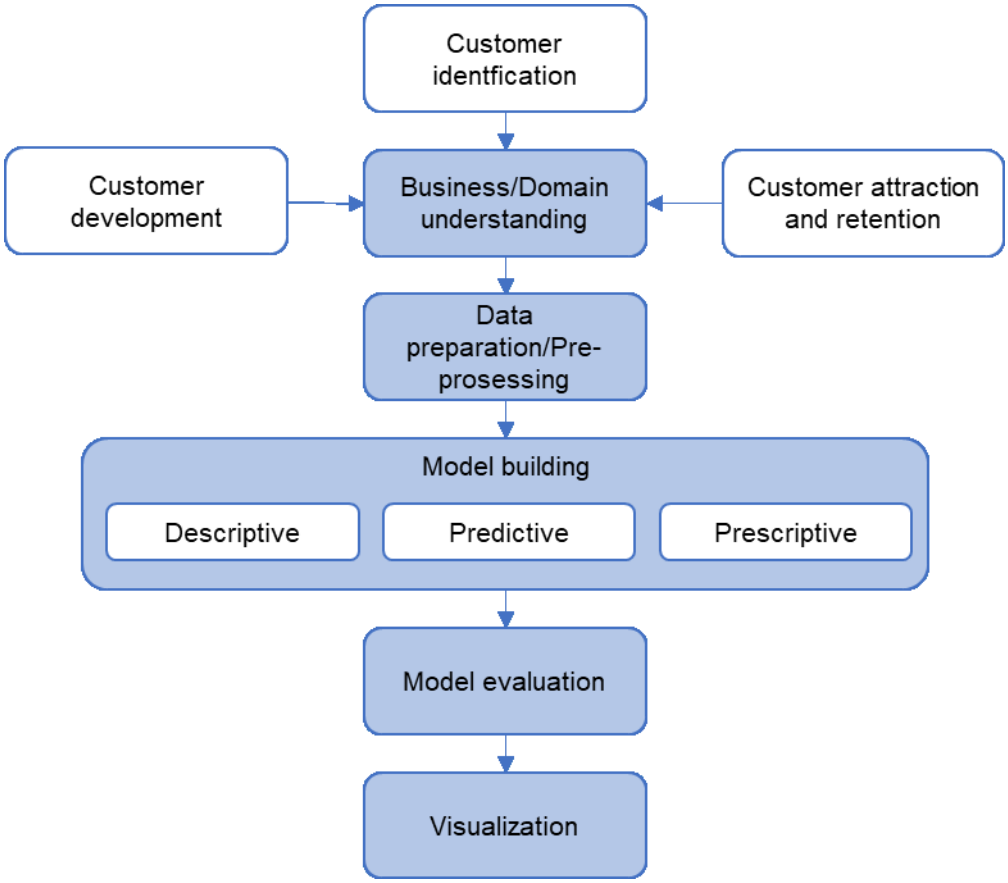

Figure 14. *Data mining framework for CRM (Wang et al. 2016; Bahari & Elayidom 2015)*

As with all data mining and the data mining process described above, the analysis begins with understanding the business requirements and goals. This will come from several different places, and bank's strategy must be carefully considered. After the business understanding phase, similar steps as in the data mining process are followed. It is to be noted that informative visualization is needed in order to achieve concrete action points.

Another way of having visual indications of concrete action points is decision trees. Decision trees are similar to decision tables mentioned previously, but in decision trees, parameters are shown in hierarchical way which represents a tree-like form. Xu & Xue (2016) illustrate a decision tree example for credit card issuance based on CRM data.

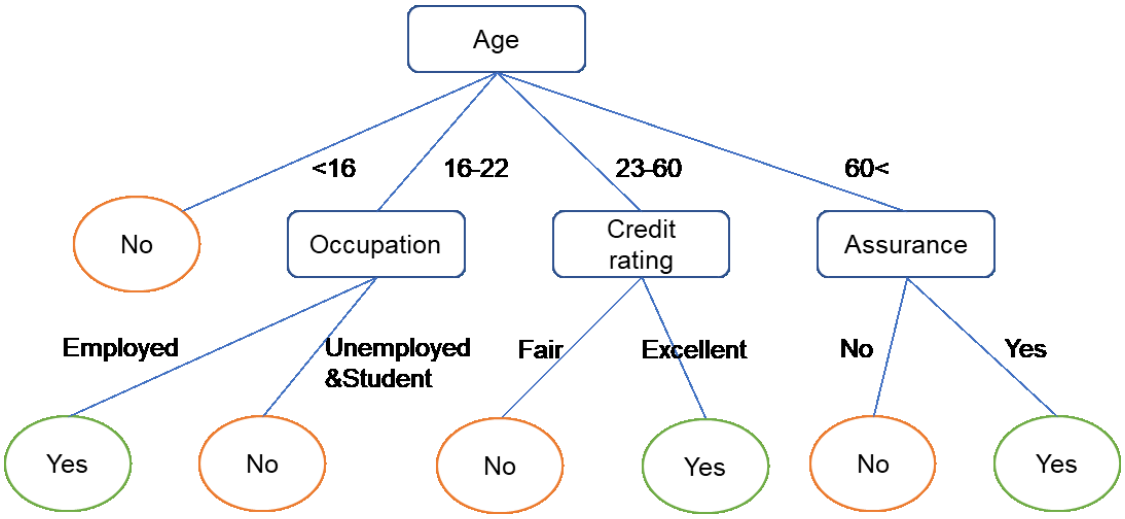

Figure 15. *Example of decision tree with pruning for credit card issuance process (Xu & Xue 2016)*

The purpose of decision trees is to gather insights and relationships from data with a similar way to decision tables. Note that not all branches of the decision tree have been expanded. This is called data pruning, where the purpose is to improve the accuracy of the resulted decision tree and reduce overfitting of the model. Overfitting occurs when a branch of the decision tree does not contribute to the overall decision tree. (Patil et al. 2010) In this example, if the age is under 16, there is no need for checking employment or credit rating. There are several different machine learning algorithms that are developed in order to achieve the best combination of simplicity and accuracy. In this case of credit card issuance, the desired outcome from the decision tree was to identify all main factors that are relevant to the customer in the credit card issuance process. This was done with the mass data coming from the CRM system.

4.3 Cloud computing

The exponential rise of cloud computing services has had an impact on several different industries and recently traditional banking sector has been thinking about their use of IT infrastructure and ways to make it more efficient. According to Awadallah (2016), all technology related matters have been identified only as a cost, but now with the emergence of cloud services, banks have identified them to be a resource-efficient alternative to traditional IT infrastructure, with main benefits of having less upfront capital

investment and reduced IT overhead. Carr et al. (2018) state that cloud adoption in banking sector is mainly about keeping pace and surviving the new market landscape. Authors argue that cloud computing is key enabler to banks where the ever-growing datasets and new technology demands new ways of accessing and interacting with the data. If choosing not to adopt cloud computing services, the risk of needing to support older infrastructures will ultimately hinder the ability to serve customers. (Carr et al. 2018)

Cloud computing is a form of computing where data is accessed through internet as opposed to on-premises databases. Cloud computing is by nature on-demand network access to a shared pool of computing resources which can be manipulated and managed with minimal effort. Different service models include Software as a Services (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). SaaS is a service which enables the service user to use the services provider's applications running on a cloud infrastructure. In PaaS, the service user is able to create and modify the provider's applications. In IaaS, capabilities are provided to the service user, where service user is able to run and configure all aspects of the infrastructure. Key distinction between the service models is that in SaaS operating model, the service user does not own nor control the infrastructure which includes the network, servers, operating systems, storage and applications resources, while in PaaS, the service user does have a control over the deployed applications. In IaaS, however, the most customizability is offered with full access to all infrastructure, apart from the actual cloud infrastructure partition. (Mell & Grance 2011) The main benefits for cloud computing services to banks are defined in the table 13.

Table 13. *Main benefits of banking in the cloud (adapted from Awadallah 2016; Yan 2017)*

Benefit	**Business examples**
Cost flexibility	• Transform fixed costs to variable costs • Pay-per-use when needed • Lower infrastructure requirements
Virtualization and scalability	• Near limitless computing capacity • Relatively cost-efficient • Dynamic expansion and data replication
Market adaptability	• Faster time-to-market • Experimentation capabilities
Masked complexity	• More sophisticated products while being simpler for users
Ecosystem connectivity and resource sharing	• New value chains • Possible new business

Main challenges of cloud computing service implementation are related to information security issues, business security issues and lack of technical standards (Yan 2017).

Table 14. *Main challenges of cloud computing service adoption to banks (adapted from Yan 2017, Wenge et al. 2014 and Rani & Gangal 2012)*

Challenge	**Business examples**
Information security	• Data breaches • Data confidentiality
Business and legal issues	• Lack of trust and credibility from new cloud technology vendors • Vendor locking • Regulatory requirements • Data location requirements
Technical standards	• Lack of industrial standards in banking sector • Different cloud providers have different data security controls

Nedelcu et al. (2015) list separate challenges for different service models. For SaaS, security risks rise when banks do not have full visibility towards the data in the cloud platform. Authors argue that identity management and access control to these SaaS applications must be defined clearly, so that sensitive data is not visible to those who should not have access to that data. For example, individual customer data should be visible only for relevant salespeople and not for all. For PaaS specific issues, strong authentication is needed in order to not have unwanted people accessing the deployed applications, as PaaS will enable the full data control and visibility. Audit trails must be configured to comply with regulations and privacy mandates. IaaS specific challenges are related to data encryption with the cloud infrastructure and the IaaS infrastructure, because in IaaS services, the customer is not fully controlling the cloud infrastructure. (Nedelcu et al. 2015)

According to Gai et al. (2018), masked complexity can be seen as a challenge to overcome in addition to being a benefit of cloud computing adoption. This is due to the fact that masked complexity will also hinder the data controls from the bank's perspective, which makes private cloud to be a preferred choice for some cases. By having a private cloud, the data itself will not leave the bank's IT infrastructure. These deployment models are explained below.

4.3.1 Cloud deployment models

There are three different cloud deployment models for banking sector identified: Private cloud, public cloud and hybrid cloud. Private cloud is a more costly alternative, where the bank will implement a separate cloud service instance for their own use. Banks' own servers can be also used to create a private cloud service. Public cloud is a model where bank will have desired resources, but which are not physically owned. Usually investments are made with subscription-based fees. Hybrid cloud model is a mix of private clouds interconnected with public clouds. This strategy has been made in order to rapidly scale up different applications. Different clouds still have the same cloud infrastructure and standardized technology in order to connect the clouds. (Carr et al. 2018; Toader 2015)

Deploying to cloud computing systems can be done with multiple different strategies. According to Hon & Millard (2018), different deployment strategies to cloud computing services include:

- Internal IT moving services to cloud
- Integration of internal services and public cloud

- Mix of private and public cloud, i.e. hybrid cloud implementation
- Mostly public cloud

In addition to these, a strict no-cloud policy has been identified, but only with 8% have this strategy. (Hon & Millard 2018)

4.3.2 FinTech and cloud platforms

FinTech landscape is also developing the possibilities of cloud computing services to be used in banking sector. Zveryakov et al. (2019) state that FinTech companies expanding their market influence by utilizing new innovative use of infrastructure, i.e. cloud computing services, together with the collaboration from traditional banks. The authors state that cloud computing will be one key trend among FinTech companies in 2019.

There are several sources in academic literature which specifically point out cloud computing capabilities to be either a key element in FinTech landscape or cloud computing expertise being a strong competitive advantage (Lee & Shin 2018; Gai et al 2018; Dhar & Stein 2017; Vives 2017). Gai et al. (2018) point out that by using cloud platforms provided by FinTech companies, banks can faster utilize knowledge discovery which in turn provides better business awareness. Lee & Shin (2018) also state that the rapid innovation with the help of cloud computing is one key competitive advantage that FinTech companies possess.

Gai et al (2018) state that security and privacy issues are hindering the adoption of FinTech cloud computing services in traditional banks. It could be argued that this is not a technological issue, meaning data security in cloud services, but more of data governance issue, where the bank will not have the same visibility to the sensitive data but has to rely on the FinTech company's data security controls.

4.4 Summary

As seen above, banks possess huge amounts of data that is called big data. At the same time, banks are pursuing in knowing the customer better, whilst understanding that the banks already have the information about the customers. What is needed is suitable methods to analyze this big data and turn it into insights for banks to use. This requires big data analytics.

In order to fully embrace big data analytics capabilities in core banking functions in addition to support functions, core banking data should be in cloud computing services. Core banking functions are processes in banks, which comprises of applications that process, and post transactions related to payments, accounts, loans to the related

database systems or back-end processes such as updating reporting tools (Hon & Millard 2018). By moving core banking functions to cloud computing services, or at least some core functions, big data analytics could be utilized more efficiently. Big data analytics CRISP-DM model could be also followed with first innovating in private cloud and when innovative analytics applications become mature, they could be deployed to public cloud for the end-users.

One of the most significant areas where banking sector utilizes big data analytics is preventing fraud and reducing malicious money laundering. The main drivers of developing more sophisticated big data analytics applications for minimizing fraud and money laundering are:

- Risk of receiving regulatory sanctions if failing to do due diligence in fraud prevention
- Increasing bank's own resource efficiency and performance.

With suitable big data analytics applications, banks can free up a lot of resources that would otherwise be manual labor, especially in the fraud prevention and AML processes. (Lopez-Rojas & Axelsson 2012) Figure 16 shows typical banking frauds and ways on how banks are combating fraud.

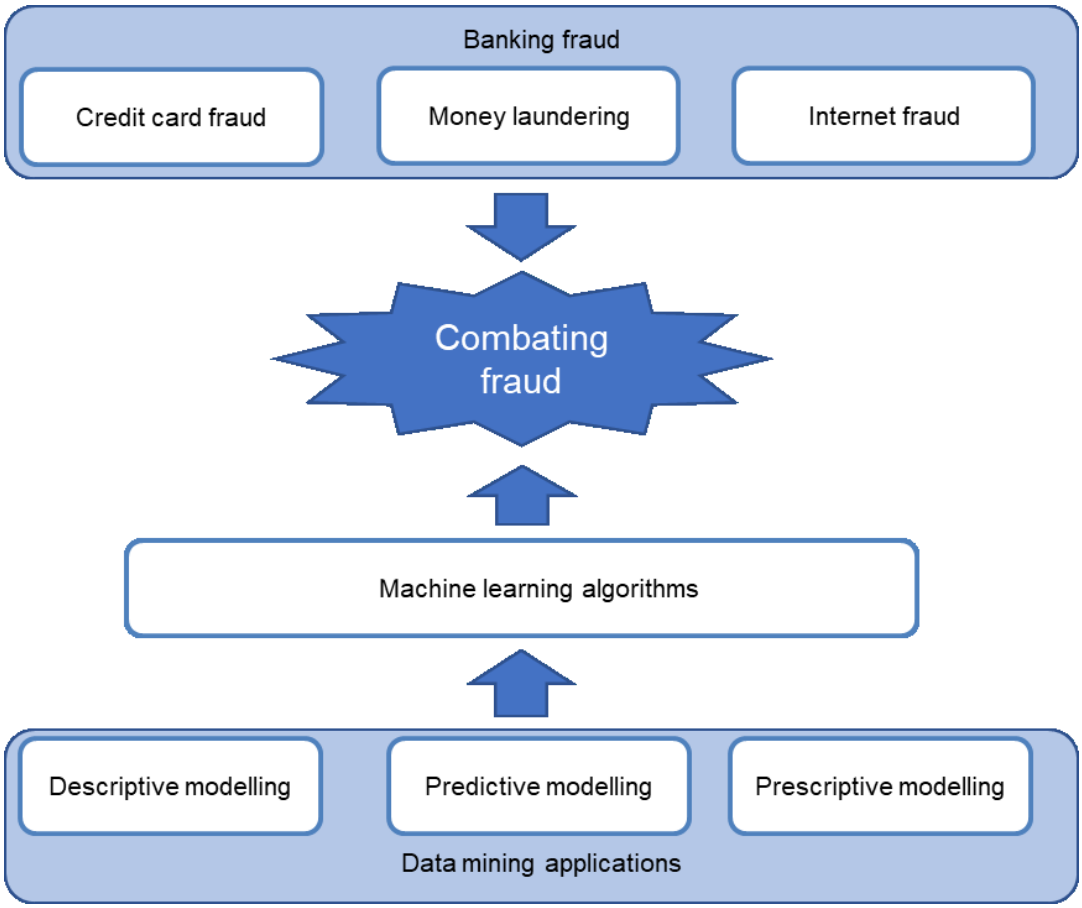

Figure 16. *General framework for combating banking fraud using data mining applications (adapted from Wang et al. 2016; Ngai et al. 2011; John et al. 2011)*

As seen on the figure and according to Ngai et al. (2011) and John et al. (2011), main data mining applications are descriptive, predictive and prescriptive modelling. Each of these statistical methods can utilize machine learning algorithms, where the aim is to shift from manually assigning rules for supposed fraudulent activities to teaching the machine learning algorithm to catch these automatically. This is high on banks' priority list as the manual labor for combating fraud takes a lot of resources (Lopez-Rojas & Axelsson 2012).

CRM is a function which will most definitely have significant positive impacts from new big data analytics applications as well as from the new Open Banking business model. According to a study made by Maus & Mannberg (2019), almost 30 % of all respondents chose prevention of customer churn as the main driver for developing Open Banking use cases. McLaughlin (2017) states that seizing the possibilities of modern data and advanced analytics capabilities, banks and other financial institutions can develop much more personalized and impactful relationships with the customers than ever before. By

knowing the customer and its needs, bank has the ability to upsell and cross-sell different services (Munaiah & Krishnamohan 2017).

Analyzing big data has certain challenges that put it apart from traditional data. One of them is the processing power needed in order to analyze the data. While computers have advanced considerably, the nature of big data requires modern solutions. Cloud computing provides a way to have flexible but powerful platforms, where big data analytics can also occur. The flexibility of cloud computing is not only being cost-efficient, but also will allow fast experimentations, where different data analytics methods such as data mining can be quickly tested. Cloud systems also have dynamic expansion and almost limitless computing scalability, which makes the cloud computing to be a viable method for analyzing big data. Introducing cloud computing to bank's critical data will also bring new challenges, mainly in the data security as the data will not be physically in the bank's premises. Also, banking regulation have requirements for how to store sensitive data.

5. ANALYSIS

In this chapter, results from the interviews are gathered into a structured form and analysis from the interviews supported with the theory from the literature review is conducted. The literature review is reflected upon the comments from the interviews and the reflection is done on Finnish banking sector point-of-view. The purpose of this chapter is to provide a cohesive as-is situation, and what are the recommendations for Finnish banks. These recommendations are derived both from the empirical analysis as well as literature review.

5.1 Big data and analytics in banks

Big data that banks possess is deeply connected with banks' customers. Almost all analytics in banking is about customer data, enriched with other data such as behavioral data and external data. In addition to customer data, banks possess internal data about their own core functions, for example data gathered from pricing and risk management processes.

On the high level, we have two types of data: We have data about the customer and data about us. (I5)

Almost all data that banks have, is related to that [customer], all transaction data, product data, customer data. – Also, from the financial crime standpoint, all data also is related to that. (I3)

In addition to data gathered from customers and internal data sources, some external data from third party institutions and companies were integrated, according to several interviewees. Large institutions, such as credit data registry, or other purely commercial partners, Bloomberg and Alma Media for example, were utilized in order to gain more insights about the customers and markets.

The amount of [external] data is rapidly expanding, and therefore also the potential is also rapidly expanding. (I5)

While previously data coming from external sources have been challenging to integrate into banks' own data platforms, now with the rise of APIs the utilization is a lot more straight-forward, provided that the legacy IT systems are not hindering it.

Many banks see that the future goal of big data and analytics would be to create new business and revenue streams. Banks are still quite unclear on how to do this in practice, and therefore at this point the most sought-after use cases for big data and analytics in

the improvement of efficiency. Improving efficiency also has an effect on customer experience, so they are not exclusive to each other.

Banking customers are more demanding about their use of data. Customers think that "you have a lot of data about me, why don't you offer me more customized services" or "why do I have to fill out this form when you must know this already". (I1)

From big data perspective, banks have for a long time used external data in addition to their internal customer data, for example in credit scoring. Open data and Open Banking add to this a new channel of data that banks can utilize.

A case in point could be to use LinkedIn data when applying for a loan. As people tend to shift more to a freelancer type of work, work history may be more fragmented, or one might be recently laid off, and according to LinkedIn profile, banks could calculate to probability and time to find a new job. (I1)

The main requirements to implement new ways aggregating open data and data gathered from Open Banking is to have a mature data aggregation platform, where data from different sources (data coming from legacy systems as well as open data and other external data) and make use of APIs to the extent that it will be beneficial to banks.

Banks are now more in the phase of streamlining existing data flows and process automatization with regards to big data. Some of the development is done on the basis of strategy, while other, such as opening data APIs has been made due to the new regulations, mainly PSD 2.

On the other hand, banks have investigated possibilities to open their data to other players, such as FinTech companies, in order to generate new business for themselves, too. (I1)

This is a key distinction in Open Banking ecosystem, where banks also might not be fully the providing part in the customer relationship, but rather a simple data provider.

Overall, big data analytics in banking today is more focused in operational excellence and cost-saving methods, but there can be seen a paradigm shift to utilize big data analytics especially for better customer experience and offering more personalized services to the customer.

We have aligned in our IT strategy that we want to utilize artificial intelligence and machine learning in order to create more competitive advantage with more personalized and smarter services. We see that most of the banking services among the banks are similar from the customer's point-of-view, so we want to differentiate ourselves by the use of artificial intelligence. – We have a target that in three years' time, at least half of the new services use artificial intelligence somehow. (I4)

The main takeaway is that banks have seen the strategic need for the big data analytics and see the investments to this as important. At this point it seems that more advanced

banks in Finland are starting to leap from the strategic goal setting into practice, so it could be argued that within a few years, big data analytics landscape in Finnish banking sector has grown a lot.

5.1.1 Data quality and value in banks

The importance of customers and their value to the bank was emphasized during the interviews. According to interviewees, the most important data that banks possess is customer data. In addition to customer data, main internal data sources used in data analytics are product data and behavioral data which comes mainly form the transactional data, the most important being customer data and behavioral data.

Mainly the customer data comes from data gathered in onboarding [of the customer] and data coming from KYC processes. – Behavioral data was gathered from inbound and outbound transactions as well as capital assets. (I2)

The quality of big data coming to banks is seen quite mixed. There were some similar comments about the big data dimensions, but also some answers were varied. For example, data validity was seen differently based on the characteristics of data. Transactional data validity was seen as sufficient, mainly due to the fact that transactional data is very standardized. On the other hand, data coming from KYC processes were seen as uncertain with regards to data validity.

From the credit card side, data coming into banks is very standardized, ISO 8583. Therefore, the data quality is quite the same. On the other hand, customer master data can be very old, or you don't know how up to date the data is. (I2)

Data validation is always critical. It is very important to identify how well the data reflects the reality. There is a lot of practical issues about this topic, where we don't know how suitable the data actually is for the intended use. (I3)

Further data validation and standardizing other than purely credit card transactions are needed in the future in order to support also in data aggregation. Customer data also has other than purely technical issues in standardizing. For example, different customer dimensions such as country of origin can be misinterpreted. This different interpretation can result in data validation conflicts with different systems as one example.

If we are thinking of for example country dimensions in KYC processes, there can be many different interpretations on what country of origin means: Is it enough to have a passport? Is it only where you are born? (I3)

This creates a data validity issue, where the inputted data can be as first intended, but still could be misinterpreted.

In addition to customer data and especially transactional data, there is a lot of other data that the bank possesses. Product data and log data are also among the most used sources of data in big data analytics. Product data is mainly metadata about the products

and services that the bank has. Log data on the other hand is internal and transactional data, which can be utilized in many ways in big data analytics.

Doing normal banking errands, the user generates a lot of log data. This log data needs to be carefully saved and is mostly regulated on what needs to be logged. But in addition [to regulatory compliance], log data is also used internally as a tool for example in services disturbances. (I4)

Utilizing regulatory data to more than just mandatory processes is something that banks should carefully consider. This is the same situation also in customer data, when customer data is used in regulatory compliance, but insights from that customer data could easily be transferred to marketing department.

The data that banks possess are mostly generated from internal sources. While there are some external data sources that are mandated by regulatory authorities, such as governmental lists of politically exposed persons (i.e. PEP screening), default of payment register and credit register information, the overall use is quite limited.

The lack of better utilization of varied data can be due to data variety and veracity in addition to the data validity issues mentioned above. Data coming from customer onboarding can be very varied, and information gained from interviewing customer can be challenging to standardize and aggregate into existing data platforms. Also, adding other information and knowledge about the customer gathered from other external sources can be difficult to integrate and aggregate.

Some of that [external data gathering] is definitely automated. – Also, there has been an interest from the institutions to automate also their abilities to provide the data to banks. – But some of the data still is needs to be manually inputted, which is not ideal at all… And this is something that banks need to think when introducing a new vendor to their data ecosystem. (I3)

All in all, some of the most mentioned issues regarding challenges were data validity and variety. In addition, data volume and volatility can be a cause for concern, as especially data volumes coming from external sources can be huge. Data volatility, where the data can be expired, can occur especially in data coming from different registers and screenings, where the date of data can be unknown. Data coming from external sources may also come in too fast, or even too slow, if for example real-time decisions are needed so data velocity is something to consider.

5.1.2 Analytics applications in banking sector

Mainly, the big data analytics methods and technologies used in banking sector rely on data mining technologies especially in the customer context. Banks want to know all they can about their customers. This has several advantages; primary one being having the possibility to offer more customized services to the customers which in turn will lead to

better customer experience and reducing risk of the customer acquisition. Banks can also leverage knowing the customer in preventing fraud and money-laundering. Minimizing these would also reduce sanctions imposed by financial institutions, which are severe.

The interviewees in general did not have a stance on whether the analytics applications are more focused on cost-saving measures or creating new business. Interviewee I5 pointed out that usually developing more efficient analytics applications will also increase the customer experience in addition to decreasing costs. Chatbots are one example of this, where banks need fewer resources while maintaining the service level or even improving it. This is the opposite of the physical world, where cutting costs for example from bank clerks usually results in decreased service level and therefore worse customer experience.

The efficiency and customer experience often go hand in hand [in big data analytics]. (I5)

Interviewee I1 was involved in a project implementing a monitoring system for misuse of financial services, and especially credit card frauds in the early 2000's. This monitoring system used rule-based, learning neural network. This was, however, only the single case where more sophisticated data analytics was mentioned in the interviews. Interviewee I3 was involved in financial crime processes, which tried to find outliers from the data, which could be suspicious activities.

Anti-money laundering today still is mostly rule-based algorithms, which get updated more or less manually. The nature of fraud being constantly evolving is challenging for these types of rule-based algorithms. (I1)

It [customer data and behavioral data] is modelled on how the customer is expected to behave, because it is crucial to identify when one is not behaving as expected. (I3)

There is a special use case for machine learning algorithms to combat this. As AML rules have been more manual labor, it naturally has been more reactive in the nature rather than proactive combating the fraudsters. Efficient use of machine learning algorithm that would be deeply integrated to core systems could enhance dramatically the capabilities of anti-money laundering as well as free up the resource now needed for manual labor. From big data perspective, integrating an efficient AML system demands especially the handling of the data volumes but also the data velocity, as data coming in is fast but also the fraudulent transactions would need to be quickly identified.

The use of transactional data in data analytics was based around creating a behavioral analysis of the customer. This is relatively easy as the data coming to banks is quite well standardized and but is still not fully utilized yet.

You could use it [transactional data]… Which was not that used… to create a behavioral analysis of the customer and generate a customer profile, which included payment behavior analysis. This was more used in credit fraud department of the bank. (I2)

This behavioral analysis was not integrated into the core functions of the bank and needed a separate process to initiate the analysis. The lack of deep integration was mostly due to lack of resources as well as there was no business case seen from the top management. Interviewee I2's position on the matter was that there would be much more to use the behavioral analysis other than just credit card fraud. Upselling was one area identified by the interviewee. There was also an issue raised by the interviewee, which was that the bank was vendor locked to a certain vendor which did not allow the analysis to be performed on a more regular basis.

In addition to AML algorithms and behavioral analyses, different dashboard applications were used from the customer data. These were done in order to gain more insight about the customer, what they spend money on and how and what to upsell the customer. These were not always as beneficial as originally intended.

I think that that [real-time dashboard application] was more of a gimmick. It was done with Tableau, and the purpose of that was more of a nice-to-see type of dashboard. The development was halted halfway, it was a nice idea, and there was an understanding of the concept to utilize the customer data. – Commitment and resources were the ones that would have been needed in order to further develop and see the possibilities. (I2)

This explorative dashboard was then not fully used to its potential. There could have been much more knowledge gained from the application if there had been more resources dedicated on finding insights about the data and not just having it just for the sake of it. Trend analyses and finding localization of different services used and how customers operated them would have had a business case in of themselves.

Machine learning was in the table and adopted in the way of thinking, but no real applications were developed, at least until 2016. (I2)

Banks want to know what is the minimum action required [for financial crime and AML]. Usually then static reports with rule-based triggering are enough. – This also requires a lot of manual labor as this generates a lot of false positives. The overall direction, however, is definitely more towards the understanding of unique customers. Machine learning is used in that where the algorithm learns the real behavior of unique customers. (I3)

Machine learning definitely is up there with the future demands and where banks are headed. It might be the case that banks are still struggling with legacy IT systems as mentioned previously and the data engineering required to get the data available for the use of machine learning algorithms. This must be done in order to fully transition from the gimmick applications to applications with real value to the bank.

In addition to regulatory compliance by the use of AML algorithms and machine learning, big data analytics were also used in marketing department as well.

We capitalize big data gathered from customers for marketing purposes, too. We aim at more precise targeting of the customers and we generate sales tips for our bank clerks. (I4)

Many banks are pursuing to have the capabilities to offer more targeted services, and in this case, not only personified sales and marketing but more targeted customer service and customer experience. (I1)

The main purpose of generating sales tips is to create more upselling, but also to serve the customer more individually. Interviewee I4 pointed out that it is a balancing act in the process of targeting sales tips where the customer does not want to feel overwhelmed by the new individual marketing. So, it is quite important to stay sensitive about this matter. At this point, the sales tips are based on manual rules rather than machine learning algorithms that would create the tips automatically, but the incentive to go towards more automized marketing is growing.

We have moderately big analytics and AI team, so we are working on this to become more data-driven in the marketing automation. It is definitely the direction where we are headed. (I4)

Interviewee I5 stated that although customer data coming from regulatory processes is used also in customer relationship management, it often needs a consent from the customer, which limits the data utilization in the CRM processes.

There are certain limitations on the data usage, if the data has been gathered for regulatory Know-Your-Customer activities. (I5)

While all data cannot be used, what can be from regulatory point-of-view, is used in order to enhance the customer experience. According to interviewee I5, the more the bank knows about the customer, the better it can also serve the customer.

While most of the big data analytics applications used in production are still quite basic, there are some indications that more advanced machine learning methods are already used in some Finnish banks.

One example of creating better customer experience is a tool for customers that classifies transactions to different bins by using machine learning, and if the tool cannot recognize some transactions, the customer can manually classify them and the tool is self-learning this for the future. (I4)

These types of machine learning algorithms that are self-learning are not that common yet, but they are a clear sign that more advanced data analytics applications are emerging.

Some of the banks have already hired quite a lot of data scientists, which do experiments in AI and machine learning. (I1)

For example, the development of neural networks in the last five years have been tremendous, and the potential of the neural networks applications is much greater. (I5)

5.2 Regulation affecting banking sector

Due diligence responsibilities and work caused by the regulation after financial crisis has been growing exponentially within banks.

Banks are seeing that the regulation affecting banking sector after the financial crisis has been explosive. (I1)

That [new regulation] has resulted in a lot of additional work for us. (I4)

Some banks have negative feelings about this, especially banks feel that FinTech companies do not have the same scrutinization that banks have to face. The purpose of regulation is to level the playing field, but FinTech companies coming to the market with a clean slate have advantage in this, according to the interviewees.

I think that banks are struggling with regulation nowadays. One thing is that regulation often is quite hard to interpret, but even harder to integrate to bank's own business processes. Also, there might be multiple regulations that are contradicting themselves. (I2)

One key area where regulation might be seen as contradictory is in payment services. On the other hand, banks need to know the transaction sender and recipient, and must do analysis of for example terrorism funding or money laundering. This has to be done at the same time, when Open Banking is forcing instant or near-to-instant payment transactions. This is something that financial crime departments of banks have to cope with at all times and is especially present in European sector, where EU is closely looking after customers' rights.

From PSD 2 standpoint, the idea of that was to break the American oligopoly, namely Mastercard and Visa. The goal was to have new operators coming from the EU to manage the customers and provide payment services. (I2)

The fear from traditional banks, where new operators would come and disrupt the financial industry on the whole, has not been liquidated. While there have been new companies founded from the basis of PSD 2 and the opening of data to competitors, it has not disrupted the traditional financial markets. Also, some banks have embraced the new regulation and opening of the data interfaces.

Many of the banks saw that [PSD 2] as something to dive deep into rather than to fight against. Which I think was the correct decision. – But still today it has not created that much of actual business benefits. (I3)

FinTech landscape has been a booster for innovation, and there are continuously new niche areas for new business opportunities. (I5)

5.3 IT infrastructure in banks

One key area which has affected big data analytics adoption in banks have been the vast majority of legacy IT systems in banks.

Banking core IT systems are from the 90's and even beyond and have been siloed into different organizations. There have also been several different IT systems, which might have redundant data, which may have not been uniform. (I1)

The silo effect that has been identified with legacy IT systems certainly has an impact on the utilization of big data analytics. While all the essential data is stored in the core IT systems and other departments do not have the ability to access that data, it creates a needless bottleneck for the data utilization. Also, if several legacy IT systems cannot communicate with each other, data aggregation and validity become an issue.

Banks are in different situation when it comes to the data utilization. – Some banks which have several legacy IT systems running in the background make it harder to aggregate. (I3)

From big data analytics point-of-view, this is directly related to the dimensions of big data. Even if there has been enough data already possessed by banks, it is clear that the utilization of that data is negligible and therefore have not created any significant value for the bank. For example, data volumes could not have been able to be processed. In addition, there is a data validity issue where redundant data that is not uniform is also not up to date.

There is an advantage in adopting cloud services to include also banking core functions where the data processing is much faster. In addition, scaling of the platforms is a key because then we can change fixed costs into variable costs. (I1)

Ability to change fixed costs to variable costs is essential, because banks are all about balance sheet. After the financial crisis banks have been forced to streamline the balance sheet. (I1)

One way of resolving issues with legacy IT systems is to start building internal APIs on top of the legacy IT systems, in order to enhance the data integration within different legacy systems.

We see that developing these [internal] APIs is also a way to streamline our IT architecture. (I4)

By developing internal APIs banks have a way of break away from the strict single point interfaces that legacy IT systems generally are. This naturally has the precondition that the legacy IT system must be developed in such a way that making APIs on top of the system is even possible. Developing legacy IT systems to be of use in today's ecosystem will explicitly need a strategic decision as the legacy IT system development is demanding and requires specific technological expertise that is not common anymore.

Another issue where regulation has had an impact is the adoption of cloud services in banking sector. According to interviewees, one major challenge regarding the adoption on cloud services was tightened regulation especially after the last financial crisis. This has severely impacted the maturity of cloud services in banks.

Regulation had the most impact on the adoption of cloud services in banks, especially in the adoption of core functions of banking. Exceptions to this were mostly related to support functions, such as in financial and management reporting services. (I1)

We have some regulatory pressure on keeping the data stored in a set way – which keeps us using the traditional solutions [as opposed to cloud services]. We are certainly moving to cloud in the future, but it will also require the regulator to more mature to that, as well as us. (I5)

To encourage banks to use more cloud services, European Banking Authority (EBA 2017) released guidance on how to implement cloud services and outsourcing in banks. This paper was aimed for providing clear instructions to all financial institutions on how to safely adopt cloud services and cloud computing to their organizations. EBA admits that even though cloud platforms have several advantages to their on-premise counterparts, such as economies of scale, operational efficiencies and cost reduction, they can also raise challenges to overcome. The challenges mainly focus on data security and location issues. In addition to these, data concentration is also seen as a possible risk, if single cloud service suppliers would become single point-of-failure. (EBA 2017)

While regulatory issues have had major impacts on cloud adoption in banks, it is not the only concern from the banks' perspective. As banks need to store their data securely and with confidentiality, they are prone to be more cautious towards new technology.

A couple of years ago, there weren't that many players in the cloud services area, where the players would have had a proven track record in the financial industry. (I2)

Four or five years ago the public cloud was not that well established and there were a lot more security risks attached, so the banks did not want to fully adopt these new cloud services. (I4)

It seems to be the case that banks are relatively cautious on shifting all data to cloud platforms. Trust factor, where the cloud service providers have not been able to prove themselves in the highly regulated banking sector, has been lacking. Therefore, the majority of core function data was on-premises data and that banks have only recently starting to seriously consider cloud platforms, according to the interviewees.

From customer data point-of-view, all [our] data was on-premises data. (I2)

This was the case for interviewee I2 at least until 2016, when the interviewee switched companies from a Finnish bank to a FinTech startup. One factor causing data to be on-premises was that large legacy systems and IT infrastructure were founded without the understanding and requirement to easily transform them into cloud platforms. The necessity and possibilities of migrating on-premises data to cloud platforms were not seen as such. On the contrary, according to interviewee I3, cloud platforms have been adopted quite well in the recent years. The contradiction may be due to rapid adoption in the recent years, where in 2016 the general view on cloud platforms were very different than in 2020.

On the other hand, when I was in the FinTech company, all data was in the cloud. (I2)

In [FinTech] start-up scene, usually almost everything is on the cloud. (I5)

This can be due to multiple reasons: First, FinTech companies may not have to deal with the same regulatory scrutiny as the traditional banks have to manage. Secondly, there might be a shift in cultural thinking and cloud adoption could easily be the first choice when looking at IT infrastructure development.

It seems that the shift towards cloud services is only a matter of time in banking sector. According to interviewee I4, the preferred system to develop new application is already a major cloud service provider. While all Finnish banks might not be yet in the same situation and the same level of cloud maturity, the direction of becoming more adapted in cloud services is apparent.

We have a policy that all new systems that we are building on, the preferred platform for that will be in the public cloud. We have invested a lot in this public cloud to develop data security features that we need. (I4)

One reason why banks may have not yet fully embraced the cloud services could be in addition to the lack of track record by the cloud service providers but also the need for large investments within the cloud services still to become compliant in terms of data security.

We see that the benefits for using private cloud is that the development of the applications is much more efficient. Tools within cloud service platforms are really advanced and they support continuous integration of the systems. (I4)

The developer experience that cloud service platforms offer can be much better when compared to normally rather static on-premises developments. Incremental deployments are supported in cloud services which makes the development within independent teams easy. Also, the economies of scale and dynamicity is something that on-premises solutions cannot compete with.

5.4 Relationship between banks and FinTech companies

Banks and FinTech companies possess quite different assets in general. Banks generally have the customers and capital, whereas FinTech companies have agility and expertise in their niche field.

5.4.1 FinTech in banking landscape

There is a rather clear consensus that banking landscape in Finland sees the FinTech ecosystem as an opportunity rather than a threat. Banks are eager to find new ways to collaborate with the emerging FinTech companies.

I think that today banks see FinTech companies as a part of the whole ecosystem, more as partners and not competitors. In the beginning banks considered FinTech companies more as a threat, now more as an opportunity. (I1)

From the financial crime point-of-view, I see FinTech collaboration more of a symbiosis, where the bank is actually a customer to the FinTech company. (I3)

I see the FinTech collaboration very positively, and I do not see the FinTech being as competition but more of generating added value to the customer via new customer value chains and finding new ways to serve the customer. (I5)

One factor contributing to the nature of collaboration between banks and FinTech companies rather than competition is the fact that in Finland, the digital maturity is already relatively high. New FinTech challenger banks cannot penetrate the Finnish market, where for example mobile banking capabilities are already high.

If you look at our [Finnish banking] markets, these challenger banks cannot bring any notable added value, one could even say that zero added value. But in other market areas this is different, where the mobile services are not as advanced. (I5)

FinTech companies have now realized that it is required to possess considerable financial capital coming to the financial industry. In addition, trust is the most critical demand from the customers for their financial needs, and people generally trust their banks, especially in Finland. Therefore, it is quite hard for FinTech companies to create business in this already competed markets.

A clear advantage of FinTech companies that banks do suffer from, is the lack of legacy IT systems.

The problem with banks about their legacy systems has been snowballing which in turn has left the door open for FinTech companies to step in. (I1)

According to the interviewee I1, FinTech companies have started to bridge the gap of customers wanting the same kind of customer experience from banks than they do in other industries.

The future of FinTech might become more of a shared ecosystem, where monetary gains play a more insignificant role. As the financial services ecosystem will grow, there may be more companies, FinTech start-ups and banks alike, in one customer value chain, which will blur the lines of service providers and customers.

I think that the future of financial services is in the ecosystems. Not only banks and FinTech companies, but all parties that might be relevant to the customer. Banks must choose their own landscape which they can manage and include the parties that are relevant to bank's customers. (I1)

I think in the future, the collaboration with FinTech companies, the data will become the currency, and no money is transferred. (I5)

Data becoming the currency in the future is an interesting observation which emphasizes the power of knowing the customer. In the future, competition about who has the most customers will become obsolete and the competition about who knows their customer the best will rise. Banks and FinTech companies alike know that when they know the customer, they can also serve the customer better which will inevitably result in monetary profits, too.

Banks utilize FinTech companies in a way that the bank takes a certain function and tests its current business processes with proof-of-concept with the FinTech company. If the proof-of-concept is better, the bank might start to work more with the FinTech company, or more usual case would be to buy out the FinTech company. (I2)

Banks are leveraging the capabilities of the FinTech landscape by either gaining completely new knowledge to the bank, or as defined above, test and benchmark their current processes. The advantages for these are faster time-to-market and the possibility to truly gain new innovation as FinTech companies can provide a new viewpoint on banking functions. Somewhat contradictory, interviewee I5 stated that FinTech companies cannot compete with banks in terms of banking business knowledge. However, the FinTech companies can offer new ways of thinking and innovation, mostly on the technological side, but core banking expertise is rarely the competitive advantage for a FinTech company.

We have not encountered a FinTech start-up which could teach us banking business yet. (I5)

It is then innovation that FinTech companies can thrive on. While FinTech companies may not have better knowledge in core banking functions, they might propose an alternative to existing process that the bank has not thought of yet.

While some banks have opened APIs for FinTech markets, the actual business use cases are still rare.

In the end, it's quite hard to figure out a revenue generation model for the API use for the FinTech companies. (I4)

In fact, there are evidence in Finnish banking sector that competitor banks use other banks' APIs in order to integrate the other banks' account balance information to their own services. The rise of APIs can certainly be argued, but no significant FinTech collaboration by only providing data has been identified in Finland as of now.

5.4.2 Risks and opportunities related to FinTech adoption

Main benefit of FinTech adoption in banks is the gained expertise in a field where banks have not previously had. This will lead to better and more diverse offering of the banks as well as set free resources which can be focused on the banks' core expertise. In addition, there may be faster time-to-market when acquiring FinTech companies or starting partnerships with the companies, compared to hiring, training and developing the knowledge by the bank itself.

We have a wish that a group of developers would evolve around our APIs, where the developers would create new services on the basis of our data. (I4)

FinTech adoption also creates a risk to the customers by scattering the offering. This is not likely to happen when acquiring FinTech companies, but if the collaboration is based on a partnership, and the outcome is not a white-label service, where only bank's brand is present, customers may become confused about the services. Also, cultural differences between agile FinTech companies and huge corporations that banks are, can create challenges, that both need to overcome.

Vendor locking to one FinTech might not be the most crucial risk to be considered, but still is one. There should be a strategic decision made on how to implement collaboration with FinTech companies and start-ups so that the platform used would be beneficial to both. This could be for example a shared platform for FinTech banks to communicate and develop services together with banks.

There are some banks in Finland which utilize shared platforms for FinTech companies. Banks invite FinTech companies to these platforms and hand out a project. (I2)

Overall, banks see FinTech collaboration very positively. Although there are always some who want to compete with traditional banks, it seems that in Finland the way for FinTech companies to prosper is to partner with bank and create added value to the customer together.

Then there are these FinTech companies that do not want to collaborate with banks but to compete with them. Not many are found in Finland, however. (I4)

One of the biggest threats to FinTech collaboration is that the banks do not see the FinTech as an opportunity. (I5)

The missed opportunities of new innovation and customer value chains, when not adopting FinTech to banks' own business processes, is a substantial loss for the banks. It is naive for the banks to vision that the bank could innovate all on its own. Therefore, the ability for FinTech collaboration is especially important.

5.5 Recommendations for Finnish banks

Finnish banks can be seen generally as being quite advanced from data analytics and digital transformation point-of-view. There are a lot of investments made recently to especially IT infrastructure and digital transformation but also to big data analytics.

In the bank where I was working, we used to joke around that we are no longer a bank but more of an IT company. (I2)

Finnish customers are also pushing banks to further develop their digitalization maturity. Customers are generally seen quite tech-savvy and they know relatively well about the possibilities of digitalization. For example, mobile banking is something most Finnish banking customers take for granted, where it can be seen as technological innovation in other countries, especially outside Europe. Also, the adoption of mobile banking and also shifting from cash to credit cards have made several data analytics applications much easier as the data is much more easily accessible.

It's hard for as a customer to tell what I want next, but it's clear that I want something… Most preferably something that the customer does not need to be involved in but comes automatically. (I2)

5.5.1 Leveraging big data and analytics

Interviewee I3 had a four-stage maturity model for utilizing data and analytics from the regulatory point-of-view. At first stage, no use in analytics was seen as beneficial nor was the regulatory compliance necessary. At the second stage, a lot of investments have been made. This can be due to being non-compliant in the past and maybe having been sanctioned as well. This might not create new business as such but is to overcome the compliance due diligence activities. This is also resource intensive both in capital and in human resources. A lot of Nordic banks are at this stage. The third stage sees the added value of investing in data analytics, where in stage two the focus is on becoming compliant. In the third stage, fundamental issues where a certain bank need to focus are identified. Not a lot more investments are needed at this stage, because it is better known where the significant risks are. Only at the third stage the risks are decreasing, whereas in the second stage the risks are relatively high still. The last stage has financial crime

and regulatory compliance under control and banks can see the made controls from data analytics applications as part of a larger picture. This is only where additional benefits from being regulatory compliant start to emerge. Financial control measures start to flow towards KYC processes also and upselling may start to occur.

The key conclusion here for banks is to create a data analytics strategy as part of the whole banking strategy. It is important to process regulatory matters and new business streams not as separate topics, but more as connected matters on the digital transformation roadmap. By not being siloed, for example by regulatory department and IT department, and sharing common goals, banks can accelerate transitioning to next stage or even leapfrog several stages.

Insights derived from data were siloed in some banks. There was discussion about the insights that came from AML or anti-fraud processes and how they could be beneficial for marketing too, if marketing department would have the access to those insights. This further emphasizes on the importance of developing big data and analytics strategy on top level, and not separately on different departments.

Transitioning from traditional functioning bank to a data-driven bank with extensive big data analytics capabilities is not a straightforward task. In addition to defining the importance of big data and analytics in banks' strategies, they should start small with more prototyping different technologies and finding the right FinTech companies and other partners to assist and support. Heavily investing on one application and considering it disconnected from the core functions could result the outcome being a general gimmick. Therefore, strong sponsor, preferably from the executives is required. In practice, commonly known frameworks such as CRISP-DM model can be utilized when banks might not have their own way of integrating big data analytics into core functions. The target should be to transition to more cohesive big data analytics processes with a sense of direction.

By having better KYC processes, the bank will ultimately know much more about the customer and their demands. This alone would be beneficial for banks, but if the KYC processes and data platforms are done in a way that for example insights gathered from regulatory processes could be further utilized in other services, the customer experience could be enhanced. This is also where automatization of different processes could become useful, if the data platforms are well-established. By automating different middle and back office processes, better product portfolio of the bank could be resulted.

They [new products] must be real-time, responsive and most preferably self-learning. (I3)

Issues to be taken into consideration from the data analytics point of view were raised during the interviews. These are presented in table 15.

Table 15. *Possible data issues in internal and external customer data*

Data origin	**Data source**	**Possible data issues**
Internal	- Onboarding o Interviews o Mandatory information from forms	- Data validity - Data variety - Data veracity
	- Data gathered from existing services o Behavioral data	- Data validity
External	- Institutions o PEP screening o Credit register information o Default of payment register	- Data volume - Data volatility
	- Commercial data sources o Financial media companies (e.g. Bloomberg) o FinTech vendors	- Data volume - Data velocity

These issues must be taken into account when developing new services as well as when improving old and existing legacy IT systems. Different data sources have different issues, while the most notable ones were concerns about data validity in internal data sources and data volumes in external data sources.

5.5.2 Finnish banks and FinTech collaboration

In terms of Finnish banking sector, banks have only recently started to invest in digital transformation in core functions and upgrading of the legacy IT systems.

We [Finnish banks] might be above average in terms of analytics capabilities -- but most likely quite far behind global leaders. (I1)

Finnish FinTech landscape is also quite decent. There is some FinTech hubs in Finland, and Finnish technology and engineering know-how is considered globally competitive. From the Nordic landscape, Sweden has had the greatest impact in terms of market traction of the FinTech companies. Finnish banking customers have also been above average in technology-savviness. Especially in Finland, internet banking adoption is generally considered as very high (Laukkanen 2016).

The three factors that slow down banks' performance are legacy technology, legacy culture and legacy customers. (I1)

Where in some countries' banks, digital transformation to them has been to develop a mobile banking application. In Finland, this has been done years ago and is the default already in Nordics. Even though Finnish customers are accustomed to mobile banking, there still remains a need for human interaction, especially in bigger decisions such as when negotiating a loan.

I think that Finnish customers are very advanced in internet banking and mobile banking and in digital services in general, all the way at the top in Europe. – Of course, then Finnish banks see to which direction to develop their services, too. (I3)

One key difference between Finnish banks and Central European as well as South European banks is the transition from cash payments to card payments. This will naturally grant the bank to have access to the customer's behavioral data with much larger visibility when compared to cash payments.

Finnish customers have been very willing to transition from cash to cards. (I3)

These factors have been positively impacting on Finnish banks collaborating with FinTech companies. Finnish customers are familiar with technology and mobile technology especially and banks also possess somewhat sufficient capabilities for FinTech companies to be able to partner with the banks.

There are two possible scenarios [with regards to banks and FinTech companies]: First scenario is that banks choose certain FinTech companies and work with them and eventually buy out the FinTech companies. The other scenario is that more advanced banks will not buy out the FinTech companies but collect the best-in-breed and collaborate with them. (I2)

Collaborating with FinTech companies and not buying them would have the benefit of decreased investment needed for the collaboration and keeping the relationship with FinTech companies in the variable costs and not fixed costs. There is also the added benefit of more flexible management of the FinTech landscape that the bank possesses.

Also, by having more FinTech companies in the bank's own landscape, the bank is also more open for innovation.

In Finland, I think this [collaboration with FinTech companies] is generally quite advanced. Also, a lot of hackathon type of events have been held by big Finnish banks. (I2)

It can be argued that there are several reasons why Finnish FinTech landscape is considered advanced. Interviewee I2 pointed directly at Nokia for this, and its influence in also banking sector and especially in FinTech startups. After shutting down the mobile devices manufacturing in Nokia, there were abundant IT expertise that waited for the next industry to infiltrate. FinTech landscape was one of these, and the main reasons are high level of education particularly in engineering and technology.

There are desirable preconditions to that [FinTech development] in Finland. Education and culture are something that has been fruitful here in Finland already. The vast amount of IT companies and gaming companies are a sign that people get IT experience and also can use it in banking sector, too. (I3)

Collaboration with FinTech companies will require a strategic choice and cannot be made purely from technological standpoint. Risk management is something that always has to be taken into account when dealing with third party providers and vendors. Different tasks may be delegated but the responsibility always will remain with the bank.

Everything starts from the fact that bank has the ultimate responsibility towards the regulator. – Everything must be done as it would be done internally. Therefore, banks must also know all about the vendors, and what are their security controls. (I3)

Banks need choose between resource investments and managing risk. By doing everything internally, the bank would need to invest a lot into the expertise and also to the infrastructure. By choosing to partner with FinTech companies, the bank will need to have sufficient management of the vendors and partners. It will not require that much initial investments and resources, but still has some challenges to be focused on, mainly in the data security and governance side.

From risk management perspective, there are three different categories of risks: Inherent risk which comes from how critical function the risk is associated. For example, KYC process is at the core function of the bank, so therefore the inherent risk is also high. The next category is about managing the risk and controlling it. What is left is the residual risk. (I3)

Banks need to carefully process the risk management from the basis of the function that the FinTech collaboration would be part of. If for example the initial risk, inherent risk, is already low, there is no real need for managing risk extensively.

The digital services of Finnish banks are generally high-quality, mobile banking applications for example. I think that Revolut [FinTech company from UK] is far behind when it comes to the features. (I4)

The general high-quality of digital services that traditional Finnish banks have, may very well be one key challenge for FinTech company disruption. While some FinTech companies have grown huge market shares in Europe, it might be a lot harder in Nordics and especially in Finland, where the FinTech companies' strategy of disrupting the traditional markets with better digital services might not work here in Finland. Interviewee I4 proposed a possible root cause of the high-quality digital services in the banking sector in Finland. After the financial crisis in the 90's, which hit hard in Finland, the Finnish banking sector started to invest a lot in internet banking for the sake of bringing costs down. The trend of moving towards digital services and closing business premises is not a recent phenomenon in Finland.

Table 16 presents different aspects in collaborating with FinTech companies and investing resources internally.

Table 16. *Pros and cons on internal and FinTech investments*

Internal investments	**Investing in FinTech companies**
Pros: - Easier risk management Cons: - Developing technology expertise takes time	Pros: - Faster time-to-market - More variable costs rather than fixed costs - Less commitment Cons: - Vendor management - Governance - Risk management due to low visibility towards the FinTech company

5.5.3 Better utilization of cloud services

The general technological capabilities for adopting cloud services is in a desirable level in Finland. Therefore, the cloud service utilization is looking promising for Finnish banking sector.

The maturity [among Finnish banks] of digitalization is generally in a decent level, which shows in the abilities for collaborating with FinTech companies. The collaboration with FinTech companies in the cloud platforms is not as straightforward when dealing with legacy IT systems. (I5)

Now that banks have been more involved in introducing cloud services to core functions of the financial services of banks in addition to only support functions, banks should become more aware of the possibilities that the cloud services can entail. Cloud service adoption has been seen as a cost-efficient way of managing IT infrastructure, but it can also bring new business areas creating added value to the banks' customer data. Banks now may see IT infrastructure as a mandatory function and being more of a cost as opposed to be an investment.

Banks are all about balance sheet; and how to minimize the balance sheet is of the utmost importance. (I1)

Banks also need to make a conscious decision on how to develop data platforms in their organizations. There are different ways of development of these data systems:

- Further develop legacy systems
- Greenfield approach, i.e. making new projects that lack constraint of prior projects (Devereux et al. 2015)
- Capsulate the mainframe and legacy systems, make APIs on top of these

All of the above-mentioned ways have different pros and cons. Banks must examine their strategy especially in IT infrastructure point-of-view to determine the best approach to data platforms and data aggregation systems. While for example further developing legacy systems are expensive and long projects with high risk, they inevitably will have to be faced at some point.

There are advantages in cloud services as opposed to on-premises solutions; for example, instance replication and scaling are big factors for financial institutions. (I2)

There is a clear benefit in using cloud services, where the demand of the data and the data access demands are varied. Cloud services utilize instance replication and fast scaling which are inherent for cloud platforms, whereas scaling is challenging and resource intensive with on-premises solutions. Fast scaling in cloud services provide also faster failover when data security and data accessibility is important.

5.5.4 Embrace core excellence and trust in the financial services landscape

Banks need to find their position in the changing banking sector landscape, where there are plenty of different players trying to penetrate the once stable and secure market.

I think that someday, even though it might not be in the near future, financial services will also shift towards having only a handful of global brands, among which could be Apple or Google. (I4)

While banks in general possess the customers and the assets while lacking the technological capabilities, and FinTech companies possess the technological expertise without customers or assets, big technology companies such as Google, Amazon or Apple has them all. It shall remain interesting to observe on how the big technology companies will adopt financial services, if they do at all.

They [big technology companies] lack trust capital. (I4)

In Finland, the lack of trust for other than traditional banks, might be more emphasized when comparing to other countries in Europe. What traditional banks should do in the future is to remain trustworthy, because Finnish customers will most likely in the future also appreciate a credible traditional bank. This is something that FinTech or big technology companies have not been able to catch up with, at least in Finland.

The trust factor that Finnish banks still have is something that the banks should hold on to, and further develop.

There are some attributes that protect traditional banks from FinTech companies: One thing is regulatory requirements – and this is something the banks are strong at. The other thing is psychological by nature; banks have certain trust from customers – which is harder to obtain from newcomers. (I3)

While big technology companies are showing interest in pursuing financial industry capabilities, it can be argued that the disruptive nature in Finnish banking sector will be milder than in markets where the possibility of a proper market disruption is more significant. Still, Finnish banks should emphasize their strengths and develop based on them, trustworthiness being one clear strength.

Many players in the banking sector see big tech companies as the biggest threats to banks and are closely paying attention to their actions. But, big tech companies do not want to become banks by the sake of it, but only if it truly is a benefit to their core business. (I1)

As stated by interviewee I1, big technology companies might want to avoid the regulation that is scrutinizing traditional banks, and therefore only wanting partnerships from banks. While this was not the primary focus of the research, it was still noteworthy as the consequences of big technology companies emerging to financial industry might have severe impacts for banks.

5.6 Summary

The customer-centricity among Finnish banks was in increased focus, when interviewing Finnish banking experts. A lot of factors are most likely driving this, two being the new regulation as well as increased competitiveness overall, especially coming from the recent advances in technology and big data analytics.

During the interviews it could be concluded that many themes discussed in the interviews affected other themes. For example, it can be argued that for a bank's successful collaboration with FinTech company, the bank's IT systems must be mature enough for other players to be able to leverage on them. Old legacy systems, while they will decrease the efficiency in the future, will also affect on how the FinTech companies and other players in the field can attach to the systems. Therefore, making a data strategy and a roadmap on how to manage this challenge is increasingly important. For example, investing resources for developing APIs on top of the legacy IT systems could be one proposed solution, where not all the core IT systems need a complete overhaul, but the capabilities are increased by utilizing APIs. These new APIs can be made use of in FinTech collaboration, such as AISPs or PISPs, as well as in later internal development.

Cloud services development is another thing that needs to be addressed by the banks. As cloud service adoption among Finnish banks is not in the advanced level of maturity, at least not in the core functions, which can make the FinTech collaboration also more challenging. The direction, though, where Finnish banks are heading, seems to be going more progressively towards the increased use of cloud services in the core functions as well.

6. DISCUSSION AND CONCLUSIONS

This chapter will summarize the analysis done in the previous chapter and use the summarization in order to answer the research problem. In addition, major findings of the literature review are presented. Findings from the empirical analysis are discussed with a focus on Finnish banking sector. This is done in order to answer the research problem and research sub-questions. Research problem is answered by first answering separately to research sub-questions and then make implications based on these to answer to the main research problem. Lastly, research evaluation and limitation are presented as well as managerial implications and proposals for future research.

6.1 Answering research questions and research problem

The role of big data analytics and FinTech collaboration among Finnish banks is not as straightforward topic as first presumed. On the other hand, big data analytics applications used in Finnish banking sector were mostly uniform with the results from the literature review. Conducting literature review, however, suggested that relationship between FinTech and banks could be disruptive in nature, but this has not been the case.

Major findings of the empirical analysis were that unlike the academic literature pointing somewhat heavily on FinTech competition, this has not been occurring in the Finnish financial industry. In fact, quite the contrary has happened, where there was a strong consensus among the interviewees to welcome the FinTech companies and having the target of collaborating and doing shared business with them, utilizing both for their advantages.

In contrast to the relative inconsistency between academic literature and Finnish banking sector, big data analytics topics were mostly in line with the academia. For example, most big data analytics applications used in Finnish banks were already introduced during the literature review, and no significant discrepancies were found. Only application that was not covered in the literature review was chatbots, but they were excluded in the literature review when choosing the research methodology for being somewhat different in nature compared to big data analytics methods such as preventing fraud or improving CRM.

Other topic that was left out of literature review but was present in the interviews was the amount of legacy IT systems, and how they affect data-driven banking functions. The

literature review focused more on the enabling possibilities of cloud computing when advancing from the old legacy IT systems, so in essence the entirety remained coherent.

6.1.1 Global trends in digital banking sector landscape

Question 1: What are global trends in digital banking and how they affect the digital banking transformation?

According to Lin (2016), two of the most influential phenomena that have shaped banking sector in the last couple decades are the rise of new technology as well as the new regulatory requirements. This research was conducted in order to examine this further with Finnish banks.

It became evident that no one single phenomenon has created this disruption in digital banking sector. It is, indeed, the result of multiple phenomena closely linking together, which only shows itself by the output of this new ways of digital banking. Even regulation, which may seem distant to business processes, has actually evolved from the basis of the events in the industry.

One might argue that the global financial crisis in mid-2000s has been a tipping point for all things related to the scope of this research. Without a stronger emphasis on governmental level and from European Union towards protecting data and need of knowing the risks of new loaners, there perhaps wasn't new areas of innovative business in this field either.

While the new technology that has been introduced to the banks can be seen easily, mainly from the big data analytics applications that Finnish banks use in their functions, regulatory compliance is not so apparent from the technological perspective. Yet, regulatory technology has also been emerging, and while there are only few technological applications that are used directly relating to regulatory compliance, such as KYC and AML, impacts of new regulation can be especially seen in the new processes that have been developing over time. In fact, while technological applications have been easier to adopt to the banks, the shift of data-driven business mindset has not yet fully been realized. An example of this is the fact that still a lot of compliance related regulatory technology is been done separately from the customer relationship management, where both have clear similarities.

Big data and big data analytics are neither a separate topic in this scope of the research. The ever-growing need of computing and analytics from the regulations named above can be solved by efficiently using new applications of data and analytics, namely big data and big data analytics. At the same time, recent advances in big data applications have

been a catalyst for this also, where the evolutionary leaps of new technology, cloud computing being one example, have started to accelerate also the performance of banks.

The rise of FinTech has been an interesting phenomenon in society, which has made use of both the requirement of more efficient banking processes, the opening of banking data and the advances of new and innovative technology in the field of big data and analytics. New regulation has created an opening for new business, which in particular start-up scene has emerged into. The opposites of lean start-up culture and relatively strict and process intensive business of banks create an interesting challenge to solve from both sides.

Figure 17 shows the digital banking sector landscape, answering the first sub-question of the research problem on what global trends are affecting digital banking transformation.

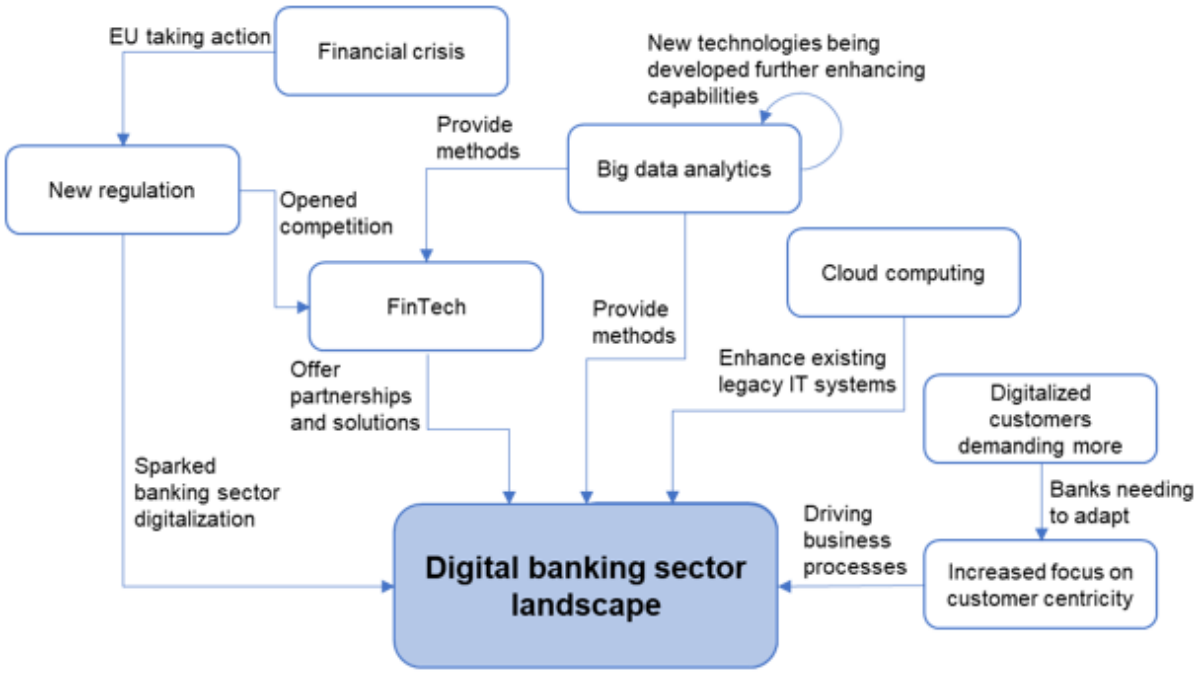

Figure 17. *Digital banking sector landscape*

The figure 17 shows the complexity and relationships between one another. It is to be noted that figure 17 is not complete and does not represent the whole area and effect on digital banking sector but shows it from the research scope point-of-view.

There is an interesting dilemma regarding new regulation from EU and especially on the conflictions that the new directives have been creating among the banks. It seems that on the other hand, EU is pursuing the banks to open the tight competition for other players in the market by forcing banks to become more open and transparent in their data and processes. This must be done at the same time where EU is also enforcing

tighter and tighter directives (e.g. GDPR, General Data Protection Regulation) on individuals' rights to their data and the importance of data security. What it comes down to for banks is that banks need to open data and competition while at the same time, the banks need to be more secure in the way they handle the data and consent from the customers. All this needs to happen at the same time when banks are in the middle of digitalization of their processes and increased demand for leveraging banks' competitive advantages.

There was a key theme apparent in all the interviews, which was the importance of customer data and knowing the customer. This was not only for regulatory compliance, even if it also was considerable reason for KYC processes, but also to truly serve the customer better with more customized product and service offerings. Interviewee I5 pointed out also social responsibility as a factor driving the KYC processes. So, while the new regulation has definitely had an impact on banks and proposed challenges for banks to overcome, some of the developments that regulators are pursuing are coming from within the banks as well.

6.1.2 Big data and big data analytics in banking sector

Question 2: What is the role of big data and big data analytics in banking sector?

In general, big data analytics applications were mostly used with two targets, either to minimize risk by preventing fraud and minimize money laundering, or gathering insights about the customer, to be used in customer relationship management or marketing. This was in line with the academic literature, where most of the applications presented revolved around these themes.

In banking sector, as well as in many others, the talk about AI and sophisticated data science is more in the talk level still, while tangible and meaningful applications are rare. This is quite natural since most of the work to be done in banks is still in legacy systems and in data integration and aggregation platforms, which came apparent during the interviews. As more advanced artificial intelligence and data science goes, *garbage in, garbage out*.

Another root cause for this marketing of sophisticated machine learning algorithms and artificial intelligence can be caused by media and the common international industry on the whole. Many market these applications for the sake of them being cutting edge technologies, while the actual impacts to the business often gets left to a lesser importance.

Question 3: What is the maturity level of Finnish banks with regard to big data analytics capabilities?

From Finnish banking sector perspective, the outcome of the research was that big data analytics applications still do not have a strong presence in the Finnish banks' business processes. Mainly the big data analytics applications were data visualization or simple and manual rule-based algorithms, for example in AML processes.

Legacy IT systems played also a role in the interviews, even somewhat more than during the literature review. It seems that academic literature is more looking for the opportunities that big data analytics can offer rather than the actual requirements of the big data analytics and what is needed in order to achieve the level of maturity in data engineering so that more sophisticated analytics can be performed. While most of the interviewees stated that banks still suffer from legacy IT systems, developing API platforms was seen as a way to solve this issue. The role of cloud services also plays a role in this, where some of the old legacy IT systems could be ultimately replaced by more advanced cloud services offerings. The presence of legacy IT systems in Finnish banking sector arguably has an impact also on the maturity of big data analytics applications that are used in Finnish banks. Therefore, it could be assumed that the most development that Finnish banking sector requires in order to make full use of modern big data analytics technologies are in the data engineering side, where the main target is to unify and integrate the data to a workable structure and provide simple interfaces for all departments within the bank to utilize, by for example using internal APIs as was the case with interviewee I4 in streamlining their bank's IT architecture.

6.1.3 Big data analytics and FinTech in Finnish banking sector

Research problem: How big data analytics and FinTech impact traditional Finnish banks?

From Finnish banking sector point-of-view, it is interesting to observe on how the FinTech collaboration with banks is developing. At the launch of the PSD 2 directive, there clear confusion and banks saw PSD 2 as a threat that would severely hinder the visibility between the customer and the bank. This has, however, not been fully realized, and it may be that the banks that embrace the new directive and explore its new possibilities, can have serious competitive advantage compared to ones that will take a defensive stance against the new regulation. Overall, the hype around FinTech penetrating the traditional banking sector seems to be calming down significantly. According to interviewee I5, the FinTech hype cycle began sloping downwards in around 2016 to 2018, and now what is remaining is the actual business cases without the hype. This has also had the impact that new innovations are being scouted less. Interviewee I5 envision

the future in a way that the hype cycle is continued, and the slope of enlightenment is reached.

It was generally thought that when PSD 2 comes, the world will change permanently. Now what has happened is that the world has changed quite little. (I5)

One idea that may have caused this is the fact that even if the PSD 2 was in theory good idea, in practice it has not been able to perform. Strong authentication, for example, that is now required in PSD 2, has not been executed very well. This impacts negatively to the customer experience and therefore the innovations will not become generalized, according the interviewee I5.

Figure 18 shows that the academic literature is heavily leaning towards investigating the competition between banks and FinTech, while the concrete evidence seems to indicate otherwise.

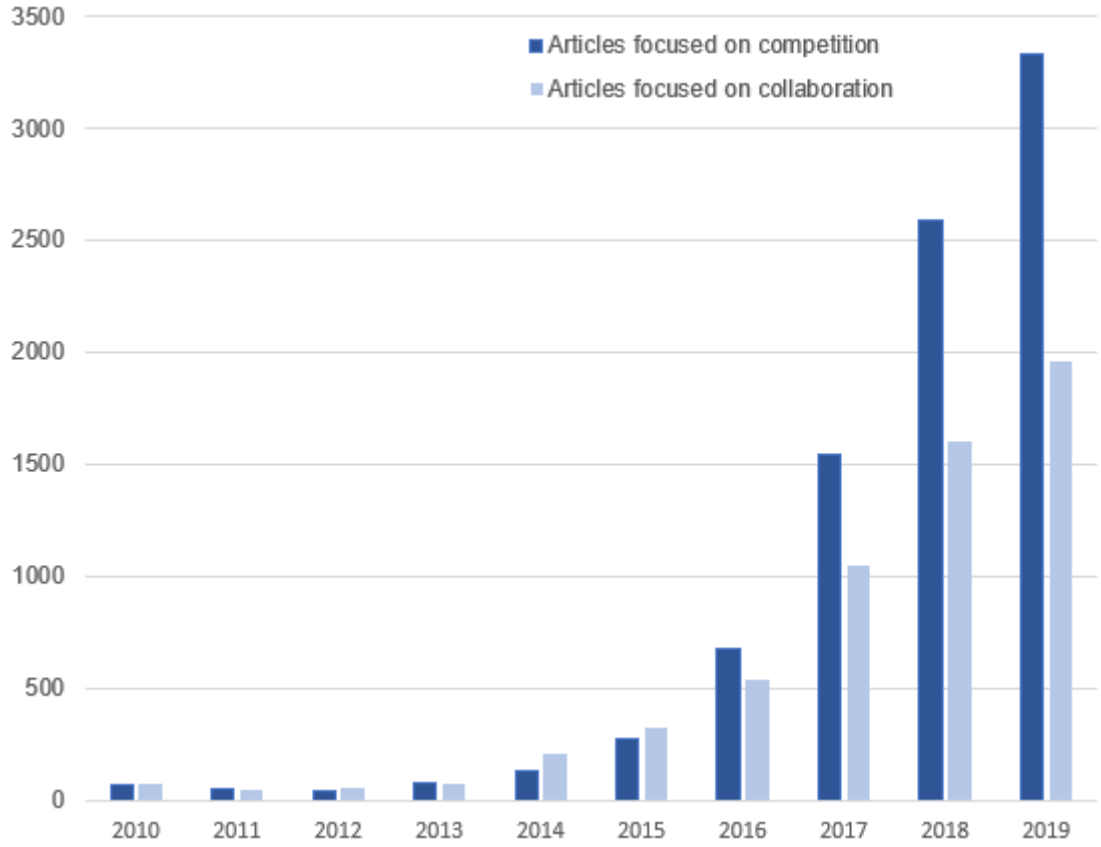

Figure 18. *Yearly comparison of Google Scholar search phrases "bank AND fintech AND competition" and "bank AND fintech AND collaboration"*

While the academic research community can be seen as more interested in the competition between traditional banking sector and FinTech landscape as seen in the figure 18, the interviews shows opposite interest from the banks' point-of-view. In fact, all interviewees had relatively positive stance towards FinTech landscape and the

partnering aspects of the relationship between FinTech and banks. This might be country specific as all the interviewees represented Finnish banks. The lack of proper market disruption in Finland could also be due to Finnish banks' generally advanced capabilities in the financial technology sector. When the market for technology innovation and increased customer demands are already fulfilled, FinTech companies are much harder to penetrate and disrupt the financial services, and therefore the FinTech landscape is more focused in partnerships and collaboration with the banks. This might not be the same in other parts in Europe and especially in developing markets, where for example mobile banking is still considered as new technology innovation.

In addition to mobile banking capabilities in Finland, there might be other reasons also steering the relationship with FinTech to a more collaborative path. As stated also in the interviews, Finnish education and especially technology and engineering expertise is an asset for FinTech development also. While Finnish domestic markets are rather small, this means that FinTech startups basically have two options: Strive for being an unicorn in the industry and penetrating global markets, or focus on working together with other players in the industry, which means that the attitude towards Finnish banks will become more friendly. The latter of the two seems to be the Finnish FinTech industry's common option as there are few FinTech companies that are successful without collaborating with a Finnish bank.

While Finnish domestic markets are rather small in comparison to other European markets, it might have had a positive impact on digitalization among the Finnish banks and the capabilities in adopting new technologies and services, for example FinTech collaboration. As the Finnish banking sector was somewhat small in market size, the markets were fairly homogenous, and banks in the Finnish financial industry are mainly Finnish or Nordic. This might have had an impact on the fact that IT systems are more manageable, and no separate regulations are hindering the development of new technologies.

One interviewee also pointed out that the financial crisis in the 1990s that had a severe impact on Finland, also might have be seen in the FinTech collaboration nowadays. As Finnish banks were struggling heavily, they had no option but to look for all possible ways of increasing efficiency. This was at the same time of emerging of the internet, and the banks showed interest in adopting internet to their core functions. The result was that Finland became one of the first countries to adopt internet banking in the masses.

The main idea of Finnish FinTech collaboration with banks was to capitalize on both the banks' and the FinTech companies' strengths in order to co-create added value to the

customer. It was evident during the interviews that both parties, the banks and FinTech, had customer value as their top priority. This is why FinTech landscape is looking for new innovative ways to create financial services and why Finnish banks want to leverage on the FinTech's innovational capabilities. Also, it can be argued that Finnish FinTech companies have realized that they also do not have all the capabilities to start directly competing with banks; mainly what is lacking from FinTech companies are the customers, but also the small size of domestic markets will make it more difficult to start penetrating the traditional banking sector markets.

Like interviewee I3 stated in the interview, Finnish banks are mostly in second stage out of four stages in the maturity model for data analytics utilization which means that most Finnish banks do have investments already made to data and analytics, but the target has been to improve due diligence and regulatory compliance. It could be argued that big data analytics has been seen only as a solution to an existing and known problem, and the full potential of big data analytics has not been discovered by the banks yet. Same conclusion is derived from the literature review where the majority of big data analytics applications were regulatory in nature, focusing on two distinct topics: Improving fraud detection and prevention and knowing the customer better, hence enhancing customer experience.

Still, compared to European banks, Finnish banking sector can be seen as relatively advanced in big data analytics capabilities. Although it could be derived from the interviews that there are still a lot of work especially in data engineering and solving issues with legacy IT systems, Finnish banks do possess the potential to truly make use of big data analytics. In this regard, active Finnish FinTech scene can also support banks with their data strategies. By collaborating together, FinTech companies can introduce new ways of utilizing big data and show new big data analytics applications for banks to use.

6.2 Managerial implications

In general, Finnish banks have acted to further accelerate digital transformation by collaborating with FinTech companies and investing somewhat in big data analytics capabilities. It seems that Finnish banks have not been shocked about the turmoil that has been present in the banking sector and financial industry on the whole, which can be seen as for example in the tight collaboration with FinTech industry. Also, big technology companies and FinTech competitors have not scared Finnish banks, and Finnish banks have been relatively confident about the future in terms of new competition.

Finnish banks' position on the new regulation seems to be rather realistic after the initial shock. As new regulation seemingly will be introduced, banks have no other option but to try to comply and remain as agile as possible with regards to being able to follow new regulation. PSD 2 is seen as a possibility to innovate, and fear of losing customers to competitors is not a real threat among Finnish banks.

Customer-centricity was seen as one major trend in international banking sector, and Finnish banks were not an exception to the rule. Finnish banks clearly show the focus on their customers, which is evident from the importance of customer data as well as the emphasis on increased customer experience demands that the banks are facing. In Finland, these demands have originated from the late 90's, when Finnish banks started to introduce internet banking and later mobile banking, which has made Finnish customers well acquainted in digital banking and therefore can demand better services, too.

What is needed from Finnish banks in order to become successful in these topics, is a strong focus on the bank's strategy to align with all departments within the bank and to holistically define the best approaches for turning FinTech companies' collaboration into a competitive advantage and what technological investments to be made. These investments include the strategic decisions on legacy IT systems and possible cloud adoption as well as more advanced analytics applications for adequate use cases. All this requires careful planning on big data issues presented previously in this research, as the nature of big data will become even more complex in the future.

It is interesting to observe the emerging of big technology companies, such as Apple and Amazon to the financial industry. While it can be argued that banks have the possession of customers and capital and FinTech companies have the expertise, big technology companies actually have all of the three components. There is much debate on why big technology companies have not yet emerged and tried to disrupt the financial industry.

6.3 Research evaluation and limitations

In consideration of the research's ability to answer the research problem, it could be concluded that all sub-questions were able to be justified and the main research problem was also answered. For theoretical contributions, the research clarified the digital banking sector landscape and reflected that to the Finnish point-of-view. This was best seen in the figure 18, which illustrated new framework for identifying factors affecting digital banking sector landscape. Although the research was done from Finnish banking sector perspective, the framework can be seen as a general framework for banks. In

addition, main big data analytics applications were identified and reflected on their use during the interviews, hence validating the Finnish banking sector characteristics. Also, the research found discrepancies when reflecting the academic research to Finnish setting, which can be seen as valuable insight. Lastly, previous empirical studies on these topics to Finnish banking sector has not been discovered by the author.

Generally speaking, there has been done relatively extensive research on technological perspectives of this research scope, namely big data and analytics. In the recent years, these topics have started to become intertwined with banking sector, which has produced a lot of big data analytics in banking type of research. Still, most of the recent geographically focused research have been done on Asian markets and other emerging markets and no extensive research have been done in Finnish setting.

All the interviewees had a technical background which made the interviews more skewed on the technical aspects, and not on other relevant perspectives, such as change management in the banks. In addition, while Finnish banking sector is relatively small, not all major Finnish banks were able to be interviewed, which may have an effect on the results. However, the results of the interviews were uniform, which will not raise suspicion on the research outcome on being biased.

As the research was done using a mono-method approach, and using qualitative methods, the reliability of the outcomes cannot be taken with full certainty. As with all interviews, there are several factors that can cause the interview to be biased. In this research, bias from the side of the author was minimized by letting the interviewee speak freely and avoided asking any leading questions.

6.4 Proposals for future research

While competition of FinTech companies and banks are more researched topic, more emphasis should be focused on the collaboration between the FinTech landscape and banking sector, especially in Finnish point-of-view as Finnish banks and FinTech companies have a relatively collaborative relationship. Future research proposal could be to examine this collaborative relationship more thoroughly, and defining a framework for successful collaboration for both parties, where the emphasis would be on how to best utilize both parties' strengths and what are the main challenges in adopting FinTech in Finnish banking sector.

When researching cloud systems implementation on top of old legacy IT systems, the topic arose multiple times during the interviews. It is proposed as future research to research how to shift from old legacy IT system to more agile cloud service within banking

context. This could be done in the viewpoint of Finnish banking sector as it can be argued that Finnish banks have somewhat similar capabilities in adopting new cloud systems.

Other future research proposals can be divided into two categories, strategic and technical. In the future strategic research proposals, researching on the FinTech adoption and cultural aspects of FinTech collaboration with banks would be examined and the transformation to a wholesome digital organization which can leverage the big data analytics capabilities companywide, so that the big data analytics methods are not siloed to each department.

In the future technical research proposals, the big data analytics capabilities could be researched more thoroughly in the Finnish banking sector, and how to technically utilize the insights of the big data analytics methods more companywide. A case in point would be how to make use of the knowledge gathered from KYC processes in regulatory compliance to be used in the marketing department or customer relationship management overall. Also, the implementation of cloud services and developing a successful API platform to a Finnish bank could be interesting research topics.

In addition to these two categories of future proposals, researching the involvement of big technology companies' actions in financial industry is an interesting topic to research. While big technology companies, such as Amazon and Apple, have shown some interest in becoming a competitor in financial services market, no real penetration have yet occurred. Future research could shed light on why big technology companies have not penetrated the markets, and what the possible implications would be. Also, analysis on which would the big technology companies compete against, FinTech companies or traditional banks, would be intriguing.

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APPENDIX A: INTERVIEW TEMPLATE

- What is your background in banking sector?
    - Role, position, experience in the field
- Role of big data analytics in banking sector
    - What kind of data do you utilize in the bank?
        - What is the most valuable data?
    - How do you utilize the data?
        - What data analytics applications do you use?
            - What are the most important ones?
    - How much of the data is in the cloud?
    - How would you describe the attitude towards data analytics applications?
        - Cost saving -- Creating new business?
        - Operational excellence/efficiency, customer centricity, creating new business
    - What external data do you utilize?
        - Open Banking data, data coming from financial institutions, FinTech vendors…?
- Relationship with FinTech companies
    - What regulation have you seen affecting your work?
    - How do you see the regulation affecting the future of banking services?
    - What kind collaboration do you do with FinTech companies, if any?
        - What is the general relationship between the bank and FinTech companies?
            - Partners, sub-contractors, company acquisition…?
        - What common opportunities and challenges do you see working with FinTech companies?
        - Where do you see the landscape of FinTech going towards with the regards to banking services?
- Assessment on Finnish banks, FinTech companies and customers
    - How ready do you think your customers are to adopt new technologies and services in your country?
    - How are Finnish banks/FinTech companies/customers comparing to the corresponding international counterparts?