Establishing a Durable Environment for Digital Financial Services

Eliciting Design Principles for the Financial Ecosystem to Develop Robust APIs for Open Banking

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Faculty of Technology, Policy and Management

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AISP = Account Information Service Provider
API = Application Programming Interface
IQ = Information Quality
NCA = National Competent Authority
PISP = Payment Initiation Service Provider
PSD2 = revised Payment Service Directive
PSP = Payment Service Provider
TIP = Technical Infrastructure Policy
TPP = Third Party Provider
RDE = Robust Design Engineering
RTS = Regulatory Technical Standard

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Executive Summary

The commercial banking industry is changing rapidly as financial services for consumers are becoming more digital every day. This research provides a set of Robust Design Principles that are able to guide the development of APIs for Open Banking.

The complexity of the financial ecosystem is caused by the many actors and stakeholders, which all have different interests and use different strategies to exert their influence on the dynamic environment. Moreover, the lack of insight in this unpredictable environment makes it very difficult to deal with the uncertainties.

New legislation obligates commercial banks within the European Union to develop API-based systems for Open Banking that allows to efficiently share financial data. Still, the technical requirements for these APIs are not completely specified, which causes inconsistencies in interpretation and issues with compliance.

The set of Robust Design Principles for Open Banking offers an overarching solution for developing APIs that deal with conflicting stakeholder interests and uncertainties in the environment. Interested organizations are able to adopt these principles to jointly establish a robust technical infrastructure and contribute to a durable financial ecosystem. Notably, design principles cannot be found in a universally applicable list. They can only be created after careful analysis of the environment. Therefore, the following research question is answered in this report:

“What design principles of API design for Open Banking accurately deal with trade-offs among stakeholder interests and prove enough robustness for the changing financial ecosystem?”

Multiple actors in the financial ecosystem admit that uncertainty in the rapidly changing ecosystem is becoming an imminent issue. Other problems originate from more intensive regulatory intervention in the financial ecosystem, which results in actors choosing different strategies without knowing what the outcome will be.

This research provides insight into the financial ecosystem by clarifying the contextual and technical aspects of the market environment. The stakeholder interests are explicated and network dynamics are explained in order to accurately deal with trade-offs among stakeholder group interests. Furthermore, a technical overview is presented by visualizing the flow of financial data and explaining the technical components.

Subsequently, the current state of the market is evaluated by a comparative case study. Furthermore, influential people at various organizations affecting the future of the financial ecosystem are interviewed. The qualitative data is analyzed with Meta-synthesis to formulate general explanations. Some future prospects about the financial ecosystem are identified with Scenario Development. This analysis allows us to explicate stakeholder interests and deal with trade-offs among them to establish a durable financial ecosystem.
The key findings include a set of Design Principles for Open Banking that is not only compliant but goes beyond legislation and protects underlying consumer concerns. To illustrate, one of the key findings indicates that the ignorance of consumers results in systematic shortcomings of data protection. Hence, one of the design principles provides a way to inform about the implications of innovation and how the use of available mechanisms helps them to control their data. Additionally, other design principles guide the financial ecosystem towards more standardisation and interoperability.

Key results of this research are the OB (Open Banking) Design Principles and the development of a framework with methods to explain all of the complexities in the financial ecosystem. The combination of methods to explicate the contextual and technical aspects of the financial ecosystem is called the Robust Design Engineering (RDE) framework. Consequently, RDE allows us to address relevant issues and provide a solution that deals with identified problems in a complex environment with multiple stakeholders.

Finally, the expected outcome of the design principles are put into a broader perspective by addressing market failures that go beyond Open Banking. In particular, characteristics of the integrated API-based systems for Open Banking are assessed as a technical infrastructure for financial data flow in order to provide insights beyond the regulatory scope.
Chapter 1

Introduction

The banking industry is changing rapidly as financial services are becoming more digital every day. In our internet based-economy with mobile devices, consumers get used to a lifestyle with automated processes and where everything can be organized anywhere at any time. Currently, the Financial Services Industry is adapting to these expectations and moving more and more towards an environment called Digital Finance [Gomber et al.2017]. Nevertheless, the transition is far from over.

1.1 The Financial Services Industry

To begin this research, an overview of the Financial Services Industry is provided. Based on the Financial Services Industry, the financial ecosystem is defined.

1.1.1 FinTech Companies

New technologies creates new opportunities for building a technological infrastructure [Justman and Teubal 1995]. The complexities multidisciplinary nature of the financial ecosystem call for a well-structured approach. One of the cornerstones of this infrastructure is the technology. A company using new technology in the Financial Services Industry is called a Financial Technology company, or ‘FinTech’ company [Arner et al.2016]. Numerous FinTech companies are emerging and they are offering innovative services in a traditionally rigid market. The capital of global investments in FinTech companies has doubled since last year and is still increasing rapidly. In 2019, the total capital invested in FinTech companies reached roughly $120 billion.

Data serves as a catalyst for new products and business models. Ultimately, data sharing leads to the development of digital ecosystems. However, the inability to share data threatens to curtail innovation in business and operating models. Until now, incumbents in the Financial Services Industry have viewed client protection as a duty rather than an opportunity to commercialize, but that is about to change [Brodsky and Oakes2017].

The Financial Ecosystem

The financial ecosystem consists of many organizations that want to offer their services in the Financial Services Industry and the Governing Agencies that have to control this environment.

Such an ecosystem needs to be built with proper guidance. The foundation of the environment is the technological infrastructure. With technological innovation alone, the infrastructure will become a scattered mess of single services unable to operate uniformly. Due to the multidisciplinary nature of the system and conflicting interests, profound policy needs to be created to guide innovation in the right direction [Justman and Teubal1995].

1.1.2 Regulatory Intervention

Policymakers are trying to steer the financial industry in the right direction with regulatory intervention. Hence, the second cornerstone of the infrastructure is legislation.

The objective is to let the industry operate at a certain Regulatory Technical Standard (RTS) [Mock and Lupini2017]. However, shaping this RTS is very complex because technological standards are hard to define. Especially for a system that overlaps with different disciplines, which in this case consist of law, finance, and ICT. Even more difficult, is to find out if the ethical values are protected by the system in place and whether the underlying values are properly aligned with the governance structure. Aligning the values with the actual system calls for a more thorough specification of the institutional environment [Williamson2000]. Consequently, the description of the financial playing field and defining regulatory framework links regulation and technology to the third cornerstone, which is services.

1.1.3 Specification of Financial Services

In the rapidly changing environment of the Financial Services Industry, certain innovative services need to be defined before they are able to be controlled.

The EU wants to create a unified financial sector in Europe with the ‘revised Payment Service Directive’ (PSD2). PSD2 forces banks and FinTech companies to comply with a set of rules before they can offer their services to customers. Officially, the Directive (EU) 2015/2366 of the European Parliament and of the Council introduces a regulatory technical standard for strong customer authentication, and a common and secure open standard for financial data exchange [EuropeanUnion2018].

The drive for enacting legislation and make businesses comply with these rules comes from an ethical or moral sense of duty. Without legislation, business might take advantage of the possibilities that technological innovation offers.

1.1.4 The Underlying Ethical Values of Regulation

In order to better understand the regulatory intervention, the ethical values as the foundation for legislation have to be identified. These values are also used to prudentially anticipate on subsequent regulatory steps taken by policymakers.

Similar to the General Data Protection Regulation (GDPR), the foundation of PSD2 is that consumers themselves should be the owner and controllers of their personal financial data. That means that customers are finally becoming the center of innovation in the banking industry, instead of the shareholders which were the case for a long time. Many other aspects of the digital transition are unclear at this moment. There is a lot of uncertainty about the actual effect of the regulation on the market. Therefore, while these uncertainties change the traditional market environment, it also creates a large variety of scientific research opportunities.

In sum, the financial ecosystem includes many organizations that offer financial services and policymakers try to control the environment by legislation. The financial services are rapidly trans-
forming by digital innovation, so a technical infrastructure needs to be established and provide a robust foundation for the financial ecosystem.

1.2 Knowledge Gap

There are many research possibilities following the changing financial ecosystem. In order to provide a more specific direction for the rest of the research, the most relevant issues will be discussed here. Ultimately, the knowledge gap becomes clear and the research problem is introduced.

1.2.1 Limited Regulatory Foundation

The regulatory component proves to be a significant factor in the Open API economy [Zachariadis and Ozcan2017]. APIs are considered the backbone of innovation in the service computing industry [Tan et al.2016]. Therefore, API design needs to be adjusted to the changing market environment, because the currently available guidelines do not fully consider the current legal aspects [Farrell2009, Henning2009, Kröner2018].

1.2.2 Insufficient Strategic Objectives

Strategic recommendations for actors in the financial ecosystem are made, but no specific requirements are formulated yet [Guibaud2016, Kröner2018, Zachariadis and Ozcan2017]. If more insight about API design [Farrell2009, Henning2009] can be provided by also taking into account the underlying values of the regulatory basis and serve the forward-looking framework [Arner et al.2016], the gap between technological applications and regulatory demands can be closed. Hence, more insights in API design requirements for Open Banking will lead to a more complete financial ecosystem [Micheler and Whaley2018] and a stronger basis [Tan et al.2016] for further applications due to an increased availability of data [Danielsson et al.2017].

Studies have showed that incumbents should develop a perspective on APIs and their benefit to the banking service model [Guibaud2016, Kröner2018]. Currently, Open Banking APIs are developed by the actors in the market. Now the question arises what the differences are between financial institutions concerning their approaches, final outcomes and actual developed APIs. Some banks develop API systems that barely meet regulatory standards, while others go well beyond the PSD2 and design for adaptability [Gong and Janssen2012, Woo and Mori2004].

1.3 Problem Identification

The previous overview gives a generic view of the financial ecosystem, but the main conclusions are not presented in a structured manner yet. Therefore, the following part briefly elaborates on the four cornerstones of the financial ecosystem from Figure 1.1: service, technology, legislation, and ethical value.

1.3.1 Rapid Change of the Financial Ecosystem

The financial ecosystem is changing rapidly due to the introduction of new technology and regulatory intervention. At the center of development are the APIs, which make it possible for organizations to efficiently interact with other data systems. Some preliminary API requirements are now specified in EU legislation, but the evolution of the financial ecosystem is far from complete.
CHAPTER 1. INTRODUCTION

The problem with the rapidly changing financial service sector is to find out what the factors of change are and what direction they are going to.

1.4 Four Cornerstones of the Financial Ecosystem

The endless possibilities of innovation identified in the Financial Services Industry are difficult to grasp. All services and other developments within and building upon this changing environment are specified as the financial ecosystem. This concept is quite big and its components are still on their peak of development, which makes the outcome nearly impossible to predict and the internal relationships very difficult to elucidate [Gomber et al.2017]. Therefore, a more structured approach to analyze the developments in the financial ecosystem is used and a conceptual framework provides an overview when the underlying reciprocity is explained. Consequently, the Four Cornerstones from Figure 1.1 are used to describe the developments within the financial ecosystem.

1.4.1 Services

A major shared concern in the financial industry is the unpredictable transformation of financial services [Zachariadis and Ozcan2017]. Especially, the way that financial data is being made available by the Open API Economy and the way that financial data is used to offer innovative services is still not fully clarified [Arner et al.2016, Henning2009, Tan et al.2016]. Although efforts are being made to provide a structured view of the changing market environment, there is still a need for more research to clarify actual application attempts of financial data used by TPPs [Gomber et al.2017, Khraisha and Arthur2018, Kröner2018]. In the meantime, the best way to protect organizations against the changing environment is to build agile and flexible systems, while still offering a high level of security [Gong and Janssen2012, Woo and Mori2004].

1.4.2 Technology

The technological aspect in the changing market environment shows three remarkable insights: Firstly, disparities in technological expertise causes firms to form strategic alliances [Guibaud2016, Svensson et al.2019]. Secondly, evolving APIs continue to show promising potential, but actual implementation initiatives are hard to discover [Gomber et al.2017, Tan et al.2016]. In other words, APIs have to be adapted [Zachariadis and Ozcan2017] as API design requirements are constantly updated according to the current regulation, but actual insight is not yet available [Farrell2009, Gong and Janssen2012, Henning2009, Woo and Mori2004]. And at last, technology is combined with regulation to form RegTech. With RegTech, companies fulfill compliance requirements more efficiently [Arner et al.2016, Dhar and Stein2016, Philippson2016a]. However, these companies only serve their own interest in this process, instead of looking at the bigger picture and align their technological expertise with the underlying principles of the regulatory basis [Micheler and Whaley2018].
1.4.3 Legislation

The revised Payment Service Directive (PSD2) legally forces banks to provide an API-based system capable of sharing financial data with TPPs. However, the technical standards for this API-based system have not been finalized yet [Kröner2018]. The EU has to update the regulatory framework in order to directly protect its cultural values, just like the UK has done already [Micheler and Whalley2018]. That requires a more forward-looking approach, rather than waiting to impose sanctions after the system has failed [Arner et al.2016]. However, the link between technological innovations and regulatory pursuits is difficult to find, because the legal aspects are hardly considered in the technical literature [Farrell2009, Han et al.2017, Henning2009, Tan et al.2016]. An effective way to account for foreseeable regulatory intervention is to look at the intentions of policymakers [Gong and Janssen2012]. Combining the life cycle theory with institutional requirements should provide more insight into financial innovation with regulatory oriented input. The idea of self-organization builds upon the notion that many financial innovations, such as stock exchanges, clearinghouses, and federal reserve banking, emerged without the government as an initiator, but subsequent clarification of these practices served as input to restrict the undesired practices within these systems [Khraisha and Arthur2018].

1.4.4 Ethical Values

The ethical aspect generally stresses the importance of more data sharing for faster innovation in the ecosystem [Farrell2009, Gomber et al.2017, Svensson et al.2019, Tan et al.2016]. Little attention is given to maleficent practices and the potential abuse of financial data [Dhar and Stein2016], whereas legitimacy is identified as an important factor for survival in the changing market environment. Therefore, investigating applications that increase organizations’ legitimacy is a promising area to research, in order to help them protect their most vital asset in the banking industry, which is their reputation [Svensson et al.2019].

1.4.5 Formulation of the Research Problem

The major commercial banks in the financial services industry are opening up their data systems, so Third Party Providers (TTPs) are able to develop new business models. The development of APIs for Open banking is shaping the current financial ecosystem. These APIs need to adequately satisfy the formulated purpose and comply with the created institutional environment.

Despite its huge potential, digital innovation in the financial services industry has been restrained for a long time. The current availability of financial data suddenly offers a wide range of opportunities, where both good and bad outcomes are foreseen.

This research provides a clear overview of how the current financial ecosystem responds to the changing institutional environment as a reaction to the emergence of digital banking. Ultimately, such an overview helps stakeholders in the financial ecosystem with their future expectations. Currently, the problem for these stakeholders is to develop their API-based systems that anticipate the changing financial ecosystem. However, only providing an overview of the changing financial ecosystem is not enough to develop adequate APIs for Open Banking.

To summarize, four cornerstones are introduced in Figure 1.1, which indicate the boundaries of the changing financial ecosystem. The literature is explored to identify current practices and define the main issues of the financial ecosystem. The main issues can be summarized by the unforeseeable potential of new services, rapid innovation in financial technology, more regulation that defines a
level playing field, and conceptual refinement of ethical value that form the foundation of future developments.

The research problem is that API-based systems are currently developed according to regulatory demand, but there is no support instrument that includes and solves the issues in the financial ecosystem. Therefore, overarching conceptual guidance to develop APIs for Open Banking is needed that helps organizations that want to contribute to a durable financial ecosystem.

1.5 Research Question

A set of design principles offers the required guidance taking the issues of the financial ecosystem into account. Most issues beyond the imposed Regulatory Technical Standard (RTS) result in trade-offs between stakeholder interests. Ultimately, the set of robust design principles that apply to API design for Open Banking also requires the flexibility to take changes into account in this dynamic environment. Consequently, these concerns result in the following research question:

“What design principles of API design for Open Banking accurately deal with trade-offs among stakeholder interests and prove enough robustness for the changing financial ecosystem?”

This research question is not easily answered because it requires a conscious analysis of the financial ecosystem and demands carefully designed principles for API design for Open Banking that result in a robust technical infrastructure. Hence, the introduction of a specifically constructed list of sub-questions to divide this research into better solvable sub-parts.

1.5.1 Sub-questions

In order to provide more structure and make the research more capable of being conducted, the research is split up into multiple sub-parts. Each part corresponds to its own sub-question. The following part consists of all sub-questions that separate the research into smaller sub-parts.

The first sub-question clarifies the stakeholder interests in the financial ecosystem and describes the technical aspect of Open Banking in which the APIs operate. Therefore, the first question is:

“1. What does the financial ecosystem look like from a contextual and technical aspect?”

The context of the financial ecosystem is clarified by explicating stakeholder interests. As a start, the contextual aspect is described using institutional analysis and stakeholder analysis. Subsequently, the technical aspect of the financial ecosystem is described by a schematic overview of Open Banking processes and the flow of financial data is presented using the Business Process Modeling Notation (BPMN).

The start of the research describes the financial ecosystem by addressing two main aspects. After the system is explained, qualitative data is gathered via two case studies. The corresponding sub-question is:

“2. What is the effect of stakeholder groups on the financial ecosystem?”

The first case study is performed to explore the current state of APIs for Open Banking. The second case study is more in-depth and explicates the impact of stakeholders on the financial ecosystem.

Subsequently, the case study findings are used to forecast the changing financial ecosystem. Hence, the third sub-question:
“3. What future scenarios can be forecast to make the requirements for APIs for Open Banking more robust?”

In order to formulate robust requirements, stakeholder interests are used to anticipate the future of the financial ecosystem. Several possible outcomes are discussed in the form of scenarios.

The answer to the following sub-question leads to a better overview of the case study findings. Specifying the impact of stakeholder groups on the financial ecosystem helps to formulate suitable requirements that deal with conflicting stakeholder interests. The fourth sub-question is focused on analyzing the case study data and make requirements for Open Banking explicit:

“4. What are the robust API design requirements according to the Four Cornerstones of the financial ecosystem?”

The requirements for the API-based systems are presented in a concise overview by relating them to the Four Cornerstones of the financial ecosystem, as indicated in Figure 1.1. The four cornerstones include the aspect of service, technology, legislation, and ethical value.

The presented set of robust requirements relates to the quality of the information in the system. Achieving Information Quality is a preceding step towards the formulation of design principles. Therefore, the fifth sub-question is posed as follows:

“5. To what extent do the requirements relate to the Information Quality Dimensions for systematic data sharing?”

Once the robust requirements are linked to the dimensions of Information Quality, a clear basis of design principles is developed. The corresponding set of design principles results in robust APIs for Open Banking. The formulation of design principles has to be answered by the sixth sub-question:

“6. What design principles are capable to deal with the dynamic environment and result in robust APIs for Open Banking?”

Until this point, every step leads towards the formulated set of Design Principles for APIs for Open Banking. The last part evaluates the design principles. The corresponding sub-question is the seventh and last one:

“7. What are the possible implications on the financial ecosystem regarding the presented set of Design Principles?”

After the design principles are validated against any undesired effects on the financial ecosystem, the set of Design Principles for APIs for Open Banking is complete.

1.6 Research Deliverable

The research question is demanding robust design principles for Open Banking. Thus, the final outcome of the research is a set of validated design principles that deal with changes in the financial ecosystem. The formulated design principles help relevant actors in the financial ecosystem to develop their API-based systems according to identified requirements.

Ultimately, interested organizations are able to adopt these design principles to jointly establish a robust technical infrastructure and contribute to a durable financial ecosystem.
CHAPTER 1. INTRODUCTION

1.7 Scientific Relevance

The final answer to the research question contributes to both the technical side of the scientific spectrum, as well as theoretical side for accurate system analysis and adequate policy development.

1.7.1 Framework for Functional System in a Complex Environment

There is no integrated framework available to reach overarching goals for establishing a Technical Infrastructure in a changing environment with multiple stakeholder interests and regulatory intervention [Camponovo et al. 2004].

This research presents a systematic approach to describing a complex environment from a technical and contextual point of view. This approach allows evaluating the regulatory and technical aspects of an environment. Subsequently, the current state of the environment is linked to the conceptual needs and a functional system for developing a technical infrastructure is presented. Moreover, the framework is tested on the financial ecosystem, but it can be applied to other complex systems with technical requirements by following a similar approach.

1.7.2 Adequate API design

The Application Programming Interface (API) has been applied by developers in a wide range of sectors. The financial service sector is now obligated to develop APIs for Open Banking as commercial banks have to share their financial data with Third Party Providers (TPPs). Consequently, APIs have become adopted even more and the application in this sector is presumed to influence API design in general.

Moreover, the strictly formulated regulation is sometimes not sufficiently explicit, so the relevant actors are gradually solving various implementation issues. Therefore, the financial ecosystem is seen as an environment that requires API design to be of sufficient quality. The competitive aspect in the market results in different practices and alternative outcomes, which serves as input for reflection on API design in general.

1.7.3 Principle-Based Design

The answer to the research question does not directly lead to actual APIs, but clarifies the requirements for API design on a higher conceptual level and create applicable overarching design principles. This research applies Principle-Based Design to the complex environment of the financial ecosystem to accurately solve general issues without losing the flexibility for the necessary specification.

Furthermore, the very complexity of the financial ecosystem requires APIs to be of better quality as the formulated design principles for Open Banking consider various aspects and different stakeholder interests. Therefore, the final set of design principles is extensive enough to inspire similar fields of interest, such as Open Data and Data Governance.

1.7.4 Enterprise Architecture

Enterprise Architecture is a field of study that focuses on the data of internal business processes to increase an organization’s performance. Yet, this research has a bigger scope and entails regulatory imposed data sharing within the whole sector. Therefore, the results of this research go beyond the discipline of Enterprise Architecture, whereas the findings add value to its importance.
1.7.5 Adequate Policy Management

As stated above, policymakers have forced commercial banks to share their financial data, but the way that the sector responds to the regulation has not been fully identified yet. The dispute in the financial ecosystem now arises whether the regulatory demands are fair and whether certain solutions to implementation issues indeed satisfy regulatory demand.

1.7.6 Technical Infrastructure Policy

In particular, the complexity to enforce adequate policy originates from a combination of three effects in the tension field. Firstly, the public demands regulatory intervention out of the societal importance that results in the corresponding legislation. Secondly, economic and corporate interests result in strategic information sharing and withholding for individual gain or protection. Third and finally, the very technical possibility to solve any identified issues and the capability of successful implementation. These conflicting interests make it very difficult for policymakers to objectively create reasonable policy.

More specifically, the multidisciplinary field due to this transforming industry requires the Technical Infrastructure to be of sufficient quality. In the past, similar network transitions occurred with energy, telecommunication and train transportation. Currently, the same Technical Infrastructure Policy (TIP) paradigm can be tested for the transition of the banking industry.

Altogether, this research uses Principle-Based Design to help organizations in a complex environment contribute to a robust technical infrastructure. Moreover, several other scientific methods and theories used to describe the financial ecosystem and provide more insight into the complexities.

Furthermore, the research of sector-wide data sharing in a commercial environment expands the horizon of general API design. In this case of Open Banking, the sensitive aspect of financial data demands APIs to be of higher quality than ever before.

1.8 Societal Relevance

Similarly to the scientific contribution, the societal relevance of this research has both a technical impact and a social one.

1.8.1 Technical Impact

Previously discussed aspects of the problem show both a technological and regulatory component, as well as the dependence on society and the influence on it. Therefore, the problem has a strong complex socio-technical basis, where the major commercial banks have a big influence on the market environment. That is, any technical problems will have a negative impact on society as a whole. For example, a security breach due to technical flaws results in a data leak that affects millions of households and consumers. Other misconducts could occur following from poor decision-making. Here the case of Cambridge Analytica is a very well known example, which applies perfectly to the risk that consumers take when they share their financial data with a TPP [Raben2018]. This remarkable event paved the way for new research aimed to prevent misconduct via regulation, which is becoming increasingly more important in general and very relevant regarding financial data.
1.8.2 Social Impact

Moreover, this research also focuses on the regulatory perspective. In particular, most regulatory interventions in the financial industry try to minimize malicious practices and stimulate economic stability. The question is if the PSD2 regulation is established for the same reason. This research aims to clarify the intentions of the regulator and verify if the banks are aware of possible outcomes resulting from their API design.

This objective leads to a more complete view of the financial ecosystem. Consequently, the result identifies the driving forces behind the regulatory intervention, the commercial interest of banks, and the strategic view of TPPs. Ultimately, this insight provides a direction of what to expect for the future of Open Banking and how the financial ecosystem is likely to unfold.

1.8.3 Explicating the Regulatory Technical Standard

Moreover, institutional improvements can always be made. In this particular sector with already tight and complex legislation, identifying a way to improve the process of regulatory intervention for enforcing a new Regulatory Technical Standard (RTS) is another very interesting field of research. Therefore, to extend the technical focus with the institutional aspect of API design for Open Banking, this research provides a more complete view of the alignment of technological development and institutional demands.

In summary, bad APIs for Open Banking result in insufficient protection of financial data. Consequently, consumers could experience the worst outcomes of privacy violations and financial misconduct.

Furthermore, a lack of technical standards results in useless API-based systems, which blocks the digital transformation of the financial ecosystem. Thus, a state of Open Banking will never be achieved because its technically impossible to share financial data.

1.9 Overview

In the fast-moving innovative environment of digital finance it is hard to keep track of changes. Therefore, the rest of the research will follow a thoroughly structured, step by step approach, which is presented in the research design in chapter 3. Figure 1.2 provides a schematic overview of the whole research outline.

The scientific knowledge gap has been identified and the main research question is presented in Chapter 1. Thus, the relevant research methods for answering the sub-questions are introduced in Chapter 2 that discusses the research design. A literature review is performed and included in Chapter 3 to provide the necessary theoretical background for the research. Subsequently, the process of the research design is carefully followed and the findings are discussed accordingly in Chapter 4. After the results are obtained, the findings are analyzed in Chapter 5 and the results are presented in Chapter 6. Finally, the main conclusions of the research are presented and some prefatory guidance is given for future research in Chapter 7.
CHAPTER 1. INTRODUCTION

Figure 1.2: Research Flow Diagram
Chapter 2

Research Design

In this chapter, the research approach and the research methods for answering a particular sub-question are explained. The following chapter addresses the considerations and application decisions of different theoretical frameworks. Additionally, the choices during the research implementation are explained.

The Research Design combines Case Studies with Design Science and Scenario Engineering. Ultimately, design principles are formulated to answer the research question, which results in Robust Design Principles for API design for Open Banking. This combination of methods is called Robust Design Engineering (RDE) henceforth.

2.1 Research Setting

This research is conducted at a global IT service company called CGI. The demand for IT services is increasing due to the digitization and automation of processes throughout the modern economy. CGI has clients in many different industries such as government, health, manufacturing, transportation, and utilities. Besides these activities, CGI also provides IT services for 19/20 of the top banks in Europe and 22/30 of the world’s largest banks. Therefore, CGI is very much interested in digitally transforming the financial industry. Especially, with knowledge about Open Banking, CGI aims to help its clients to stay ahead of competition.

2.1.1 Geographical Scope

During this research, interviews are conducted at organizations in the financial ecosystem. The geographical scope of the financial ecosystem is restricted to organizations in the Netherlands, so the decisions and underlying ideas about Open Banking might be different at organizations in other countries.

2.2 Search Method

The current state of the art literature is searched for by using Web of Science, Scopus and Google Scholar. The key terms that are used to place this subject in the right context and understand the market environment are: “Digital Finance”, “FinTech” and “Open Banking”. Subsequently,
the terms “Application Programming Interface” (API), “Banking-as-a-Platform” (BaaP) and “API ecosystem” are used for the technical approach and clarify the digital structure of the financial ecosystem. Finally, the regulatory component is analyzed with the terms “RegTech”, “Third Party Providers” (TPPs) and “Ethics and PSD2”.

2.3 A Brief Overview of the Design Approach

The methods are discussed in order to explain how each sub-question is answered. Ultimately, the results lead to a set of Robust Design Principles for Open Banking.

2.3.1 Design Science

Design Principles cannot be found in a universally applicable list. These principles can only be created after careful analysis of the system they are designed for. Thus, Design Science is used to effectively create adequate design principles and answer the research question.

“What design principles of API design for Open Banking accurately deal with trade-offs among stakeholder interests and prove enough robustness for the changing financial ecosystem?”

Figure 2.1: Design Science Research Cycles [Hevner2007] p.88

Design Cycles

Design science uses three design cycles to provide a structured approach [Hevner2007]. To begin with, the rigor cycle is used to construct a knowledge base that consists of gathered data from literature and a case study including relevant actors in the ecosystem. Secondly, the relevance cycle is used to analyze the previously gathered information. The analysis is based on the underlying rationale of the different actors in the ecosystem and their mutual interest. At last, the design cycle
CHAPTER 2. RESEARCH DESIGN

is used to deduct design principles from the findings unidentified in the previous cycles. Ultimately, the constructed set of design principles are evaluated by experts and improved if necessary.

2.3.2 Methods for Answering Sub-questions

The chosen method includes enough flexibility to deal with the discussed uncertainties of the dynamic environment. The research question is divided into smaller sub-parts, answering different sub-question in every sub-part. Different information is needed to answer these sub-questions, where different data sources are needed to collect the right information. The tools to collect and analyze the data are discussed in the following sections.

Figure 2.2: Sub-Questions with Corresponding Methods
System Analysis

Firstly, a system analysis will be made, which illustrates the institutional environment, the technical background, and the relevant actors in the system.

The first sub-question aims to clarify the needs of the financial ecosystem and the Open Banking environment in which the APIs operate. Therefore, the first question is:

“1. What are the trade-offs in the financial ecosystem look like from a contextual and technical aspect?”

Thus, the start of the research describes the financial ecosystem. After the system is explained, the qualitative data will be gathered via a case study.

Case Studies

The first case study will be performed to explore the digital environment of the financial ecosystem. In particular, the developer portals of Dutch banks will be assessed. The second sub-question identifies how the previously identified needs are currently satisfied by the current state of the financial ecosystem.

In particular, the market is analyzed to clarify how APIs are currently designed for Open Banking. Regulation and compliance is a big driver that shapes API design requirements for financial institutions. Furthermore, the APIs are mostly used by Third Party Providers (TPPs) that request financial data. Therefore, these TPPs also have a big impact on formulating the requirements for the APIs for Open Banking. Therefore, the second sub-question is:

“2. What is the effect of stakeholder groups on the financial ecosystem?”

To answer this sub-question, the stakeholder groups are described and their effect on the financial ecosystem is identified by case studies. The case studies explicate the ideas behind the implementation processes and final outcomes of the API-based systems. Interviews are held to find out the vision of specific actors regarding Open Banking.

Scenario Engineering

Future developments are forecast according to the findings of the case study. The scenarios entail the most important indicators that determine the future of Open Banking. Scenario Engineering provides a structured and concise way of processing the case study findings and formulate expectations about the future market environment.

Ultimately, these scenarios are used to make sure the set of Design Principles are well protected against possible future market developments. These scenarios help to formulate requirements with a sufficient level of Robustness. Thus, the third sub-question is presented accordingly:

“3. What future scenarios can be forecast to make the requirements for APIs for Open Banking more robust?”

The gathered data from the case studies indicates how different stakeholder interests affect the financial ecosystem. The case study findings serve as input for scenarios that help to forecast the future of the financial ecosystem. By presenting scenarios and anticipating on the changing financial ecosystem, the requirements for APIs for Open Banking become future-proof.
Analysis of the Case Study Findings

The functionalities of currently operational APIs are assessed in the case study. The rest of the case study findings are further analyzed by explicating trade-offs among stakeholder interests. The impact of different stakeholder groups are generalized and presented in a concise overview. Hence, the fourth sub-question is:

“4. What are the robust API design requirements according to the Four Cornerstones of the financial ecosystem?”

The interviews from the case study result in narratives that entail different stakeholder interests. Narrative Synthesis and Pattern Identification helps to determine trade-offs among stakeholder interests. Subsequently, generalized stakeholder interests and the previously identified scenarios are combined to formulate robust API design requirements for the financial ecosystem by Meta-synthesis. Finally, the results are presented in a concise overview according to the aspects of service, technology, legislation, and ethical value.

Qualitative Data Findings and Results

The identified requirements need to be related to the quality of the information in the system, which acts as a preceding step towards the formulation of design principles. The quality of data sharing in an information system is determined by the Information Quality Dimensions. Therefore, the fifth sub-question is formulated as follows:

“5. To what extent do the requirements relate to the Information Quality Dimensions for systematic data sharing?”

The answer to this sub-question is the last step towards the formulation of design principles. After the requirements are linked to the Information Quality Dimensions, the design principles of APIs for Open Banking can finally be formulated.

Principles-Based Design

Finally, the research question can be answered with the input from previously mentioned findings. The presented scenarios will serve as a basis to formulate design principles for API design in an Open Banking environment. The aim is to increase the robustness of API design in the changing financial ecosystem. Therefore, the sixth sub-question is formulated as follows:

“6. What design principles are capable to deal with the dynamic environment and result in robust APIs for Open Banking?”

Until this point, every step leads towards the formulated set of Design Principles for APIs for Open Banking. The last part discusses the validation procedure for making sure the final set of design principles is perfect.

Evaluation

The final step of the research design is to evaluate the design principles. Experts in the financial ecosystem are used to evaluate the formulated set of design principles to expose any shortcomings or incompleteness. After such remarks, the set of design principles is updated accordingly in order to improve its effectiveness. The corresponding sub-question is the seventh and last one:
“7. What are the possible implications on the financial ecosystem regarding the presented set of Design Principles?”

After the design principles are evaluated against any undesired effects on the financial ecosystem, the set of Design Principles for APIs for Open Banking is complete. Every step of the Robust Design Engineering (RDE) approach discussed in this research design leads to a robust set of design principles capable of producing APIs in a changing financial ecosystem towards Open Banking.

Furthermore, RDE is applied in this case to form the set of Design Principles for APIs for Open Banking. The research is performed in a unique environment and with a certain scope that needs to be made explicit. More specifically, the research setting clearly explains the environment in which the research is conducted and the data is gathered.

As previously discussed, answering the research question ultimately leads to a set of verified design principles that deals with the changing financial ecosystem. The methods for answering the sub-questions are provided. The following part discusses the methods more extensively.

2.4 System Description

As mentioned before, the system description consists of several parts. The contextual aspect of the financial ecosystem is explained by an institutional analysis, a network analysis, and a stakeholder analysis.

The technical aspect of the financial ecosystem is explained by a schematic overview of the financial data flow using BPMN, and the relevant technical API specifications are discussed by referring to official explanations of important API developers.

2.4.1 Contextual System Description

The system description starts with the more general contextual aspect, where relevant actors of the financial ecosystem are introduced.

Institutional Analysis

Institutional analysis is performed according to the four level framework of formal and informal rules [Williamson2000]. The relevant actors in the system are placed in the corresponding institutional layer according to the system thinking guidelines [Hermans and Cunningham2018]. Additionally, the concepts of Open Banking and API design are linked to its corresponding institutional layer.

Critical Transactions

The institutional environment needs to be coordinated by the implementation of adequate technical components. These technical components need to be of a certain quality to guarantee the system’s performance. In order to create adequate technical components for a system of interest, the whole infrastructure needs to be taken into account. The core functionalities of the infrastructure are called ‘critical transactions’ [Kunneke et al.2010].

Stakeholder Analysis

The stakeholder analysis builds upon a preliminary Actor Overview. A full overview of relevant actors in the Dutch financial ecosystem can be found in Appendix D. The stakeholder analysis uses
a more structured approach than just summing up a list of actors. It follows a more in-depth analysis of their interests and capabilities, so the relative positions of stakeholders can be evaluated.

Network Analysis

In the introduction, the network hierarchy and the relationships among stakeholder groups are briefly discussed according to the network theories of multi-actor systems [De Bruijn and Ten Heuvelhof2000].

In the system analysis, the multi-actor system is further evaluated by focusing on the decision-making process in the financial ecosystem. More specifically, possible positive and negative strategies of stakeholder groups are discussed which relate to the actual behavior of the organizations from the case study.

2.4.2 Technical System Description

For this research, the alignment of technical components with the right institutional layers is used to link the APIs for Open Banking to the financial ecosystem. An analogy for digital banking can be made with other reformed systems and infrastructures, such as rail transportation, energy, and telecommunications. Especially telecommunications is an interesting example because it also uses a network with different stakeholders to provide digital services to society. Telecommunication is a service that is now acknowledged in the Netherlands as a necessity of life in our society. The prospect of digital banking shows much resemblance to the aforementioned services.

Business Process Modelling Notation

Subsequently, the technical aspect of the financial ecosystem is described by a schematic overview of the process flows is presented using the Business Process Modeling Notation (BPMN), according to the BPMN 2.0 standards [Chinosi and Trombetta2012]. The technical part describes the data flow within the financial ecosystem by representing it in a comprehensible overview. The represented flow of data is the beginning of the transition towards an Open Banking system.

2.4.3 Combining the Contextual and Technical Aspects

Thus, the start of the research describes the financial ecosystem. A complete overview of the system is provided by combining the contextual and technical aspects of the financial ecosystem. Finally, the findings from both contextual as the technical side of the system are brought together by formulating general API design considerations.

In short, the contextual and technical aspect of the financial ecosystem is fully described by the methods introduced above. The next part evaluates how the market is currently performing and to what extent this contextual demand is satisfied.

2.5 Case Study

As stated earlier, there is no perfect API for Open Banking and every organization is designing them with a different approach. Therefore, the case study is providing more insight into how APIs are currently developed. Afterward, design processes are analyzed to identify systemic developments.
That is, the contemporary market conditions are evaluated. Qualitative data is gathered via a case study, to explain the current state of the financial ecosystem.

The second sub-question addresses how the previously identified needs are currently satisfied by the current state of the financial ecosystem. In the system analysis, the relevant actors in the financial ecosystem are introduced and their positions are explained. In this part, the roles of the commercial banks in the financial ecosystem are evaluated and later relevant stakeholders are thoroughly examined by interviews.

Case Study Design

A case study is considered an empirical method that investigates a contemporary phenomenon in depth and within its real-world context. Especially when the boundaries between phenomenon and context may not be clearly evident, a case study helps to explicate the underlying reciprocity [Yin2017].

The case study for this research is designed to determine how the financial ecosystem is changing due to Open Banking. Therefore, the focus lies on a contemporary phenomenon. APIs are consistently evolving as the market is changing and regulation is adapted to the changing environment.

2.5.1 Exploratory Part for Technical Compliance

The first part consists of an exploratory case study, which focuses on technical requirements. The commercial banks in the financial ecosystem of the Netherlands are evaluated on regulatory demands. All of these banks had to present their operational developer portals to comply with Open Banking requirements. These banks all had some space to develop their own functionalities and implement relevant services according to their best capabilities. Consequently, these developer portals show some differences that are interesting to compare.

Comparative Analysis

For revealing the variations in the program definition depending on the perspective of different actors, the case study begins with an exploratory case study. Different developer portals are assessed by comparative analysis. The main goal is to observe specifications of the available developer portals and discover the differences between them.

The exploratory case study is combined with a more in-depth explanatory case study. More specifically, the explanatory case study aims to find out differences in strategic views between organizations. In particular, interviews are conducted to identify the differences. Consequently, each part addresses a specific view on the topic and assesses the environment in an alternative way.

2.5.2 Explanatory Part for the Contextual Aspect

The explanatory case study evaluates how organizational strategies affect the contextual aspect of the financial ecosystem. The explanatory part of the case study includes multiple organizations from different stakeholder groups. The different perspectives help to get a complete overview of the financial ecosystem.

The purpose of the explanatory effort is to provide deeper insight into a concept, where a wide range of topics forms the essence of the description. The topics are considered with their underlying rationales and help to develop a theoretical base for the research design.
**Impact on the Financial Ecosystem**

The objective will be to find out how and why differences in developer portals occur via interviews with carefully selected persons at the relevant organizations. Moreover, this part of the case study includes more organizations than banks alone and takes the broader ecosystem into account by involving up- and downstream organizations affected by the digital transformation of banks, in particular TPPs and the Dutch banking Authority, DNB.

A case study is performed to explore the current state of API design for Open Banking and explain its effect on the financial ecosystem.

### 2.5.3 The Case Study Approach

The case study approach is presented in the case study protocol, which provides a concise overview of why and how the case study is performed. Both the explanatory and the exploratory case study each have their corresponding case study protocol.

#### The Case Study Protocol

The case study protocol includes several steps to clearly communicate the purpose and the data-collection procedure. The specific steps of the case study protocol are presented in Table 2.1.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Overview and background information</td>
</tr>
<tr>
<td>2.</td>
<td>Data collection plan</td>
</tr>
<tr>
<td>3.</td>
<td>Formulation of assessment topics</td>
</tr>
<tr>
<td>4.</td>
<td>Tentative outline of case study report</td>
</tr>
</tbody>
</table>

Table 2.1: Case Study Protocol Steps

#### 2.5.4 Selection of Data Sources

Based on all aforementioned considerations, the data sources for collecting the qualitative data are determined here. For the exploratory case study, the developer portals for the major commercial banks in the Netherlands are included. The exploratory study is easier to perform because the assessment criteria include technical requirements.

On the other hand, the explanatory case study is more complex because the assessment criteria are focused on the contextual aspect of the financial ecosystem. Therefore, the selection of data sources for the explanatory case study requires a more structured approach.

#### Conceptual Test Checklist

The following approach considers a method for data source selection according to the specific validity and reliability requirements. Once the data source selection procedure passes this checklist, the quality of data gathering is guaranteed.

The case study passed the four conceptional tests of quality in the following way.

The information-gathering procedure should be improving during the research according to Rigor. Although, optimizing the data gathering procedure must not influence the specified topics that serve as the foundation of the gathered data and indicators of comparison.

After the design is complete, the case study is ready to be performed. The following part discussed how data is collected via the case study.
CHAPTER 2. RESEARCH DESIGN

Data Source Quality Features

- General validity is ensured by using multiple sources of evidence. The sources are selected according to certain selection criteria.
  - Exploratory part: developer portals of banks in the Netherlands are considered
  - Explanatory part: interviews are held with a project leader to clarify the strategic aspect, and a lead developer to clarify the technical aspect
- Internal validity: rival explanations are used for the explanatory study part. Thoroughly assess if events are causal, despite contrasting rival explanations.
- External validity: search for answers to the how and why questions with an analytical generalization of the findings and deduct design principles that apply to the entire financial ecosystem.
- Reliability: the research should minimize errors and biases. Clear communication of data collection procedures should ensure that any repetition leads to the same results. In particular, an explicit case study protocol is provided to guarantee the reliability of this research.

Table 2.2: Checklist for Data Source Quality \[Yin2017\]

2.5.5 Preparing to Collect Case Study Evidence

The case study data is collected according to the case study protocol, which consists of four parts. Each part is briefly introduced and directly followed by relating them to the research subject.

Overview of Background Information

Firstly, an overview has to be provided where the objective is presented. Additionally, the case study issues have to be expressed and the relevant readings about the topic need to be included.

In particular, the key driver that sparked the changing market environment is the regulatory impact of PSD2, so relevant literature and readings are included in the preparatory work. Additional background information concerns API design and its development.

Data Collection Plan

The data collection plan is specified in the selection of data sources in Table 2.2, in which the selection procedure for choosing the relevant sources of data is discussed.

Formulate Assessment Topics

Subsequently, the topics of assessment are formulated according to the five levels of data gathering presented in Table 2.3. For the exploratory part, the topics include assessment criteria. For the explanatory part, the topics include interview questions.

Tentative Outline of Results

The final part of the case study protocol includes a tentative outline of the case study report, so the report is more structured and the results are better comparable. The outline is included in Table 2.4.
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Data Gathering Level
- The general topics for the different subjects (or subject groups) are explained in the case study protocols.
- The formulation of specific topics follows from the prior knowledge base.
- The patterns of findings are deducted from the data across multiple cases.
- The information beyond the case study evidence includes additional literature presented in the literature review.

Table 2.3: Checklist for Data Gathering [Yin2017]

Results Part
- Tables to present the exploratory case study findings in a comparable overview and associative figures to better explain case study findings.
- The collected data is documented and included in Appendix F and G to present the complete basis on which the conclusions are drawn.
- The bibliographic information in the Bibliography includes the literary basis on which assumptions are made for developing methods and preliminary theories.
- Apart from the ability to better compare the results, most interviews are recorded and saved for allowing a more precise analysis of the answers given. It also allows focusing on the conversation without being distracted by writing along during the interview.

Table 2.4: Tentative Outline of Case Study Findings [Yin2017]

2.5.6 The Design

Before the case study can be designed, the actual purpose has to be formulated. Since API development for Open Banking has to comply with the regulatory standards, the minimal requirement seems clear. However, the process of developing APIs, determining what specific functionalities to include, and the way the APIs are operating may result in differences among the relevant banks. These differences occur because the strategic views form the basis for API development and result in sometimes contrasting implementation approaches and alternative outcomes.

Rival Explanations

Several assumptions are made based on prior conducted system analysis. These preferably contradicting assumptions are called rival explanations and are formulated before the case study is conducted. Anticipating on potentially important rival explanations helps to conduct a more complete case study. If both contradicting rivals are unexpectedly revealed after the data analysis, it serves as input for designing future case studies [Yin2017].

2.5.7 Planning

To begin with, a mixed-method approach is used to gather the required information. The literature serves as background information to construct a theoretical base and formulate sharp questions about the topic.

As indicated earlier, the Rigor cycle is used to form the knowledge base. The literature background marks the conceptual starting point of the case study. In other words, the relevant literature explains the boundaries of knowledge about Open Banking and the financial ecosystem.
Exploratory vs. Explanatory

The first part of the case study is constructed to evaluate the differences between how the banks shape their developer portals. This is done during the exploratory case study, which leads to findings that result in additional input for the explanatory case study.

Thereafter, the reason why the banks develop their portals as they did is analyzed by conducting interviews with relevant persons at the banks. Finally, the rest of the ecosystem is analyzed by further interviewing relevant persons at carefully selected organizations. Ultimately, the case study reveals how the financial ecosystem is changing towards Open Banking.

Briefly, the exploratory part of the case study includes a comparative analysis of the commercial banks’ developer portals, which evaluates the technical side of the current market.

The explanatory part dives deep into the stakeholder groups by conducting interviews, which focuses more on the contextual side of the current financial ecosystem.

The approach of conducting the actual case studies is further elaborated and serves as the foundation for the case study protocols.

2.6 Scenario Engineering

In order to make the requirements future proof, the financial ecosystem needs to be elucidated. For that reason, the information gathered in the case study will be analyzed and the conclusions will serve as input to carefully develop specific scenarios via Scenario Engineering.

2.6.1 Robust Design Principles

Ultimately, these scenarios are used to make sure the set of Design Principles are well protected against possible future market developments. To do so, the requirements have to be validated and updated accordingly if any sign of incompleteness is shown. The requirements are successfully protected against probable future developments if they pass the test and prove their robustness.

2.6.2 Approach

The scenarios are developed according to specific attributes and specific techniques are used. The specific attributes are included in Table 2.5 where possible alternatives are explained. Thereafter, the applied techniques are introduced.

Judgment Based

Quantification is too difficult, so qualitative data is gathered. This implies that a judgment based

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Explanation of Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basis:</strong></td>
<td>Scenarios are either developed based interpretation of qualitative data and judgment of the environment or quantification of observations and measurement of probabilities.</td>
</tr>
<tr>
<td><strong>Perspective:</strong></td>
<td>A future forecast is based on identified characteristics and a forward-looking approach is used to consciously predict possibilities, or similar events of the past are used in a backward-looking approach to adopt similar outcomes.</td>
</tr>
<tr>
<td><strong>Input:</strong></td>
<td>Scenario techniques primarily rely on groups to provide input for scenario development, otherwise sector experts (geniuses) are able to fulfill a similar role.</td>
</tr>
</tbody>
</table>

Table 2.5: Attributes of Scenario Development

Bishop et al.2007
CHAPTER 2. RESEARCH DESIGN

approach has to be chosen.

Forward-looking

Instead of backward-looking. Some similar events are introduced, such as SEPA project and Instant Payments. However, the system analysis shows that APIs for Open Banking has too many unique characteristics that a backward-looking approach is unfit for proper scenario development. Otherwise, design principles could have been adopted from other events, which is impossible due to the different impact on the identified financial ecosystem.

Findings from Stakeholder Groups

The findings from the case study provide the input for the scenarios. The perspectives and strategies from different stakeholder groups determine how the financial ecosystem unfolds itself. Therefore, the findings from the interviews serve as a foundation for scenario development.

2.6.3 Scenario Development Techniques

According to previously selected attributes, there are specific techniques that are able to be selected. The most adequate techniques based on the produced outcomes are presented here. Most scenarios are used to anticipate future events and form the basis for strategic planning [Ringland and Schwartz1998].

In short, scenarios are created to make the design principles of future proof or robust. The scenarios are developed according to certain attributes and different techniques are used to present reliable scenarios.

2.7 Analysis of the Qualitative Data

The results are shown in a comprehensible form to provide a concise overview of the case study findings presented in narrative form. The gathered data from the case study is quite extensive and difficult to present comprehensively. Therefore, a structured approach is chosen to present the findings.

2.7.1 Narrative Synthesis

The narrative synthesis method is used to analyze the case study findings and to clarify the collective influence on the financial ecosystem. The narrative synthesis method combines of cross-case synthesis [Cruzes et al.2015], and meta-synthesis for preliminary theory building [Hoon2013].

Cross-Case Synthesis

The qualitative data in the form of narratives is used to extend the knowledge base. The most important findings are summarized and presented in a comprehensible overview, which allows coping with a large evidence base. The narrative serves are input for theory building, but the reviewer has to stay unbiased and control any prejudices [Cruzes et al.2015].
Goal and Synthesis Process

For each stakeholder group, the findings are compared. Consequently, a generalized stakeholder interest and effect on the financial ecosystem can be explained. Ultimately, the impact of different stakeholder groups determines the needs and characteristics of the changing financial ecosystem.

During the process of narrative synthesis, trustworthiness is a key factor for achieving a logical explanation of sufficient quality. Clearly communicating the outcomes and traceability of certain decisions secures the trustworthiness of the synthesis [Cruzes et al. 2015].

2.7.2 Pattern Identification

A pattern is defined as the reason why a phenomenon is occurring. The conceptual idea of pattern identification is to verify if the predicted assumptions about the financial ecosystem are indeed correct. The literature is the primary source of these assumptions. More specifically, the literary basis is used to form certain rival explanations and the case study is conducted to verify which explanations are actually correct [Yin 2017].

Every interview leads to its own unique explanation theory. After the explanation theories are formed, the rival explanations are tested against the case study findings. The conceptual idea of pattern identification is to find these analytically predicted causal connections between events, so certain theoretical explanations support probable future outcomes [George et al. 2005].

The actual execution of pattern identification will not be done via complicated computer programs or extensive model building. The patterns are identified and explained on a conceptual level with the congruence testing method.

Congruence Testing

Before the case study is conducted, several rival explanations are formulated. These rival explanations are tested during the data analysis. Congruence testing is an allows verifying if predicted outcomes actually match the case study results [Bennett 2004].

Ultimately, the confirmed rival explanations form the foundation for the design principles. Whereas the false ones are rejected based on the case study findings.

2.7.3 Explanation Building

The gathered data from the interviews serves as input to develop explanatory theories about the changing financial ecosystem. Although, the deeper structures of the underlying issues and interests are not directly observable. Explanatory process theories aim to clarify these deeper levels of the narrative structure and penetrates deep into the Fabula behind the story a person is telling [Pentland 1999]. In other words, the story is a version of the underlying Fabula that researchers use to explain the particular set of events and the relationships occurring in the system. A schematic overview of the levels of structure in narratives is presented in Figure 2.3.

Process Theory helps to make explanations from descriptions and Meta-synthesis merges the results from the analysis into a general systemic theory.

Process Theory

The levels of Structure in Narrative [Pentland 1999] set out how to move from surface levels of information to a deeper level. Ultimately, the gathered information from interviews has to be translated into conceptual mechanisms. In other words, the contextual explanation behind the
findings from the interviews is presented in the form of main concerns and key concepts for each stakeholder group.

**Meta-synthesis**

The final part combines the previous findings of the data analysis and creates a theoretical conclusion that explains the contextual demand of the financial ecosystem. A structured step-by-step approach is used to formulate the explanatory theory. Table 2.6 includes the Meta-synthesis steps, where the link with this particular research is explained. Finally, the requirements for the API-based systems is related to the Four Cornerstones of the financial ecosystem, as indicated in Figure 1.1. The four cornerstones include the aspects of service, technology, legislation, and ethical value.

<table>
<thead>
<tr>
<th>#</th>
<th>Process</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Analyze on a case-specific level</td>
<td>Discuss findings per stakeholder group</td>
</tr>
<tr>
<td>2.</td>
<td>Synthesis on a case-study level</td>
<td>Discuss patterns within the broader financial ecosystem</td>
</tr>
<tr>
<td>3.</td>
<td>Building theory from Meta-synthesis for decision-making by cognitive shift</td>
<td>Evaluate on financial ecosystem to form the basis for the design principles</td>
</tr>
<tr>
<td>4.</td>
<td>Discussion of outcome</td>
<td>Communicate the limitations and intrinsic assumptions</td>
</tr>
</tbody>
</table>

Table 2.6: Step-by-step Approach for Meta-synthesis

After conducting the Meta-synthesis, the Open Banking requirements are related to the Four Cornerstones of the financial ecosystem. That is, each stakeholder interest is discussed by addressing the corresponding aspect of the Four Cornerstones from Figure 1.1.

In sum, the data analysis completes the contextual analysis, which allows us to present the final requirements. The outcome is used to align the technological opportunities with the financial ecosystem’s demand. Finally, the requirements for the API-based systems are linked to the aspects
of service, technology, legislation, and ethical value.

2.8 Formulation of Design Principles

After the design requirements are formulated, the requirements for API design has to be assessed on a higher conceptual level in order to reach overarching goals. Ultimately, the evaluated set of design principles for API design for Open Banking can be used by participants to contribute and establish a durable financial ecosystem.

The formulation of requirements is subject to interpretation issues of the needs and the perception of the changing environment. Whereas design principles are defined as normative, reusable and directive statements that guide architects in designing the capabilities needed to achieve overarching goals [Bharosa and Janssen2015].

2.8.1 Information Quality Dimensions

An intermediate step before design principles are formulated is linking the financial ecosystem’s demand to the Information Quality (IQ) dimensions. The IQ dimensions provide the functional foundation, which is pursued by the design principles.

One concept of developing information systems comes from the military and is called Network Centric Operations (NCO) [Bharosa and Janssen2015]. NCO is described as being able to let the respondents decide the quality of the data by involving relevant people that are able to judge the data quality.

2.8.2 Formulation of Design Principles

The requirements for Open Banking are linked to Information Quality dimensions. Subsequently, a set of design principles is presented that satisfies the concerns of the financial ecosystem and safeguards the Information Quality dimensions. Ultimately, interested organizations are able to adopt these principles to jointly establish a robust technical infrastructure and contribute to a durable financial ecosystem.

Inspiration for formulating the design principles is found in similar projects for the financial ecosystem, such as Regulatory Technical Standard (RTS), SEPA project and Instant Payments.

To summarize, the requirements for Open Banking in the changing financial ecosystem are linked to the Information Quality Dimensions of systematic data sharing. Subsequently, a set of design principles is created that satisfies the requirements for API design for Open Banking and ensures the quality of the information system.

2.9 Evaluation

The final step of the research plan is to evaluate the design principles. More specifically, experts in the financial ecosystem evaluate the formulated set of design principles to expose any shortcomings or incompleteness. After such remarks, the set of design principles is updated accordingly in order to improve its effectiveness.
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Expert Validation
The design principles are evaluated by experts in the financial ecosystem. The evaluation process is structured by following a sequential approach, which includes verification, validation, and reliability. The following theoretical background leads to the expert assessment form, which is included in Appendix H.2.

2.9.1 Selection of Experts
Before the criteria are able to be assessed, the required experts have to be selected. The most suitable experts for assessing the design principles are the people that provided the input for the design principles. Therefore, the experts responsible for the evaluation are the same people that were selected for the interviews.

2.9.2 Evaluation Approach
The expert assessment form is sent to the experts by e-mail and they are explicitly asked to provide rectification of their choice to increase the reliability.

Verification
Firstly, the relevance of each design principle is addressed by a verification test. Therefore, the first part of the expert assessment form includes questions that require to score the applicability of the design principles [Balci and Smith1986].

Validation
Secondly, the performance of each design principle is evaluated by a validation test. The expert assessment form includes a scoring model where the perceived accuracy of the design principles is required to be indicated [Balci and Smith1986].

Reliability
Finally, the reliability of the expert evaluation results is addressed by the part that requires experts to provide specific feedback and rectify the given scores. This particular part consists of an open question that requires more thorough arguments for feedback than the previously indicated scoring based approach. Consequently, the reliability of the expert evaluation is increased due to the included explanation of their assessment [O’Keefe and O’Leary1993].

As a final step, the set of design principles is evaluated by experts in the financial ecosystem in order to assess the quality of the design principles.

2.10 Preliminary Implementation Overview
Finally, the results are placed in a conceptual perspective by providing an overview of the outcomes if the design principles would be implemented correctly.
Technological Infrastructure Policy Creation

The design principles are presented in a pragmatic overview by using the Technological Infrastructure Policy (TIP) Creation [Justman and Teubal1995]. The system is described on a higher conceptual level, which allows to place the research outcome directly to the applicable environment and explain a conceptual purpose. The results describe the consequences of adequate design principles and reflect on the desired result of robust APIs for Open Banking.

The desired outcome for the financial ecosystem is finally linked to the Four Cornerstones from Figure1.1. The design principles are influenced by the concerns identified from the literature research and show the progress of this research in a concise overview.

2.11 Conclusion

The last part introduced the research approach and all the methods for answering the sub-questions. In a more general perspective, this research provides a methodology to analyze a complex multi-actor system by combining several frameworks and theories. Subsequently, this so called Robust Design Engineering (RDE) framework is tested on the financial ecosystem in the Netherlands and leads to the a set of Robust Design Principles for APIs for Open Banking.
Chapter 3

Literature Review

Several methods were introduced in the last chapter. These methods rely on several theoretical concepts and frameworks, which will be elaborated here.

The following literature study starts with background information about the financial service sector and the changing financial ecosystem. Subsequently, some relevant theory is discussed to further explain the methods for conducting the research.

A brief elaboration on theoretical background for the introduced methods is provided to formulate a strong foundation for executing the research. The selected methods are further explained with relevant literature and decisions about the methodology are discussed. The research design is becoming of sufficient quality due to the thorough consideration of theoretical background. Ultimately, the research design is strengthened by the consciously determined specifications of methods that further shapes the Robust Design Engineering (RDE) Framework.

3.1 Literature Background on the Changing Financial Ecosystem

First, the market environment is described, where openness vs. security of data is discussed. Subsequently, the technical background is discussed, where the API is the key concept. The changing financial ecosystem revolves around the implementation of the APIs. Finally, the subject is addressed from a regulatory perspective. The current regulatory landscape within the European Union will be discussed and the impact of international legislation on the market environment. Additionally, a concise overview of the reviewed literature articles is provided in Table A.1 which is included in Appendix A.

3.1.1 Market Environment

Several financial innovations have come from non-financial institutions, such as Amazon, PayPal, and Blockchain. The construction of a meta-theory could help explain certain trends in the market and provide structure in analyzing the response of incumbents [Khraisha and Arthur2018]. Many other FinTech companies offer services that reduce compliance costs for incumbents in the financial industry and increase their efficiency [Philippon2016b].

Third Party Providers (TPPs) are playing a more significant role in the changing market environment. TPPs use data from other market players and provide the services that others fail to
Examples of TPP services are provided by Payment Initiation Services Providers (PISPs), such as Adyen, or by Account Information Service Providers (AISPs), such as Smart accounting FinTechs like Bizcuit.

To a similar extent, APIs play a central role in sharing financial data in the banking industry as it provides access to account (XS2A) information. This data can be used in turn by web services provided by other businesses. Despite the fact that commercial banks are now legally obligated to share data to a certain extent, good architectural design becomes more important than ever. Generally, banks tend to have integrated data systems which are often very large (and old). Whereas the current market environment demands data to be easily accessible and systems to be functionally capable of small changes in the form of transactions. Therefore, these old systems need to be updated to a new structure where smaller sets are securely contained and efficiently operating [Espinha2015]. The concept that defines the transforming structures of financial organizations is encompassed by the term “Open Banking” [Zachariadis and Ozcan2017].

Current regulation has been the first step towards Open Banking, but every day new interpretations of redefining the financial landscape. The APIs need to be considered as a component of the entire architecture [Happel and Seedorf2006]. The ontology is a vital aspect in software engineering, so a structured approach that defines explicit functionalities and guarantees security must be ensured to maximize API performance. Eventually, no perfect API can be developed, it is an ongoing process of redefining the requirements and applying state of the art technology.

The most important feature of technology for sharing information for Open Banking is the Application Programming Interface (API). Giving a conceptual definition of the API helps to consider its role for the rest of the research. Therefore, the API and its considered implications is explained right here.

### 3.1.2 Application Programming Interface (API)

An Application Programming Interface (API) is used to exchange data between systems, so it plays a central role in financial data sharing. Although, APIs can have several functionalities that make the use of APIs more complex. More specifically, an API provides a consistent and predictable software interface between its provider and consumer [Jacobson et al.2011]. An API is generally self-contained and deliberately designed to have limited functionality, so for API design the interoperability of the individual APIs in the whole API based system is a crucial factor for the overall performance.

Despite the rather early introduction of the first API by the Salesforce in the year 2000 [Lane2012], it took some time before they were widely adopted. Since 2006, APIs have increased a thirtyfold and still continues to rapidly grow [Evans and Basole2016]. Currently, modern web service APIs are used to integrate applications into externally provided services. [Vinoski2008].

The Quality of an API

Before data can be extracted from a system by a caller, the caller has to gain access through a verification procedure.

Currently, different API access verification methods are used by API developers in the industry [Vijayakumar2018]. In recent years, market developments caused that API design became a procedure of trade-offs between security (strict accessibility) and flexibility (optimal usability) [Woo and Mori2004]. Moreover, IT systems have to become more agile to be able to adapt to the changing regulatory environment [Gong and Janssen2012].
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The design of APIs is constantly evolving because developers have to protect against malicious practices without affecting the operational processes [Farrell2009]. Through this, the development of computing services is moving from academia to the industry where the API economy is shaped [Tan et al.2016].

A bad API is usually caused by bad design, which then results in bad programming. Consequently, bad APIs require a lot of extra work for other programmers in the financial ecosystem and result in unnecessary additional costs. There are guidelines that can be used to design better APIs, but the best way to improve the general level of APIs is a structural cultural change by getting API design the attention it needs [Henning2009].

3.1.3 API Accessibility

APIs used to exist publicly or privately, which indicates if data is respectively internally or externally accessible. With Open Banking, the ‘partner’ API is created [Krönert2018]. Financial data now has to be openly available to certain licensed, ‘trusted’ partners of a bank, also known as Third Party Providers (TPPs) [Zachariadis and Ozcan2017].

3.1.4 The Right Level of Openness

One way for incumbents to secure their market position is by collaborating with TPPs by sharing complementary resources and capabilities in order to realize joint innovation. The right level of openness stimulates co-creation and can, in turn, lead to a flourishing platform ecosystem [Parker and Van Alstyne2005]. However, too much openness results in a loss of control over the customer relationship, which can have a negative effect on market potential [Ondrus et al.2015]. For this reason, 80 percent of current banks are expected to prosper from a new market equilibrium, while the remaining 20 percent are at risk of losing relevance and become insignificant in the new market environment [Krönert2018]. A well-defined governance mechanism safeguards a healthy collaboration structure. In order to protect an organization from any undesired loss of control, adequate formulation of decision rights, control, and incentives are of vital importance [Tiwana et al.2010].

The aforementioned implications about openness build upon previously conducted exploratory field studies. The interviews at financial institutions have shown that managers were uncertain about the financial outcome of the created APIs. Useful business cases could not be provided to back the investments made to develop the APIs for Open Banking [Schreieck and Wiesche2017].

Other studies about the environment introduce attributes that make a platform complete, any shortcomings in fulfilling them will result in the vulnerability of that company’s market position [Dhar and Stein2016]. Yet, the future of FinTech and incumbents is hard to predict as market failures hinder standardization [Kavuri and Milne2019]. Nevertheless, partnerships between FinTech start-ups and traditional banks could be beneficial to both organizations [Guibaud2016].

3.1.5 From a Regulatory Perspective

Risks to financial stability is an important factor for proper regulatory intervention [Financial-StabilityBoard2017]. Different measures describe how regulatory frameworks are used to control the financial industry today. A new phenomenon combines technology with law and introduces a new concept called Regulatory Technology (RegTech) [Arner et al.2016]. In the UK, the Financial Conduct Authority (FCA) already takes regulation further than PSD2. UK banks were already compelled to standardize account information and product data years ago. The FCA incorporated
technology into law and offered a chance to test novelties in a controlled environment called a “regulatory sandbox” [FinancialConductAuthority2015].

Still, the current top-down approach of regulators has not yet resulted in a structural change of the financial sector [Philippon2016a]. Policymakers are constrained by the operating systems in place, which limits the implementation of effective legislation [Gong and Janssen2012]. Currently, new regulation creates opportunities for FinTech companies to enter the market and use new technology to increase efficiency. However, these companies do not necessarily contribute to a more stable financial industry as their commercial interests often hinder standardization of the market [Milne2016]. Nevertheless, standardization efforts for big data systems are under development and fair benchmarks are already available [Han et al.2017].

The inability to patent the majority of financial innovations allows other firms to offer similar products and services, which limits firms to gain excessive market power [Khraisha and Arthur2018]. Within the regulatory boundaries, governance structures could be defined by the incumbents in collaboration with TPPs. This way there is an incentive for dialogue and co-creation via a durable collaborative structure [Tiwana et al.2010]. It also allows for dynamic optimization of the API performance as demands, and its underlying values might change with market developments.

All in all, Table A.1 in Appendix A provides a literature overview, where the emphasis lies on the Four Cornerstones of the financial ecosystem from Figure 1.1. Ultimately, the results of this research are related to the same Four Cornerstones.

The literature research continues by providing background information about the methods for answering the sub-questions. The concepts that form theoretical framework for this research are discussed in the following part.

### 3.2 Systematic Description of an Environment

The rigor cycle is used to construct a theoretical framework. In order to construct this framework, some background information about systematic descriptions of an environment is provided here. The financial ecosystem is conceptually divided by consisting of two distinct aspects. These aspects are described from a contextual and technical point of view.

#### 3.2.1 Contextual Aspects of a System

The system analysis starts with a description of the conceptual aspect of the financial ecosystem. Firstly, the contextual aspect of the financial ecosystem is described by considering its institutional environment. Subsequently, the actors in the system are considered by describing the
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financial ecosystem as a network. To complete the contextual view of the system, the relevant actors in the financial ecosystem are categorized and divided into stakeholder groups.

Institutional Theory

For the start of the system analysis, the concept of institutional theory is considered. The financial ecosystem is described by addressing different conceptual layers of the Economic Institutions in place. The Williamson Framework [Williamson2000] is applied to guide institutional analysis in the right direction.

Williamson Framework

The institutional analysis is performed according to the four level framework of formal and informal rules [Williamson2000]. The layers are explained in Table 3.1.

The relevant actors in the system are placed in the corresponding institutional layer according to the system thinking guidelines [Hermans and Cunningham2018]. Additionally, the concepts of Open Banking and API design are applied to its corresponding institutional layer.

<table>
<thead>
<tr>
<th>Layer</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embeddedness:</td>
<td>The most informal layer of the system, which represents the norms and values of the considered environment. In this layer, the underlying ethical basis for regulation is evaluated.</td>
</tr>
<tr>
<td>Institutional</td>
<td>The norms and values influence the rules of the game for the environment. The rules of the game are considered in this layer, which becomes effective in legislation.</td>
</tr>
<tr>
<td>Environment:</td>
<td></td>
</tr>
<tr>
<td>Governance:</td>
<td>The play of the game entails the way the rules are enforced. Governance structure uses the regulatory power to steer the market into the desired direction by intervening when necessary.</td>
</tr>
<tr>
<td>Resource Allocation:</td>
<td>This is the most concrete layer of the economy, where the actual economic transactions take place. Any unwanted activity needs to be corrected by adjusting the corresponding flaws in the preceding (or underlying) layers on top.</td>
</tr>
</tbody>
</table>

Table 3.1: Williamson Four Level Framework [Williamson2000]

Stakeholder Theory

A range of models that help understand actors and their strategic interactions are used for stakeholder analysis. A few concepts of systems thinking are described first before the actors are further analyzed using stakeholder analysis [Hermans and Cunningham2018]. This part builds upon the preliminary actor overview from the introduction and

<table>
<thead>
<tr>
<th># Stakeholder Analysis Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stakeholder Group Identification</td>
</tr>
<tr>
<td>2. Interest and Resource Description</td>
</tr>
<tr>
<td>3. Stakeholder Classification According to Attributes</td>
</tr>
<tr>
<td>4. Examination of Dynamic Relationships</td>
</tr>
<tr>
<td>5. Evaluation of Generic Stakeholder Management Strategies</td>
</tr>
</tbody>
</table>

Table 3.2: Stakeholder Analysis Steps [Bunn et al.2002]
serves as a further refinement before data is acquired from interviews.

Stakeholders groups have general attributes that characterise their behavior [Bunn et al. 2002]. These particular attributes are presented in Table 3.3.

**Network Theory**

Besides the institutional economic view of the system, the financial ecosystem is also considered on another contextual aspect. To provide a complete view on the contextual aspect of the financial ecosystem, different stakeholder groups are put into the network perspective. General characteristics of a multi-actor system are discussed and related to the financial ecosystem.

**Network Dynamics**

Specific characteristics of a multi-actor system are captured by the Network Dynamics, which include: the variety of actors, the closedness towards interventions, and the interdependence of stakeholder groups [De Bruijn and Ten Heuvelhof 2000]. An overview of the main obstacles and opportunities concerning the Network Dynamics are included by a table from the book, which is represented in Figure 3.2. Relevant issues addressed by the presented Network Dynamics are applied to the financial ecosystem.

Additionally, other characteristics of multi-actor systems are included to the network hierarchy and the relationships among stakeholder groups are briefly discussed according to the network theories of multi-actor systems [De Bruijn and Ten Heuvelhof 2000].

**Stakeholder Strategies**

In the system analysis, the multi-actor system is further evaluated by focusing on the decision-making procedure in the financial ecosystem. More specifically, certain strategies of stakeholder groups are discussed which relate to the actual behavior of the organizations from the case study.

The contextual aspect of the financial ecosystem is fully examined by the aforementioned methods. The other part of the system analysis describes the financial ecosystem from a technical point of view.

**3.2.2 Technical Aspects of a System**

The second part of the system analysis entails the technical aspect of the financial ecosystem. The system is described from a more technical point of view by using TIP theory [Justman and Teubal 1995] and discussing the critical transactions [Künneke et al. 2010] of the financial ecosystem.

**Technological Infrastructure Policy Theory**

Technological Infrastructure Policy (TIP) theory is a conceptual framework, which addresses the structural change of industries that depend on technical components. Technical infrastructures differ from conventional infrastructures with solely physical aspects such as roads and water, due to...
### Table: Obstacles and Opportunities

<table>
<thead>
<tr>
<th>Obstacles</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety</td>
<td>Higher chance of success with some of the parties</td>
</tr>
<tr>
<td>Limited reach of intervention</td>
<td>Possibilities for ‘divide and rule’ innovation</td>
</tr>
<tr>
<td>Possibilities for tailor-made</td>
<td>Functional reinterpretation</td>
</tr>
<tr>
<td>approach limited</td>
<td></td>
</tr>
<tr>
<td>Intervention reinterpreted/</td>
<td></td>
</tr>
<tr>
<td>transformed</td>
<td></td>
</tr>
<tr>
<td>Closedness</td>
<td>Support gained from closed party means that the</td>
</tr>
<tr>
<td>Intervention fails due to closedness and might become a ritual</td>
<td>strength of this party can be utilized</td>
</tr>
<tr>
<td>Interdependence</td>
<td>Dependencies can be utilized</td>
</tr>
<tr>
<td>Leads to hit-and-run and so to chaos</td>
<td>Incentive for cooperative behaviour</td>
</tr>
<tr>
<td>Network as a whole becomes opaque</td>
<td>Many exchange possibilities</td>
</tr>
<tr>
<td>Leads to sluggishness</td>
<td>Leads to rich and meaningful decision making</td>
</tr>
<tr>
<td>Leads to poor decision making</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3.2: Network Dynamics** [De Bruijn and Ten Heuvelhof2000] p.22

<table>
<thead>
<tr>
<th>Hierarchy</th>
<th>Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular and sequential</td>
<td>Irregular and no clear sequence of activities</td>
</tr>
<tr>
<td>Phases</td>
<td>Rounds</td>
</tr>
<tr>
<td>Actors are stable</td>
<td>Actors join and withdraw and behave strategically</td>
</tr>
<tr>
<td>One arena, process has a clear starting point and end point</td>
<td>Several arenas, no isolated starting point and end point</td>
</tr>
<tr>
<td>Content of the problem is stable</td>
<td>Content of the problem shifts</td>
</tr>
<tr>
<td>Incentive to regard problems as structured</td>
<td>Incentive to regard problems as unstructured</td>
</tr>
<tr>
<td>Consistency and predictability</td>
<td>Flexibility and unpredictability</td>
</tr>
</tbody>
</table>

**Figure 3.3: Decision-making Process** [De Bruijn and Ten Heuvelhof2000] p.26

the technical components and economies of scale [Justman and Teubal1995]. Good TIP is scalable and truly worthwhile if the system is of a certain conceptual size because it requires a considerable amount of effort before it can be formulated.
There are two forms of technical infrastructures, which are explained in Table 3.4. The corresponding characteristics are shown in Figure 3.4. In both modes, TIP defines a catalytic role for government that emphasizes institutional innovation rather than price-based measures, a role that is fully consistent with economic liberalization.

<table>
<thead>
<tr>
<th>Modes</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic TIP:</td>
<td>relies on conventional industries and requires a market-building approach to the assimilation of technological progress that stimulates the supply of technological services while promoting the articulation of their demand.</td>
</tr>
<tr>
<td>Advanced TIP:</td>
<td>for leading-edge technologies emphasizes the importance of user cooperation and coordination when user-need determination cannot be separated from capability creation.</td>
</tr>
</tbody>
</table>

Table 3.4: Two Modes of Technical Infrastructure Policy [Justman and Teubal1995]

TIP Modes

To place the results in conceptual perspective, stakeholders’ interests are able to be presented in a concise overview using the Technological Infrastructure Policy (TIP) Creation. The results following from analyzing the different stakeholder groups are processed.

<table>
<thead>
<tr>
<th>Market Failure</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Consumer uncertainty and doubt:</td>
<td>Limits the infrastructure potential of the infrastructure</td>
</tr>
<tr>
<td>2. Network externalities:</td>
<td>Lead to unequal distribution of earnings among actors</td>
</tr>
<tr>
<td>3. Controlled knowledge distribution:</td>
<td>Expert consulting services in the network ask high tariffs</td>
</tr>
</tbody>
</table>

Table 3.5: Examples of Market Failures [Justman and Teubal1995]
The only way to prevent these market failures is by adequate Technical Infrastructure Policy (TIP) and collaboration leading to durable relationships among stakeholders. More specifically, adequate policy should inform consumers about the outcomes of the changing financial ecosystem so the infrastructure is reaching its potential. Whereas, collaboration should lead to equal distribution of both earnings and knowledge throughout the system.

3.2.3 Organising a System’s Performance

The institutional environment needs to be coordinated by the implementation of adequate technical components. These technical components need to be of a certain quality to guarantee the system’s performance. In order to create adequate technical components for a system of interest, the whole infrastructure needs to be taken into account. The core functionalities of the infrastructure are called 'critical transactions' [Künneke et al.2010].

(Organizational requirements in parenthesis)

<table>
<thead>
<tr>
<th>Scope of control</th>
<th>System (requires directive intervention)</th>
<th>Subsystem (requires coordination)</th>
<th>Component (requires corroboration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of adjustment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T0</td>
<td>Authoritative supervision ['system operator']</td>
<td>Collaborative supervision ['system regulator']</td>
<td>General framework conditions ['system norms and standards']</td>
</tr>
<tr>
<td>Operational balancing (requires supervision)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>Compulsory monitoring and enforced adjustment</td>
<td>Mutual monitoring and stimulated adjustment</td>
<td>Self monitoring and voluntary adjustment</td>
</tr>
<tr>
<td>Capacity utilization (requires monitoring)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T15</td>
<td>Controlled allocation mechanism</td>
<td>Guided allocation mechanism</td>
<td>Competitive allocation mechanism</td>
</tr>
<tr>
<td>Capacity allocation (requires facilitation)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T20</td>
<td>System transformation and innovation (requires planning)</td>
<td>Directive planning</td>
<td>Indicative planning</td>
</tr>
</tbody>
</table>

Figure 3.5: organizational Requirements in Parentheses [Künneke et al.2010] p.502
Payments as Critical Transactions

For this research, the alignment of technical components with the right institutional layers is used to link the APIs for Open Banking to the financial ecosystem.

An analogy for digital banking can be made with other reformed systems and infrastructures, such as rail transportation, energy, and telecommunications. Especially telecommunications is an interesting example because it also uses a network with different stakeholders to provide digital services to society. Telecommunication is a service that policymakers in the Netherlands want to acknowledge as a basic need of its citizens. The prospect for digital banking shows much resemblance to aforementioned services. Moreover, physical money in Sweden is already fully replaced by digital cash, called e-krona.

3.2.4 Conclusion

For describing the contextual aspect of the financial ecosystem requires institutional economic theory, stakeholder theory, and network theory. All relevant aspects of these theories are explained above.

The technical aspect requires theory of Technical Infrastructure Policy creation, which is later combined with the contextual theories to address the system’s performance.

3.3 Scenario Development Theory

Scenario development has a broad definition, where alternative futures are forecast to anticipate most probable developments in the environment. Nevertheless, the scenario development is different from scenario planning in the sense that foreseeable outcomes are only predicted and defined, planning is one step beyond the anticipation of probable events as requires certainty of the future situation [Bishop et al. 2007].

3.3.1 Required Attributes

Scenarios are developed according to specific attributes and techniques. The specific attributes are introduced earlier in Table 2.5.

3.3.2 Scenario Development Techniques

According to previously selected attributes, there are specific techniques that support scenario development. The most adequate techniques based on the produced outcomes are discussed here. Usually, scenarios are used to anticipate future events and form the basis for strategic planning [Ringland and Schwartz 1998].

Visualization of Scenario Outcomes

A narrative technique that helps to present relevant findings on paper is visualization. This technique is particularly suitable for policy analysis, strategic planning, and creative problem-solving. Visualization supports showing a concise initial presentation of conceptual direction, that builds on identified values and relaxation of intellectual boundaries [?].

\[2\]https://www.rijksoverheid.nl/actueel/nieuws/2019/03/05/staatssecretaris-keijzer-ekz-dient-wetsvoorstel-ongewenste-zeggenschap-telecom-in

\[3\]https://www.riksbank.se/en-gb/payments-cash/e-krona/
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GBN Technique for Matrix Development

Peter Schwartz formed the Global Business Network (GBN) and produced a scenario planning technique. The technique entails a checklist, which became widely adopted by several companies in various industries. The checklist is conceptually extensive and specifically helps a company with strategic planning [Schwartz2012].

The most important part of the technique discusses the presentation of fundamental uncertainties in a matrix. These fundamental uncertainties are the most significant scenario drivers [Schwartz2012].

For this research, the GNB technique is the conceptual tool for visualizing the inputs for scenarios. Ultimately, the scenarios capture the findings from the contextual aspect of the financial ecosystem and connect them with the outcomes of the systemic analysis and market analysis.

In order to capture the developments in the financial ecosystem and protect the design principles from the changing environment, the scenario drivers are chosen according to more specific scenario techniques.

Coates’s Systemic View

A systemic view on scenarios is chosen, which includes both a policy-making and business strategy point of view [Coates2000].

At the basis of the systemic scenario development lies the system analysis. Furthermore, the actual scenario drivers are chosen based on the case study findings.

INTERAX

Additionally, a model that helps to present different probable situations is included. The boundaries of the matrix indicate the conceptual extremes of the scenarios drivers. In other words, the extreme and highly improbable outcomes are found at the far ends of the matrix, which are used to broaden the spectrum of expectation.

The perfect technique to develop such extreme outcomes for scenario drivers is the INTERAX technique [Enzer1980]. The INTERAX technique requires several input variables to be identified, before the extremes can be formulated. The required input variables are formulated in Table 3.6.

Table 3.6: Required Input Variables for Extremes

<table>
<thead>
<tr>
<th>Input Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>The evolutionary process is understood</td>
</tr>
<tr>
<td>Unprecedented future changes can be anticipated</td>
</tr>
<tr>
<td>Societal forces can possibly control the process or the changes</td>
</tr>
<tr>
<td>Societal forces can be mobilized for timely, appropriate action</td>
</tr>
</tbody>
</table>

Some background information about several relevant techniques for scenario development is provided. The findings extend the knowledge base for developing scenarios.

3.4 General Conclusion of Literature Review

In general, all of the literature presented in the literature review builds on the existing knowledge base following the rigor cycle and finalizes the Robust Design Engineering (RDE) framework.

The relevance cycle is used for the next part of the research, where intermediate findings are again added to the knowledge base in an iterative way. While the environment is becoming better understood, intermediate research objectives can be targeted more explicitly.
Chapter 4

Overview and Analysis of the Current Financial Ecosystem

As indicated in the previous chapter, the Robust Design Engineering (RDE) methodology starts with an analysis of the research context by performing a system description. In this case, the research context is called the financial ecosystem. The following part begins with the context by conducting an institutional analysis.

Ultimately, the goal of the system description is to explicate the context and gain insight into the system’s performance. The financial ecosystem is transforming towards Open Banking. Therefore, besides analyzing the context, also the technical aspect is analyzed. Open Banking entails secure and efficient sharing of financial data, which should be uniformly accessible throughout the financial ecosystem. The system description starts with identifying relevant actors in the financial ecosystem. Thereafter, the technical aspect of Open Banking is analyzed by providing a schematic overview of the data flow in the financial ecosystem. The overview is visualized using the Business Process Modeling Notation (BPMN).

Contextual vs. Technical

Subsequently, the context of the financial ecosystem and the technical aspects of Open Banking are brought together in a conceptual way. More specifically, some notions are provided regarding the design of APIs for Open Banking in the financial ecosystem. These notions are formulated by API design considerations.

Finally, the context is made clear and the technical aspects are made explicit conceptually. Still, there are more technical specifications which are particularly important for APIs. These specifications entail certain API standards and design protocols.

4.1 Institutional Analysis

For the institutional analysis, it is essential to stress what the main objectives are of the previously introduced Governing Agencies. Their main point of interest is to ensure a stable economy and protect consumers from malicious practices. Both objectives are rather broad, so the requirements within these goals are constantly adapted.
However, the current state of the Financial Services Industry has some undesired side-effects in the pursuit of these goals. According to the literature, the most frequently mentioned outcome of the institutions in place is high compliance costs. Due to the constantly changing financial ecosystem, more and more rules are added to the compliance list.

In order to make the system more efficient, this part of the research focuses on the foundation and the roots of the institutions in the financial industry. The four level framework of formal and informal rules \cite{Williamson2000} is used to clarify the institutional aspect of Open Banking. The findings result in a view on API design in a broader perspective, which helps to build a durable design that lasts.

The presented levels of the institutional scheme are conceptually linked with the conceptual basis of the Financial Services Industry in the following way.

The research is focused on the pursuit of Open Banking in the Netherlands, based on EU regulation. Therefore, the corresponding cultural believes that form a basis for the institutional environment are analyzed from a European perspective \cite{Bell and Cooper2018}.

4.1.1 Embeddedness

The first level of the framework is Embeddedness as was introduced in Table 3.1. This level is specified by the informal rules, norms and traditions. Embeddedness is the foundation on which regulation is built. There are numerous concerns captured by European values that serve as input for regulation. The following part is limited to the concerns relating to both financial data and financial stability. The Embeddedness layer leads to establishing a Technical Infrastructure Policy (TIP) that supports a durable financial ecosystem.

General Concerns in the European Union

The informal rules of the embeddedness layer are expressed by general concerns based on European norms. These concerns are included and briefly explained in Table 4.1. A more elaborate explication of these concerns is included in Appendix C.

The essence of the institutional framework and values underlying the regulation is that financial data in the changing financial ecosystem must be used responsibly. A vital aspect of financial data use is the uncontrollable distribution after it is shared. The ownership, management, and exploitation of data and information will be the basis of the new business models, potentially generating...
CHAPTER 4. OVERVIEW AND ANALYSIS OF THE CURRENT FINANCIAL ECOSYSTEM

<table>
<thead>
<tr>
<th>EU Concern</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.1 Data Protection:</td>
<td>European citizens very much value their privacy</td>
</tr>
<tr>
<td>C.2 Data Sharing:</td>
<td>Consumers should be the owner of their data</td>
</tr>
<tr>
<td>C.3 Efficiency</td>
<td>Desire interoperability and pan-European efficiency</td>
</tr>
<tr>
<td>C.4 Malicious Practices:</td>
<td>Criminality should be minimized by effective countermeasures</td>
</tr>
<tr>
<td>C.5 Financial (Systemic) Risk:</td>
<td>Another financial crisis should be prevented</td>
</tr>
<tr>
<td>C.6 Pure Risk:</td>
<td>Risk beyond economic harm should be actively identified</td>
</tr>
<tr>
<td>C.7 Misconduct:</td>
<td>Negative sides of innovation should be actively safeguarded</td>
</tr>
<tr>
<td>C.8 Consumer Benefit:</td>
<td>The consumer should experience some explicit benefit from sharing personal data</td>
</tr>
<tr>
<td>C.9 Data Security:</td>
<td>Private data should be systematically protected</td>
</tr>
</tbody>
</table>

Table 4.1: Brief Overview of Concerns based on European Norms

breakthroughs for benefits of markets and societies but also introducing new risks to consumers. Similarly to the oil industry, there are a few companies that control the majority of data called TechGiants (Google, Facebook, Apple, Microsoft). The biggest threat for consumers related to increasingly powerful TechGiants is the limitation of perceived freedom, in behavior (spending patterns) and thinking (desire).

One side of the story warns about the speed of innovation, whereas the other side poses the dependency on data that informs and makes life cheap and easy. Certain requirements can safeguard morality and ethical innovation by requirements such as non-maleficence, beneficence, respect for autonomy, and justice [Van de Poel2016, Stahl et al.2014].

4.1.2 Institutional Environment

This level includes the rules of the game and describes the laws and regulations that come forth from the cultural believes and normative standards. The aforementioned concerns come from the roots of the current institutional system in place.

Three Pillars of Innovation

As mentioned in by C.8 in Table 4.1, people should benefit from innovation. This institutional system has three main focus points on which the rules apply. These focus points are the three pillars of innovation that each equally supports the formulated institutions and determine the system’s success [Scardovi2017].

The first pillar is the information economy, which demands personal data from customers. Yet, awareness of how that data is obtained and possible value for corporate usage is vital for conscious decision-making before data gathering is approved by customers.

The second pillar stresses the possible applications of this personal data, which requires understanding what intelligence is coming out of the data and how it is applied by companies. If the consequences of sharing are known by customers, decisions about controlling the data could be made more consciously.

The third pillar considers the interconnections where data is of value, where preferably the expected outcome after sharing the data is known beforehand. In the ideal situation, customers should be able to make a conscious decision before they share their data at that interconnection. Therefore,
they have to know the impact of the deal that is offered to them. For example, a trial version with manual input of data and the fictitious output would lead to more insight for a consumer, without the obligation to directly commit to sharing their personal data.

**Technical Infrastructure Policy**

The financial ecosystem is conceptually described according to the TIP theory [Justman and Teubal1995]. Firstly, the mode of the financial ecosystem is discussed. Secondly, the types of infrastructure is related to the financial ecosystem. Finally, the possibilities of market failures in the financial ecosystem are explicated.

**Basic Technical Infrastructure Policy**

Table 3.4 categorizes two distinct modes of technical infrastructure policy. The Advanced TIP is applied to the financial ecosystem due to its corresponding explanation.

The financial ecosystem is already extensively controlled by regulation. Moreover, technical standards are already imposed by Governing Agencies and relevant organizations are forced to contribute to the interoperability by creating API-based systems. Governing Agencies are stimulating innovation in a liberal market, but they do not have the expertise to prescribe API requirements as explicit as is actually necessary.

**Technical Infrastructure Characteristics**

Based on the characteristics of Basic TI from Figure 3.4, the financial ecosystem can be more thoroughly evaluated. Table 4.2 presents a selection of relevant characteristics and links each one to the financial ecosystem by explaining the correspondence.

**Market Failures**

The general market failures occurring with Technical Infrastructure Policy (TIP) are presented in Table 3.5. These examples form the basis for creating a more efficient and economically equal
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<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services as output</td>
<td>API-based systems are the product that provide financial data as a service.</td>
</tr>
<tr>
<td>Diffusion Support</td>
<td>Describing API requirements in the legislation and demand technical solutions from the commercial banks.</td>
</tr>
<tr>
<td>Focus on sector</td>
<td>The financial ecosystem currently needs to digitally transform and be able to share financial data efficiently.</td>
</tr>
<tr>
<td>SME User-base</td>
<td>Accessible financial data benefits far more organizations than TPPs alone.</td>
</tr>
<tr>
<td>Little output</td>
<td>Open Banking is limited to regulatory imposed functionalities, so applications are similar for different businesses.</td>
</tr>
<tr>
<td>differentiation</td>
<td></td>
</tr>
<tr>
<td>Reachable need</td>
<td>The objectives for the financial ecosystem to reach Open Banking are clear.</td>
</tr>
<tr>
<td>definition</td>
<td></td>
</tr>
<tr>
<td>Moderate user</td>
<td>Stakeholder groups in the financial ecosystem are jointly involved in the formulation of guidelines.</td>
</tr>
<tr>
<td>involvment</td>
<td></td>
</tr>
<tr>
<td>Market for output</td>
<td>The market for Open Banking itself is convenience, so banks are using funds that otherwise would be spend on monetary sanctions.</td>
</tr>
<tr>
<td>Independency</td>
<td>The financial ecosystem is already too complex and big for self-employed people to successfully prosper.</td>
</tr>
<tr>
<td>unlikely</td>
<td></td>
</tr>
<tr>
<td>Industrial organizations</td>
<td>The financial ecosystem relies on industrial businesses to adopt and use Open Banking.</td>
</tr>
<tr>
<td>Government as</td>
<td>Policymakers are already imposing a Regulatory Technical Standards to catalyse interoperability.</td>
</tr>
<tr>
<td>catalyst</td>
<td></td>
</tr>
<tr>
<td>Market building</td>
<td>Most importantly for the financial ecosystem is the creation of a technical infrastructure for Open Banking.</td>
</tr>
<tr>
<td>policy</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2: Explanation of Selected TI Characteristics

Market Failure                                                                 Application of Example
1. Consumer uncertainty   Communicate impact of decisions by consumers according to the Three Pillars of Innovation for Figure 4.2
2. Network externalities  Explicit specification of tariffs for API use in Resource Allocation layer

Table 4.3: Mechanisms to Prevent Market Failures in the Financial Ecosystem

Securing the Critical Functions
The financial ecosystem relies a properly working infrastructure, where the financial transactions are its critical function. In order to make sure the critical functions are constantly operational, the
The scope of the financial ecosystem reaches from the system to the subsystem but the authorities let components be substantiated by the actors in the market. Whereas for the speed of the system, the regulators only interfere with the operational balancing of the transactions as monitoring is still too complex to include. The scope of control and the level of interference. In Figure 4.3, the limitations of the scope of control and the speed of adjustment is indicated.

In particular, more adequate monitoring mechanisms could help to better identify pure and systemic risks as mentioned by C.5 and C.6 in Table 4.1.

**PSD2**

As a first and foremost official European Directive, the Revised Payment Service Directive (PSD2) marks the official center encaptured by Open Banking of the Institutional Environment layer from Figure 3.1. PSD2 not only forces financial institutions to comply with a set of regulatory standards for protection and security. PSD2 also dictates that financial institutions should share financial data...
upon request of their customers. Especially, the explicit notion of consent is an important factor of the regulation and explicates the intentions of policymakers in line with C.2 of Table 4.1. A significant factor of PSD2 is the space it leaves for market players to offer discounts if consumers do share their personal information. Consequently, the price of data will be made explicit by market dynamics. This phenomenon will be elaborated on further in the next section.

In short, Article 1 of PSD2 describes three main objectives. Firstly, the procedure of strong customer authentication is imposed by the regulation, which is necessary before consumers are allowed to make decisions about their financial data. Secondly, PSD2 protects the confidentiality and integrity of the payment service user’s personalized security credentials. Thirdly, PSD2 establishes common and secure open standards for the communication between account servicing payment service providers, payment initiation service providers, account information service providers, payers, payees and other payment service providers in relation to the provision and use of payment services.

GDPR

As mentioned earlier in the Embeddedness in C.1 of Table 4.1, the General Data Protection Regulation (GDPR) is similarly important for financial data gathering and usage. Every organization in the financial ecosystem must comply with this directive as well. The most striking part about this regulation is the "right to be forgotten", which is one of the major concerns for consumers following the decision of sharing their data with TechGiants. In other words, European citizens value their privacy and want some sort of guarantee that they can restore their position of anonymity after they have shared their personal data with any organization in the financial ecosystem. Currently, it is hard to determine the exact output of the system in place, so only time can tell if particular mechanisms fully comply with regulatory demand.

Risk Precautions

Other regulatory instruments are trying to minimize systemic risks as mentioned by C.5 in Table 4.1. As of yet, the regulatory intervention that minimizes systemic risks is limited despite the thorough efforts of the Basel Committee on Banking Supervision (BCBS). It is very hard to identify the actual risks that are caused by mechanisms and procedures of the current financial system, such as Know-Your-Customer and Anti-Money-Laundering specifications.

Other examples of systemic risk identification requires a fundamental restructuring of the industry. An example of counteracting systemic risks are measures taken against the maximum loan for private mortgages, and mandatory investment ratios of financial institutions that require a minimum amount of invested debt compared to equity (Basle III).

Regulatory Expansion

Currently, the authorities supervising the financial ecosystem are focusing on the operational balancing of the system and the subsystems. This is a short-term strategy for securing critical transactions. Therefore, the next step for regulators to improve the operability is to expand their influence. In particular, the scope would then include the component level, so more specific conditions would lead to more standardization. Also, the speed of adjustment (or interference) would involve monitoring the transactions, which means that financial data could be used to better identify malicious practices and improve Anti-Money Laundering (AML) activities. Furthermore, the aforementioned risk precautions would be a step for the very long-term, which could be controlled by capacity allocation.

1https://www.banken.nl/bibliotheek/basel-III
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That is, the facilitation of funds can be better controlled by Governing Agencies if the speed of adjustment is extended.

In conclusion, the aforementioned regulatory intervention is an attempt to control the distribution of financial data, and further intervention could support systemic risk minimization. However, the current formulation is only solving these problems to limited extent.

Once the financial ecosystem is facilitating Open Banking and data is available to the right Governing Agencies, the European Union is able to use financial data on a larger scale. The desired outcome would be able to detect malicious practices and create a more stable economy, but that requires sophisticated mechanisms to be in place. Despite the ambition and massive benefits to optimize the economic system, these objectives are rather unrealistic as it requires a lot of effort on a short-term basis. The following Governance part discusses more achievable outcomes as a result of more available financial data.

4.1.3 Governance

As already mentioned, this section focuses on the play of the game and getting the operational mechanisms right. The processes that follow from the regulatory structure have to align with the cultural values and have to result in the desired outcomes. National Competent Authorities (NCAs) are monitoring organizations operating in the industry of concern. In the financial industry, this is called a National Banking Authority, which is De Nederlansche Bank (DNB) in the Netherlands. They are responsible to identify malicious practices and have to impose sanctions on the perpetrators according to their misconduct.

Services Definition

In current regulation, PSD2 consists of two parts. The first part dictates requirements for Payment Initiation Service Providers (PISPs), and the second part mentions guidelines for Account Information Service Providers (AISPs). DNB has the power to impose sanctions in the Netherlands if an organization in the Netherlands does not fully comply with the rules. However, the regulation is not particularly specific about the clear mechanisms and exact implementation of functionalities. In other words, prescriptive rules for Open Banking are not formulated yet.

Service Implementation

As a consequence, other Governing Agencies are responsible for the formulation of Guidelines, which are more specific than the articles of PSD2. The guidelines are formulated by the European Banking Authority (EBA). They address implementation issues encountered by the relevant organizations in the financial ecosystem, which are mostly commercial banks right now.

Collaboration Initiatives

Nevertheless, despite its regulatory authoritative position, the EBA is quite slow with the formulation of its guidelines. There are other decentralized initiatives that also formulate guidelines to help banks deal with general problems during their implementation issues. Such organizations include the Berlin Group for German-oriented organizations, and STET for French-oriented organizations.
Open Banking

Open Banking depends on APIs of sufficient quality, so sensible API designs contribute to that level of quality. As indicated API design serves as the backbone for data exchange. Not only regulatory artifacts can contribute to required institutional structures, but also technological paradigms through scientific research can set a technological standard and help to come to desired outcomes. For example, similar projects in the Financial Services Industry led by the European Payments Council (EPC) have tried to guide Europe to a new Regulatory Technical Standard (RTS). Although, projects such as SEPA that imposed a new European standard for bank account numbers and lead to the introduction of IBAN, more specific from the beginning compared to PSD2. Similarly, the Instant Payments project that led to instant money transfers between different banks within the European Union was formulated quite extensive by the Guidelines for Instant Payments.

In conclusion, the Governance layer of this institutional analysis describes the structure of how the European Union tries to control the changing market. This was already mentioned earlier in the introduction, at the part about the hierarchy of the network’s structure [De Bruijn and Ten Heuvelhof2000] in the financial ecosystem. Now that the roles of the Governing Agencies are clear and placed in the institutional environment, the last and most concrete part layer will be introduced: the Resource Allocation.

4.1.4 Resource Allocation

The lowest layer relies on economic theory and business strategies that comply with the law. Within the formulated rules and the playing field of the financial ecosystem, commercial organizations are able to offer their services in the changing market and find out what their competitive advantage is. As indicated earlier, commercial banks are no longer the unique owner of financial data. Consumers are now able to decide what happens with their personal (financial) data. The market is now transformed into a level playing field, according to the European Union.

Level Playing Field

This level playing field creates opportunities for new entrants to penetrate the market and offer services with input from other organizations that have kept this data to themselves. In other words, the current market environment consists of traditional incumbents and innovative newcomers.

Financial Services

Due to Open Banking, services in the financial ecosystem [Scardovi2017] can be or be similar to any of the examples included in Table 4.4.

Incumbents vs New Entrants

The institutional environment is changing and that affects incumbents and newcomers in the financial industry. As mentioned earlier, determining the right level of openness leads to the changing market power of incumbents. For new market entrants, the very foundation of data-driven operations requires a sufficient level of openness. Data has to be shared before it can be used by TPPs within the financial ecosystem. However, too much openness can endanger the strategic position of incumbents.

Application of New Technologies
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# Example
1. Exchange products or services on a global scale via safe, efficient and effective transactions.
2. Allow conservation, capitalization and transfer value over time via “saving and investment”.
3. Funding of large and indivisible projects by pooling resources from a large variety of sources.
4. Provide safe and reliable transfer of funds across counterparts by matchmaking tools (APIs).
5. Performing financial risk analysis and offer more security with financial products (hedging).
6. Assess and ensure non-financial (pure) risks by IoT monitoring and value risk and damage.
7. Combining all predetermined risks and services to offer a more complete and fair service.

Table 4.4: Examples of Open Banking Services

<table>
<thead>
<tr>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Data and information advance management</td>
</tr>
<tr>
<td>2. Intelligence by applied analytics, ML and AI</td>
</tr>
<tr>
<td>3. Interconnectivity and junction management</td>
</tr>
<tr>
<td>4. New business solutions design</td>
</tr>
<tr>
<td>5. Trust and credibility management</td>
</tr>
</tbody>
</table>

Table 4.5: New Technologies for the Financial Ecosystem

Incumbents typically have trouble adopting new technologies, due to their rigid organizational structure and many legacy systems. They often rely on their strong brand name and high level of perceived trust.

Whereas, agile FinTech companies or FinTechs, have the capability and knowledge to apply and implement technologies much faster. They rely on their practical skills and rapid adaptability to apply new technology for innovative services. Market challengers use technological developments to offer services in the changing market. The use of new technologies in the changing financial ecosystem is presented in Table 4.5.

Mechanisms Defined by Regulation

Three very specific mechanisms are mentioned in PSD2. However, differences in interpretation or chosen alternatives still lead to slightly different applications before Authorization can be given by a consumer.

Firstly, the Authentication method should help to create an extra step for consumers to initiate transactions by entering a password either static (has to be remembered) or dynamic (generated one time as a token of access via another device). This method is also referred to as “something you know”.

Secondly, device verification methods should help a consumer build a stronger link with the service provider by linking his personal device to the service operator, so he ensures that transactions can only be done using the verified device. This method is also referred to as “something you have”.

Thirdly, the last mechanism relies on inherence by checking consumers’ biometrics, such as fingerprints or facial recognition. This method is also referred to as “something you are”.

Previously specified methods must be independent. When these methods are distinctively combined, Strong Customer Authentication (SCA) is achieved. In the event that one method fails, the account is still unable to be compromised directly.

---

2PSD2 Art.6
3PSD2 Art.7
4PSD2 Art.8
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Required Mechanisms

The last aspect of the regulatory standards demands service that meets the underlying European values for privacy. A well-structured way of protecting financial data in the financial ecosystem is required, so organizations should include Privacy Protection by Design in their services. The Privacy by Design Principles is a well-known solution to protect consumer privacy for any system. The seven foundational principles in Table 4.6 are ensuring privacy in system design for any service in the financial ecosystem.

Finally, the contextual aspect of the financial ecosystem is fully described by the institutional analysis. The main takeaways are the high level of privacy protection within Europe that serves as an underlying value for EU regulation, as well as the need to ensure long-term economic stability.

Despite the formulation of some conceptual guidelines and general implementation solutions for API-based systems, the ways to interpret and provide services on the edge of compliance are countless. Therefore, the contextual aspect is further analyzed with some stakeholder analysis that builds upon the provided Actor Overview.

4.2 Actor Overview and Interest

The actors in the financial ecosystem can be classified into specific conceptual groups, which corresponds to the role they play within the financial ecosystem. These groups are the commercial banks, the Governing Agencies, and the Third Party Providers (TPPs). In Appendix D, an overview is given of the considered actors in this research and their business strategies are explained.

4.2.1 The Commercial Banks

Firstly, the major commercial banks in the Netherlands have clearly distinct strategies, which are further explicated in Appendix D.2. These strategies result in varying business activities and commercial choices in adapting to the changing financial ecosystem. Each commercial bank relies on its relatively strong position of the incumbent, but they all are very aware that they have to change something in order to stay relevant. In Figure 4.4, the banks are placed on a scale with two axis lines that represent their position relative to each other.

The Relative Market Positions of Banks

The relative market position is described in Figure 4.4. Their positions are determined by the two indicators, which are represented on a horizontal and a vertical axis.

Horizontal Axis

The horizontal axis is technically sided and represents the amount of drive for system innovation of the particular bank. On the far right are the most innovation-driven banks, who started quite
early with developing their API-based systems. On the left side of the scale are the more traditional banks that waited for the others to pave the way and see how they solved the encountered problems before they would develop their own systems.

**Vertical Axis**

The vertical axis is more marketing-minded and represents the aspect of consumer perceived legitimacy, where the conservative banks can be found on the bottom side of the axis. In other words, the bank that relies a lot on legitimacy seeks to intensify its relationship with already existing customers by building upon its original marketing strategy. Thus, creating their API-based system is seen as an extension of their existing services rather than a way to reach new market potential. On the top side of the axis, the more progressive banks can be found. These banks reinvented themselves by adapting their services and become more of a FinTech company than a traditional bank. The level of convenience and attracting new customers is seen as more important than the level of perceived legitimacy, which is a trade-off where innovation often comes at the price of trust \[\text{Svensson et al.2019}\].

### 4.2.2 Governing Agencies

Secondly, the Governing Agencies are non-profit organizations that have the purpose to serve the public interest. The regulators are the most important because they enact the legislation, such as PSD2. However, PSD2 is a directive that needs to be incorporated into domestic law by each country. The roles of the most important Governing Agency organizations are discussed in Appendix D.1.

The law is open to interpretation, so the European Banking Authority (EBA) determines guidelines that are adapted to the latest market developments. The National Competent Authorities (NCAs) are responsible for monitoring if the actors are all compliant to the...
law and formulated guidelines. The NCAs have to make sure that they all interpret the formulated laws and guidelines in a consistent manner. The European Union (EU) has to move towards a new RTS and this standard has to be consistent in every country. Therefore, market behavior has to be uniformly accepted or rejected without exceptions or diverging countries.

### 4.2.3 Third Party Providers (TPPs)

The last group consists of the Third Party Providers (TPPs) and several typical TPP organizations are introduced in Appendix D.3. Their main interest is to take full advantage of the financial data becoming available due to PSD2. Officially, banks have to fully comply with PSD2 standards by September 2019, but this transition in the Financial Services Industry is a process of testing and bargaining about specifications that have been taking place for a very long time.

A simple schematic overview of the TPPs’ market position is given in Figure 4.6. A TPP is able to use financial data of banks to offer services to consumers, which was previously impossible because banks were allowed to keep the data to themselves.

> Figure 4.6: TPP’s Market Position

In short, the financial ecosystem includes countless actors, which are all part of one of three groups: Governing Agencies, Commercial Banks, or Third Party Providers (TPPs).

### 4.3 Identification of Stakeholder Groups and Strategy Exploration

A range of models that help understand actors and their strategic interactions are used for stakeholder analysis. A few concepts of systems thinking are described first before the actors are further analyzed using stakeholder analysis [Hermans and Cunningham2018]. This part builds upon the preliminary actor overview from the introduction and serves as a further refinement before data is acquired from interviews. The steps for stakeholder analysis are taken based on Table 3.2.

#### 4.3.1 Stakeholder Group Identification

The system of interest is Open Banking, which is placed in the larger system of the entire financial ecosystem. The Open Banking system produces financial data, which is available for other actors within the financial ecosystem. This level of open access to data requires well-designed APIs as an artifact. Several tools are used to analyze decision-making, policies and value perception. The following part concentrates on the stakeholder analysis in order to finalize the contextual aspect of the financial ecosystem.
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4.3.2 Stakeholder Interests

Another commonly used word for actor is stakeholder, so stakeholder analysis is also used to describe the interests of the involved actors [Bunn et al., 2002]. The key types of stakeholders that are active in the system of interest are: Policymakers, Authorities, major commercial banks, Third Party Providers (TPPs), FinTech companies, and Consumers. These stakeholders were already subdivided into three groups: Governing Agencies, commercial banks, and TPPs. In this part, consumers are treated as a self-standing stakeholder group.

4.3.3 Stakeholder Classification According to Attributes

The stakeholder interests are categorized into the Four Cornerstones of the financial ecosystem from Figure 1.1. All previously introduced actors of the system of interest are represented by their corresponding stakeholder group. Subsequently, the stakeholder groups are evaluated on certain generic stakeholder management strategies [Bunn et al., 2002], which refer to Table 3.3.

Figure 4.7 shows the relative amounts of a strategic drive for every stakeholder, where each corner represents a 100% score of a generic stakeholder management strategy and 0% is at the very middle of the hexagon.

4.3.4 Evaluation of Dynamic Relationships

The relative scores of generic stakeholder management strategies show how their interests differ among stakeholder groups. These results help to complete the conceptual overview regarding the contextual aspect of the financial ecosystem. A short overview of conclusions from the management strategies is given here.

![Figure 4.7: Management Strategies with Attributes](image)

(a) Gov Agencies  
(b) Banks  
(c) TPPs

**Governing Agencies**

The Governing Agencies want to protect economic stability and create a fair market (level playing field) by legislation. They can only do so by involving the actors in the financial ecosystem and find out the potential business models. Thus, the corresponding management strategy is indicated in Figure 4.7a.
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Commercial Banks

The commercial banks enjoyed a unique position for a long time, where they were the only controller of financial data. Yet, commercial banks are now obliged to share financial data upon consumer requests, so their strategies come down to staying relevant as indicated in Figure 4.7b.

The banks want to protect their market position, but are now forced to reinvent their business models. The most important strategy to stay relevant is to be included in the financial ecosystem by involving the right organizations. Apart from the drive to be included, banks are following different strategies because the exact outcomes are currently unclear.

TPPs

Some commercial banks want to act as a TPP and fulfill two roles in the changing financial ecosystem. In contrast to banks, TPPs are offered the chance to use the available financial data to offer new services and they want to seize this opportunity at all costs as indicated by the mix in Figure 4.7c. Collaborating with banks is vital to be able to interact with their data systems. TPPs want to create the financial ecosystem around them, so involving as many parties as possible determines their success. Furthermore, being a leader and having the first-mover advantage is very valuable in innovative markets. To educate or monitor depends on a TPPs business model, so it is difficult to generalize these strategies.

The stakeholder groups all have different interests that lead to particular strategies. In short, TPPs try to take advantage of new available financial data provided by commercial banks, who try to maintain their strong market position.

Governing Agencies are protecting consumer interest while a level playing field is created, in which organizations are fighting for their place in the changing financial ecosystem.

4.4 Network Structure and Relative Positions

The financial ecosystem can be seen as a multi-actor network [De Bruijn and Ten Heuvelhof 2000]. This particular network consists of banks and TPPs, where the Governing Agencies keep this dynamic network stable from a hierarchical position as visually presented in Figure 4.8.

4.4.1 Variety of the Network

In this network the previously discussed groups show great variety in interest, power and, despite that particular groups are rather uniform, the group of actors within the European economic area falling under PSD2 is very big as it consists of countless banks, TPPs and Governing Agencies.

Due to the extent and complexity, this research focuses mainly on the financial ecosystem in the Netherlands. Still, the bigger picture of the European economic area is kept in mind during this research as the overarching system.
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4.4.2 Dependencies

Despite the hierarchical position of the Governing Agencies, they still depend on the good intentions of banks and TPPs towards the public interest. Although, they have the power to determine what banks and TPPs are allowed to do, the public interest depends on the behavior of businesses. If legislation is incomplete or authorities are incompetent, the network fails. Therefore, the optimal situation is for all interests to be aligned. However, this is not always the case. Often, the most valuable information is also the most sensitive financial data, where the economic gain for businesses is not always in line with the public interest.

Banks and TPPs depend on each other to be included in the future of the financial ecosystem. TPPs develop their business models based on the financial data they get from banks. Whereas banks want to stay significant in the future state of the financial ecosystem, so they have to develop interoperable and user-friendly API-based systems.

4.4.3 Hierarchical Signals

Mutual trust and open communication are key for the network to survive and operate efficiently. The Governing Agencies depend on transparent communication, so they can adequately react to market behavior based on valid information. The banks and TPPs have a great interest in keeping a good relationship with their NCA because the fines are high when they get punished for compliance issues.

4.4.4 Dynamic Behavior in a Stable Ecosystem

Probably the most important remark can be made about the stability of the network because of the dynamic behavior and the constantly changing financial ecosystem. The government agents want to keep the network stable, without losing the healthy amount of dynamic competition. In other words, the legislation has to be specific enough to prevent misconduct, but there still has to be enough competition to create a level playing field for the actors and stimulate economic liberalism.

4.4.5 Evaluation of the Network Structure

The last step in the stakeholder analysis considers the structure of the network. The network structure is evaluated using the concepts of Network Dynamics [De Bruijn and Ten Heuvelhof2000], which were introduced in Figure 3.2. The network structure included the concepts of variety, closedness, and interdependence.

Subsequently, the corresponding decision-making process [De Bruijn and Ten Heuvelhof2000] is addressed with a more in-depth evaluation of the network by using the corresponding characteristics, which were presented in Figure 3.3.

Variety of the Network

Due to the high variety and countless actors that are active in the financial ecosystem, the influence that each actor has on the network is quite small. Therefore, each actor benefits most from using standard solutions to stay included in the financial ecosystem. Nevertheless, the large variety leads to different interpretations of regulatory intervention, so different standards are often developed [De Bruijn and Ten Heuvelhof2000]. Geographically corresponding banks in the financial ecosystem often have corresponding systems in place, so initiatives such as the German Berlin Group and French STET are mainly followed by domestic or neighboring organizations.
Despite the limited standardization and variety of the financial ecosystem, this variety also has its advantage [De Bruijn and Ten Heuvelhof 2000]. Explicitly, it causes actors in the system to create their own solutions within the imposed boundaries, which hopefully are even better than one that would have been dictated by the Governing Agencies.

**Closedness**

The opposite of openness towards regulatory intervention is captured by closedness [De Bruijn and Ten Heuvelhof 2000]. It is obvious that PSD2 is not in the best interest of the commercial banks, so some struggle in cooperation is expected. The only way to overcome closedness is to include the actors that are willing to cooperate and make the system better for everybody.

**Interdependence**

Every network has its internal relationships and collaboration agreements [De Bruijn and Ten Heuvelhof 2000]. A problematic situation would be if partnerships or agreements will be violated and trust in the network is lost. Therefore, the interests of stakeholder groups have to be made explicit for the policymakers to create adequate and successful legislation. Although the interests of multiple stakeholders have to be taken into account, the final policy cannot result in a gray compromise of interests where the ultimate goal is lost.

Despite the many threats, interdependency within a network also creates opportunities for the actors. The most important one is to realize that cooperating is more beneficial than ignoring or fighting, which results in moderate behavior of stakeholders. Furthermore, complex interdependencies on a variety of subjects create more opportunities to negotiate and minimizes the situation of a deadlock. As a final result, the outcome of various suggestions and compromises leads to an enriched product that better matches market demand and is more likely to be included in the financial ecosystem [De Bruijn and Ten Heuvelhof 2000].

### 4.4.6 Decision-making in Hierarchical Structure

The hierarchical structure of the financial ecosystem has a big influence on the decision-making process within the network. A transparent role of the regulator is vital in providing a tranquil environment, instead of a chaotic one without the guidance of a supervisor [De Bruijn and Ten Heuvelhof 2000]. Thus, a structured approach with clear communication has to be followed, so the rest of the actors in the system know the objective of the regulator at all times. Table 4.7 contains decision-making strategies [De Bruijn and Ten Heuvelhof 2000] for the regulator that guides the financial ecosystem towards Open Banking.

<table>
<thead>
<tr>
<th>#</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Regular and sequential</td>
</tr>
<tr>
<td>2.</td>
<td>Phases</td>
</tr>
<tr>
<td>3.</td>
<td>Actors are stable</td>
</tr>
<tr>
<td>4.</td>
<td>One arena and processes with clear start- ing point and end-point</td>
</tr>
<tr>
<td>5.</td>
<td>Content of the problem is stable</td>
</tr>
<tr>
<td>6.</td>
<td>Incentive to regard problem as structured</td>
</tr>
<tr>
<td>7.</td>
<td>Consistency and predictability</td>
</tr>
</tbody>
</table>

**Decision-making in a Network**

The network side of the financial ecosystem consists of banks and TPPs as indicated in the Hierarchy Wheel. The network has no hierarchy, so the interactions show different characteristics. The main
regularity is captured by the term capriciousness, which means that the lack of structure and authority leads to two remarkable outcomes: substantive capriciousness and process-based capriciousness [De Bruijn and Ten Heuvelhof2000].

Respectively, the first component entails that the content of problems and solutions is constantly shifting and redefined. In particular, the conflicting strategies of banks and TPPs results in a difficult setting for self-regulation, as TPPs rely on financial data and banks fear to be excluded from any result after sharing it.

The second considers the decision-making process, which has no starting point or end point without clear guidance. Hence the success of decision-making models that provide an analytical approach and result in solution implementation. However, the financial ecosystem has many actors, so these models are useless when internal processes depend on the outcomes of others outside of the organization.

The financial ecosystem can be seen as a network that includes commercial banks and TPPs. The Governing Agencies are trying to keep this network stable from a hierarchical position.

Certain network dynamics follow from this structure, which offers opportunities that can be exploited by carefully choosing suitable strategies.

4.5 Overview of Financial Data Flow in BPMN

The contextual aspect of the financial ecosystem is now clarified, so now it is time to focus on the technical aspect. To begin with, the flow of financial data is represented here. The schematic overview of data flow is represented using the Business Process Modelling Notation (BPMN) [Chinosi and Trombetta2012].

4.5.1 Outline of Financial Data Flow

In short, the flow of financial data is represented by the arrows, which connect different processes for Open Banking. Previously introduced stakeholder groups all contribute to the financial ecosystem by offering their services. These processes depend on the financial data of other actors in the financial ecosystem. The following part discusses how financial data is currently flowing in the financial ecosystem.

There are two distinct processes that depend on financial data for Open Banking according to PSD2. Firstly, there is the service of an Account Information Service Provider (AISP). Secondly, there is the service of a Payment Initiation Service Provider (PISP).

4.5.2 BPMN Representation of AISP

The process of AISPs is perceived as more simple because the account information is only collected for display. Some functionalities are possibly offered by FinTech companies to make some analysis, that makes a consumer more aware of spending behavior or might it might help with tax returns. Yet, no process of AISPs has a direct influence on the account balance. Therefore, the only APIs needed for these processes are exchanging static information, which only depends on the data systems of the bank where the account is held. Figure 4.9 represents the process of AISPs and indicates the flow of financial data for this process.

The actual process is explicated in Appendix E.1, where a step-by-step route is followed according to Figure 4.9.
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To summarize, Figure 4.9 gives an overview of the AISP process and indicates crucial points of success. Although the service cannot be specified explicitly, the process of getting the necessary financial data to deliver the service is explicated by the visualized sequence of steps in Figure 4.9. This process can be made more efficient with APIs that anticipate frequently requested financial data. The content of this financial data is an important part of the API design.

4.5.3 BPMN Representation of PISP

The process of PISPs is more complex because they have altered bank account balances in order to transfer money. Nevertheless, the rest of the process is rather similar, so the PISP process is a slightly modified and extended AISP process as indicated in Figure 4.10. A lot of web-shops already rely on PISPs to successfully handle their transactions. However, former payment processes required specific agreements with certain commercial banks, which gave the banks a lot of power. Yet, with PSD2 the banks have to comply with the PISPs and create an API-based system that facilitates Open Banking. Thus, current regulation already extends the present possibilities, but the potential for the financial ecosystem goes far beyond contemporary expectations.

Similarly to the AISP process, the PISP process is explicated step-by-step in Appendix E.2.

In conclusion, Figure 4.10 gives an overview of the PISP process and indicates crucial points of success. The process has some similarities with the one the AISP presented in Figure 4.9. However, a PISP requires to mutate data, whereas an AISP only has to receive a static copy of data.
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4.6 Technical API Specifications

In the current API development market, there are certain standard API formats. This section will provide insight into the most commonly used formats. The following API specifications indicate the technical boundaries of API design for Open Banking. An elaborate overview of certain API design initiatives that support a standardized approach is provided in Appendix B.

Simplicity and Standardization for Interoperability

The most important notion about the technical side of the financial ecosystem relates to the management strategies of the banks and TPPs. These organizations all want to be included in the new final state of the financial ecosystem. Therefore, their data systems need to have the simplicity to be easily included. The most eminent way to reach simplicity and interoperability is to use as much standardization as possible. In particular, the APIs should be designed in their most standard form so they can be easily included by other organizations and contribute to the financial ecosystem.
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However, these standards are hard to identify and even harder to define. The following list consists of API standards that are most commonly adopted in API design. The most situation would be if different initiatives develop different standards and result in a divided financial ecosystem.

4.6.1 Two Technologies for API Design

Earlier on a definition of an API was given, which stated that an API is used to exchange data between systems. Also, an API is generally self-contained and deliberately designed to have limited functionality. To continue from there, the following part elaborates on two alternatives to build APIs.

SOAP

APIs exist in two formats. The first, the Simple Object Access Protocol (SOAP) API is developed by Microsoft and DevelopMentor. The SOAP API sends its data in an XML document, but a receiver often needs a guiding WSDL (Web Service Description Language) before they can use the data. SOAP became the W3C standard for web services, so it was applied in a wide range of industries for data exchange [Espinha2015].

REST

The SOAP technology was succeeded by the second technology to develop web services, which is called the REpresentational State Transfer (REST). Originally, REST was developed for another purpose, but it proves to be a good alternative to SOAP [Espinha2015]. RESTful web services perform very well on two main functionalities of APIs: message exchange and remote procedure calls [Pautasso et al.2008]. REST APIs are HTTP based and has more standard defined functionalities. More specifically, there are different HTTP requests that define the API’s functionality, such as GET, POST, UPDATE, and DELETE.

4.6.2 JSON

JavaScript Object Notation (JSON) is a data format for the request. Often JSON is combined with RESTful APIs, which makes the JSON part concise because the functionality is already described by the HTTP request (GET, POST, UPDATE, or DELETE). JSON can be used to specify in a clear overview of what is requested, such as reference numbers. For example, JSON is quite easy to interpret for somebody if there are very few lines of code, so a specific date and transaction number can be found in one glimpse.

4.6.3 Identification

Before an API’s functionality can be executed, it has to be identified in a certain way. PSD2 has formulated that identification is a critical part of the process for Open Banking. Identification is a security measure that is captured by the following protocols.

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Authentication
The authentication is the first step for an API to verify the validity. PSD2 obligates the API to comply with the Regulatory Technical Standard (RTS). In this case, the RTS prescribes the Strong-Customer Authentication (SCA) as the authorization requirement. However, this SCA specification is still not specific enough to result in a standard approach because various standards fall under the directive.

Authorization
The second part of the protocol is called Authorization. Once the API is verified by the authentication step, the user has to give explicit consent via the API to authorize its functionality. Once again, the RTS is not specific enough to result in a standards approach.

OAuth 2.0
As a solution to the broad formulation of PSD2. The EBA has announced that there is an authentication protocol that they deem acceptable, which is the OAuth 2.0 protocol.

OAuth 2.0 is typically used for REST APIs to offer standardized mechanisms and functionalities. For SOAP, there were already certain standards for authentication, such as WS-Trust and WS-Security.

Procedure Part
• a procedure for enabling a client to register with authorization server,
• a protocol for obtaining authorization tokens from authorization server with the resource owner’s consent, and
• protocols for presenting these authorization tokens to protected resources for access to a resource.

Table 4.8: OAuth 2.0 Decision-making Procedure

Comprehensibly, an OAuth 2.0 authorization procedure entails the parts included in Table 4.8. The OAuth 2.0 is a Web Authorization Protocol that grants a Third Party access to protected resources via a unique ID-token. It emerged from social media platforms, but became widely adopted in other industries for safe data sharing via protected APIs.

OIDC Workflows
OpenID Connect 1.0 extends OAuth 2.0 with identity authentication and verification layers. Moreover, the framework provides a way to create secure APIs, mobile and browser applications in a cohesive architecture. Identity Tokens can either be generated and then authenticated, or the required identity attributes can be retrieved from an external source.

This OpenID workflow was developed in 2016 by OpenID Foundation Financial API Working Group by Nat Sakimura (Nomura), Tony Nadalin (Microsoft), and Cindy Barker (Intuit).

10https://openid.net/connect/
4.6.4 Functional Requirements of APIs for Open Banking

For Open Banking, the European Banking Authority (EBA) has presented guidelines based on PSD2. These guidelines are more technical implementation requirements that provide a more concrete interpretation of the legislation. This helps banks with their decision-making for compliancy and results in more standardization of the financial ecosystem.

4.6.5 API Design Considerations

Designing APIs is not trivial. Throughout the last decades ‘open APIs’ have shown to be the cornerstone of creating an ecosystem for Google Maps, Facebook, eBay, and Salesforce. These APIs have a relatively high level of openness and their surrounding ecosystem thrives because of it. Google Maps for example relies on input data of organizations to provide general information, such as contact information and opening hours. If this data turns out to be incorrect, the organization experiences a direct negative effect.

Tailor-made API Standards for the Financial Ecosystem

For APIs for Open Banking, it is impossible to adopt the same design approach and provide the same level of openness because the data is more sensitive. In today’s financial ecosystem with personal financial data being requested and shared with third parties, proper architecture and well-designed API components are more important than ever before. Changing market and regulatory requirements influence the concerning APIs. Therefore, the API design method has to be durable and account for changes in the dynamic environment [Gong and Janssen2012] in order to adapt to the accessibility concerns without reducing usability [Woo and Mori2004].

Ongoing Development

Within API ecosystems, complications regarding the rights to use APIs arise. Several notions are made varying from copyright-related protection issues to revenue models that firms radically change to maximize profits after an API’s popularity increases [Evans and Basole2016].

In other cases, TPPs showed certain expectations regarding the openness of APIs in banking. The functionality was limited to a “read-only” API, whereas TPPs expected to be able to also execute transactions via the API. Openness could either be realized by structural change of legacy systems, or by building an extra internal API layer to facilitate standardization of data in back-end systems [Schreieck and Wiesche2017].

To summarize, several API specifications are indicated above. Some of them are already as the standards for Open Banking. However, there is still a long way to go before a Regulatory Technical Standard (RTS) is formed. The design of APIs is now more important than ever due to the adoption of APIs for Open Banking.

The next part includes the case study. The current state of the financial ecosystem is evaluated in its transformation towards Open Banking.

4.7 Exploratory Case Study

In this part, the criteria for the assessment of the developer portals are formulated. Firstly, a brief overview of the case study protocol is given, which discusses the purpose of the exploratory case
CHAPTER 4. OVERVIEW AND ANALYSIS OF THE CURRENT FINANCIAL ECOSYSTEM

study and the case study approach. Subsequently, the findings are discussed and a brief conclusion of the exploratory case study is provided.

4.7.1 Overview of the Exploratory Case Study Protocol

The part of the exploratory case study evaluates the developer portals. Ultimately, the variations are revealed in the program definition depending on the perspective of different actors. More specifically, different developer portals of commercial banks are assessed by comparative analysis. The main goal is to observe functionalities and specifications of the developer portals in the Netherlands, so differences between them are discovered. The case study process is explained more thoroughly in the case study protocol, which is included in Appendix F.1.

Meeting the Technical Requirements

The assessment criteria are mainly based on the technical specifications described in PSD2. However, the case study is conducted during the summer of 2019, so the commercial banks did their best in order to be compliant. Furthermore, the documents supporting the developer portals are used as background information to provide additional information about possible uncertainties.

An additional constraint entails the scope of the case study, only developer portals of commercial banks in the Netherlands were included.

4.7.2 Comparative Analysis

The comparative analysis indicating the differences among developer portals is presented in Table 4.9. The criteria of assessment are based on the functionalities described by PSD2. The criteria of assessment are discussed in Appendix F.2. The most striking observations are discussed here.

Assessment of Developer Portals

A more in-depth description of the developer portals is provided in Appendix F.3. A general overview and remarks about the different developer portals is given. Furthermore, the more elaborate discussion of developer portals allows rectification of the choices made for filling in Table 4.9.

Conclusion of the Findings

The findings show that not all developer portals are fully compliant. Some assessment criteria are hard to determine because limited information is available and the documentation is frequently updated.

Another striking observation entails the difference between regular commercial banks and Tech companies with a bank license such as Bunq. The approach and structure of the developer portal are quite outstanding and specific functionalities are different from the regular banks.

Furthermore, Tikkie is a payment initiation service of ABN Amro. Tikkie has been around quite longer than other competing services of the other commercial banks. Consequently, the functionalities of Tikkie are more extensive and stand out in the financial ecosystem.

4.7.3 Explaining After Exploring

The exploratory case study is combined with a more in-depth explanatory case study. More specifically, the explanatory case study aims to find out differences in strategic views between organizations.
### Functionalities

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>ING</th>
<th>ABN</th>
<th>Rabobank</th>
<th>Bunq</th>
<th>Triodos</th>
<th>Volksbank</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPP verification</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Destruction of credentials</td>
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<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Deactivation of credentials</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revocation of credentials</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<td></td>
</tr>
<tr>
<td>Account Information</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Payment Initiation</td>
<td>X</td>
<td></td>
<td>extra</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Confirmation of funds</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>OAuth 2.0</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Back-up system</td>
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<td></td>
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<tr>
<td>Open access to Sandbox</td>
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<td></td>
<td>X</td>
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</tr>
<tr>
<td>Meet max. time constraints</td>
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<td></td>
<td></td>
<td>X</td>
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<td>Frequency checker</td>
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<td>X</td>
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</tr>
<tr>
<td>Virtual Ledger Account</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Consistent format of data</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>REST/JSON format</td>
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</tr>
<tr>
<td>Traceability mechanism</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Transaction logging</td>
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<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Unique stamping</td>
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<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notification kit</td>
<td>X</td>
<td></td>
<td></td>
<td>extra</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Foreign exchange rates</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Request code list</td>
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<td>X</td>
<td>X</td>
<td>extra</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Error list</td>
<td>X</td>
<td></td>
<td>extra</td>
<td>X</td>
<td>extra</td>
<td>X</td>
</tr>
</tbody>
</table>

**Legend:** [] = not included, [X] = included, [extra] = extensively included

Table 4.9: Comparison of Developer Portals

In particular, interviews are conducted to identify the differences. Consequently, each part addresses a specific view on the topic and assesses the environment in an alternative way.

In sum, the comparative analysis shows that the developer portals of commercial banks in the Netherlands are barely compliant to PSD2 requirements. Some banks already provide some additional functionalities to distinguish their services from competitors in the financial ecosystem. Notably, the services for AISP and PISP are fully operational, which could be a result of the earlier deadline of March 2019 for these particular services.

Ultimately, the case study aims to clarify the process of the financial ecosystem in its transformation towards Open Banking. Therefore, an explanatory case study is performed to provide more
4.8 Explanatory Case Study

In this part, qualitative data is gathered via interviews. An explanatory case study is performed for a more thorough analysis of the financial ecosystem.

The following explanatory case study aims to evaluate the changing financial ecosystem by determining the rationale that formed the strategic foundation of the decisions made at the considered organizations. These findings serve as input to evaluate the strategic directions of stakeholder groups and determine the effect on the financial ecosystem.

Overview

Firstly, a brief overview of the case study protocol is given, which discusses the purpose of the explanatory case study and the case study approach. Subsequently, an overview of the interview results is given and a conclusion of the exploratory case study is provided.

4.8.1 Explanatory Case Study Protocol

The purpose of the explanatory part is to provide deeper insight into the contextual aspect regarding the current state of the financial ecosystem. This requires to include multiple organizations from different stakeholders. A wider range of topics is considered with their underlying rationales.

Selection of Interviewees

The interview selection procedure is explained in the case study protocol, which is included in Appendix G.1. A concise overview of actually selected interviewees is provided in Table 4.10. Some additional remarks are made here based on the selected interviewees.

The commercial banks are big organizations with distinct areas of expertise and clearly defined business roles. Therefore, more people had to be interviewed to obtain a good perspective of this particular stakeholder group. The variation in the approach of different banks also affects the outcomes and complicates the identification of unambiguous stakeholder interest. Nonetheless, a clear vision of the stakeholder group is determined by selecting multiple people at different commercial banks.

The Governing Agencies were difficult to identify due to the limited scope of the research. To identify the regulatory process in the Netherlands, the DNB is included because that is the Dutch NCA. Furthermore, the perspective of DNB is included at a moment right before PSD2 became effective. Since time and scope were identified as important actors, the French STET perspective...
is included by a French oriented consultancy firm. Moreover, this particular consultant provided additional insight regarding the timing because the project started at a moment of great uncertainty where no EBA guideline was published yet.

The TPPs include smaller organizations, so data experts and executives were able to provide all the information necessary. Both organizations were pioneers in the financial ecosystem paving the way for TPPs, where one particular organization started even before PSD2 was published. Thus, some striking remarks are made about the impact of creating API-systems before and after PSD2.

**Interview Protocol**

The questions address three main parts. Firstly, stakeholder identification in the financial ecosystem and the perceived interests of these actors. Secondly, the explanation of processes is discussed that helps the organization of interest adapt to the changing financial ecosystem. The third and final part of the interview addresses the future expectations of the organization of interest, which aims to clarify how different stakeholders perceive the future of the financial ecosystem. The data collection plan in Appendix G.2 provides additional information about the collection of data and interview preparation.

The discussed parts respectively explain: background information and the contextual perception from a stakeholder’s point of view, the produced output by the stakeholder and the influence on the financial ecosystem, and the future expectations of the stakeholder that allows to identify indicators that determines the future of the financial ecosystem.

**4.8.2 Interview Questions**

With the provided guidelines for the case study protocol, a set of interview questions is created according to the Qualitative Interview Design method [Turner III2010]. In Appendix G.3, the interview questions per stakeholder group is included.

The questions are created by following a general conceptual structure, which allows to discuss the same topics relevant for this research. However, the selected organizations have different interests. Thus, for every stakeholder group, the questions are slightly different to address the topic from the desired point-of-view. More specifically, the questions serve as a basis for systematic explanation building and allows to develop explanatory theories about the development of the financial ecosystem [Gugiu and Rodríguez-Campos2007].

When the case study is completed and all qualitative data is collected, the results are presented. The best way to so is discussed below.

**Presenting the Findings**

The interviews are conducted at organizations across the financial ecosystem, so more flexibility is needed for this part to gather the data and analyze differences on multiple indicators. As a result, the set of interview questions address multiple topics and the questions differ slightly for the different types of organizations. That way, the procedure increases in complexity, but the data is collected more specifically due to its increased flexibility.

Providing numeric results via some formulaic procedure with statistical generalization is considered to add little value at this premature point of Open Banking. Also, this method does not lead to the results than gains full insights into occurring relationships. Therefore, analytical generalization will be used to answer how and why certain developments occur in the environment.
4.8.3 Results

The main conclusions from the conducted interviews will be presented here according to the previously introduced methods. That is, the narratives following from the conducted interviews is provided in Appendix G.4 and the main conclusions are presented here.

Banks’ Concerns

The narratives of the conducted interviews at several commercial banks in the Netherlands are included in Appendix G.4.2. The main concern for commercial banks is being compliant. Since the announcement of PSD2, the commercial banks have been occupied with developing their API-based systems. Although, the level of uncertainty regarding the PSD2 regulation is a big problem for them.

The commercial banks all addressed the various ways that the legislation can be interpreted, which complicates the decision-making process of designing a compliant API-based system. As a consequence, the commercial banks in the Netherlands all follow the Berlin Group guidelines because they assume that the market standard is represented by these guidelines.

All of the commercial banks have started by implementing an API-based system that meets the compliance standards. After the regulatory imposed deadline of September 14th, the commercial banks can continue with searching for innovation opportunities and extend their API-based systems.

TPPs’ Concerns

The narratives of the conducted interviews at certain TPP organizations in the Netherlands are included in Appendix G.4.3. The TPPs demand a level playing field and an efficient financial ecosystem. PSD2 is a step in the right direction, but the transition is far from over. The commercial banks still do not fully comply with the regulatory requirements stated in PSD2.

Furthermore, NCAs are monitoring the domestic financial ecosystem but their decisions often affect other countries throughout the EU as well. The corresponding procedures differ among countries and TPPs are concerned about a uniform practice of the requirement specified in PSD2.

Moreover, some particular mechanisms do not adequately align with the underlying intent of the legislation. For example, the consumer’s consent expires after 90 days which inefficiently, and arguably inaccurately, satisfies the need for consumer control of financial data. Regulators are caught up in time-consuming processes, which causes them to be poorly attainable and results in insufficient transparency and broadly experienced uncertainty.

Regulatory Concerns

The narratives of the conducted interviews at organizations that provide insight into the role of Governing Agencies is included in Appendix G.4.1. The general regulatory concerns are found by comparing the French and Dutch approach of NCAs. Also, the Dutch NCA is interviewed just before PSD2 became effective and the French perspective is based on the period just after PSD2 was announced when the regulatory requirements were lacking the desired specification.

The NCAs are concerned with the alignment of their individual interpretations. They want to offer a consistent financial ecosystem with the same decision for every issue. Although this is a difficult objective to achieve, the NCAs are in close contact with the EBA in order to approach this European wide standard of regulatory acceptance.

Ultimately, the EU commission wants the financial ecosystem to be a level-playing field where market forces lead to an equal balance of fair prices for innovative financial services in an interoperable environment. The problem for the regulator is the inability to create such an ecosystem because
they can only prevent misconduct. However, the creation of a financial ecosystem depends on the
actors operating in the market and these actors have to work together with similar intentions.

The process of an NCA is a very difficult one because the involved actors are countless and of
great variety. Their interest and business strategies differ which makes the process of involving
the actors very important. NCAs want to create a uniform policy towards monitoring, but uncertainties
regarding the specific interpretation and the various possibilities of business models complicate this
objective.

4.8.4 Key Takeaways of the Case Studies

All stakeholder groups identified PSD2 as the key driver of the changing financial ecosystem.
Although, uncertainty about interpretation and unspecific regulatory boundaries in the financial
ecosystem is one of the main issues for the transition to Open Banking.

The multi-interpretative formulation of the legislation results in varying developer portals and dif-
fering implementation of functionalities. Different standards or rarely occurring components causes
a lot of extra work to include in information systems and limits the interoperability of the financial
ecosystem.

4.9 Conclusions of Findings

This chapter answers the first two sub-questions. A full system analysis is conducted to answer the
first sub-question:

“1. What does the financial ecosystem look like from a contextual and technical
aspect?”

Subsequently, a comparative analysis is performed and several interviews are held to answer the
second sub-question:

“2. What is the effect of stakeholder groups on the financial ecosystem?”

With these findings, the contextual, technical, and current state of the financial ecosystem is de-
scribed.

Furthermore, the interviews give a more in-depth explanation of the stakeholder interests and
their perspectives towards the past, present, and future of the financial ecosystem. A short overview
of the findings is provided here.

This extensive chapter contains a lot of information, so the main findings are divided into the
contextual aspect and the technical aspect.

4.9.1 Contextual Aspect

Based on the network and institutional economic aspect of the system, as well as the different
stakeholder groups’ interests, the following conclusions can be made.

Firstly, the regulatory impact is the most eminent driver of the transforming financial ecosystem,
as the commercial banks fear getting fined if the are not compliant. Temporarily, the financial
ecosystem is completely occupied by PSD2 requirements and gradually developed EBA Guidelines,
so more regulatory intervention is currently not expected.

Secondly, DNB is aware of its role as the National Conduct Authority and tries to be as clear and
transparent as possible. Still, due to many uncertainties in the European Economic Area and the
CHAPTER 4. OVERVIEW AND ANALYSIS OF THE CURRENT FINANCIAL ECOSYSTEM

large scale of the financial ecosystem, it is hard to explicitly communicate a uniform regulatory standard.
Thirdly, different interests are leading to different (and sometimes opposing) strategies of actors in the financial ecosystem, even within stakeholder groups. It is currently difficult to determine what is the best strategy for a particular stakeholder group, especially banks are experiencing negative effects of the changing financial ecosystem.

4.9.2 Technical Aspect

Based on the comparative analysis of developer portals and the technical needs of the financial ecosystem, the following findings are evaluated.
Firstly, the financial ecosystem relies on a technical infrastructure with digital payments as its critical transaction. That is, without digital payments, no financial data.
Secondly, the rest of the functionalities evolve around the secure implementation of APIs and financial data transfer, where data protection has to satisfy consumer demand for privacy.
Thirdly, clear communication and transparency of operational effectiveness are key to develop market standards and ensure the interoperability in the financial ecosystem.

4.9.3 Relative Impact

The contextual and technical aspects of the financial ecosystem are both affecting the environment with different attributes. A future prospect on the relative impact is provided by describing scenarios.
Ultimately, all of the findings are synthesized and guidance towards establishing a robust technical infrastructure that forms the basis of a durable financial ecosystem is presented.
Chapter 5

Data Analysis

The previous chapter focused on data gathering and explicating the current state of the financial ecosystem. The next step of the research is to analyze the data. As a start, some scenarios are discussed to forecast future developments of the financial ecosystem. Subsequently, the case study findings are analyzed to determine trade-offs among stakeholder interests by discussing rival explanations.

5.1 Scenario Engineering

A future prospect on the relative impact is provided by discussing the most likely attributes that are the key drivers of the changing financial ecosystem. The scenarios represent some possible outcomes if the financial ecosystem is developing further in the identified direction.

5.1.1 Selection of Attributes

The scenarios are created according to the Attributes of Scenario Development from Table 2.5. The attributes are discussed in Table 5.1 and related to the changing financial ecosystem.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Judgment</td>
<td>The case studies indicate that the most essential attributes for change are regulatory intervention and the adoption rate of Open Banking by consumers</td>
</tr>
<tr>
<td>Future Perspective</td>
<td>The literature and the case studies indicate plausible outcomes of the changing variables, which are presented by the Scenario Matrix in Figure 5.1</td>
</tr>
<tr>
<td>Findings from Stakeholder Groups</td>
<td>The stakeholder groups are considered the most influential factor that shapes the future of the financial ecosystem</td>
</tr>
</tbody>
</table>

Table 5.1: Attributes for Scenarios
5.1.2 Scenario Matrix

The presented scenario development techniques from the literature review are applied for developing scenarios. The foundation of the created scenarios is formed by using techniques. The input variables of the INTERAX technique from in Table 3.6 is used among others.

Results

With the gathered data, the future market environment is forecast. Based on previous conclusions, Scenario Engineering is used to clearly illustrate how the financial ecosystem is most likely to unfold itself.

Two Scales for Attributes

Based on the case study findings, certain attributes can be identified. These attributes are used to introduce several extreme outcomes according to the INTERAX input variables of Table 3.6.

A matrix is presented in Figure 5.1 to guide the scenario development into a structured direction. The scales of the matrix consist of two variables, one is driven by the market and the other depends on the regulators. Respectively, the first scale corresponds to the Regulatory Intervention and the other scale corresponds to Adoption Rate. The numbers indicate the possible extreme outcomes.

1. Further Regulatory Intervention

The regulation is currently intervening at the level of sub-systems, and the present role of the authorities is limited to a supervising role. This role and strategy of control by the Governing Agencies correspond to the organizational structure that indicates the scope and the level of interference. Therefore, the next regulatory step can be identified by looking at the organizational Requirements in Parentheses [Künneke et al. 2010].

Figure 5.2 forecasts the outcome if policymakers decide to extend their regulatory intervention in the financial ecosystem. The regulatory intervention could result in a larger scope of control, an increasing speed of adjustment, or both. A larger scope means that relevant organizations are ordered to use specific frameworks for certain components. That leads to strict compliance requirements for APIs and Authorization protocols, such as an explicit OAuth 2.0 implementation invigorating the EBA guidelines.

If policymakers decide to extend their speed of adjustment, the relevant organizations in the financial ecosystem have to comply with a monitoring process. Moreover, new mechanisms need to be implemented that build on their operational systems. Such measurements are undesirable for the banks who already complained about the high costs to comply with regulatory demands.
### 2. Collaborative Initiative Outside the Regulatory Scope

If policymakers decide to restrain from any further regulatory intervention concerning the financial ecosystem, the market is free to develop their own standards. For the speed of adjustment and corresponding hypothetical monitoring mechanisms, this means fewer costs of changing operational systems.

Regardless of regulatory intervention, the aspect of standardized components remains relevant to the development of the financial ecosystem. In particular, standardization of components leads to more interoperability within the financial ecosystem. All actors benefit from more interoperability as long as interests are aligned before the infrastructure is extended. Therefore, the innovation will not necessarily come at the expense of other market players but still is a result of corroboration. Ideally, rework would be minimized in the financial ecosystem due to a clear direction leading to standard components and a high level of interoperability.

### Table 5.2: Follow-up on Organizational Requirements in Parentheses

<table>
<thead>
<tr>
<th>Scope of control</th>
<th>System (requires directive intervention)</th>
<th>Subsystem (requires coordination)</th>
<th>Component (requires corroboration)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T_0</strong></td>
<td>Authoritative supervision ['system operator']</td>
<td>Collaborative supervision ['system regulator']</td>
<td>General framework conditions ['system norms and standards']</td>
</tr>
<tr>
<td>Operational balancing (requires supervision)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>T_3</strong></td>
<td>Compulsory monitoring and enforced adjustment</td>
<td>Mutual monitoring and stimulated adjustment</td>
<td>Self monitoring and voluntary adjustment</td>
</tr>
<tr>
<td>Capacity utilization (requires monitoring)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>T_{15}</strong></td>
<td>Controlled allocation mechanism</td>
<td>Guided allocation mechanism</td>
<td>Competitive allocation mechanism</td>
</tr>
<tr>
<td>Capacity allocation (requires facilitation)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>T_{20}</strong></td>
<td>Directive planning</td>
<td>Indicative planning</td>
<td>Decentralized planning</td>
</tr>
<tr>
<td>System transformation and innovation (requires planning)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.2: Follow-up on Organizational Requirements in Parentheses [Künneke et al. 2010] p.502
Adoption Rate

The second scale on the Scenario Matrix presented in Figure 5.1 relates to market demand and refers to the adoption rate of the systems in place. On one side, certain mechanisms building on the increased availability might lead to more convenience. On the other side, convenience often comes at a price, which is stressed by commercial banks. More specifically, the commercial banks fear that the financial ecosystem becomes data-driven and personal advertising for financial services might come at the expense of privacy.

Thus, the Adoption Rate depends on consumer behavior. After banks have presented their services, the prospect of new business cases depends on the willingness of consumers to use these innovative services. Notably, the Three Pillars of Innovation discussed in Figure 4.2 refer to the foundations of the financial ecosystem and explain their downsides.

3. No User Interest

In the extreme event that all downsides of Three Pillars of Innovation are massively exaggerated and result in the societal paradigm of rejection. This extreme event is highly unlikely as any actor is considered capable of analyzing the market potential of certain services and tweaking them to more appealing outcomes.

Therefore, the adoption rate is scale depending on trade-offs. Hence, the exploration of the opposite extreme which entails a very high adoption rate of financial services by consumers.

4. High Adoption Rate

In the event that many people are willing to share their financial data, a large variety of organizations will collect big amounts of data. In turn, this can lead to a threat as these amounts a difficult to control and protect against malicious practices. In other words, people with bad intentions become more determined to obtain valuable data when it is potentially available at multiple sources.

On the other side, the available financial data is a catalyst for the financial ecosystem to strive as the possibilities to offer services to consumers will become endless. Ultimately, consumers will decide what services are worth the trade-off, so keeping track of consumer decisions and their underlying trade-offs determines the value of the financial data as input.

To summarize, the third sub-question is answered in the previous part.

“3. What future scenarios can be forecast to make the requirements for APIs for Open Banking more robust?”

Both extremes concerning the adoption rates are introduced and the possibilities concerning the regulatory intervention are discussed. Despite the factors of uncertainty, some general remarks provide more evident and contributing insight into the development of the financial ecosystem.

Common Factors of Change

The most evident development concerns the corroboration of the actors in the market. The widely experienced urge for interoperability calls for even more standardization of components. The OAuth 2.0 framework is already adopted as the market standard for the authorization mechanism, but there are still other components that are
CHAPTER 5. DATA ANALYSIS

Documentation of Processes and Outcomes

Regardless of the outcomes that may differ from other systems, organizations, or preliminary market standards, extensive and comprehensive documentation is vital in order to be included in the financial ecosystem.

5.2 Meta-synthesis for preliminary theory building

The previously presented findings are able to provide a basis for collaboration. The presented incentives for the involved actors serve as input for a partnership structure in order to build a durable financial ecosystem. For future research, this partnership structure needs to be adequately designed and satisfy all concerns which are present in the environment. Thus, designing such a hypothetical partnership structure requires additional research identifying the specific concerns and incentives for potential stakeholders to work together.

Ultimately, designing such a collaboration initiative for building a durable financial ecosystem can be used for additional theory-building about the creation of partnerships in changing market environments.

5.2.1 Narrative Synthesis

Particularly, the narrative synthesis is used to discuss the trade-offs among stakeholder interests and identify possibilities to jointly establish a robust technical infrastructure, which results in a durable financial ecosystem. The findings from the interviews are analyzed on a higher conceptual level to identify common factors of interest, which leads to incentives for actors to cooperate and deal with trade-offs among stakeholder groups.

Rival Explanations

The documented narratives are synthesized by evaluating the introduced rival explanations in Table G.1. The rival explanations help to better understand the necessary trade-offs between stakeholder group interests.

Network Dynamics and Strategies

Rival explanation number 3 refers to the utilization of network dynamics and the decision-making process, which are discussed in Figure 3.2 and 3.3.

DNB is following the suggested network strategies better than other NCAs within Europe, especially by following a sequential approach with structured phases and clear communication. Despite their efforts of being consistent and predictable, the communication towards the financial ecosystem has to be even more explicit and transparent than their current performance. Additionally, DNB is able to take more advantage of the network dynamics by providing more positive incentives for the other stakeholders to help them, instead of using solely the fear of punishing to stimulate cooperative behavior. A more durable approach benefits the whole financial ecosystem in the long-term.

The other stakeholders are able to align their interests and choose organizations of similar mindsets to create durable partnerships. This requires a great amount of trust because the possibility of a hit-and-run strategy is currently too realistic.

CHAPTER 5. DATA ANALYSIS

Discussion of Results for Each Number of the Rival from Table 5.1

<table>
<thead>
<tr>
<th>Number</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>TPPs benefit directly from well-designed API-based systems, and banks benefit if their systems are included. Ultimately, consumers benefit from more extensive and better working financial ecosystem.</td>
</tr>
<tr>
<td>2.</td>
<td>Regulators have the power to impose sanctions when necessary, due to their hierarchical position. However, NCAs are unable to perfectly monitor the whole financial ecosystem from the beginning. Therefore, they have to utilize the opportunities of Network Dynamics.</td>
</tr>
<tr>
<td>3.</td>
<td>Both the Governing Agencies and the other stakeholders have opportunities to optimize their decision-making process by strategic use of the Network Dynamics. The results of this rival explanation are further elaborated following this table.</td>
</tr>
<tr>
<td>4.</td>
<td>Overall, Open Banking leads to a unique transformation of the financial ecosystem because never before was the impact considered this big and disruptive. Nevertheless, some inspiration for design principles can be obtained from the cases of Instant Payments and the transition to IBAN because those transitions were experienced positively.</td>
</tr>
<tr>
<td>5a.</td>
<td>All organizations admitted that available resources never have been an issue for them, although the reasons differed among stakeholder groups. DNB credited the good planning and sequential enforcement. Banks prefer spending money on their system rather than on fines and do it anyways.</td>
</tr>
<tr>
<td>6.</td>
<td>Corporate interest in financial data did spark the regulatory initiative. However, from a policymaker’s perspective is argued that legislation is mainly the consumers’ best interest because regulatory establishment minimizes misconduct and societal abuse.</td>
</tr>
<tr>
<td>7.</td>
<td>Currently, an estimation of the adoption rate of Open Banking functionalities cannot be made because the potential is not fully discovered. Nevertheless, consumers will be tempted to adopt Open Banking functionalities forthwith, so establishing and maintaining a secure environment is essential.</td>
</tr>
<tr>
<td>8.</td>
<td>Regulatory intervention is an endless ongoing process, which never stops when problems continue to evolve. Currently, Governing Agencies are trying to extend the potential of PSD2 as much as possible by new interpretations and formulating guidelines that redefine previously unidentified boundaries.</td>
</tr>
<tr>
<td>9.</td>
<td>Almost all organizations agree that regulation is necessary in the consumer sensitive financial ecosystem. However, all organizations benefit from clearer communication about the rules and less variety in interpretation.</td>
</tr>
</tbody>
</table>

Table 5.2: Results of the Rival Explanations

In sum, only for rival number 5 it is concluded that 5a. is the true one. The other rival explanations share truths with their corresponding alternatives. Nevertheless, the results do provide comprehensive insight into the financial ecosystem by making the case study findings explicit. The results are an excellent basis for the formulation of design principles.

5.2.2 Pattern Identification

Similarities among different focus groups are discussed here. Clarify corresponding interests and general patterns. Comment on where differences come from and stress their underlying cause.
Banks
Some similar patterns of design for API-based systems at several banks can be identified based on the interview results. All the commercial banks explained that compliance is the most important driver to design their API-based system. In every design progress, this is their starting point and gets priority in decision-making. The Dutch banks all followed the Berlin Group for their implementation guidelines.

Similarly important is the level of security that is offered to consumers by the API-based system. The security of financial data directly affects consumer trust towards banks and the perceived legitimacy. So, in the event that possible security issues may cause implications, the design is reevaluated until everybody involved feels confident about the system’s performance. Therefore, a sufficient degree of innovation at banks is important in order to stay relevant in the changing market environment.

TPPs
TPPs depend on financial data that the commercial banks have to deliver through their API-based systems. The regulator is responsible for supervising the financial ecosystem and intervene if commercial banks are not compliant, but TPPs find the pace of transformation slow and incomplete. Small-sized TPPs have difficulties with influencing the financial ecosystem due to its enormous size and countless actors involved.

However, TPPs do not seem to understand the power they have because of their knowledge. They often are the innovation experts in the market that are able to inform Governing Agencies and guide the regulatory process.

Governing Agencies
The patterns in the process of NCAs relate to the interpretation of the PSD2 regulation. In particular, the NCAs follow the guidelines presented by the EBA. In any case of uncertainty, the NCAs communicate the concerns to the EBA and NCAs in other countries to align their views and interpretations.

The NCAs are now in the phase of gathering information about business models and intentions of potential actors in the market. After receiving this information, the NCA has to judge if the intentions comply with the regulation and in what way these business models are allowed to be executed. In case of unforeseen circumstances, the NCAs notify the EBA and other NCAs to prevent any differences in interpretations and discrepancies in competencies among different countries. In other words, different countries should have the same policy on how certain businesses are allowed to operate.

5.2.3 Explanation Building
Finally, the requirements for the API-based systems are related to the Four Cornerstones of the financial ecosystem, as indicated in Figure 1.1.

An overview of the general stakeholder group interests regarding each of the Four Cornerstones is provided in Table 5.2.

5.3 Conclusion of the Data Analysis
In this chapter, the third sub-question is answered:
Stakeholder Group | Service | Technology | Legislation | Ethical Value
---|---|---|---|---
Governing Agencies | NCAs admit that not every possible service can be anticipated, so they rely on the application process of certificates to monitor the market before any effect. | A uniform Regulatory Technological Standard is hard to impose, because of the many developments in the financial ecosystem. However, standardization of the market makes monitoring far more manageable. | Good international and vertical communication (to the EU and other NCAs) is key to be uniform and make legislation gradually more explicit | NCAs are accountable for any misconduct and rely on NCAs from other countries for practices within their jurisdiction, so they hope that governance processes are equal
Commercial Banks | Are trying to reinvent themselves and look beyond the regulatory imposed services to find new business models | Banks relied on their legacy systems for a long time, but are now forced to transform and conform to a new market standard. | PSD2 led to a thought transformation of the whole industry, so banks did everything in their power to earn their influence on the future. | Some banks are using this transformation to create partnerships with like-minded organizations
Third Party Providers | The level playing field offers a chance for TPPs to offer more and easier scalable business models | Every organization benefits from a technical standard, especially the ones that rely on externally provided financial data. | PSD2 is a positive step in the right direction, but still a lot more is to be done before true Open Banking is achieved. | Clear communication and transparency about a uniform standard leads to more interoperability and ultimately benefits the whole financial ecosystem

Table 5.3: Explanation Building Overview

3. What future scenarios can be forecast to make the requirements for APIs for Open Banking more robust?

The most influential factor that determines the future of the financial ecosystem is the stakeholder group interests. Their behavior will determine and be determined by regulation and market demand.

Regulation is only the first step that determines the market, the room for interpretation leads to strategic behavior of stakeholder groups. For example, commercial banks are trying to gain the trust of the regulator by cooperation, so their position becomes stronger and they can be more influential. These conflicts of interests make it difficult for NCAs to monitor and for regulators to determine fair policy.

The results are summarized in this chapter by answering the fourth sub-question:

4. What are the robust API design requirements according to the Four Cornerstones of the financial ecosystem?
Nobody in the financial ecosystem seems to think that the Open Banking will be useless. However, there are concerns about the development of services that touch the edge of regulatory boundaries and question the ethical norms and values. For these malicious practices, the financial ecosystem trusts NCAs to be uniform and capable of adequate monitoring.
Chapter 6

Results

For this research, certain design principles are created to increase the robustness of APIs for Open Banking and make them more future proof. Some common factors of change were identified in the previous chapter that serve as input for the design principles discussed in this part of the research. The dimensions are presented in order of importance, where the first dimension is regarded as the most important principle for API design for Open Banking.

API Backbone

The principles form the backbone in the design process as the information system constructed. In particular, the design principles for API design for Open Banking apply to the financial sector but also relate to the sharing of semi-publicly available data in a more general sense. The following set of dimensions is presented based on previous studies [Bharosa and Janssen 2015] and extended due to the findings in the financial ecosystem.

6.1 Information Quality Dimension

First, the relevant Information Quality dimensions are linked to the findings from the financial ecosystem evaluation. Subsequently, the remarks and concerns are translated into robust design principles.

6.1.1 Compliance

Compliance is the most important driver of API design for commercial banks. The following drivers follow from regulatory specifications, as they are included in the PSD2.

Accessibility

A TPP first has to get the certified status in the country that it wants to operate. The National Competent Authority (NCA) has to verify if the TPP meets the regulatory requirements.

There are four distinct certifications[^1] that a financial service company can apply for: Account Servicing, Account Information Service Provider (AISP), Payment Initiation Service Provider (PISP),

[^1]: PSD2 Art.34
and Issuer of card-based instruments. Once the TPP is on the list of certified TPPs, the bank has to allow the TPP unrestricted access for 90 days after a consumer provides its consent. Initially, the EBA specified that banks are forbidden to interfere with the TPP’s accessibility after the consumer gave its consent. The Dutch banks had some security concerns as a malicious TPP could abuse its certified status and also ignore revoke requests from the targeted customers. They felt that consumers would blame their bank of negligence, which would seriously damage their perceived reliability. Similarly, the perception of legitimacy is identified as a vital asset of a bank’s future success [Svensson et al.2019]. Consequently, the banks negotiated with the DNB (Dutch NCA) and they are now allowed to protect their customer’s financial data via a two way revoke mechanism. Some banks have included a ‘master switch’ that allows a consumer to revoke all access via the personal digital environment of the client’s bank.

Security
Although security is an important part of the legislation and vital for the system’s success, the security aspect is not explicitly mentioned in the original set of dimensions [Bharosa and Janssen2015].

Information Overload
In the event of a system overload, created for example by a DDoS attack, the bank is obligated to offer some back-up mechanism. Contingency measures must be taken if the interface does not respond within 30 seconds. These measures include alternative (back-up) service functionalities for consumers, error notification protocols for the National Competent (Banking) Authority (NCA/NBA),

One bank had complied with almost all rules and let an external party validate the code used in the sandbox environment. After submission to DNB, the bank was told to perform a stress test on the system to comply with PSD2 art.33.

Accuracy
The communicated data must be accurate. The minimal requirements that certified parties need to provide are specified in the legislation. However, being accurate is difficult due to the differences in interpretation.

Timeliness
In the legislation, the maximum time of a response after a request is not allowed to take more than 30 seconds. Additionally, a user can access the account for no more than five minutes after the authentication procedure is successfully completed. Moreover, one bank has indicated explicitly that Instant Payments has a direct influence on the timeliness of data when payments are instantly processed and the money is transferred directly. Thus, the data quality improves accordingly as real-time becomes standard.
CHAPTER 6. RESULTS

Momentarily, at least one bank is experimenting with timeliness already\(^8\) by providing a management option to see what transactions can be expected in the future. This bank is able to predict some likely transactions of the near future, such as direct debits and other indicated allocation of funds, which offers a more complete overview of the account. Therefore, this bank is able to communicate some state of an account to a TPP or a consumer even earlier, which increases the quality of the ecosystem in terms of timeliness\(^9\).

**Frequency**

Before data can be exchanged, the TPPs are unable to make more than four requests in a 24-hour period. Except if there is an explicit consent given the user\(^10\).

Additionally, The consent of sharing your financial data automatically expires after 90 days. Therefore, the users are asked at least every 90 days to give their consent again before their data can be used\(^11\).

**Format**

The format\(^12\) of the available data largely depends on the operating back-end systems of banks. One bank explicates that they began with standardizing their data systems European wide and make their systems perfectly interoperable by creating internal API-endpoints.

Subsequently, this bank links one publicly available API for Open Banking to the internal endpoints, thus creating a European wide single point of access for every type of API. This approach requires a very careful communication protocol because one update in the API directory (being a single link) influences the whole chain. In other words, the transition to more standardization is a process of many changes influencing the system. If parts of the system are altered without careful communication, the system leads to untraceable failures and reparation is nearly impossible.

No regulatory standards are given for data standards. Security protocols and other implementation guidelines are given, such as the OAuth 2.0 authentication standard and almost all API-based systems follow the REST format.

Despite the differences, the majority of the data follows the REST/JSON standardization. The types of occurring errors are roughly the same but often differ in the display (or syntax). The Format shows the biggest opportunity to improve standardization in the sector. Therefore, this research will focus extra on the standards used, which are most likely to be widely adopted in the future. For example, ING sticks to many ISO standards\(^13\).

**Traceability**

There are no explicit requirements, but traceability\(^14\) is indicated as an important aspect to safeguard how financial data is treated after it is shared. The unique stamping that some commercial banks already implemented are improving the dimension of traceability, but this is only the first step. The regulation needs to be more explicit and better specified to maximize the security of the financial ecosystem.

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\(^{8}\) ING https://www.ingwb.com/insights/virtual-cash-management/virtual-bank-accounts

\(^{9}\) https://www.ingwb.com/insights/virtual-cash-management

\(^{10}\) PSD2 Art.36

\(^{11}\) PSD2 Art.10

\(^{12}\) PSD2 Art.36

\(^{13}\) ISO 8601 for date/time

\(^{14}\) PSD2 Art.29
Furthermore, traceability is also a vital part of monitoring the financial ecosystem. Therefore, incorporating specific traceability mechanisms in the Regulatory Technical Standard prepares the financial ecosystem in case the regulator wants to expand the speed of adjustment as indicated in Figure 5.2.

Consistency

Consistency is another aspect that differs among organizations. Consistencies between organizations are hard to identify in this early stage. It is expected that the ecosystem will unfold by adapting to the best practices, only after they are identified. Nevertheless, the legislation does explicitly state that every organization must offer its data with the same level of availability and performance to any actor that is allowed to receive it.\footnote{PSD2 Act.32}

Consistency within organizations is ensured by regression testing and careful documentation of the implementation decisions. The first mechanism monitors the outcome of the new system and verifies if it leads to the same result as the old system. The second mechanism traces the steps of the system, so the system can easily be analyzed in the event of a mismatch. If such discrepancies occur, it is vital that verification is done at each step and the steps are small enough to know the exact location of the error.

6.1.2 Additional Information Quality Dimensions

Beyond the regulatory guidance, there are additional Information Quality Dimensions that serve as input for formulating design principles.

Identification

Although this requirement does not refer to a specific article, but the OAuth 2.0 protocol is widely adopted after the EBA recommended it as a compliant mechanism for identification.

Relevance

The majority of banks do not consider relevance yet because they are far too busy with the compliance as their top priority. At this moment, the regulators decide what is relevant and any idea that builds upon the currently implemented functionalities is stored until it is time for new projects.

In the current market environment, TPPs depend on the API-based system of banks. They have some ideas or concerns about data they find relevant and they try to share their suggestions improvements with other stakeholders.

Completeness

The completeness of data is perceived differently among stakeholders and is difficult to assess at this moment in time (at the beginning of Open Banking).

The Bank’s Perspective:

The majority of commercial banks in the Netherlands defines completeness by building their API-based system according to the implementation guidelines formulated by the Berlin Group.\footnote{https://www.berlin-group.org/nextgenpsd2-downloads} Completeness often directly associated with meeting all of the publicly available guidelines, despite their lack of regulatory status. In other words, the banks see these guidelines as a unified standard that
allows them to rectify their design choices, but the EBA has already formulated requirements in the past that differed from the Berlin Group. Consequently, the banks had to alter their systems for compliance, which led to a lot of rework.

**The Third Party Provider’s Perspective:**
TPPs want commercial banks to be fully compliant to the regulatory imposed requirements and offer an efficiently working API-based system that allows TPPs to achieve the promised potential of the financial data.

Furthermore, PSD2 is currently insufficiently safeguarding underlying consumer demand by imposing inadequate mechanisms that annoying instead of effective. These mechanisms are impeding the efficiency of TPPs and the rest of the financial ecosystem due to a misalignment of the identified regulatory demand and proposed technical solutions. Thus, regulatory requirements are both incomplete and inaccurately extensive.

**The Authority’s Perspective:**
The Dutch NCA has to follow the rules imposed by the EBA. Moreover, the interpretation of the regulation has to be in line with the rest of NCAs in other European countries. The degree of performance of API-based systems has to meet the same compliance standards in every country. Therefore, the level of completeness is hard to define and requires intensive communication with the NCAs of other countries to define a clear and fair policy.

Most Information Quality dimensions are included in PSD2, so this makes them part of the Regulatory Technical Standard (RTS). Moreover, current legislation goes beyond the original Information Quality dimensions, but only with unspecific requirements. Open Banking already adds to the quality standards of general information systems.

### 6.2 Design Principles

The design principles are formulated according to the IQ Dimensions and the relevant literature [Bharosa and Janssen2015]. Additionally, the structure of the financial ecosystem is considered according to the various characteristics: variety, dependencies, hierarchical signals, and dynamic behavior [De Bruijn and Ten Heuvelhof2000].

An overview of the final set of design principles are presented in Table 6.1, which ensures that the IQ dimensions are protected and supports the development of adequate API-based systems for Open Banking. The formulation of the design principles is inspired by other well-performing design principles [Gong and Janssen2012, Garfinkel2005].

#### 6.2.1 Open Banking Design Principles

The set of Robust Design Principles for APIs for Open Banking are presented according to the requirements of the financial ecosystem, which were identified during this research. The common factor of these design principles is that they guide towards designing API-based systems that anticipate variables that most-likely change the financial ecosystem. Therefore, the final set of principles is called Open Banking (OB) Design Principles.

#### 6.2.2 Categorisation for General Purpose

The OB Design Principles are divided into three categories, which makes their general purposes easier to understand and the principles more manageable for interested organizations to apply. The
### CHAPTER 6. RESULTS

<table>
<thead>
<tr>
<th>Category:</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For Responsibility:</strong></td>
<td></td>
</tr>
<tr>
<td>1. <strong>Stewardship:</strong></td>
<td>One single person should be responsible for a particular API to guarantee regular updates and long-term performance.</td>
</tr>
<tr>
<td>2. <strong>Privacy by Design:</strong></td>
<td>Consumer privacy is one of the most important factors in Open Banking, so the foundational steps for privacy by design [Cavoukian2010] are suitable.</td>
</tr>
<tr>
<td>3. <strong>Modularity to Adopt New Components:</strong></td>
<td>The API-based system needs to be designed with interchangeable components, so new standards are able to be implemented quickly.</td>
</tr>
<tr>
<td>4. <strong>Define Inter-organizational Risks:</strong></td>
<td>Continuously monitor the environment to adequately identify systemic and pure risks [Scardovi2017].</td>
</tr>
<tr>
<td><strong>For Specification:</strong></td>
<td></td>
</tr>
<tr>
<td>5. <strong>Create and Adapt Portfolios for API Standards:</strong></td>
<td>A clear overview of the specific parameters used by different API-based systems helps to realize more standardization.</td>
</tr>
<tr>
<td>6. <strong>Align APIs with Regulatory Guidelines:</strong></td>
<td>Frequently update API requirements by aligning the business developments with the intentions of the Governing Agencies.</td>
</tr>
<tr>
<td>7. <strong>Redefine Regulatory Guidelines:</strong></td>
<td>Help Governing Agencies with defining clearer and more uniform policy by addressing shortcomings and providing additional information from a business point of view.</td>
</tr>
<tr>
<td>8. <strong>Discuss Prospects with Government Agencies:</strong></td>
<td>Assist Governing Agencies with taking the next regulatory step by informing them about the technical possibilities and guide the course in an ethical direction.</td>
</tr>
<tr>
<td>9. <strong>Prepare for Increased Regulatory Interference:</strong></td>
<td>Prepare the API-based system by design such that new mechanisms are easily implemented and minimize the possible amount of rework in the event that Governing Agencies increase regulatory intervention.</td>
</tr>
<tr>
<td><strong>For Compliance:</strong></td>
<td></td>
</tr>
<tr>
<td>10. <strong>Integrate Financial Data with External Media Sources:</strong></td>
<td>Educate consumers about developed mechanisms in the financial ecosystem and make them aware about the impact of their decisions in order to protect them against undesired outcomes before the choice is made.</td>
</tr>
<tr>
<td>11. <strong>Maximize Information Flows:</strong></td>
<td>Actively create partnerships with trustworthy organizations to maximize financial data exchange and support the growth of an efficiently operating financial ecosystem.</td>
</tr>
</tbody>
</table>

Table 6.1: Open Banking Design Principles with Explanation

categories ensure: API **responsibility** to create durable solutions, continuous **specification** of requirements for constant improvement of the APIs, **compliance** to meet and improve the Regulatory Technical Standard (RTS), and **expansion** to support durable growth of the financial ecosystem.
6.3 Evaluation of Design Principles

The proposed set of design principles is sent to the experts of the financial ecosystem in order to assess the quality. The selection of experts is explicated in Appendix H.2.1.

The performance of design principles has different aspects, so the level of perceived performance is divided into distinctive categories. The categories are explained in Appendix H.2.2. In particular, the assessment criteria include verification, validation, and reliability [O'Keefe and O'Leary1993].

The scores are indicated in the expert assessment form as presented in Table H.2. The choice is varying from strongly agree to strongly disagree, and anything in between.

6.3.1 Results

The set of Design Principles for APIs for Open Banking provides a strong basis for the development of API-based systems. Interested organizations are able to address broadly perceived concerns of the financial ecosystem. The results are included in Appendix H.2.3 and Table H.3 provides an overview of the evaluation scores.

Generalized Remarks

In general, the design principles do satisfy the requirement for reaching overarching goals without losing the flexibility for the necessary specification. Nevertheless, the financial ecosystem far away from its final constitution, so the transformation continues and the uncertainty remains a problem. A more elaborate explanation of the expert remarks is provided in Table H.4.

The following part concentrates on future prospects of the financial ecosystem that lies beyond Open Banking.

6.4 TIP Building Beyond Open Banking

Ultimately, the API Design Requirements provide a strong basis for the creation of reliable Technical Infrastructure Policy (TIP) [Justman and Teubal1995]. The final results are related to the characteristics indicated in Figure 3.4.

Transition to Advanced TIP

According to the Modes of TIP presented in Table 3.4, the financial ecosystem now resembles the basic TIP with the creation of API-based systems. Consequently, the next step for the financial ecosystem is to optimize the API-based systems and by progressing to advanced TIP.

This transition entails creating incentives for cooperation and coordination, so the best technologies can be identified and become available to further specify the Regulatory Technical Standard (RTS).
CHAPTER 6. RESULTS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D requirements as output</td>
<td>More technical knowledge gaps need to be identified from market failures in the financial ecosystem.</td>
</tr>
<tr>
<td>Innovation Support</td>
<td>New technological functionalities need to be developed to satisfy new system needs.</td>
</tr>
<tr>
<td>Focus on functionalities</td>
<td>The financial ecosystem becomes conceptually bigger than Open Banking and influences other sectors as well.</td>
</tr>
<tr>
<td>Select user-base</td>
<td>Developing particular functionalities are mostly for specific organizations, such as monitoring mechanisms for extensive Regulatory Interference.</td>
</tr>
<tr>
<td>High output differentiation</td>
<td>When specific organizations provide input for required functionalities, the financial ecosystem is able to evolve in countless directions.</td>
</tr>
<tr>
<td>Inarticulate need definition</td>
<td>Impossible to say where the potential of the financial ecosystem lies after Open Banking is reached.</td>
</tr>
<tr>
<td>Intensive user involvement</td>
<td>The opportunities of the financial ecosystem need to be indicated by potential users with specific requirements.</td>
</tr>
<tr>
<td>Market for Output</td>
<td>Difficult to determine potential markets, but despite the infeasible regulatory demand Governing Agencies might deem it worthwhile anyway.</td>
</tr>
<tr>
<td>Independency Impossible</td>
<td>Applications of business models beyond Open Banking requires too much knowledge of different sectors, which can be solved only by joining forces.</td>
</tr>
<tr>
<td>Consortium clientele</td>
<td>The future needs in the financial ecosystem might be too specific and expensive to be afforded by one firm, so a consortium of stakeholders is a more realistic client.</td>
</tr>
<tr>
<td>Government as Broker</td>
<td>Policymakers are suitable mediators of big projects with multiple interests and stakes are high</td>
</tr>
<tr>
<td>Capability creation policy</td>
<td>Policymakers should focus on solving urgent needs by bringing proficient people together.</td>
</tr>
</tbody>
</table>

Table 6.2: Explanation of Advanced TI Characteristics [Justman and Teubal1995]

New Infrastructure Characteristics

The prospect of the Technical Infrastructure includes several new characteristics after Open Banking is achieved. The potential is based on the advanced characteristics from Figure 4.2. The corresponding explanations regarding the financial ecosystem beyond Open Banking are included in Table 6.2.

Preventing Market Failures

The general examples of market failures from Figure 3.5 also apply to advanced Technical Infrastructures, so the concepts still apply to the future of the financial ecosystem. That is, the same market failures could occur in the advanced TI due to new circumstances and characteristics from Table 6.2.

Table 6.3 discusses these new possibilities for market failures by introducing potential market failures in the future of the financial ecosystem.

The nature of these market failures is similar to previously identified market failure in Table 3.3. Therefore, the design principles should be capable of preventing the new market failures from Table 3.5 as well. Nevertheless, warning for changing circumstances is always helpful. The future still
CHAPTER 6. RESULTS

<table>
<thead>
<tr>
<th>#</th>
<th>Market Failure</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consumer uncertainty</td>
<td>Communication mechanisms might not work, so better explanation needs to be given possibly by other means</td>
</tr>
<tr>
<td>2</td>
<td>Network externalities</td>
<td>New services could become unexpectedly critical, so potential externalities have to be identified</td>
</tr>
<tr>
<td>3</td>
<td>Knowledge distribution</td>
<td>Implementation issues of standards could remain a problem, so the Regulatory Technical Standard has to be explicated comprehensively</td>
</tr>
</tbody>
</table>

Table 6.3: Future Potential for Market Failures in the Financial Ecosystem

cannot be predicted with certainty, so anticipation is the only sufficient method to offer protection from calamities.

6.4.1 Final Reflection of the Results

Finally, a reflection of general results is provided in Table 6.4, where the Technical Infrastructure Policy is related to the Four Cornerstones from Figure 1.1.

<table>
<thead>
<tr>
<th>TIP:</th>
<th>Service</th>
<th>Technology</th>
<th>Legislation</th>
<th>Ethical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The design principles for APIs for Open Banking</td>
<td>provide safe and innovative digital financial services to consumers and enable organizations to operate more efficiently.</td>
<td>offer a robust foundation of financial data interaction to further apply and develop new technologies.</td>
<td>guide organizations in the right direction and enable Governing Agencies to take a succeeding regulatory step.</td>
<td>explicate stakeholder interest to offer transparency and get the institutional layers better aligned with consumer demand.</td>
</tr>
</tbody>
</table>

Table 6.4: Final Reflection on the Results

6.5 Conclusion of the Results

This chapter entails the answers to the last sub-questions and the final answer to the research question. That is, the research deliverable is created by presenting the set of robust design principles for APIs for Open Banking.

This chapter starts with answering the fifth sub-question:

“5. To what extent do the requirements relate to the Information Quality Dimensions for systematic data sharing?”

All the analyzed findings from the research are related to the Information Quality (IQ) dimensions, which led to the formulation of design principles. Subsequently, the sixth research question was answered:

“6. What design principles are capable to deal with the dynamic environment and result in robust APIs for Open Banking?”
The final set of Design Principles for APIs for Open Banking are evaluated by technical experts of the financial ecosystem. That led to the answer to the seventh and final research question:

“7. What are the possible implications on the financial ecosystem regarding the presented set of Design Principles?”

Finally, a future prospect is given on the financial ecosystem that goes beyond Open Banking.
Chapter 7

Discussion and Conclusion

The last chapter offers a recap and reflection on the research outcomes, the process, and its impact. Firstly, the research question and its answer are discussed, along with the answers to the sub-questions. Secondly, the research limitations are discussed by reflecting on the process and methods and suggestions are provided for further research. And finally, the impact of the research is evaluated. Additionally, the link of this research to CoSEM Master’s Program is explicated.

7.1 Research Question

To summarize, this research provides systematic insight into the rapidly changing financial ecosystem by identifying the requirements for a digital transformation that allows stakeholders to securely and efficiently share financial data. Furthermore, a solution to the uncertainties and trade-offs among stakeholder interest is provided by a set of robust design principles that helps the digital transformation of the financial ecosystem. Relevant actors are able to use these principles to contribute to the financial ecosystem and realize a robust technical infrastructure for Open Banking. The aforementioned objective is captured by the following research question:

“What design principles of API design for Open Banking accurately deal with trade-offs among stakeholder interests and prove enough robustness for the changing financial ecosystem?”

This research question is answered after a structured analysis of the financial ecosystem by including relevant actors in the Netherlands. Principles for API design for Open Banking are carefully designed, which ultimately leads to API-based systems and helps to establish a robust technical infrastructure. The research is performed by answering a specifically constructed set of sub-questions that lead to the answer of the final research question.

7.1.1 Sub-questions

The answer to the first sub-question explicates stakeholder interests in the financial ecosystem and clarifies processes of Open Banking in which the APIs operate:

“What does the financial ecosystem look like from a contextual and technical aspect?”
This answer consists of two parts. The contextual aspect is described by an institutional analysis, which explains the relevant set of formal and informal rules of the financial ecosystem. Additionally, the relevant actors in the financial ecosystem are categorized into different stakeholder groups and their general interests are explained. Their relationships and strategies are explicated by performing network and stakeholder analysis.

The second part of the system analysis describes the technical aspect by presenting a schematic overview of the financial data flow in a BPMN model of the Open Banking process. Subsequently, the critical transactions of the system are explicated and the technical characteristics of the APIs for Open Banking are introduced. The final part of the system description provides a full overview of the financial ecosystem by combining the contextual and technical aspects, where the characteristics of technical infrastructure are explained.

In short, the financial ecosystem is a complex and constantly changing environment due to the influence of different stakeholder interests. Many regulatory requirements shape the technical components and the technical infrastructure for Open Banking.

After the system description, the current state of the financial ecosystem is examined by a case study, which gathers qualitative data in two distinct parts and answers the second sub-question:

"2. What is the effect of stakeholder groups on the financial ecosystem?"

The exploratory case study evaluates the technical performance of the financial ecosystem in the Netherlands by comparing functionalities of the commercial banks’ developer portals.

The second part is an explanatory case study that gathers contextual information about the different interests and contingencies among stakeholder groups. After interviewing carefully selected persons at specific organizations in and outside the Netherlands. The findings from the interviews are presented in narrative form.

The commercial banks are trying hard to develop compliant API-based systems and experience issues with the interpretation of the regulatory requirements. The Governing Agencies are struggling with enforcing a uniform policy due to many unforeseeable outcomes by the various actors in the financial ecosystem. The TPPs want to gain as much financial data as possible as fast as possible, so they can develop new business models and take full advantage of their market potential.

Subsequently, the variables in the financial ecosystem are identified to forecast the changing environment and help the API-based systems more robust. Hence, the answer to the third sub-question:

"3. What future scenarios can be forecast to make the requirements for APIs for Open Banking more robust?"

Some insights regarding the future of the financial ecosystem are explained by discussing several possible outcomes in the form of scenarios. The variables of the changing financial ecosystem consist of regulatory intervention and the adoption rate of Open Banking.

The qualitative data is synthesized and trade-offs are made that deal with stakeholder group interest. Priorly developed rival explanations allow the findings to be linked to requirements for Open Banking. The fourth sub-question is focused on the qualitative data analysis and is answered by providing a more concise overview of the findings:

"4. What are the robust API design requirements according to the Four Cornerstones of the financial ecosystem?"
The requirements for the API-based systems are related to the Four Cornerstones of the financial ecosystem, which include the aspect of service, technology, legislation, and ethical value.

All stakeholders benefit from standardization through uniform implementation and transparent governance. Furthermore, legislation is a product of an organic process between actors, where the regulator requires information to create effective policy. Finally, all actions by every actor should be aligned with the long-term goals of the financial ecosystem and ultimately benefit consumers.

Before the design principles are formulated the robust requirements are linked to the the quality of the information system, which answers the fifth sub-question:

“5. To what extent do the requirements relate to the Information Quality dimensions for systematic data sharing?”

In short, the majority of Information Quality dimensions clear and gradually becoming more accurately specified by Governing Agencies. The most difficult Information Quality dimensions to satisfy, are the ones that require mechanisms that are not available yet.

Once the dimensions of Information Quality explicate the requirements of the changing financial ecosystem, the sixth sub-question is answered by creating the corresponding set of design principles for robust APIs for Open Banking:

“6. What design principles are capable to deal with the dynamic environment and result in robust APIs for Open Banking?”

The set of OB Design Principles is categorised and presented in Table 7.1.

The answer to the last sub-question evaluates the quality of the design principles by having experts in the financial ecosystem reflect on the formulated set of design principles:

“7. What are the possible implications on the financial ecosystem regarding the presented set of Design Principles?”

The expert reflected the design principles on their experience in the financial ecosystem. Notably, they concluded that developing adequate systems should be supported by actively educating consumers about the mechanisms and explicate the risks and implications of their choices to improve the performance of Open Banking.

Finally, a future prospect of the financial ecosystem is presented by reflecting on the characteristics of advanced Technical Infrastructure Policy.

7.1.2 Research Question

At last, the results of all previous sub-questions leads to the answer to the final research question:

“What design principles of API design for Open Banking accurately deal with trade-offs among stakeholder interests and prove enough robustness for the changing financial ecosystem?”

The robust set of design principles for developing APIs for Open Banking is divided into categories and presented in Table 7.1. The categories entail: assigning the responsibility of specific APIs, specific design guidelines for privacy and standard components, procedural design guidelines for compliance and anticipation of increased regulatory intervention, and exploit opportunities to expand the financial ecosystem.

The design principles can be used by interested actors to contribute to the financial ecosystem and realize a robust technical infrastructure for Open Banking.
CHAPTER 7. DISCUSSION AND CONCLUSION

7.2 Research Limitations

Despite the extensive report, the research has some limitations. The following section introduces the most important research limitations to explicate what parts can be extended.

7.2.1 Limited Scope of the Research

The research focuses on the financial ecosystem in the Netherlands. In both case studies, primarily qualitative data was gathered because the financial ecosystem is changing very fast and criteria for quantitative data were hard to identify. The comparative analysis was performed by evaluating developer portals of commercial banks in the Netherlands and the interviews were conducted at primarily Dutch organizations.

7.2.2 Design Principles

Furthermore, the design principles are rather conceptual, so it is difficult to determine their actual performance. The expert evaluation attempts to provide some additional insights, but objective measurement would be a more representative indicator to test the design principles. For example, the adoption rate by organizations in the financial ecosystem would be a more convincing score of the applicability.

7.2.3 Uncertain Environment

Due to the constantly changing financial ecosystem and many uncertainties for the involved actors, it was very difficult to identify explicit stakeholder interests. The interviews have identified that commercial banks and Third Party Providers can benefit from Open Banking by creating strategic partnerships and jointly contribute to their area of interest in the financial ecosystem.

---

Table 7.1: Final Set of the Robust Design Principles for Open Banking

<table>
<thead>
<tr>
<th>Category</th>
<th>#</th>
<th>Design Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Responsibility:</td>
<td>1.</td>
<td>Stewardship</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>Privacy by Design</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>Modularity for Adopting New Components</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>Define Inter-organizational Risks</td>
</tr>
<tr>
<td>For Specification:</td>
<td>5.</td>
<td>Create and Adapt Portfolios for API Standards</td>
</tr>
<tr>
<td></td>
<td>6.</td>
<td>Align APIs with regulatory Guidelines</td>
</tr>
<tr>
<td></td>
<td>7.</td>
<td>Redefine Regulatory Guidelines</td>
</tr>
<tr>
<td></td>
<td>8.</td>
<td>Discuss Prospects with Government Agencies</td>
</tr>
<tr>
<td></td>
<td>9.</td>
<td>Prepare for Increased Regulatory Interference</td>
</tr>
<tr>
<td>For Compliance:</td>
<td>10.</td>
<td>Integrate Financial Data with External Media Sources</td>
</tr>
<tr>
<td></td>
<td>11.</td>
<td>Maximize Information Flows</td>
</tr>
</tbody>
</table>

---
However, this research does not suggest specific criteria or conditions for actors to realize such a strategic partnership. The design principles only address the importance of defining inter-organizational risk and provide guidance for consciously expanding the financial ecosystem. The focus of this research was mainly to take the broader financial ecosystem into account.

**Limited Insight in Market Failures**

The identified Market Failures in Tables 4.3 and 6.3 only provide insight of possible shortcomings in the current market. Some suggestions are given to prevent these market failures, but it is difficult to measure how severe or realistic these market failures are.

**7.3 Suggestions for Future Research**

The current impact of this research and the identified limitations allow for some suggestions to conduct further research on this topic.

**7.3.1 Statistic Analysis**

Providing numeric results via some formulaic procedure with statistical generalization was considered to add little value at this premature point of Open Banking. However, PSD2 has now become effective, so many actors in the financial ecosystem have to be compliant and others build upon the API-based systems of banks. Thus, the reaction to the regulation results in many opportunities to evaluate the new market environment after PSD2 became effective. This research provided some initial criteria that are able to be assessed via statistical analysis on a larger scale by extending the scope of the research.

Furthermore, additionally provided insight into the financial ecosystem can be used to develop new assessment criteria for statistical analysis that go beyond the functionalities of developer portals. Also, the adoption rate of the presented design principles by organizations in the financial ecosystem could be assessed by statistical analysis.

**7.3.2 Measure and Identify New Market Failures**

For now, this regulatory process seems to successfully exclude undesired practices form the financial ecosystem. The question is how long this will last because there will be a moment where current legislation falls short and new market failures emerge.

Future studies could explore market failures that fall outside the regulatory scope of PSD2 and the EBA guidelines. The findings can explicate what the shortcomings of current are and assist policymakers in formulating new legislation. Consequently, the financial ecosystem will be guided into the desired direction by preventing more market failures.

**7.3.3 Creating Durable Partnerships**

During this research, the results indicated that there are enough opportunities in the financial ecosystem to create new partnerships. However, it is still very difficult for organizations to determine a strong foundation of trust and realize a durable partnership where interests are fully aligned.

This research marks a starting point for future research by the specification of stakeholder interests in the financial ecosystem and the introduction of the network dynamics. Therefore, future research is able to focus on partnership criteria to provide a strong basis for cooperation. The result
would benefit both organizations and strengthen their position in the changing financial ecosystem when a hit-and-run scenario is made impossible.

7.3.4 Generalizability of the Research

The generalizability of the Robust Design Engineering (RDE) framework can be assessed by applying this methodology to other systems with a complex contextual and technical aspect. Furthermore, the design principles add to the collection of available design principles and could serve as inspiration for other domains, such as Open Data and Data Governance. In particular, the set of Information Quality dimensions is extended by the adding the concept of traceability of data in an information system.

7.4 Societal Relevance

The biggest concern from the societal perspective is the possible impact of the newly available financial data in the financial ecosystem. The results are summarized by the following implications on society.

7.4.1 Regulatory Intervention

It seems the banks are unaware of the exact implications that possibly result from Open Banking. Their primary focus is to be compliant, regardless of possible impacts. The commercial banks are working very hard to develop API-based systems in order to avoid regulatory sanctions. However, the banks should look beyond the regulatory requirements and estimate what the effect on society to satisfy the regulatory intention.

7.4.2 Future Prospect

Yet, the commercial banks do not seem to have an idea yet what Open Banking might lead to in the future and only time can tell with certainty. This research is able to explain the current market conditions and reflect on contemporary implications. A future prospect is given based on current stakeholder interest and behavior, but that can all can change caused by unforeseen events. Additionally, the technical infrastructure is addressed to forecast the future of the financial ecosystem.

The European regulator demands that financial data should be openly accessible for certified TPPs, but the actual procedures of different countries do not synchronously match yet. NCAs interpret PSD2 articles differently and apply their own procedures that might lead to discrepancies. More standardization is needed to create a more consistent institutional environment.

7.4.3 Influence on the Financial Ecosystem

Based on this research can be concluded that the biggest influence on the financial ecosystem comes from the stakeholder groups. The results explain their interest and provide insight on how they affect the changing market environment.

Ultimately, consumers have to benefit from a more efficiently performing economy. The way that TPPs will use Open Banking and apply the openly accessible financial data, will determine the economic activity. The availability of financial data can help people to be more aware of their own
spending behavior. As a result, the PSD2 regulation can lead to more conscious spending behavior and ultimately stimulate the stability of the economy.

Other stakeholders might abuse the available financial data for personal gain. Therefore, this research explicates that the created mechanisms for Open Banking are a tool for consumers to benefit from more digitalization. However, the consumers should be made aware that their choices have risk implications and are a vital component of the performance of Open Banking.

7.5 Academic Reflection

The literature study revealed a lot of uncertainty in the rapidly changing financial ecosystem. Stakeholder groups seemed to have conflicting interests and regulatory requirements are incomplete or unspecific. The academic reflection provides insight into the academic contribution of the results.

7.5.1 Robust Design Engineering Framework

Firstly, the financial ecosystem is a complex environment in which many actors and technical components affect unpredictable outcomes. This research combined different theories and methods to construct the Robust Design Engineering (RDE) framework. This framework was able to explain many uncertainties and align the contextual aspect with its technical components. Ultimately, design principles are created to be adopted by any actor in the financial ecosystem that wants to contribute to a robust technical infrastructure.

The RDE framework can also be used for similar design problems. The RDE is especially suitable for artifacts in more complex environments that require extensive preliminary research before design decisions can be made. The preliminary research in the RDE framework consists of extensive system analysis and market analysis, so the created artifact has a well-defined conceptual foundation.

7.5.2 Design with a Future Perspective

Design principles are developed in line with the forecast for the future of the financial ecosystem. Currently, artifacts are often designed according to the needs and demands of a contemporary environment. However, creating robust components for entire ecosystems requires to follow an overarching approach that uses a forward-looking method. In this case, robust design principles are formulated to provide stability in a rapidly changing and uncertain market environment.

Furthermore, the theory of Technical Infrastructure Policy is applied to provide a transcending point of view. TIP allows to exceed the contemporary analysis of the financial ecosystem and evaluates the APIs not as products, but as components that are the foundation of the technical infrastructure for Open Banking.

7.5.3 Regulation for Breaking an Intelligence Monopoly

This research relates to the discipline of Enterprise Architecture in the sense that data is used to improve a system’s performance. However, this research goes beyond an organizational perspective by considering the whole financial ecosystem and including multiple stakeholders.

Enterprise Architecture is a step of innovation that banks should have taken some time ago, but failed to create partnerships and share their financial data. Now, banks are forced by legislation to share their data with other organizations in the financial ecosystem that creates new opportunities in the sector at the cost of incumbents. Therefore, the results from this research also stress the
importance of systematic innovation for incumbents in a sector, because the outcome in case of collective negligence results in regulatory intervention.

The prolonged resistance of banks to restrict others from using their financial data led to regulatory demand that breaks the intelligence monopoly and forced them to share their financial data now. In turn, the sudden availability of financial data leads to a shock of innovation in the sector that has an inevitably negative effect on the dominant market position of the commercial banks.

7.6 Reflection on the MSc Program

Finally, the research is related to the CoSEM Master’s Program in the following part.

In General

The Complex Systems Engineering and Management (CoSEM) Master’s Program entails the development or optimization of complex systems. The curriculum includes several courses where different aspects of complex systems are explained. Different methods and theories for analyzing and understanding these systems are evaluated, which creates the ability to choose a wide variety of systems with a combination of various characteristics.

The Master program focuses on the societal relevance of technical systems by providing the knowledge to offer technical solutions to complex problems. This often involves different and sometimes conflicting interests that lead to unclear and unpredictable requirements.

In short, a complex systems engineer has the ability to develop a systematic solution for unidentified problems, or question the current state of systems in place and optimize their performance by effective interference.

Explicit Relation to the Curriculum

The Robust Design Engineering (RDE) framework consists of several methods. The theoretical foundation is taught in courses from the MSc CoSEM curriculum. The courses address theories included in Table 7.2.

<table>
<thead>
<tr>
<th>Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Institutional Economic Theory</td>
</tr>
<tr>
<td>• Stakeholder Theory</td>
</tr>
<tr>
<td>• Network Theory</td>
</tr>
<tr>
<td>• Multi-Actor Decision-making</td>
</tr>
<tr>
<td>• Design Theory</td>
</tr>
<tr>
<td>• Information System Development</td>
</tr>
<tr>
<td>• Enterprise Architecture</td>
</tr>
</tbody>
</table>

Table 7.2: List of Corresponding MSc CoSEM Theories
Bibliography


Appendices
Appendix A

Literature Review Table

The table A.1 below gives an alphabetic overview of the literature considered as a basis for the literature review in Chapter 2. Each article is discussed by addressing each perspective of the Four Cornerstones from Figure 1.1.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Service</th>
<th>Technology</th>
<th>Legislation</th>
<th>Ethical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Arner et al.]</td>
<td>2016</td>
<td>Discusses the evolution of FinTech 2.0 to FinTech 3.0 today</td>
<td>Only discusses technology for regulatory purposes: RechTech</td>
<td>Challenges are indicated about political demand</td>
<td>Stresses importance of RechTech and forward-looking frameworks</td>
</tr>
<tr>
<td>[Dhar et al.]</td>
<td>2016</td>
<td>Emergence of platforms influence strategies of FinTechs</td>
<td>Describes functionalities of platforms and vulnerability of incumbents</td>
<td>Only as business opportunity to assist compliance</td>
<td>Warns about potential power of TechGiants</td>
</tr>
<tr>
<td>[Farrell]</td>
<td>2009</td>
<td>Improving API design by moving to API 2.0</td>
<td>Increasing security measurements with OAuth methodology</td>
<td>No remarks about regulation or legislation</td>
<td>Stresses the importance of data management</td>
</tr>
<tr>
<td>[Gomber et al.]</td>
<td>2017</td>
<td>Framework to identify opportunities</td>
<td>Discusses technologies that are used in the new landscape</td>
<td>Regulation is a driver of new FinTech companies</td>
<td>Society benefits from the increasing amount of digital services</td>
</tr>
<tr>
<td>[Gong et al.]</td>
<td>2012</td>
<td>The business operations has to be identified in order to implement an effective system</td>
<td>Technological developments are often interrupted by regulatory intervention, so the system has to agile</td>
<td>Legislation has to deal with the operational information systems in place, which limits regulatory intervention</td>
<td>Considering regulatory intentions while the systems are developed could prevent modifications in the future</td>
</tr>
</tbody>
</table>
### APPENDIX A. LITERATURE REVIEW TABLE

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Service</th>
<th>Technology</th>
<th>Legislation</th>
<th>Ethical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guibaud et al.</td>
<td>2016</td>
<td>Fast emerging FinTechs might be interesting organizations for banks to create a partnership with</td>
<td>APIs offer much more possibilities beyond what PSD2 is prescribing, banks have to keep exploring</td>
<td>Incumbents should find ways beyond regulatory standards to stay relevant for consumers</td>
<td>Banks should use the availability of data to offer more complete services and target ‘forgotten’ segments</td>
</tr>
<tr>
<td>Han et al.</td>
<td>2017</td>
<td>Lack of data structure limits the use of big data</td>
<td>Standardization and benchmarks are proposed to improve data usability</td>
<td>No regulatory or legislative remarks are made</td>
<td>Big data can be used for a variety of good, but also bad, causes</td>
</tr>
<tr>
<td>Henning</td>
<td>2009</td>
<td>Good API design improves the entire ecosystem and creates more services</td>
<td>Guidelines improve the overall quality of APIs design across sectors</td>
<td>No regulatory or legislative remarks are made</td>
<td>Poor APIs lead to extra work and unnecessary costs, which is bad for the economy</td>
</tr>
<tr>
<td>Khraisha et al.</td>
<td>2018</td>
<td>The meta-theory aims to provide structure in the emergence of innovative products and services</td>
<td>Argues that innovation is demand driven rather than technology driven</td>
<td>Regulation has a limited effect on financial innovation but the complexity demands more investigation</td>
<td>The societal value of financial innovation is identified as a key driver of acceptance by consumers</td>
</tr>
<tr>
<td>Kroner</td>
<td>2018</td>
<td>Banks should create an API system that offers services beyond regulatory requirements</td>
<td>Technological capabilities are the foundation of service possibilities that should be exploited for Open Banking</td>
<td>Current regulation lacks technical specifications for desirable API systems that banks should comply with</td>
<td>The customer should be the center of innovation for Open Banking, instead of the shareholders</td>
</tr>
<tr>
<td>Micheler et al.</td>
<td>2018</td>
<td>Services offer an efficient way to be compliant</td>
<td>A large variety of technological applications are used to assist the government</td>
<td>Technology should serve the law and be directly adopted to protect cultural values</td>
<td>Regulation can help to create a better system from the start</td>
</tr>
<tr>
<td>Philippon</td>
<td>2016</td>
<td>New FinTech companies enter because financial services are expensive</td>
<td>Quantitative research indicates the inefficiency of incumbents in the market</td>
<td>Regulation is needed to create equal opportunities to enter the market</td>
<td>The financial sector has to become more efficient by letting FinTechs enter</td>
</tr>
<tr>
<td>Schreieck et al.</td>
<td>2017</td>
<td>Openness is determined by the trade-off between collaboration and value co-creation</td>
<td>The level of openness affects API functionalities and data sharing with TPPs in the financial ecosystem</td>
<td>Within regulatory boundaries the incumbents are free to construct dynamic governance structures</td>
<td>Ethical values might change with market developments, so API should be able to adapt accordingly</td>
</tr>
<tr>
<td>Author</td>
<td>Year</td>
<td>Service</td>
<td>Technology</td>
<td>Legislation</td>
<td>Ethical Value</td>
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<td>-------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>[Svensson et al.]</td>
<td>2019</td>
<td>Newcomers struggle with perceived legitimacy in the rapidly changing financial ecosystem</td>
<td>Disparities between firms in technological expertise cause firms to form strategic alliances</td>
<td>PSD2 forced incumbents to open up their data and strengthened the market position of FinTechs</td>
<td>A level playing field is created to spark innovation, which ultimately benefits consumers</td>
</tr>
<tr>
<td>[Tan et al.]</td>
<td>2016</td>
<td>Transition from Service Oriented architecture to the Open API economy</td>
<td>APIs are the backbone of innovation in the service computing community</td>
<td>No regulatory or legislative remarks are made</td>
<td>Better APIs will provide the necessary information for other research areas to evolve</td>
</tr>
<tr>
<td>[Zachariadis et al.]</td>
<td>2017</td>
<td>Discusses opportunities in the digital transformation of financial services</td>
<td>APIs are changing and constantly evolving in the Open API economy</td>
<td>The PSD2 regulatory framework has a big impact on the changing environment</td>
<td>Insights provide recommendations to prepare the industry for big changes</td>
</tr>
</tbody>
</table>

Table A.1: Tabular Overview of Literature Background
Appendix B

API Design Initiatives

Various API design initiatives are specified here. These initiatives are developed specifically for the financial industry. The most striking differences among them will be highlighted.

B.1 Financial-grade Open API (FAPI)

OpenID\(^1\)\) formed a working group to develop secure APIs. OpenID have communicated their own set of specifications and requirements in order to cope with brittleness caused by screen scraping and password storing of Third Parties. This model takes into account commercial and investment banking, as well as insurance and credit card accounts. The aim of the working group is to provide JSON data schemas with security and privacy recommendations and protocols. More specifically, FAPI provides protocols for the following functionalities: utilize financial data, interact with accounts, and enable users to control the security and privacy settings.

B.2 Open Banking Standard for the UK

The UK had already established their Open Banking Implementation Entity (OBIE\(^2\)) in 2016. It prescribed software standards in order to make the financial data more compatible, which led to more interoperability. The key functions for the Open Banking Directory were: enabling effortless confirmation of an entity’s regulated status by real-time updates from a central source, offering a searchable directory of trusted banks and TPPs in order to enhance transparency in the dynamic market, and support automated client registration thereby further reducing entry barriers for new market entrants.\(^3\)

B.3 The Berlin Group’s NextGenPSD2 Framework

The Berlin group\(^4\) is a coalition of several European Banks that work together to set data structure requirements and strive for interoperability from the beginning. Among several other working groups and market initiatives the Berlin group is a big player. Although they lack a official legal status, they

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\(^1\)https://openid.net/wg/fapi/
\(^2\)https://www.openbanking.org.uk/
\(^4\)https://www.berlin-group.org/nextgenpsd2-downloads
are perceived to have a significant influence on the technical standard. Ultimately, the Regulatory Technical Standard is determined by the ECB, but the joint force of this initiative is likely to have some influence on the final outcome.

**B.4 Financial Data Exchange’s Durable Data API (DDA) Standard**

The Financial Data Exchange (FDX)\(^5\) is a similar initiative that unifies financial institutions and FinTech companies. The FDX has introduced a standardized interoperable framework centered on an API, which is called the Durable Data API (DDA). The DDA is presented as a replacement for screen scraping and credential sharing. Notably, most FDX members are based in the USA. The initiative is supported without the regulatory obligation in the USA. Although its requirements are quite similar to the PSD2 standard, its components already comply to the European market.

**B.5 STET’s PSD2 API**

STET\(^6\) is an operating system owned by six French banks. It originated from the initiative to combine forces in order to meet SEPA and payment requirements. It has now evolved to create interoperable systems for the major banks in France. STET has presented its PSD2 API for Open Banking\(^7\). The latest version uses REST, OAuth 2.0, JSON and HTTP-signatures. The technical specifications rely on ISO20022 elements for data exchange. Notably, STET is a participant of the Berlin Group, so their interests and output are aligned.

**B.6 Polish API Standard**

The Polish API standard\(^8\) is the sector response of Poland to meet regulatory requirements. The major banks in Poland combined their knowledge to independently create a compliant API for national banks by following a durable method. Besides sharing knowledge, the approach also led to cost reduction and more efficient API development.

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\(^6\)https://www.stet.eu/en/about-us/

\(^7\)https://www.stet.eu/en/psd2/

\(^8\)https://polishapi.org/en/
Appendix C

Concerns in the European Union

The following part provides a more elaborate explanation of the Concerns in the European Union from Table 4.1

C.1 Data Protection

Firstly, the data protection is fulfilling are more central role within European regulation. Over the past decades, personal data use by Tech companies has been a major concern for European citizens. Privacy is considered a fundamental good and needs to be protected. Other regulations, such as the GDPR, is an example of a regulation that aims to protect personal data.

C.2 Data sharing

Secondly, as opposed to the GDPR, PSD2 aims to encourage the sharing of personal financial data. However, the EU has implemented a well-balanced policy by starting with the GDPR and later introduce PSD2, so the personal data is still controlled and owned by the person it concerns. PSD2 is actually enacted in order to force financial institutions to share data that concerns their consumers. In other words, the PSD2 gives the power of personal data back to EU citizens. Despite the misunderstanding that financial institutions are forced to provide full openness in the light of a transparent world where there is no privacy anymore. Moreover, without PSD2 banks were making deals with FinTech companies and TechGiants outside the regulatory scope. That is not possible anymore because specific concepts and essential practices are now defined by the European Union.

C.3 Efficiency

Thirdly, the European Union wants its member states to meet at a certain technical level of operation. The ultimate objective is to make the payment system within the EU more secure, more efficient and increase the interoperability. In order to reach the objective, certain subparts are specified to define the regulatory standard. These subparts originate in the SEPA Credit Transfer system and led to the Instant Payment requirements. Additionally, there is an overlap with payment (PSD2) and privacy (GDPR) legislation. The pursued level of operation is captured by the term Regulatory Technical Standard (RTS).
C.4 Counteracting Malicious Practices

Fourthly, as mentioned earlier the financial industry has always been subject to criminals that operate on the edge of the financial institutional environment by trying to convert their earnings into regular money. On the other side, authorities have been trying to catch these criminals and stop their malicious practices in a “cat and mouse” kind of game. Within Europe, the overall public opinion has always been in favor of authorities, so investigation units are always improving and becoming more digital and specialized.

C.5 Financial (Systemic) Risk

The fifth concern affects a broader scale. The financial industry is subject to financial and pure risks, both captured by the term Systemic Risks. Traditionally, banking relies on tools to identify and analyze these risks, so financial institution can adjust their fees and services to those risks. The structure of the financial institutions have an impact on the systemic risks of the financial industry. A lack of understanding or poorly identification of risks results in an unstable environment which could cause another financial crisis, as has happened in 2008. Thus, the objective for enforcing new regulation on the market is to minimize risk and stabilize the financial industry as much as possible in a continuous, iterative process of monitoring and analyzing.

C.6 Pure Risk

The Ninth concern involves the financial risk management. Traditionally, financial institutions have been concerned with identifying and analyzing risks in the financial industry. Banks have been focusing on both financial and non-financial risks and they are now using improved tools to transform their input from historical (instantly outdated) data to timeless (constantly monitored) information. The Basle II regulation for credit scoring is based on the paradigm that historic data is regarded as “true enough” to use. Yet, digital and technological innovation are now promising to deliver concrete ways to revolutionize risk perception, exceeding the distinction between financial and “pure” risks via a present looking approach. Basle IV aims to prevent malicious practices via Know Your Client (KYC) and Anti-Money-Laundering (AML) requirements, but there is a lack of prescriptive specifications that these processes have to meet. Moreover, the procedures in place are relying on the limited sources of available information. The best outcome of digitalization would be a redefined set of indexes and an improved market infrastructure that leads to a more stable and transparent state of the financial industry. The objective should be to offer a more secure environment for consumers that facilitates more stable and realistic prices for financial products and assets.

C.7 Misconduct

The Seventh concern entails that introducing new technologies may be accompanied by harmful consequences, which in this case are described by data abuse and professional misconduct. The introduction of APIs for Open Banking relies to some extent on the moral responsibility of the involved actors. For the most part the regulatory components have tried to provide restrictive measurements to prevent calamities. These a priori control measures demand a degree of anticipation. However, in case of Open Banking many risks are currently unforeseeable and are therefore difficult to prevent.
by regulatory standards. These particular risks are controlled a posteriori measures because the idea of full anticipation is abandoned [Doorn et al.2016].

C.8 Consumer Benefit

The sixth concern regards the use of financial data for numerous maleficient practices, but what makes the risk of sharing the personal financial information worth to take an cooperate with Open Banking? Ideally, consumers would not share their information with large companies for one single discount. The actual perceived benefit for consumers would be an increased level of financial aid and more complete overall service from financial advisors. Ultimately, a trusted advisor would help a person with their taxes or mortgage without having to ask for a (sometimes incomplete and unorganized,) thick and heavy folder with years of financial transactions. It would be far more convenient to click and share that information if some sort of guarantee is made that ensures the information will never fall into the wrong hands.

C.9 Data Security

An eight concern depends on the consumer’s value of safety as they demand a high level of data security management. The intention of consumer protection should be to convert a posteriori measurements to a priori system standards. In other words, security by design should be the standard instead of imposing sanctions when it is already too late.
Appendix D

Actor Specification

The part provides more extensive information about the actors in the financial ecosystem. The actors are divided into one of the three stakeholder groups, which will be discussed here. The three groups correspond to the introduced stakeholder groups and consist of: Governing Agencies, Commercial Banks, and Third Party Providers (TPPs).

D.1 Governing Agencies

The second group consists of Governing Agencies. The following Governing Agencies play the most important role in the financial ecosystem:

D.1.1 The European Union (EU)

The European Union translates concerns into European society into legislation. They have the power and responsibility to formulate this legislation such that a directive is specific enough that any concerns about it will be resolved when member states create their corresponding laws. The revised Payment Service Directive (PSD2) is enacted according to the same principle.

D.1.2 European Central Bank (ECB)

The ECB is mainly responsible for the monetary policy within the European economic area. Additionally, the ECB has to increase the overall level of payment facilities. Therefore, it does have an important task related to the digitalization of payments as a basis for Open Banking. However, the ECB operates on a higher hierarchical level than the other authorities, which are more directly involved.

D.1.3 Banking Authorities

The banking authorities are responsible for supervision in the financial sector. They have to ensure the parties comply with the rules and regulations within the economic area they control through inspection and monitoring the activities. There are different authorities, which all have their own jurisdiction and specified guidelines that help them maintain order in the industry. Every country has its own National Competent Authority (NCA).
The European Banking Authority (EBA)

Similarly to the ECB, the European Banking Authority is a pan European organization that acts as a primary regulator. More specifically, the EBA is responsible for compliance in all member states. All organizations within the EU have to comply with the rules stated in PSD2. Any interpretation issues have to be resolved by the EBA and they do so by formulating guidelines that make the PSD2 elements more specific.

De Nederlandse Bank (DNB)

Similarly to the ECB, DNB is responsible for the economic sustainability within the Netherlands and helps financial institutions with their financial policies. They also monitor the sector for any instabilities and irregularities, so they can act and warn the affected organizations if necessary.

Additionally, DNB fulfills the role of the National Competent Authority (NCA) or nationally active banking authority. Within DNB there is a special department that is concerned with compliance issues regarding PSD2. They have to carefully follow the EBA guidelines, so they are in close contact with other NCAs to prevent any discrepancies among other countries.

Autoriteit Financiële Markten (AFM)

The AFM is another authority in the Netherlands on a bigger scale with a smaller scope. They are mainly responsible to prevent financial misbehavior, such as money laundering and financing of terrorist activity. Therefore, they do not only focus on commercial banking, but also on corporate banking. Financial institutions have to comply with certain rules and regulations via specified procedures to minimize the chance that such practices occur. Due to these procedures, it is easier for the AFM to control financial activities and trace any violators of these regulations.

D.2 Commercial Banks

The first stakeholder group consists of major commercial banks. They are developing their API-based systems to comply with PSD2. Their strategic views differ among each other. Still, all banks are aware of the changes that occur in the industry. Hereafter, the strategic view will be discussed per bank that plays a role in the environment.

D.2.1 ING

ING is one of the most renowned banks in the Netherlands with a market share of over 35%. They offer a large variety of services and their origin traces back to the year 1881. Due to many mergers and acquisitions over the past century, ING has to deal with many legacy systems in the organization.

Despite their historic origin and old operating systems, ING is trying to reinvent itself as an IT company with a banking license. As a result, they want to transform their entire organization into a digital environment. Therefore, ING is focusing a lot on digitizing its processes and services. This is a very innovative and ambitious mindset, which they hope to achieve as quickly as possible.

ING hopes to have established enough trust to overcome any issues along the way of transformation, without losing perceived legitimacy. Ultimately, they hope to gain more market power within Europe by creating a uniform data system and increase its interoperability. This calls for a very progressive marketing strategy to extend their brand on a larger scale.

1https://www.banken.nl/bank/european-central-bank
D.2.2 ABN Amro

ABN Amro focuses more on large corporations and corporate banking, but ABN Amro still accounts for over 15% of the retail market share in the Netherlands. Therefore, it is a big brand in the Netherlands and is also focusing on digitalizing its services for private customers. For example, Tikkie was the first service incorporated by PSD2 and it is currently the most widely used service of its kind in the Dutch market. Despite the fast adoption of Tikkie, most people do not know it operates under the umbrella of ABN Amro. The bank is rather traditional at its core regarding the system innovation. Their data systems are following a step-by-step approach towards more interoperability, but they do not want to be at the forefront of the innovation.

In terms of legitimacy, ABN Amro is a quite conservative bank. They have a strong market position in the Netherlands and established a position of trust over the years. However, their market position in Europe is different from the market share that ING has gained over the years. Still, ABN Amro does not seem to jeopardize their perceived position of trust in the Netherlands by rapid expansion within Europe. They prefer to offer their new services under a new name like Tikkie.

D.2.3 Rabobank

The Rabobank is also an old Dutch bank that finds its origin in the agricultural sector with a cooperative structure. As a consequence, the Rabobank has had a very decentralized organization. Over the past decade, the Rabobank has tried to overcome organizational issues and digitalize its processes to improve the organization’s efficiency. Currently, they see the changing financial ecosystem as an opportunity to innovate and they trying to find ways to use Open Banking to their advantage.

Rabobank relies more on its current market position and feels like its digital transformation should benefit its existing customers. They are confident and satisfied with their current market position, so there is no need to risk their legitimacy by any ambition to gain excessive market power.

D.2.4 De Volksbank (ANS, RegioBank, SNS)

De Volksbank is a collective name for smaller brands under one government-owned umbrella. The digitalization process is centralized, so every sub-brand can benefit from the functional outcomes. As with most organizations after their nationalization, the organization is becoming less competitive. Similarly, in the case of De Volksbank, the bank shows limited innovation and does what the legislation demands from them but nothing more.

The organization is very traditional and spends a lot of effort in maintaining the trust of its clientele. They have no interest in gaining more market power by taking advantage of the changing financial ecosystem. They have developed an API-based system, but are very aware of any risks it might have on their legitimacy.

D.2.5 Triodos Bank

Triodos is quite a new bank in the Netherlands. They focus mainly on sustainability and their main objective is to invest in environmentally friendly projects. This philosophy has its impact on every strategic decision in the organization. Despite their relatively small size, Triodos develops its own IT solutions to keep up with the changing environment. They were not an early adopter of Open Banking, but they are now actively searching for innovation opportunities that would help them make the world even more environmentally friendly.
Legitimacy is very important for Triodos, they are spending a lot of effort to inform their consumers about the changing financial ecosystem. Moreover, Triodos is very keen on communicating how they use this transformation to help their customers to be even more friendly to the environment. Triodos feels that their financial position will become stronger by creating their own ecological minded financial ecosystem around them. In other words, they want to gain more market power but they do that by building upon their current strategy.

D.2.6 Bunq Bank

Bunq is the newcomer in the Financial Services Industry. They started as an IT company in 2012 and received a banking license from the Dutch Banking Authority (DNB) in 2015. They feel that they can change the future of banking and innovate financial services by using a digital approach. Therefore, they are the most innovative bank in the Netherlands and they try to be a real game-changer. In other words, they paved the way for digital banking.

Being a new bank with a digital and innovative strategy leads to some implications in terms of legitimacy. Bunq tries to overcome any trust concerns by focusing on young people and offer their services in the most convenient way possible. Their innovative strategy is combined with a progressive mindset and leads to efficient services, able to help a large number of customers at once. In turn, Bunq hopes to gain market power at the cost of more traditional-minded banks.

Most banks are developing their API-based systems by themselves. This sometimes causes problems with the interpretation of specific parts of regulation and the EBA guidelines. To help the sector be consistent with their interpretation, there are some interbank initiatives:

D.2.7 Betaalvereniging Nederland

Betaalvereniging Nederland (Dutch Payments Association) is an overarching organization that acts as a decentralized point of cooperation between the commercial banks and the National Banking Authority in the Netherlands (DNB). DNB already has a lot of administrative and regulatory work due to PSD2. Therefore, it is convenient for DNB to have another organization dealing with Frequently asked questions and general implementation concerns.

Betaalvereniging Nederland is concerned about how the roughly 6000 banks will interpret the PSD2 regulations and implement their API-based systems. They foresee that the TechGiants are the only ones that are able to deal with the variety of APIs in the ecosystem. Consequence, FinTech companies experience boundaries that limit them to digitally distinctive standardization as banks are currently working together on a national scale. On a European scale, the Betaalvereniging Nederland fears that the lack of standardization leads to limited interoperability, which can only be solved if they depend on the expertise of TechGiants (Google, Apple, AWS, etc.).

Betaalvereniging Nederland tries to prevent any standardization issues by setting up a cooperation initiative called the National Implementation Support Platform (NISP). The NISP strives towards national standards in the Netherlands and aims for more standardization within Europe. In doing so, the NISP follows the EBA guidelines and offers active implementation assistance.

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2https://www.bunq.com/nl/about-us
4https://www.betaalvereniging.nl/betalingsverkeer/psd2/nisp-nl/
D.3 Third Party Providers

The final group is that of the Third Party Providers (TPPs). This group uses financial data that becomes available due to PSD2. TPPs act in the position between the bank and the consumer to provide innovative services that banks fail to offer.

In general, Third Party Providers (TPPs) have the potential to fulfill different roles under PSD2. The first role is that of a Payment Initiation Service Provider (PISP). Three major components that define the payments value chain are: acquiring, processing and issuing. 1. Acquiring has to comply with authorization, clearing, and settlement 2. Processing has to offer account and customer interaction management 3. Issuing (by banks) are finally responsible for distribution and hold the agreement PayPal is one of the most well-known PISPs in the market. The Payment Initiation Service Providers (PISP) are offering their services while the market is becoming more digital. Simultaneously, these PISPs are gathering information and attempt to use that information to increase their services in order to strengthen their market position. The other role is that of an Account Information Service Provider (AISP). This role is rather new, but Compello is an AISP company that provides an overview of transactions for customers with accounts at multiple banks. AISP's are more dependent on data sharing for Open Banking than PISPs. Moreover, from the moment financial data sharing becomes widely provided, the possibilities of AISPs will be increasing.

D.3.1 New Automatic Teller Machines by Geldmaat

Geldmaat is an organization, which originated because multiple banks did not want to care anymore about distributing cash anymore. Geldmaat started by taking over the service of distributing coins from the commercial banks in the Netherlands. By now, they are also responsible for the distribution of all cash money for ING, ABN Amro, and Rabobank. These banks combined their interest and wanted to provide one common operational type of ATM for customers of the major commercial banks. Therefore, these commercial banks already bundled their forces through Geldmaat and created data an interoperable ATM. As a consequence, they already had to solve all data infrastructure issues that came along with this project.

D.3.2 FinTechs

All over the world, FinTech companies are emerging and they are using technological innovations to offer cross-boundary services. These services are more commercial than Geldmaat as they often directly target consumers instead of corporate clients.

Banking as a Platform (BaaP) is a new trend that plays a central role in the services provided by Fintech companies. APIs serve as the backbone of the information sharing and the input of service providers. Better API design for Open Banking results in better available financial data. Consequently, other developments could be improved due to more and better available financial data as input. Continuously, the gap between the use of Digital Currencies outside the institutional environment, and the digitalization of traditional money inside the institutional environment is attempted to be closed.

\[^5\]https://www.geldmaat.nl/expat-information
D.3.3 Holland FinTech

Holland FinTech is an independent ecosystem that provides an overview of FinTech developments in the Netherlands. The initiative started in 2014 and now includes 507 member companies. Holland FinTech goes beyond the more institutionalized initiative of the Dutch Payment Association by focusing more on market demand than imposed regulation. As a result, Holland FinTech is a commercial-oriented association gathering mostly start-ups and offering joint solutions to market demand through cooperation rather than clarifying regulatory interpretation issues.

D.3.4 Bizcuit

Bizcuit is a new company in the Netherlands that aims to integrate different accounts into one interface. They want to offer consumers an overview of their bank accounts in one integrated display. Moreover, Bizcuit wants to facilitate payment services to transfer money with one quick and easy to operate transaction functionality. In order to achieve this, they must have the necessary data and authorization facilities from the banks that their services require.

D.3.5 WTSS B.V.

WTSS helps banks connect their data systems to the European financial ecosystem. WTSS helps banks with validating their APIs via the chain validation service. WTSS has verified bank accounts at every bank in Europe, which are available for testing their clients’ APIs. For example, a bank has developed their API-based system and wants to test if they perform at the desired level. This bank can ask WTSS to use their verified testing accounts to check if the bank’s services have the desired outcome at the consumer side of the chain. Normally, this is only possible if the bank has verified accounts at all banks across Europe, but WTSS relieves the banks from this burden by offering their accounts without the registration and verification procedure.

D.3.6 Online Retail Companies

Online retail companies, such as Amazon, bol.com, Wehkamp, Rituals, Zalando sell goods on their website and make sure the products are delivered to the consumer. Due to PSD2, it will be possible for these companies to ask for clients’ account information. This could lead to a preferred status of the client and could allow for additional privileges such as discounts.

For example, Zalando published a guide for developing APIs. Banks can adapt their API standards according to their formulated guidelines and code formats in order to make data systems compatible.

6https://hollandfintech.com/about-us/
7https://www.bizcuit.nl/
8https://www.wtss.nl/services/our-finance-laboratory/chain-validation/
9https://opensource.zalando.com/restful-api-guidelines/
Appendix E

Elaboration on AISP and PISP processes

In the following part, the steps in the processes are explicated more specifically.

E.1 Account Information Service Provider

Figure 4.9 represents the flow of financial data for Account Information Service Providers (AISP). The process of AISPs is discussed here by addressing specific steps.

E.1.1 The Start

A user of an AISP has to start the application before the service can be delivered. Prior to the process of using a service by an AISP, the user might have to register and provide the necessary information before a request can be made. This initial step is not included here as it is only necessary once and this process represents the repetitive steps before an AISP is able to offer its service to consumers.

Hence, the process starts with a consumer that wants to use the service of an AISP. Subsequently, the AISP has to formulate a request based on the consumer’s wishes and find out what financial data is needed before the AISP is able to deliver that service.

E.1.2 Security Measures

After the request is clear and the AISP knows what financial data is needed to perform that service, the system has some protection mechanisms to ensure that the data is only shared if an organization has the proper consent and required permission to obtain the necessary financial data.

The first security protocol entails the discussed identification, which includes the steps of authentication and authorization. The OAuth 2.0 method is the most widely adopted solution for these requirements. This step leads to the first point of rejection or permission to proceed.

E.1.3 Verification of a TPP

In case it is allowed to successfully proceed with the AISP process, the AISP is sending the request to the relevant bank. The bank has to perform the second security measure in the system, which
is the verification of the TPP or in this case the AISP. The bank has to check if this TPP has the proper certifications to obtain the requested account information. That is, the TPP has to be a certified and registered organization that is recognized by its relevant National Competent Authority (NCA). Usually, the relevant NCA is the domestic one and the bank has a list of certified TPPs, which they use to verify the request.

E.1.4 Getting the Right Account Information

After successful verification of the AISP, the bank has to retrieve the requested account information. In case this requested information is unavailable for any particular reason, the AISP has to be notified. Also, in case the AISP is not on the list of certified TPPs, the bank has to communicate the reason of the failing request.

E.1.5 Using an API for More Efficiency

If all steps are successfully passed, the AISP is able to receive the requested information. However, the indicated process from a bank’s front-end to back-end and searching for specific information after a request is rather cumbersome. AISPs are usually asking for the same kind of information to provide their services, so this system can be made more efficient by anticipating specific requests. This is where an API gets introduced.

An API is able to streamline the information sharing process. Therefore, the AISP can be linked directly to the back-end after the necessary verification steps. This means that the bank has to create an API that allows to efficiently share specific information with an AISP. This API prevents that an excessive load is put on the system due to complicated and extensive search commands. The red box in Figure 4.9 indicates the tasks that can be performed with a specific API request and make data sharing more efficient.

E.1.6 Service Delivery

The final step of the AISP is to provide the requested information to the user. An AISP is a new concept in the financial ecosystem that only relies on the type of financial data that is needed to provide a service. The type of service itself is difficult to specify because new services are constantly developed and the possibilities to apply account information are endless. Therefore, the particular task in Figure 4.9 cannot be specified more explicitly than “Provide Service”.

E.1.7 Final Steps of the Process

The last part of the AISP’s process is to communicate relevant information to the user about their service. This is preferably successful, so the service is delivered according to the request. Alternatively, in case of any failure, the AISP has to communicate the point in the process that the problem occurred and what the exact problem is. An error message has to explain why the error occurs and where the error occurs in the process, so the user is able to search for a solution. In particular, the points of failure are indicated in Figure 4.9 by the Gateways, so the problem is easier to trace. After the error message is commented or the failure of authorization is explained, the user is able to make a decision to try again or give up his demand for this service if the problem seems unsolvable.
**APPENDIX E. ELABORATION ON AISP AND PISP PROCESSES**

### E.2 Payment Initiation Service Provider

Figure 4.10 represents the flow of financial data for a Payment Initiation Service Providers (PISP). The process of PISPs is similar to the one of AISPs. The specific steps are discussed here.

#### E.2.1 Similar Start

The PISP process begins with the same tasks as the AISP, but the content of the request is different. The request not only contains a demand for information but also includes instruction to perform a monetary transaction. Thus, some additional specifications are needed, such as an amount. Still, the rest of the procedure for sending the requests and the authentication/authorization process remains the same.

Notwithstanding the rest of the process, the amount can be specified by various actors in the current market environment. One case entails a consumer that wants to pay for products, so the amount is determined by the price that a company asks for that product. The other case considers a user that makes a payment request to ask money from another person, so the amount is determined by the user itself. In either case, the rest of the process is unaffected. Therefore, the specification of the amount is not considered in the BPMN model, as it is irrelevant for the rest of the data flow in the system. More specifically, this model assumes the amount to be already enclosed, so the first step for PISPs is to invoke a request because it might already be made by another actor.

#### E.2.2 PISP Verification check

When the request is invoked by the PISP and the user successfully authorized the payment, the request is sent to the bank. The bank has to perform some additional steps compared to the AISP.

The TPP still has to be verified, but a PISP requires different certifications. A PISP does not only "read" information, but also interact with other systems by initiating transactions. In other words, they are allowed to change data rather than just copying it. Thus, the list that a bank has to check is a different one than the previously used for the AISP process.

#### E.2.3 Additional Internal Processes for Banks

The next step for banks after a PISP is verified, is to check if the account has enough funds to complete payment. This is done by the solvency check, which preferably results in a positive outcome if payment is feasible.

Subsequently, the payment can be performed if all checks are completed by the bank and all signs are positive. To complete the payment, the money has to be transferred from the payer’s account to the beneficiary’s account. Therefore, specific information is needed in the request of a PISP in order for the payment to be completed. Still, there are certain things that could go wrong with a money transfer regardless of the request details. Hence, the last check in the bank’s back-end shown in Figure 4.10.

#### E.2.4 More Error Possibilities

Figure 4.10 shows more possibilities that can go wrong with a payment. The TPP verification is similar to the AISP procedure in Figure 4.9 and the solvency check results in a rather simple yes/no outcome. However, the final task is to transfer the money after previous checks are completed. The possible errors occurring after a failed transaction are countless. Especially because many of
these errors depend on the system of the specific bank, which can result in unique and unforeseeable outcomes.

Obviously, a PISP wants to know why a payment could not be completed. Thus, the errors have to be carefully communicated by the bank if an error occurs. Moreover, the PISP process includes one more task before the money is transferred and failure can have many more reasons.

E.2.5 Implementation of APIs for PISP

Similarly to the AISP, the PISP process also offers an opportunity to make use of APIs for more efficiency. The API is able to accept a transaction request in a standard format after the verification. In Figure 4.10 there is a red box again that indicates the tasks that can be performed with a specific API request and make data sharing more efficient.

E.2.6 Final Steps

Similarly to the AISP’s process of a successful outcome, the bank processes payment and is able to provide additional services afterward. Subsequently, the user receives either a successfully completed payment or sees that the payment has failed and has to interpret the corresponding error statement. After a failed payment, the user is again able to try for another time to conduct payment or give up if the error seems unsolvable.
Appendix F

The Exploratory Case Study

For the exploratory case study, different developer portals are assessed with a checklist. The checklist and its main conclusions are presented in the main text, but some background explanation to rectify the assessment results needs to be included. Thus, the following additional explanation of the checklist results is included here.

F.1 Exploratory Case Study Protocol

The following part considers the full case study protocol for the exploratory case study. The Checklist for Five Levels of Protocol Development presented in Table 2.1 is followed to present a complete case study protocol.

F.1.1 Overview and Objective

The purpose of the exploratory case study is to evaluate the currently operational API-based systems of commercial banks. The API-based systems are called Developer Portals. The functionalities of the developer portals are designed according to the interpretation of PSD2 and follow the EBA guidelines. However, developer portals still show some differences. The exploratory case study makes these differences explicit by conducting a comparative analysis.

F.1.2 Data Collection Plan

The differences between developer portals are evaluated by a comparative analysis. The differences are mainly caused by certain strategic decision-making and technical feasibility implications. These decisions ultimately influence the functionalities of the developer portals. Therefore, the functionalities are easily observable assessment criteria.

All developer portals included in the case study are thoroughly analyzed. The evaluation of the different developer portals is included in Appendix E.3. Subsequently, based on the evaluation, the assessment table is filled in to provide a concise overview of the assessment findings and make the results easily comparable.

F.1.3 Data Source Selection

The data sources were selected according to the data gathering criteria from Table 2.3.
APPENDIX F. THE EXPLORATORY CASE STUDY

The relevant organizations are selected in order to successfully conduct the explanatory case study because a more diverse selection leads to a more complete view of the financial ecosystem. A representative view on the market environment is given by including different types of banks. The topics of the exploratory case study are explicated in Appendix E.2 by discussing the criteria of assessment.

The patterns of findings are discussed more extensively and linked to the rest of the research during the data analysis after both case studies are completed. Although, a preliminary overview of the findings is included right after the case study is performed.

F.1.4 Constraints

There are some limitations in this exploratory case study. Firstly, the performed comparative analysis is limited to commercial banks in the Netherlands. Secondly, the case study is performed during the summer of 2019 prior to the PSD2 compliance deadline of the European Union.

Scope Restriction

The first constraint limits the geographical scope of organization selection. It is deemed impossible for this research to fully provide a European wide view on the topic, so the selection of organizations is limited to the Netherlands.

Time Restriction

The other constraint concerns the available time for the research. The time was to conduct the research was restricted and the financial ecosystem is changing really fast. Therefore, the findings of the exploratory case study might not be exactly up to date at the time the research is made public.

F.1.5 Preliminary Outline of Findings

The comparative analysis is presented in Table 4.9. The selected commercial banks are compared on different criteria and the findings are presented in a concise and comparable overview.

F.2 Criteria of Assessment

The first part of the background information explains how the criteria of assessment are selected and why they are included in the list. Basically, the basis for the selection criteria is formed by the PSD2 legislation. PSD2 describes many functionalities. Despite the lack of specific implementation guidelines, it does prescribe strict conceptual requirements for an API-based system. In the case study checklist

F.2.1 Consumer Protection

As indicated in the BPMN Figures 4.9 and 4.10, a crucial part of these processes is the verification of the TPPs before financial data is shared. The developer portals are assessed on this particular requirement. Furthermore, PSD2 describes additional mechanisms ensuring the security of consumer credentials.

PSD2 obligates banks to invest time and money in their developer portals in order to be compliant. The API-based system has to meet the minimum regulatory standards, which is seen as a
common driver for all banks. Beyond compliance, the extra functionalities and differences between the developer portals of banks are an attempt to distinguish their services from competitors and be more innovative than the rest.

TPP Verification

The aforementioned Third Parties Providers (TPPs) are described in PSD2 as being a Payment Service Provider (PSP). This generalizes the type of business practices, which also includes part of what banks are already doing.

A Payment Service Provider is defined by PSD2 to perform any of the following business activities. Moreover, a PSP needs to be officially registered with the correct certification to perform either one of these services:
- account servicing
- payment initiation
- account information
- issuing of card-based payment instruments

For all of these certificates, there are special lists available for banks to check whether a PSP is certified before the financial data is shared. Moreover, a bank also has to check if the consumer has given its explicit consent to the PSP to request the information.

Thus, the first functionality entails a TPP verification before financial data is shared. This procedure consists of both a check for requisite certification, as well as a check for explicit permission by the consumer.

Managing Credentials

PSD2 explicit states that a PSP has to comply with some specific security measures. The system has to include processes that apply to consumer credentials. In particular, a PSP has to be able to perform the following tasks upon consumer request:
- Destruction of credentials
- Deactivation of credentials
- Revocation of credentials

F.2.2 Data Flow in the System

As described in the system analysis, there are two main functionalities that require a specific flow of financial data. These particular data flows are presented by the BPMN models in Figures 4.9 and 4.10. The third functionality is included in Figure 4.10 of the PISP process as a sub-part. However, the EBA has also prescribed the “confirmation of funds” as a distinct functionality.

Account Information

As described in Figure 4.9, the full process has to be in place. PSD2 has now obligated banks to create an API with a minimum set of requirements that makes the process of sharing account information significantly more efficient. Moreover, the AISP does not rely on private agreements with banks anymore to obtain the information because of the regulation in place.

1PSD2 art.34 (3)
2PSD2 art. 27 (a, b, c)
APPENDIX F. THE EXPLORATORY CASE STUDY

Payment Initiation

Roughly the same idea of the AISP applies to the PISP, which process is described in Figure 4.10. Similar API requirements are created by the EU that demands banks to open up their data systems and allow third parties to efficiently interact with a bank. Again, these third parties are not bounded by private agreements anymore because the process is now defined in the legislation.

Confirmation of Funds

The last functionality for data flow in the system is a sub-part of the PISP process. It can also be seen as a very specific type of account information attribute because no data is added to the bank’s system. Nevertheless, policymakers found the functionality important enough to define it in the regulation. The confirmation of funds-functionality has to be simple and understandable, so it only returns a yes/no answer after a request.

F.2.3 Specific Systematic Functionalities

The following functionalities are less specific, but PSD2 does describe some type of solution for specified cases. In particular, the cases are described for: the authentication, a back-up system for contingency, an environment for testing, meeting time constraints, ensure system stability, and another very specific functionality is described here.

Authentication Mechanism

PSD2 describes a Strong Customer Authentication (SCA) procedure rather extensively with certain requirements. Theoretically, banks are free to adopt any method that complies with the regulatory demand. Yet, the majority of banks chose a safer option and adopted a market standard. As indicated earlier, the most popular authentication method is the OAuth 2.0 protocol. The most evident reason is the recommendation of the OAuth 2.0 protocol for the authentication mechanism in the EBA guidelines. Thus, the most interesting notion to analyze for the authentication method is to check the adoption of OAuth 2.0 after the regulatory recommendation.

Alternatives in Case of Failures

In case the system encounters unforeseeable failures or excessive errors, the bank is required to have a system in place to deal with these circumstances. PSD2 describes the anticipation of these events as having contingency measures.

This back-up system for dealing with contingencies consists of multiple functionalities. Most of these functionalities are described according to certain events. Mainly, the policymakers expect clear communication of the reasons for the failure. A solution for this was also described in Figures 4.9 and 4.10 at the part of error statements for AISPs and PISPs respectively.

Limited Test Environment

The UK called this test area for developers a "Sandbox" in their Open Banking Directive, so the rest of the countries in Europe have adopted that term in the financial ecosystem.

Some banks chose to grant open access to these sandboxes, while others chose for a more controlled environment. In case a Sandbox is not openly accessible, a tester is required to create a

\[^3\text{PSD2 art.33}\]
\[^4\text{https://standards.openbanking.org.uk/}\]
registered account before they have permission to interact with the trial system. Nevertheless, any sandbox has to be openly accessible for testing, so permission cannot be denied even after registra-

Specific Time Constraints for Certain Requests

Some requests are seen as rather simple, so they can be completed with a certain amount of speed. Therefore, the system has to react within a specific amount of time. PSD2 includes maximum time constraints for some processes, which the banks need to comply with, such as a maximum response time of 30 seconds.

F.2.4 System Stability

In data systems, there are some concepts that define the stability of a system. In PSD2, the specific functionality of the system prescribes a frequency checker. The frequency is defined as the number of requests that the system is receiving per unit of time.

A frequency checker can be used to guarantee the system’s stability by indicating how many requests a system can handle. If the latency of the system is affected due to many requests, the system has become slower in processing these requests. A solution to increase a system’s stability is for example to apply load balancing, which preferably results in a better-distributed load that increases the system’s performance.

Furthermore, the regulation also demands from TPPs that they contribute to stable API-based systems. Therefore, TPPs are forbidden to send more than 4 requests to banks without specific customer orders or private agreements with that bank.

Virtual Cash Management System

A Virtual Ledger Account is a rather unique invention, which is not specified in any legislation yet. Specifically, a Virtual Ledger Account helps consumers with their spending behavior by offering a virtual cash management system (a Virtual Ledger Account). ING is currently the only bank in the Netherlands that offers such a service, but it is highly likely that other banks will adopt the idea and invent their own version.

Moreover, a regulatory specification is expected when these types of systems become widely adopted. The market term for these virtual cash management systems is currently hard to determine, but policymakers always find an appropriate term for a new concept.

F.2.5 Standardized Implementation

The following criteria are based on more vague specifications of the legislation. These criteria demand a certain choice of implementation.

Consistency

The first criterion for standardization entails the demand for consistency. This criterion is rather hard to determine or assess because of the subjectivity of the interpretation. Therefore, consistency
is assessed based on the general impression that the developer portal has. The information has to be presented in a standard format that is easy to obtain and quick to understand.

**API Data Format**

Earlier in the research, some standards of API formats and other specifications were discussed. The RESTful API and JSON data format were included, so one of the assessment criteria is evaluating the adoption of these standards in the Netherlands.

**Traceability of Data After Sharing**

Traceability mechanisms of financial data are also hard to identify, despite the explicit regulatory requirement in PSD2. The developer portals are assessed based on the documentation discussing their traceability mechanisms.

**Logging Transactions**

The commercial banks have to specify how they log their transactions. Every transaction has to be registered by some mechanism, so it can be found when necessary.

**Unique Stamping and Monitoring**

Unique stamping is an extra feature that extends the logging of transactions by assigning a unique and easily traceable label. Tracing transactions is only possible by some unique labels assigned to a specific transaction.

Moreover, this unique label can help the Governing Agencies take the next regulatory step towards monitoring the financial ecosystem by making the data more easily traceable.

However, some easily traceable label might have a negative impact on the security and privacy of consumers. Therefore, such a unique label is better to be anonymous and only directly relatable to specific persons when necessary.

**F.2.6 Extra Functionalities**

The following functionalities are not directly related to PSD2 requirements but go beyond the regulatory scope of innovation.

**Notification Kit**

Many applications now have the ability to send notifications on a mobile phone or in a browser. Some developer portals have included this mechanism in their API-based systems.

**Including Foreign Exchange Rates**

This functionality can be used to quickly receive the current rates via an API that a commercial bank uses. This mechanism is a typical example of changing specific data that can be efficiently exchanged via an API, so other organizations in the financial ecosystem can use it for their services.
F.2.7 Profound Documentation

The last criteria of the comparative analysis are related to the documentation. The commercial banks are obligated to publish documentation about their developer portals and the functionalities.

F.2.8 Data Interaction Opportunities

The code list provides an overview of the possibilities that developer portals offer for data interaction. Every API request has the standard beginning of the RESTful format, but the JSON part of the request includes the specifications of the

F.2.9 Most Occurring Errors

When a request fails, there can be multiple causes. By offering a list of the most occurring errors, a developer portal is more user-friendly. An extensive list of errors helps developers from other organizations to include the specific commercial bank by offering guidance when their requests fail.

F.3 Assessment of the Commercial Banks’ Developer Portals

The second first part of this case study includes a thorough analysis of developer portals. For this part, the developer portals are assessed by several commercial banks in the Netherlands.

F.3.1 ING

The ING developer portal\(^9\) presents its APIs per functionality in the dashboard. Every API has its separate page with information about usage, code, and possible errors.

Notably, ING is the only commercial bank that offers a Virtual Ledger Account. They have given their system this particular name, but the general mechanism is used by others in the industry.

F.3.2 ABN Amro

ABN Amro has a similar developer portal\(^10\) where the APIs are presented per functionality in a dashboard. Per API, there is a separate page with information about usage, code, and an extensive list of possible errors.

Three OAuth flows are described: Client credentials, Authorization codes, Refresh Token. Two Authentication methods: TLS-MA, Signed JSON Web Token and it refers to the OAuth 2.0 Authorization Framework by the Internet Engineering Taskforce (2012)\(^11\).

Especially the payment initiation service of ABN Amro is quite extensive because Tikkie\(^12\) is one of the first payment initiation companies in the financial ecosystem. Tikkie is operating under the ABN Amro umbrella, so they have a lot of resources to innovate and they have had more time to extend their services.

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\(^9\)https://developer.ing.com/api-marketplace/marketplace
\(^10\)https://developer.abnamro.com/overview
\(^12\)https://www.Tikkie.me/over-Tikkie
F.3.3 Rabobank
Rabobank has a more limited developer portal but a similar structure is followed. There is a small set of functional APIs and errors and explanations are provided. Notably, they did explicitly state that they meet the required time constraints.

F.3.4 Bunq
Bunq has a more unique developer portal. Bunq follows the approach of a tech company, rather than that of a bank. The APIs and functionalities are presented in a long list of functionalities and corresponding codes. Its extensiveness does come at the cost of understandability, but that is usually no problem for developers. Still, the representation has high modularity as it does not follow an order of functionalities, but leaves the applicability to the ones interested in building upon the Bunq developer portal.

An interesting choice of implementation is that Bunq uses additionally used Okta for its authentication, whereas other banks all follow the OAuth2.0 protocol.

Furthermore, the extra functionalities and provided documentation are very well elaborated. These functionalities are typical for a Tech company, they just applied particular functionalities in the financial ecosystem. Moreover, the unique stamping and traceability mechanism is explicitly discussed.

F.3.5 Triodos
Triodos has a simple but limited developer portal. Its sandbox environment for testing is only available after registration. The account has to be verified through its authentication procedure before access is granted.

F.3.6 De Volksbank
De Volksbank has only published its documents for the developer portal. It shows a small set of functionalities and permission to the sandbox is only granted after registration.

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13https://developer.rabobank.nl/overview/payment-initiation
14https://doc.bunq.com/
15https://www.oauth.com/oauth2-servers/getting-ready/
17https://developer.triodos.com/reference/initial-access-token-service
18https://openbanking.devolksbank.nl/apis.html
Appendix G

Explanatory Case Study

The following part includes the case study protocol for the explanatory case study. Firstly, the context is evaluated for selecting the interviewees and the purpose of the case study is discussed. Subsequently, the interview protocols for the different stakeholder groups are presented with the corresponding interview questions. The interview questions have some slight differences as they are adjusted to the different stakeholder groups. Nevertheless, roughly the same protocol is followed for every stakeholder group.

G.1 Explanatory Case Study Protocol

The following part considers the full case study protocol for the explanatory case study based on the case study protocol steps from Table 2.1.

G.1.1 Overview and Objective

The objective is to find out why differences in developer portals occur by conducting interviews with carefully selected persons at the relevant organizations. Moreover, this part of the case study includes multiple organizations at different stakeholder groups. More specifically, the broader environment is considered by including up- and downstream organizations that are affected by the digital transformation of financial services. For example, TPPs and the Dutch Banking Authority (DNB) are included in the explanatory case study in order to provide a full overview of the financial ecosystem in the Netherlands.

G.1.2 Data Collection Plan

The second part of the case study is more complex as it examines the topic with a broader view that goes beyond identifying differences among developer portals by explaining the reasons behind certain decisions. Therefore, an embedded approach is best suited for this part of the case study, as the level of inquiry is becoming more detailed.

Embedded Approach

This part of the case study is more complex than the exploratory one. The financial ecosystem is evaluated on a broader perspective by focusing on the reasons behind certain implementation deci-
sions, which goes beyond identifying differences among developer portals. Therefore, an embedded approach is best suited for this part of the case study, which allows to finalize the questions according to intermediate findings and make the level of inquiry more detailed.

G.1.3 Data Source Selection
The sources to gather qualitative data are selected according to the data source quality features from Table 2.2. Firstly, the validity aspects are addressed here. Secondly, the reliability of the case study is ensured by providing an overview of the selection of Interviewees in Table 4.10 and by including an elaborate interview protocol in Appendix F.2.

A Multiple and Holistic Approach
Case studies are either multiple or single, which relates to the number of sub-units being analyzed \cite{Yin2017}. In particular, the case explanatory study is multiple because multiple organizations are considered within different stakeholder groups. Additionally, the case study is holistic because multiple stakeholder groups are included to provide an overview of the financial ecosystem as a whole.

With banks alone, the whole market environment would not have been sufficiently represented, so also other actors are included in conducting interviews. In particular, the National Competent Authority (NCA) takes part in this research. De Nederlandsche Bank (DNB) fulfills the task of the NCA in the Netherlands. Also, FinTech companies that build upon the accessible financial data that is becoming available by Open Banking are included in the case study in order to find out what they expect and demand from a bank’s API-based system.

After the organizations are selected, the relevant persons within these organizations are selected. In order to get a full view of the strategic and technical implications of the changing market environment and APIs for Open Banking, it would be best to interview two types of persons for the larger organization. Hence, the complete vision of the organization is identified by including multiple experts.

The first person fulfills the role of a project leader, so the strategic view of the organization can be clarified. The other person has to be a data architect or lead developer, who understands the strategic view but can also elaborate on technical implications.

G.1.4 Constraints
Now that the criteria for selecting people at the chosen organizations are clear, the constraints can be addressed.

Scope Restrictions
The first constraint limits the geographical scope of organization selection. It is deemed impossible for this research to fully provide a European wide view on the topic, so the selection of organizations is limited to the Netherlands.

Time Restrictions
Another constraint concerns the available time for the research, so in total it is only possible to include seven organizations. The interviews are conducted in a rather short time span in order to make the results optimally comparable. In particular, the interviews are conducted in four weeks, at
the end of July and the beginning of August 2019. The market environment is constantly changing,
so perceptions regarding the topic are roughly the same.

**G.1.5 Outline of Findings**

The outline of the findings is based on Table 2.4. More specifically, the patterns of findings of the
exploratory case study are evaluated in a comparable overview by certain rival explanations. These
rival explanations from Table ?? are assessed by the answers of the interview questions included in
Appendix F.3. A full narrative of the interview is included in Appendix F.4. Finally, the case study
results serve as input for further analysis of the financial ecosystem.

**G.2 Data Collection Plan**

The data collection plan is created according to the assessment topics from Table 2.3. The interview
protocol is based on the aforementioned case study protocol and elaborates on the data collection
plan via interview questions. The topics are constituted by the preliminary findings prior to this
exploratory case study. Based on these findings the topics can be addressed more specifically and
are captured in the rival explanations, which serve as input to formulate specific interview questions.

**G.2.1 Interview Protocol**

Every interview starts with an introduction of the research. It provides a short overview of the
research background and the goal of the interview.

**Rival Explanations**

The rival explanations presented in Table G.1 form the foundation of the interview questions for
each stakeholder group. The table is divided into three sections, where each section corresponds to
a different part of the interview questions.

After the interviews are conducted, and the narratives are presented. The results are analyzed
and the results are discussed. The rival explanations and its alternatives are either confirmed or
rejected. Subsequently, the results are evaluated and explained accordingly in Table 5.2.

**G.2.2 Preparing Interview Questions**

With the provided guidelines for the case study protocol, a set of interview questions is created
according to the Qualitative Interview Design method [Turner III2010].

**Slightly Adjusted Questions for Different Stakeholder Groups**

The interviews are conducted at organizations across the financial ecosystem, so more flexibility is
needed for this part to gather the data and analyze differences on multiple indicators. As a result,
the set of interview questions address multiple topics and the questions differ slightly for the different
types of organizations. That way, the procedure increases in complexity, but the data is collected
more specifically due to its increased flexibility.

When the case study is completed and all qualitative data is collected, the results are presented.
The best way to so will be discussed here.
### Rival Explanation | Alternative Rival Explanation
---|---
1a. Consumers benefit most from well-designed API-based systems | 1b. TPPs benefit most from well-designed API-based systems
2a. Regulators are responsible for assessing the quality of APIs | 2b. TPPs are responsible for assessing the quality of APIs
3a. The relevant Network Dynamics are optimally utilized | 3b. There are still relevant Network Dynamics that unused
4a. Similar events and developments are indicated that resemble Open Banking | 4b. No events or developments can be compared with Open Banking
5a. Available resources caused no issues regarding the development of API-based systems in the financial ecosystem. | 5b. Limited resources are available during the transition of the financial ecosystem towards Open Banking
6a. PSD2 and Open Banking is consumer driven | 6b. PSD2 and Open Banking is a corporate initiative to break the financial data monopoly
7a. Nobody will use the Open Banking functionalities | 7b. API-based systems are unable to deal with the high adoption rate
8a. Regulatory intervention of the financial is complete, so no more legislation is needed | 8b. PSD2 is definitely replaced by a successor in the near future
9a. The ideal market environment should be extensively restricted and explicitly established. | 9b. The financial ecosystem should be a free market, where the best practices and most virtuous organizations will prevail.

Table G.1: List of Rival Explanations

### G.3 Interview Questions

The questions address three main parts. To begin with, stakeholder identification in the financial ecosystem and the perceived interests of these actors. Secondly, the explanation of processes is discussed that helps the organization of interest adapt to the changing financial ecosystem. The third and final part of the interview addresses the future expectations of the organization of interest, which aims to clarify how different stakeholders perceive the future of the financial ecosystem.

The stakeholder groups respectively include Governing Agencies, Commercial Banks, Third Party Providers (TPPs). The following part includes the interview protocols for each stakeholder group.

**Introduction (formality for constructing a clear picture)**

I would like to start with a short and explain the purpose of the interview and what I hope to achieve with this interview.

I am Barend. I study in Delft and I am writing my Master’s Thesis at CGI in Amsterdam at the Department of Banking and Capital Markets. For this research, I would like to find out how the financial ecosystem is changing towards Open Banking. I am performing an explanatory case study and via these interviews, I try to gather qualitative information at several banks and other organizations. Ultimately, I am trying to analyze the changing environment, while focusing on API development for Open Banking. I hope to use this information for my research by giving an overview of how the market observes the changes in the industry and how the relevant organizations act on them. The research will focus on API design for Open Banking because this is seen as a starting
APPENDIX G. EXPLANATORY CASE STUDY

point for data sharing in the Open Banking environment and a key element for further innovation.
Could you explain your role at your organization?

G.3.1 Governing Agency

The first stakeholder group is that of the Governing Agencies. In particular, the Dutch National Competent Authority (NCA), called De Nederlandsche Bank (DNB), is interviewed to explicate the regulatory view on the financial ecosystem.
Furthermore, some of these questions were also used to identify a foreign point of view. In particular, a company based in Luxembourg that worked closely with the STET is used to consider a French oriented approach.

Identify stakeholders of API design (up-, main, and downstream impactees)

Who do you think will ultimately benefit from well-designed API-based system for Open Banking?
Who is responsible for the formulation of explicit requirements for APIs for Open Banking?
Who is responsible for developing adequately operating APIs for Open Banking?
Who will benefit from an efficiently operating financial ecosystem?
Who is best suited to evaluate the APIs for Open Banking and should be responsible to determine the quality of APIs?

Background (make the process of API design explicit for the organization)

Can you describe the process of monitoring and assistance? (relative to other types of regulation)
What is the degree of impact/involvement that TPPs/Banks have on interpretation/enforcement?
Have you experienced any particular issues regarding the interpretation of PSD2?
Can you relate API development to other/previous legislation in the past (IT or other innovation/reformation)? What would you say are key differences? Good or bad?
Have you experienced any particular dilemmas that relate to Open Banking? (strategic/technical)
What is the financial (resource) situation during this period of problem identification?
Would you say PSD2 is more consumer-driven, or corporately driven?

Contextual information (surrounding factors that could potentially be beneficial/harmful)

What circumstances could potentially harm or benefit the Open Banking environment?
Are there community factors (perceived convenience or fear) that could affect Open Banking?
Are there any settings that affect the future of Open Banking? (adoption rate/specific technical requirements)
What can be the regulatory impact on Open Banking in the future? What do you foresee for PSD3?
What could be the motivation of the EU for more regulation relating to Open Banking?
Are there any subsequent steps that could be identified?
Are there any controversies surrounding API design for Open Banking?
Are there conflicts of interest?
Can you described dilemmas that your organization has encountered?
If you look back, could you describe what you would have liked to be different? (an ideal situation)
G.3.2 Commercial Banks

The next stakeholder group consists of some commercial banks in the Netherlands. These banks include ING, Triodos, and De Volksbank.

**Identify stakeholders of API design (up-, main, and downstream impactees)**

Who do you think will ultimately benefit from well-designed API-based system for Open Banking?
Who is responsible for the formulation of explicit requirements for APIs for Open Banking?
Who is responsible for developing adequately operating APIs for Open Banking?
Who will indirectly benefit from an efficiently operating financial ecosystem?
Who is best suited to evaluate the APIs for Open Banking and should be responsible to determine the quality of APIs?

**Background (make the process of API design explicit for this organization)**

Can you describe the process of API design in your organization? (relative to legacy systems)
What is the degree of impact/involvement that TPPs/Authorities have on your API design?
Have you experienced any particular issues regarding API design and its implementation?
Can you relate API development to other/previous projects in your organization (IT or other innovation/reformation)? What would you say are key differences? Good or bad?
Have you experienced any particular dilemmas that relate to Open Banking? (strategic/technical)
What is the financial situation of API design in your organization, who benefits and who pays?
What is the impact of good/bad API design? What are the possible outcomes? Would you say API development is more innovation-driven, or compliance-driven?

**Contextual information (surrounding factors that could potentially be beneficial/harmful)**

What circumstances could potentially harm or benefit API design for Open Banking?
Are there community factors (social impacts) that could affect API design for Open Banking?
Are there any settings that could affect API design for Open Banking? (adoption rate, well-organized/high SEO-ranking)
What can be the regulatory impact on API design for Open Banking in the future?
What do you expect from PSD3?
What could be the motivation of the EU for more regulation relating to Open Banking?
Are there any subsequent steps that could be identified?
Are there any controversies surrounding API design for Open Banking?
Are there conflicts of interest?
Can you described dilemmas that your organization has encountered?
If you look back, could you describe what you would have liked to be different? (an ideal situation)
G.3.3 Third Party Providers (TPPs)

The last stakeholder group is that of the Third Party Providers (TPPs). They rely on the financial data that banks are making available to them. Two distinct types of TPPs are included, each with its own view on their API-based systems and the financial ecosystem in a broader sense. Specifically, the considered TPPs are Bizcuit and Geldmaat. The first has a more market-oriented perspective, whereas the latter has a more cooperative view on the subject.

Identify stakeholders of API design (up-, main, and downstream impactees)

Who do you think will ultimately benefit from well-designed API-based system for Open Banking?
What do you expect as a TPP from the regulator and from the banks?
Who will benefit from an efficiently operating financial ecosystem?
Who is best suited to evaluate the APIs for Open Banking and should be responsible to determine the quality of APIs?

Background (make the process of API design explicit for the organization)

Can you describe the process of developing your system? (relative to other types of business)
In what way do you involve the regulator and the banks with the development of your system?
Have you experienced any particular issues regarding the interpretation of PSD2?
Can you relate API development to other/previous legislation in the past (IT or other innovation/reformation)? What would you say are key differences? Good or bad?
Have you experienced any particular dilemmas that relate to Open Banking? (strategic/technical)
What is the financial (resource) situation during the process of system design and development?
What is the impact of efficient systems? What are the possible outcomes?
Would you say PSD2 is more consumer-driven, or corporately driven?

Contextual information (surrounding factors that could potentially be beneficial/harmful)

What circumstances could potentially harm or benefit the Open Banking environment?
Are there community factors (perceived convenience or fear) that could affect Open Banking?
Are there any settings that affect the future of Open Banking? (adoption rate/specific technical requirements)
What can be the regulatory impact on Open Banking in the future? What do you foresee for PSD3?
What could be the motivation of the EU for more regulation relating to Open Banking?
Are there any subsequent steps that could be identified?
Are there any controversies surrounding API design for Open Banking?
Are there conflicts of interest?
Can you described dilemmas that your organization has encountered?
If you look back, could you describe what you would have liked to be different? (an ideal situation)
G.4 Narratives of Conducted Interviews

The following part contains the narratives as a result of the conducted interviews. These narratives are divided into three sections, which each corresponds to a different stakeholder group. Firstly, the narratives of the Governing Agencies are presented. The second part includes the narratives of commercial banks. Lastly, the third part contains the narratives of the Third Party Providers (TPPs).

G.4.1 Governing Agencies

The first part contains the narratives of the Governing Agencies stakeholder group. Interviews were held at the Dutch National Competent Authority (NCA), which is De Nederlandsche Bank (DNB). Additionally, the French perspective towards PSD2, Open Banking, and Regulatory processes is discussed by explaining the view of the STET. This perspective is elucidated by an interview with people from CGI Luxembourg that worked together with the STET.

De Nederlandsche Bank

The interviewee is responsible for PSD2 certifications and compliance at De Nederlandsche Bank (DNB). DNB is the Dutch NCA (National Competent Authority) and they are responsible for PSD2 compliancy in the Netherlands.

The digital payments market has been developing rapidly and the PSD2 regulation is setting the boundaries in Europe before standards are getting more divided. Currently, many FinTech companies are entering the market and innovating the payment service industry. A big component of digital payments is the creation of financial data. The PSD2 regulation is a mean for the authorities to set a Regulatory Technical Standard (RTS).

PSD2 is regulatory imposed by the European Union as a directive. Subsequently, the Dutch government has implemented the legislation into Dutch law. DNB has to enforce the specific articles of which the PSD2 is composed. DNB is trying to delineate the PSD2 regulation into smaller compartments. The EBA has set regulatory guidelines to translate the articles into mechanisms for implementation. The most difficult task for DNB is to align the guidelines with the expectations of the Dutch market. To begin with, DNB has presented a timeline for the banks and TPPs to clarify what DNB demands from them. DNB has presented different deliverables due in periods of 3 months, this way DNB has divided the work into smaller steps. Banks and TPPs have to deliver their plans according to certain specified standards, in which they discuss what and how they will implement their API-based systems and define their strategic business goals.

During the 3-month periods, a lot of uncertainties became clear and were solved by communicating with other NCAs across Europe (Germany, Belgium, England, but also directly to the EU). Communication is necessary in order to shape a consistent policy across Europe for cases, which could not be foreseen while PSD2 was written. For example, the implementation of a ‘hoofdschakelaar’ (main switch) that allows consumers to revoke access to financial data via their bank (EBA QA 43.09), and the redirected model that allows banks to reroute consumers’ payment process via their own digital environment.

Also, the authentication procedure offers two types of choices now. Firstly, the Qualified Website Authentication Certificate (QWAC) procedure works with a certificate or key that grants access after it an Extended Validation (EV) according to a list of verified companies. Secondly, the Qualified Certificates for electronic seals (QSEAL) depends on a session where the requesting entity has to agree to certain terms before access is granted.
Differences across countries in Europe are experienced in terms of volume and workload. DNB has constructed a timeline to divide the work and identify issues along the way. Whereas other countries demand a full report by the regulatory deadline of September 14th, which is expected to cause a lot of extra work. Other differences in valuation and approving certain practices are trying to be avoided by discussing interpretations and jointly shaping the Regulatory Technical Standard.

In the end, society will benefit from a regulated market by setting this Regulatory Technical Standard. Although the initial effect will only be seen by banks and TPPs before the consumers will experience the effects directly. From a different perspective, different organizations in the market were already experimenting with financial data and this was the very concern of the regulator that caused the enactment of PSD2. Without PSD2, FinTechs and banks could not only use unlimited amounts of financial data, but it also set a legal standard for other software companies that provided services to banks and TPPs. For example, Exact offers accounting software and other technical solutions to banks and other companies, but the contracts differed among these companies. PSD2 now offers a legal basis for these types of contracts and provides a sector wide-standard, which shapes clearer expectations of the parties involved.

For now, the regulators in Europe will be busy with interpretation and implementation issues because every week there are more problems identified which could not be expected yet. Through intensive communication between and alignment of different regulatory and authority organizations, the regulation will gradually get more substantial and specific.

The ideal situation would be for the market to realize the regulatory intentions of the European Union and anticipate on that. Instead of seeking exemptions and opportunities to take advantage in the early stage of the current formulation, as it leads to a lot of staggering effort for both regulators and other stakeholders. In particular, a European initiative that strives for more standardization will be more effective than a compliance-driven sector in the long run. Despite the bank’s fear to lose a competitive battle to FinTechs or TechGiants, such an initiative would lead to a more congruent financial ecosystem. The question is if the involved actors are willing to set those fears aside and make concessions for an efficient and interoperable market environment.

CGI

The interviewee is responsible for a new Open Banking service in Luxembourg. That led to a compliancy process that was different from the one in the Netherlands. Additionally, the moment in time was not very convenient for development, because the EBA guidelines were not developed yet. Thus, the French API standards of STET were followed instead of the German Berlin Group. During, the development it became clear that the uncertainties regarding PSD2 were a major issue. The interviewee’s involvement with the STET was in the beginning quite good, but more actors were gradually involved and the influence on the standards diminished. The functionalities that were developed by the interviewee led to a well-working product but did not become the market standard.

The Open Banking service was developed for a company that wanted to include payment services and process financial data as an extra service to their main business activity. Ultimately, the customers would benefit from the new functionalities and make their interaction more efficient. Besides the consumers, the companies developing Open Banking services would also benefit from more standards and an efficiently operating financial ecosystem because adding new services takes more effort if the underlying infrastructure is badly structured. Formulating API standards should be done by competent people that understand the regulatory demand and they should be able to clearly communicate those standards in order to ensure API quality on a large scale.

Due to the early start of the project, there was not much monitoring yet and the assistance was
not very thorough yet either. The regulators were mostly gathering relevant information about API implementation for Open Banking. In the very beginning, nearly everybody involved in Open Banking service development was involved in the regulatory refinement, but only the big actors remained in the core group when PSD2 became urgent. Most issues with PSD2 were caused by uncertainty and insufficiently explicit requirements. Other IT projects were less restricted by regulation, so that made Open Banking definitely more difficult than other services. Financial resources became an issue when the compliancy problems turned out to be more complex than initially thought. The client was losing confidence as the problems increased, so the financial resources were restricted.

It is difficult to give a prospect for Open Banking because the project is prematurely terminated. Therefore, the desired outcomes of Open Banking projects are limited by regulatory restrictions. No issues were experienced with the technical capability of solving the encountered problems. The adoption rate is difficult to predict, but the client seemed confident with extending its services by adopting Open Banking functionalities until the regulatory issues had become problematic. After this project, there are two big lessons to be learned. Firstly, the experience with developing Open Banking functionalities can be used for other potential clients in the future. Secondly, better communication and more clarity about the regulatory demand would probably make the project more successful.
G.4.2 Commercial Banks

For the exploratory case study, several interviews were held with people at three commercial banks. These banks include ING, Triodos, and De Volksbank.

ING

A Feature Engineer at ING is responsible for making sure the APIs are operating without errors and delivering the specified standard that is demanded by the bank. The APIs should interact as is specified by the formulated functionalities and offer the desired solution in the entire system. Therefore, this role goes further than the ICT aspects of the APIs alone, as the outcomes also have to satisfy the conceptual requirements formulated for the entire system. This holistic approach is chosen due to the strategic view of ING because they want to create a single point of access for their APIs across Europe.

A customer journey expert is responsible for the service of Team Payments. The customers have the most benefit for the APIs. Furthermore, Tech Giants are able to build upon our Open Financial data and increase their services towards customers. Additionally, extending payment services will increase money transfer convenience for consumers and the efficiency of checkout via third parties. ING also has a great number of corporate clients, who can benefit from a more efficient payment system. It could lead to cost reduction and better customer experience. In the current market development, TPPs see cost reduction, efficiency and increased service experience as their biggest advantages when ING finalizes their Open Banking environment.

During our API development process, interpretation of existing legislation is the starting point and infrastructure is built from there. Other organizations have different interpretations that lead to different systems. In the Netherlands, the DNB has to supervise market developments, but a difficult task is foreseen for the National Banking Authority due to discrepancies and diverse interpretations of regulation. Therefore, DNB is informed about the output and consulted if necessary. This way, the risk is minimized while developing unusual systems.

A specific example includes the way that Payment Initiation Services are offered. A bank can either offer its payment service redirected (via a full switch to the bank’s application) or embedded (where the payment service is fully integrated into the TPP’s interface). ING has chosen for the redirected approach because this method leads to more control and more influence on security. Initially, both approaches were required, but DNB agreed that the redirected method is offered first and the embedded approach will follow in a later stage. Along the way of development, many new ideas and approaches are created. Currently, the first deadline in September is most important in order to be compliant. Subsequently, the previously documented ideas and follow-up projects will be reviewed to extend the available services.

Equally important during the development process is to clearly document the steps and underlying foundations in order to improve internal monitoring. Therefore, it increases understandability and minimizes the issues currently encountered with legacy systems. Additionally, regression tests and end-to-end integrity helps to minimize systemic errors. Instant Payment is a payment initiative that is finally taking effect in the Netherlands. This is a significant development that influences the Open Banking ecosystem because retailers can deliver their products without a payment delay. Instant Payments will spark the potential of PSD2. Hence, there is no data delay, without payment delay.

Poland proved to be a difficult country to incorporate because the Polish API guidelines differ slightly from the ones that the Berlin Group had formulated. That is, the Polish NCA has created this Polish API standard to meet PSD2 compliance standards via its own interpretation, which slightly differs from the other 16 PSD2 countries within Europe. As a consequence, it led to some
rework to make the ING systems operational with the Polish business unit. However, the Polish part of ING will also adopt the European standards for commercial reasons and increase interoperability. Therefore, this consideration goes beyond the process towards compliance according to the Polish NCA. Despite the Polish API standard, a small group of banks in Poland operating in many European countries, which follows yet another standard. This led to even more rework for ING, because this group is an important client for ING Poland and they have to include them in their API-based service system.

Despite the many regulations that banks have to comply with, ING is very much aware of the importance. Especially because of the recently imposed sanctions towards the organization due to failing “Know Your Customer” (KYC) protocols, which led to money laundering activities. The key driver for ING to prevent such problems in the future is to protect its brand (perceived legitimacy). For this reason, no restrictions or limits are experienced budget-wise during the PSD2 compliance program. The most important issue regarding budget planning is to determine if new propositions are absolutely necessary for the PSD2 compliance program.

ING tries to design the API-based systems according to the regulatory guidelines. However, sometimes guidelines are unclear and the interpretation leads to discussion. The regulators often publish new standards, which leads to a lot of rework. Most newly published guidelines specify similar functionalities for existing services, regulators are extending the existing requirements this way and try to incorporate as many functionalities before the deadline of September 14th. ING is working very hard to meet compliance guidelines, but when the demands are unfeasible they discuss a more realistic objective.

For example, the regulator in Luxembourg wanted to expedite the PSD2 deadline. This had some advantages because it accelerated the decision processes. Still, the new date for the deadline proved to be too early to meet all requirements and some requirements had to be excluded in the minimal set of compliancy. Also, the new deadline was postponed from the initial June 14th to July 8th. The most important aspect of negotiating compliance requirements is to protect your credibility and safeguard the trustworthy relationship with the regulator. 41% of the commercial banks do not meet the requirements. As a consequence, the regulator has to be realistic and has to keep the dialogue going in order to maintain a fair institutional environment.

Apart from regulators, ING selected a group of ‘friendly Third Party Providers’ and involves them in the development of the API-based system. An example of a friendly TPP is Yolt that develops Wishful Thinking Services, which broadens traditional perspectives by addressing the chances to innovate. TPPs are trying to offer consumers more financial insight by acting as an AIS. ING is offering the required standardization as is specified. Under the ING umbrella, YOLT offers AIS in the UK. Thus, ING hopes to keep track of market developments in this way and stay ahead of the competition with their own self-operating start-up.

Under PSD2 that TPPs are applying in countries with more efficient procedures in order to become a licensed party acting within the whole European Union. An extra check for TPPs leads to better monitoring, so ING is performing that check before sharing financial data information with that organization. Additionally, the role of banks in the new ecosystem shifts back to an information provider to clients. Therefore, transparency and communication become vital to maintaining trusted relationships with consumers. Moreover, ING tries to translate the role of reliable service provider into functionalities within its own digital environment to make consumers less dependent on TPPs.

The aforementioned trends combined with GDPR influence internal processes for data management. More specifically, Team Payments has been working together with its legal department to categorize data sensitivity and adjust the protection protocols accordingly. Similarly, Instant Payments influences the internal processes within ING, which in turn affects other organizations. ING is now helping their clients to anticipate how their own internal processes are affected, so they can im-
prove their own organization. The main distinction between corporate and private banking clients is the tariffs that banks can charge them. PSD2 prescribes standard tariffs for specific services. Therefore, corporate clients are less interested in certain functionalities because usually, they have already been receiving those services from their accountants for example. As opposed to private consumers, these services are often free of charge so they are usually much more interested.

The current regulation (PSD2) lacks specific technical requirements that prescribe technical standards. The SEPA project did have technical specifications that banks had to comply with, in an earlier stage of the transformation. With PSD2, banks are offering and communicating their functionalities, but the actual implementation of the functionalities differs among organizations. That leads to discrepancies in the ecosystem, whereas the EU aims to stimulate interoperability and standardization. At the moment, discussions arise about the enactment of PSD3 in which standard requirements have to be formulated in order to realize a more uniform and compatible data infrastructure. This way, it has to become easier for TPPs to build their services upon the banks’ data systems and create a more uniform ecosystem. However, the specification of these rules takes time, so it will take years before banks formulate new requirements and operating systems have to comply with new standards.

In PSD3, EBA will provide more specific requirements for technical standards for banks. Also, the requirements for becoming a registered TPP will become more clear. Moreover, the GDPR influence on TPPs and the link with PSD2 will become more specific. ING tries to contribute to more standardization by following market initiatives such as the Berlin Group. Ultimately, different standards from various existing knowledge groups will be combined through harmonization in new legislation, which will set the new market standard. ING feels that the Berlin Group determines a big part of this process.

Compliance is the most important objective for ING right now. After the regulatory deadline, ING will start focusing on innovation again. However, other regulatory requirements such as the improvement of the KYC protocol will be the next big objective after PSD2. Banks are usually 50% occupied by compliance-related issues.

The most important strategic decision for the PSD2 project is the creation of a single point of access within Europe. ING had to adapt the internal database infrastructure to realize this objective. From a technical perspective, creating a single point of access is not the most convenient approach. Still, the strategic long term version is deemed the best way to go, so despite the extra work ING has decided to create a more centralized data system. The one bank strategy is a commercial decision made by the board of directors, which also influences the development of an API-based data system.

During the PSD2 compliance project, there was a lot of uncertainty which led to hectic circumstances. With more clear requirements from the beginning, the project can run more smoothly and the digital environment would have been designed more robust. In other words, some parts of the ING system had to be delivered in a too narrow time window, which led to a rather unstructured approach. Nevertheless, ING always allows people to speak up if serious concerns are raised regarding the potential flaws of a system, in which case the implementation can be postponed despite the consequences. In such a situation, communication is vital to manage expectations.

**Triodos**

Triodos is focused on adopting Open Banking to improve its services for its customers. They are aware of all the positive and negative possibilities, so they assure that their policy is always in line with their strategic objectives and matches their clients’ desire for sustainability. They want to use the Open Banking opportunity to their advantage by creating partnerships with eco-friendly companies and build a durable financial ecosystem. A key factor in this mission is good communication
with clients and being transparent about financial data management. Therefore, companies with interesting sustainable business models are already included to find out if the developed APIs are technically capable of dealing with these prospects.

Triodos decided to develop its own API-based system with a relatively small team, but they are very happy until now with their decision. The during the development of the API-based system, the NCA was very inclusive in communicating its processes and objectives. Triodos started rather late with developing their API-based system. Looking back on the process, that decision resulted in a smooth creation of the API-based system because many solutions to generally experienced problems were already available. Therefore, Triodos is fortunate that its API-based system could be developed rather quickly and the organization accepted the amount of money that the project had to cost. Triodos sees many opportunities in the changing environment for them that evolve from their API-based system so that relieved some negativity that was initially experienced. At the start, the API-based system was a regulatory imposed necessity, but innovative ideas grew as Triodos became more aware of the Open Banking potential. The only dilemmas were experienced with deciding if potential partners matched their vision for sustainability enough to include them for further development. More specifically, the trade-off would often be between convenience and absolute sustainability (both customer oriented and environmental friendliness).

Triodos is very aware of the negative effects of financial data becoming widely available, due to the concerns of their clients. Therefore, Triodos is constantly stressing the importance of transparency and clarity concerning Open Banking functionalities towards their clients. The expectations from any further regulatory intervention are difficult to predict, but the Triodos is confident that the NCA will manage any further steps well and ensures a smooth transition regardless of the direction. The ideal situation would include a more specific formulation of regulatory imposed API requirements in an earlier stage of the PSD2 process.

De Volksbank

De Volksbank is one of the smaller commercial banks in the Netherlands. Although the PSD2 project is quite extensive, de Volksbank decided to develop its API-based systems with their own specialists. They feel that PSD2 forces them to open up their data for TPPs, but it is unclear what the banks get in return. Moreover, the bank is concerned if PSD2 is really in the consumers’ best interest. The legislation is deemed incomplete to protect consumer values and the current implementation seems to only serve the interest of the TPPs, whoever that may be.

In order to meet compliance standards, de Volksbank is following the guidelines and standards formulated by the Berlin Group. In particular, the process for developing their API-systems started by looking at the EBA and Berlin group guidelines. Subsequently, some internal meetings were held to discuss which functionalities were absolutely necessary and find out what the future prospects of the decisions might include. Developing an API-based system is necessary to be compliant and has no directly specified budgetary or resource restrictions. However, the proposed functionalities are carefully assessed and its importance is thoroughly discussed before the development is incorporated in the PSD2 project.

Generally, de Volksbank is rather skeptical about the PSD2 regulation and tries to comply with the minimally mandatory requirements. Their API-based system is more a convenient way to share data than alternative methods of extracting data used by TPPs, such as screen scraping.

There are some differences between the API-based systems of the European banks due to the legacy systems. Nevertheless, the general functionalities are roughly the same. A bigger difference can be identified between the Northern European countries, such as the Nordics and in Western Europe, and the countries in the rest of the European Union, such as in the Mediterranean area.
This difference occurs mainly in the infrastructure and the standards of the data systems. A big advantage of the PSD2 legislation is that those data systems are also transformed to a more congruent Regulatory Technical Standard (RTS), which should lead to more interoperability.

The most comparable projects with PSD2 are the Instant Payments Project and the SEPA Project. The resemblance is that it leads to more standardization in Europe and there are several aspects that try to unify and improve European payments. However, the difference is that PSD2 focuses more on financial data in the financial ecosystem. The regulation obligates banks to share their financial data after a consumer’s request, but the question is if that is really in the consumer’s best interest. Despite regulatory precautions, the impact cannot be fully anticipated and, even worse, malicious practices cannot be prevented.

Another difference between Instant Payments is the formulation of a clear objective. With instant payments, the specified requirements directly lead to an operational payment system where the money is instantly transferred from one account to another. Whereas, PSD2 does not directly lead to an Open Banking environment. Open Banking is about creating a financial ecosystem, but PSD2 only imposes banks to open their data systems. This one-sided perspective currently lacks incentives for other organizations to share their data in return and create a multi-sided Open Data ecosystem.

The future of Open Banking does not depend on an expected PSD3, because a successor of PSD2 implies that any shortcomings will be rectified. However, the Payment Service Directives were initially constructed to impose a level playing field in Europe, not to create an Open Banking environment for the entire financial ecosystem. Therefore, an “Open Banking Directive” or OBD1 would be far better suited to guide the member states to a desired Open Banking environment in Europe. Moreover, the ethical foundation for such legislation is far more obvious as it implies the cooperation of more than the banks alone. In other words, the whole financial ecosystem should meet the hypothetical compliance requirements for financial data sharing, not just the commercial banks but also the TechGiants and other multinational companies that influence our society with big data.
G.4.3 Third Party Providers

The Third Party Providers (TPPs) include the narratives of two organizations. Both actors explicate their own perspective on the changing financial ecosystem and their perception of the other stakeholder groups.

**Bizcuit**

The name Bizcuit originates from business and kit, it is actually the toolkit for every SME business that needs help with their finance. Therefore, Bizcuit is sure that ultimately the consumers and self-employed people benefit from well-designed API-based systems and Open Banking services. Despite the many opportunities Bizcuit sees due to PSD2, the banks still neglect to be fully compliant on some particular parts and it is hard to demand improvement from them.

Bizcuit continues to grow with the availability of financial data and Open Banking. The team of developers has been expanding and they really just solve one problem at a time by using their own capabilities. The news and regulatory announcements are big indicators of their strategy. The direct interaction with banks and the regulator is complicated because of the underlying interests. Banks want to use insights and recommendations as feedback on their developer portals, but they do not particularly want to help Bizcuit improving. The regulator is too busy with the amount of work they have and have their own agenda, so the contact with them is minimal.

Usually, the type of work for Bizcuit and competitors include cloud migration projects. Hence, the Open Banking project makes a world of difference due to the many actors involved that go beyond the technical issues. Primarily, PSD2 created a level playing field and provided strict rules for banks to share their financial data with others in the financial ecosystem without prior selection or ability to refuse. Additionally, some financial was already available via different means, which are now becoming more efficient due to PSD2. Nevertheless, the newly available financial data is valuable, so it is worth the extra effort and financial resources.

Some regulation mechanisms are not very well explicated and others are just annoyingly misfits. In particular, the limit of 90 days for consent is something that many clients want to switch indefinitely, but that is not specified in PSD2. From a security perspective, some other requirements are understandable but there is proportional doubt that these functionalities can really prevent the security issues or financial data disasters. If hackers or malicious organizations really want to abuse financial data, they always find a way to circumvent the mechanisms in place.

The biggest concern is the uniformity of NCAs across Europe in enforcing the rules and monitoring the practices. It causes concern that the certification procedure has varying takes more time here than in other countries, so that must imply that there are systematic differences within the EU.

In short, the most important part of Open Banking that is desired to be different afterwards is for the NCA to be more explicit and uniform, and for the commercial banks to be more compliant and operate faster.

**Geldmaat**

Geldmaat develops a single interoperable Automatic Teller Machines (ATM) for multiple banks. A considerable amount of issues for Geldmaat would not have been relevant if PSD2 was already effective. Regulation is really seen as a supportive instrument for more efficiency. Ultimately, Geldmaat experiences a lot less rework and consumers are able to use our services more often and more conveniently.

This project was started before the PSD2 regulation was published, so the interaction with the commercial banks was complicated because there was no regulatory framework to refer to and no
API-based system to connect to. Therefore, the solutions had to be developed from scratch, so it took a lot of effort to make an overview of the data flows to different banks and convince them that particular links to their data systems were absolutely necessary.

PSD2 forces commercial banks to develop API-based systems that enable TPP to efficiently exchange financial data and improve the overall performance of the financial ecosystem. The key difference with other data system related projects is that commercial banks are very concerned about security, so every request of data related decisions involving trade-offs between efficiency and security tend to result in impediment from the bank’s side.

The next regulatory step entails more specification of technical requirements and more standardized solutions to generally experienced issues. The regulatory process is gradually creating new boundaries that minimize broadly experienced problems. However, there are countless multinational retail companies that value this transformation by taking advantage of the advertising opportunities that result from the available financial data.
Appendix H

Design Principles

The following part elaborates on the design principles. Firstly, the design principles are discussed by further explaining what each principle entails and how organizations in the financial ecosystem should use the principles. Secondly, the design principles are evaluated by experts in the financial ecosystem. The procedure for evaluation is presented followed by the results of the assessment.

H.1 Elaboration on Design Principles

The OB Design Principles of Table 6.1 are discussed more extensively here. Furthermore, the purpose of the design principles and the application approach is explained.

H.1.1 Stewardship

Stewardship is a popular concept in information systems. It requires a person to be the owner of a particular part of the data system. A steward is made responsible to ensure decisions are made with the organization’s interests as the primary motivation and ignore individual utility in the trade-offs [Davis et al. 1997]. Thus, a reliable steward must be chosen to protect corporate interest against personal gains and other drivers that keep company performance from improving.

In the case of Open Banking, a steward is assigned for a specific API. That steward is responsible for maintaining the quality of the API and proactively ensure that the functionalities are updated to the changing environment. The commercial banks already adopted a similar mechanism and they call an API the product. The Product Owner is responsible for the specific API.

H.1.2 Privacy by Design

Privacy is identified as one of the most important factors for consumers in the financial ecosystem. Therefore, privacy by design is included as a design principle for developing APIs for Open Banking. This design principle follows the previously introduced steps of Foundational Principles of Privacy by Design from Table 4.6.
H.1.3 Modularity to Adopt New Components

Anticipating on standard components is already covered by the alignment design principle, but other measures can also help to make the API-based system more robust. When certain components are chosen as the new standard, the API-based system needs to be able to adapt and the new components need to be quickly implemented. Therefore, the API-based system needs to be designed with interchangeable components and have a modular character.

H.1.4 Define Inter-organizational Risks

The regulator has the responsibility to assess risk and request documentation from certified organizations operating under PSD2. The commercial banks and TPPs have to show that their API-based systems comply with PSD2 and in the event of an emergency, they have to immediately notify their NCA.

Emergency prevention is always better than punishment afterward. Therefore, the Dutch NCA (DNB) has communicated a strict timeline where the involved organizations have to deliver specific documentation at multiple deadlines. This increases the ability to monitor the environment and enforce a provisional security standard. Furthermore, innovative technologies from Table 4.5 can be used to more efficiently monitor the financial ecosystem and adequately identify systemic or pure risks.

H.1.5 Create and Adapt Portfolios for API Standards

PSD2 and the corresponding implementation guidelines have only formulated standards regarding the functionalities. A clear overview of the specific parameters used by different API based systems is a clear shortcoming of the regulation. Since there is a need for such an overview to let the ecosystem grow, different smaller organizations are trying to create such an overview. These businesses want to sell that to as many organizations as possible and there is quite some interest because it takes some effort to come to the same result.

H.1.6 Align APIs with Regulatory Guidelines

A weekly meeting to align business developments with the guidelines formulated by EBA and Berlin Group is most relevant for banks. However, banks need to verify if their interpretation of the guidelines aligns with the intention of the NCA.

Conversely, the alignment of the EBA Guidelines with the available APIs is addressing the concerns of TPPs, in which they state that some regulatory imposed mechanisms are insufficiently safeguarding underlying consumer values. This institutional misfit by imposing inadequate technical solutions cause the financial ecosystem to be more inefficient. Therefore, the alignment requires all relevant actors in the financial ecosystem to propose better-qualified solutions for generally experienced problems and improve the Regulatory Technical Standards from the bottom up.

H.1.7 Redefine Regulatory Guidelines

A subsequent step after collecting various business intentions and API-based system designs is to redefine the guidelines according to new input. Put differently, a regulator cannot foresee everything that might be possible, so the NCA has to adapt to new business ideas developed in the market. Some prospect for new technologies is given in Table 4.4.
DNB has indicated that submitted documentation is carefully analyzed for novelties, previously unanticipated for. As a result, these developments are discussed with NCAs in other countries to align their policy towards creative interpretation and the new guidelines aim to communicate a clear view on the subject in case of similar intentions by others.

**H.1.8 Discuss Prospects with Government Agencies**

Based on the optimization of organizational systems for regulators from Figure 5.2, the next regulatory step should be taken into account when developing data systems. The possibility that Governing Agencies take the next regulatory step should be anticipated when designing an API-based system. That is, the scope of control could be extended or the speed of adjustment could be changed.

**H.1.9 Prepare for Increased Regulatory Interference**

The API-based system also needs to anticipate if the regulator decides to increase the speed of adjustment in the system. That means that the NCA is required to not only supervise but also actively monitor the financial ecosystem. In that case, the API-based system needs extra functionalities, such as mechanisms that actively identify money laundering activities for example.

These mechanisms are not absolutely necessary to be included in the API-based system. However, the API-based system needs to designed such that these mechanisms could be easily implemented and minimize the possible amount of rework in the event that Governing Agencies increase regulatory intervention.

**H.1.10 Integrate Financial Data with External Media Sources**

This is again a principle that is not covered within compliance directives but builds upon the Three Pillars of Innovation from Figure 4.2.

Integration with external media sources, such as social media, is the most obvious application of the newly available data. This idea leads to some controversy as the general public opinion is that advertising companies already know a lot of your personal interests and fears. Therefore, extending the amount of data already available by TechGiants with financial data is a great driver in the market which is tried to be restricted by the regulator with certain imposed mechanisms.

An important remark has to be made about the currently available mechanisms, as GDPR already limits the use of personal data via explicit consent. However, the question remains how effective this mechanism is. Some remarks were made about the ability to test the effectiveness of this mechanism, as financial data is generally perceived as more personal than for example browsing behavior. In particular, the availability of financial data leads to the opportunity to research.

**Awareness Reference**

1. How is this data currently used?
2. Are people aware of how the data is used?
3. Is the current mechanism of giving consent indeed serving the purpose specified by the institutional framework? (Does it align with the underlying values?)
4. Are there other mechanisms available that better serve the public opinion regarding personal data protection and prevention of abuse?

Table H.1: Awareness about External Integration of Financial Data
These examples are just the beginning of questioning the currently formulated paradigm of data (ab)use by commercial organizations.

H.1.11 Maximize Information Flows

The information flows have to be standardized such that data can be exchanged between different organizations. The considered organizations do make an effort to collaborate for developing a financial ecosystem, but they stress their concerns that the European landscape is complex and outstretched. As a result, it is hard to include the desired amount of companies, which limits the pace of growth.

Currently, maximizing the information flow is done step by step and starts with including as many domestic organizations as possible.

H.2 Evaluation of Design Principles

The design principles are evaluated by following a structured approach. The selection of experts for evaluation is explained. Secondly, the execution of the evaluation procedure is explicated and the assessment form is included. Lastly, the results of the feedback are discussed after the procedure of assessment is presented.

H.2.1 Selection of Experts

The design principles are evaluated by experts in the financial ecosystem at CGI Netherlands. These experts are working in the financial service sector for over 10 years and have a great experience with the architecture and security of information systems.

H.2.2 Execution of Evaluation

The experts were asked to fill in the expert assessment form and provide additional feedback where possible. The feedback and remarks were mostly given verbally in order to get maximum response and minimize the extra effort of writing things down.

Expert Assessment Form

The assessment form in Table H.2 asks to evaluate the design principles on three criteria and allows to give general feedback for further improvement.

Verification

Firstly, the verification aspect ensures that the right system is built. In other words, verification asks if the design principle is applicable for API design for Open Banking in the financial ecosystem.

Validation

Secondly, the validation aspect relates to the performance of the design principle. More specifically, validation aims to find out if the design principle would effectively lead to adequate design principles.
<table>
<thead>
<tr>
<th>#</th>
<th>Design Principle</th>
<th>Verification</th>
<th>Validation</th>
<th>Reliability</th>
<th>General Feedback or Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Stewardship</td>
<td>++/++/+/-/-/</td>
<td>++/++/+/-/-/</td>
<td>++/+/-/-/</td>
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<tr>
<td>2.</td>
<td>Align APIs with Regulatory Guidelines</td>
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<td>++/+/+/-/-/-</td>
<td>++/+/-/-/</td>
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<tr>
<td>3.</td>
<td>Privacy by Design</td>
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<td>++/+/+/-/-/-</td>
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<td>4.</td>
<td>Maximize Information Flows</td>
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<tr>
<td>5.</td>
<td>Define Interorganizational Risks</td>
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<tr>
<td>6.</td>
<td>Redefine Regulatory Guidelines</td>
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<td>7.</td>
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<td>8.</td>
<td>Integrate Financial Data with External Media Sources</td>
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<td>9.</td>
<td>Discuss Prospects with Government Agencies</td>
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<td>10.</td>
<td>Modularity for Adopting New Components</td>
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<td>11.</td>
<td>Prepare for Increased Regulatory Interference</td>
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</table>

Table H.2: Design Principle Assessment Form
Reliability
Lastly, the reliability addresses the specification and has no undesired secondary effects. In particular, the design principle should be reliable to only make an API for Open Banking better without affecting other design principles or decrease the overall performance.

H.2.3 Evaluation Results
The experts have evaluated the set of Design Principles for APIs for Open Banking on the aspects of verification, validation, and reliability. Furthermore, they have provided feedback where possible and they found necessary.

<table>
<thead>
<tr>
<th>#</th>
<th>Verification</th>
<th>Validation</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Privacy by Design</td>
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<td>External Media Sources</td>
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<td>5.</td>
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</table>

Table H.3: Average Validation Result by Experts

The general results are provided in Table H.3. The average response is presented by a list per assessment criteria and the design principles are placed in descending order. In other words, the ranking goes for each aspect from the most strongly agreed design principle on top to most disagreed at the bottom.

Furthermore, the generalized remarks of the experts are provided in Table H.4. The order of design principles is roughly the same as the order of agreement in Table H.3.
APPENDIX H. DESIGN PRINCIPLES

<table>
<thead>
<tr>
<th>Design Principle</th>
<th>Generalized Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Privacy by Design</td>
<td>The starting point should be to place data ownership in the hands of the consumers.</td>
</tr>
<tr>
<td>2. Selection of Standard Components for API Standards</td>
<td>Standardization is the key to an interoperable financial ecosystem, but the selection should be done consciously.</td>
</tr>
<tr>
<td>3. Create and Adapt Portfolios for API Standards</td>
<td>APIs should be divided according to their level of importance to secure a manageable workload.</td>
</tr>
<tr>
<td>4. Integrate Financial Data with External Media Sources</td>
<td>The consumers are the absolute weakest link in the financial ecosystem, no mechanism can protect an ignorant consumer.</td>
</tr>
<tr>
<td>5. Discuss Prospects with Government Agencies</td>
<td>Preparing the systems and infrastructure for the future is always beneficial, but difficult to execute.</td>
</tr>
<tr>
<td>6. Align APIs with Regulatory Guidelines</td>
<td>Especially helpful to perform frequently in the early phase of a project.</td>
</tr>
<tr>
<td>7. Prepare for Increased Regulatory Interference</td>
<td>Compliance is vital for commercial organizations to avoid fines so long the efficacy is ensured.</td>
</tr>
<tr>
<td>8. Maximize Information Flows</td>
<td>Expansion of data flows will undoubtedly increase, so the infrastructure should be scalable and flexible.</td>
</tr>
<tr>
<td>9. Redefine Regulatory Guidelines</td>
<td>Requires high agility, which is very difficult to implement.</td>
</tr>
<tr>
<td>10. Define Inter-organizational Risks</td>
<td>Regulatory tasks can improve with assistance from commercial organizations but they are not responsible.</td>
</tr>
<tr>
<td>11. Stewardship</td>
<td>Stewardship is difficult to assign due to the multidisciplinary environment, so the CIO is the only qualified steward.</td>
</tr>
</tbody>
</table>

Table H.4: General Remarks based on Feedback by Experts

Explanation of Feedback on Design Principles

Some experts provided additional feedback on the design principles, which is provided in Table H.4. The general remarks are summarized here.

Firstly, the experts have been working with actors in the financial ecosystem, so they are able to provide their insight related to the stakeholder interest.

In general, the design principles demand high flexibility and sub-dividing of internal components to manage the workload. This is in line with the objective of the design principles to reach overarching goals without losing the flexibility to specify.

In particular, the consumers are identified as the weakest link. Thus, besides addressing the technical components of the APIs for Open Banking, the design principles adequately capture this concern.

At last, some principles are necessary but difficult to implement due to responsibility issues and remaining uncertainties in the financial ecosystem. The responsibility of a stable financial ecosystem remains a regulatory task the complexity of the network with conflicting stakeholder interest makes joint contribution practically impossible. Nevertheless, the rules still be fair and effectively serve the desired cause. Still, absolutely preventing calamities can never be guaranteed by any design principle.