UNIVERSITY
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University of Twente
Faculty of Behavioral, Management & Social Sciences
M.Sc. Business Administration

Technical University of Berlin
Faculty of Economics & Management
M.Sc. Innovation Management and Entrepreneurship

Technische
Universität
Berlin

MASTER THESIS

INTEGRATING OPEN DATA REUSE INTO THE

BUSINESS MODELS OF GERMAN COMPANIES

by

TANYA STAMOVA
University of Twente, Matr. N. s1695258
Technical University of Berlin, Matr. N. 364139

SUPERVISORS

Dr. Michel Ehrenhard
First supervisor, University of Twente

Ir. Björn Kijl
Second supervisor, University of Twente

Prof. Knut Blind
Supervisor, Technical University of Berlin

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"No act of kindness, no matter how small, is ever wasted." – Aesop

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Management Summary

With the existing large quantity of open data and new emerging datasets, businesses have new opportunities to create and capture value from open data reuse. But unlike other countries such as the UK or the US, companies in Germany are rarely engaging in such activities. With an identified economic potential of over €130 billion per year, the question arises of how companies can get involved into this promising field.

In line with this, the purpose of this paper is to identify ways in which open data can be integrated into the business models of German companies. It also aims to outline the challenges that German companies face in the business reuse of open data and to identify ways in which these can be overcome.

To study the business model of each company, the current study focuses on six distinctive business model elements: value proposition, value adding process, value network, value in return, value capture and value management, and investigates how open data can be integrated into these. For the analysis, the study uses a combination of desk research and a case study approach, analyzing secondary data from 29 open data companies in Germany and conducting semi-structured interviews with representatives from seven of those.

The research findings show that there is great economic potential for companies willing to engage in open data reuse, and countless ways to do so. Numerous possibilities for open data integration into companies' business models are derived for each of the six business model elements.

Managers can use these results to generate ideas on how to use open data in their business models, or even as means to create their own open data business models based on the presented elements.

Key words: Open data, Business models, Value creation, Value capture

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

APPENDIX

1. INTRODUCTION

With the digital transformation that has been taking place in the past 20 years, businesses in many industries have undergone significant changes in the ways they operate and create value. Many of companies' activities are now being performed either exclusively in the digital world, or online in addition to offline. From distribution, to supplier and customer relationships, to marketing and employee acquisition – the online presence of a company today plays a crucial role in its existence. This vast amount of tasks and activities performed online, combined with individuals spending an increasing amount of time in the digital world, have resulted in the demand and supply of enormous amounts of data, gathered from various sources and for different purposes.

With this trend of data becoming increasingly important for both citizens and businesses, the governments of various countries have initiated the digitalization of much of the data that traditionally has been collected by them. And with various organizations and businesses following their example, individuals now have free access to large amount of so called "open data" – data available free online, with no technical restrictions to its download, use or commercialization. Analysts indicate that this data has an enormous potential for businesses, and successful companies in countries such as the Netherlands, the UK and the US are heavily investing in its reuse. At the same time, in the specific case of Germany, there are only a few examples of commercial open data reuse, despite the great business potential.

In line with this, the goal of the current research is to identify ways in which German businesses can integrate this open data into their value creation process. More specifically, as value creation is typically studied in the concept of the business model, the central research question of this study is the following, "*How can the reuse of open data be integrated into the business models of German companies?*" Instead of seeking to create a new typology of open data business models, this study aims to dive deep into the business models and investigate through which business model elements companies can integrate open data reuse into their operations.

In investigating this question, the paper will employ the methodology of the case study analysis, looking in depth into seven specific cases of German companies reusing open data. The study will also provide a broader overview of all German companies that have been identified to currently engage in the reuse of open data. Before that however, the term open data needs to be specified and its potential defined. Also, the question of how the results of the current study will be beneficial to academics and practitioners needs to be answered.

1.1. DEFINITION OF OPEN DATA

In aiming to understand the concept of open data, one has to answer two underlying questions: 1) "What is data?", and 2) "What is openness as related to data?"

In regards to the first question, Spek & Spijkervet (1997) give the following definition for data: "Data are understood to be symbols that have not yet been interpreted" (p. 13, quoted by Tuomi, 2000, p.104). In this sense, when referring to data, one could think of tables or lists, containing various figures, numbers or words that cannot be used as basis for action before their meaning is clarified. For example, data could show the amount of individuals employed in the automotive industry or the temperature levels during a particular time of the day. However, in order for this data to be meaningful and useful to individuals, it has to be processed through activities such as data analysis. For instance, to interpret the data from the previous example, one could benefit from a comparison of the amount of employees in the automotive industry and the ones employed in agriculture, or one could observe how the numbers have been changing in a selected time-frame. In this sense, data can be seen as the foundation for building information.

Second, Zimmermann & Pucihar (2015) point out that openness in regards to data is related to the free use, reuse and redistribution by anyone. Therefore, to comply with the criteria of openness, data has to be free of charge, obtainable by everyone, and with no technical or other restrictions as to what can or cannot be done with the data - it can be used for individual, as well as commercial purposes. In addition, Bonina (2013) describes that in order for data to be open, it needs to comply to four criteria: it must be accessible, usable, intelligible and assessable. Open data must be published in a manner easy to find, use and reuse, and it must make it possible for individuals to judge its reliability and to scrutinize it.

Finally, this leads to the definition of open data. For the purposes of this paper, the definition of Jetzek, Avital & Bjorn-Andersen (2013) will be used, describing open data as data which is:

> *freely accessible online, available without technical restrictions to re-use, and provided under open access license that allows the data to be re-used without limitations, including across different fields of endeavor (e.g. commercial and non-commercial alike).*

1.2. OPEN DATASETS CURRENTLY AVAILABLE IN GERMANY

As in many other countries, the government has traditionally been the main publisher of open data in Germany, seeking to increase transparency and accountability, stimulate innovation and entrepreneurship, and reduce operating costs. Currently, over 27,000 open datasets are published on Govdata.de alone – the portal for open government data in Germany. The information ranges from transport, to health, to economic and education data. Through the portal, individuals and businesses have free access to information such as a list of existing schools or hospitals in a chosen city in the country, information about noise pollution or available sports clubs in a given area.

And although to this day the majority of open data remains public government data, businesses, institutions and organizations have also recently started to open up their databases. A good example in this regard is "Stromnetz Berlin", a company providing electricity services in the country's capital. The firm has developed its own open data portal – Netzdaten-Berlin.de - and currently has published nearly 200 datasets, categorized into 8 distinctive categories, all related to electricity. Another example is "VBB Verkehrsverbund Berlin-Brandenburg", the company providing public transportation services in the capital. It currently publishes open transport data, for example information about routes, timing and lines of busses and metro trains. Many other institutions and businesses have also opened their data.

A good summary of much of the available open data in Germany is provided by the online portal OffeneDaten.de. The website was initiated by private individuals in 2010, and includes datasets from both public institutions and private businesses and organizations. Today, the website provides over 10,000 open datasets online from various sources and numerous categories, such as environment and climate, education, economics, culture, health, infrastructure etc. The data is available in different formats, such as CSV, XLS, HTML, JSON and can be used by anyone who has internet access. Through the portal, individuals and businesses have access to information such as a list of parking ticket machines in a given area, description of the yearly Christmas markets or the locations of all defibrillators in a given geographical region.

All of the above points to the fact that there is a vast amount of open data available online. And despite the minor exceptions of some data provided under restrictive licenses, most of it is freely available to be used for commercial purposes. Moreover, its usage is not only allowed but also encouraged by the publishers of the data.

1.3. THE POTENTIAL OF OPEN DATA FOR GERMAN BUSINESSES

In line with the above, one important question arises and this is whether or not this data has any value for businesses and whether or not it can in practice be used by companies. In other words, is the data useful for businesses and what is its potential?

In fact, both researchers and analysts have recognized that there is an enormous economic potential coming from the reuse of open data. Open data has recently been described as "digital gold" or "the new oil" (Dapp et. al., 2016). According to estimations of the McKinsey Global Institute, open data is expected to enable an annual value of 3 trillion USD worldwide (Manyika et. al., 2013). For Germany, most recent study by the Konrad Adenauer Stiftung (Dapp et. al., 2016) identified that open data could generate up to 131.1 billion EUR per year in an "optimistic scenario" and 43.1 billion EUR in a so called "ambitious scenario".

Another factor pointing to the potential of open data for businesses is the fact that there already exist numerous examples of companies worldwide that generate high profits through the reuse of open data. Such is for instance the case of Zoopla – a UK based company active on the real estate market. Zoopla is claimed to be the leading online property search platform in the UK (Zoopla, 2016). Apart from other sources of data, the company uses for their website open house sales data from the UK land registry (The World Bank, 2014), transforms it, and offers it to users in a more understandable way. According to the company's website, Zoopla's web platform now attracts over 40 million visits per month. In 2015 the company had revenues of £107.6 million and net profit in the amount of £25.4 million (Zoopla, 2015).

Moreover, there are also some best practice examples in Germany of firms that have successfully integrated open data into their businesses, showing the potential of open data. These have received international recognition and have been growing in the past few years. Among others, examples are start-ups such as "Green City Solutions" (Dresden), "Aleph" (Berlin), and "Viomedo" (Berlin), all of which have received funding in the amount of €100,000 from the Open Data Incubator for Europe, ODINE. Through being recognized by ODINE these companies have shown themselves to belong to Europe's top open data innovators and have been identified to have great potential for success.

1.4. PROBLEM DEFINITION, GOAL OF THE RESEARCH & CENTRAL RESEARCH QUESTION

All of the above shows that there is a large quantity of open data already available in Germany and great potential associated with it. But the examples of firms creating open-data-related products and services are currently very scarce. Rather, data is most often reused by (groups of) private individuals, without the establishment of a legal entity or goals of revenue generation. This is facilitated by initiatives that aim to promote open data, such as the "Code for Germany" program where designers, developers and enthusiasts meet on a regular basis and develop free open-data-based applications.

Such apps and tools contribute to the overall open data landscape in Germany, where the majority of products based on open data reuse are rather simple visualization tools that present the data online and are provided to customers free of charge. Such are the examples of "Trinkwasser" (visualizing data on the content of drinking tap water in the region of Heilbronn), and "ParkenDD" (visualizing parking places data in the city of Dresden). For users, such tools are beneficial in offering comprehensibility of data for individuals with no technical background, as opposed to the raw data that is typically usable mainly by IT specialists. However, these projects bring no monetary benefit to their creators, but are instead developed for the purposes of serving the community, enhancing personal programming skills, or fulfilling other private motives.

In line with this and the potential of open data outlined above, this raises the question of how companies in Germany can use open data not only to serve the community, but also to extract monetary and non-monetary benefits for their businesses. This sets **the goal for the current study: to identify ways in which German businesses can integrate open data reuse into their value creation process**. In doing so, companies can get involved in realizing (some of) the economic potential identified by researchers and analysts.

In order to fulfill this goal, the research will employ the most common practice used by academics and practitioners when describing how value is created by companies - the business model (further described in §2). Thus, **the central research question of this study is the following: How can the reuse of open data be integrated into the business models of German companies?**

To answer this, the study will focus on investigating the business models of German companies currently active in the reuse of open data, in order to identify how open data is integrated into those, and to outline the challenges such companies face. This aims to lead to conclusions and recommendations on how companies can create and capture value in a way similar to currently existing business practice.

1.5. CONTRIBUTION OF THE STUDY

Theoretical contribution: The study will build on the research of Zeleti, Ojo & Curry (2016) as per the authors' future research suggestion to overcome the limitations that current business models are "the outcome of the researchers' perception" (p.11), rather than the result of an empirical investigation. Although some researchers have focused on developing theoretical frameworks on open data value creation and business modeling (e.g. Musings, 2012 ; Ferro & Osella, 2013 ; Howard, 2013), empirical research on open data business modeling is in practice still very limited, and academic literature in the field is "in its infancy" (Zuiderwijk et. al., 2014, p.1). Bonina (2013, p.12) points out that "the business models that may help extracting the potential value of open data are not well understood", confirmed also by Zeleti, Ojo & Curry (2016). Therefore, the study aims to fill this gap by investigating how the theoretical framework developed by academics is being applied in practice and what potential measures can be taken, in order for open data businesses to thrive, in particular in Germany. This will help to shape the future of academic research on the topic of value creation in the open data industry.

Practical contribution: The study aims to assist practitioners in the decision-making process of (1) whether or not and (2) how to incorporate open data into their value creation processes. As for the first, the study enables companies to consider open data as a potential way for generating value by showing that open data can bring monetary and non-monetary returns. As for the second, the study provides insight into the way in which open-data-reuse-pioneers on the German market are already using open data to create value. Thus, the study offers businesses valuable information such as various existing business models and their elements, current open-data-based products and services, and challenges arising from the reuse of open data. The study results can be used by managers to identify potential ways to reuse open data in their specific case. They can be beneficial for all kinds of companies - from (potential) start-ups to large corporations, and from those that have never been involved in the reuse of open data to those searching for new ways to do so. The study specifically aims to fill the information gap on open data business modeling for the German market, where legislation is different than in the majority of other countries, businesses using open data are still few and information of best practice examples is scarce.

2. RESEARCH FRAMEWORK

In order to find ways in which German businesses can integrate open data into their value creation processes, a fitting research framework needs to be selected and implemented. In studying similar questions related to value creation and capture, academics and practitioners typically use the business model, as it provides the researcher with an opportunity to dive deep into the various parts of a company's operations, to understand the logic of the relationships between them, and thus to gain an understanding about the business as a whole. Kindström (2010), for example, explains the business model as "a useful analysis framework to understand a company and its inherent parts" (p.481). Following this example, the business model has been selected to be used in this study.

2.1. THE BUSINESS MODEL CONCEPT

Although the concept of the business model is still relatively "fuzzy and vague" (Al-Debei & Avison, 2009, p.359) and there is no unanimity among researchers into what constitutes a business model (Janssen & Zuiderwijk, 2014), academics mainly agree that business models are derived from an organization's mission and strategy and show the rationale behind generating value (Keen & Qureshi, 2006). More specifically, the business model describes:

> *"the architecture of a firm and its network of partners for creating, marketing and delivering value and relationship capital to one or several segments of customers in order to generate profitable and sustainable revenue streams"*
> *(Dubosson-Torbay, Osterwalder & Pigneur, 2001, p.3).*

By dividing the value creation process into distinguishable elements, the business model provides a way to study the logic of a business and answer questions such as:

- What is the unique product or service that the company provides?
- Through what network of partners does the company create value?
- What activities are involved in the value creation process?
- How does the company generate revenues from the products and services created?

In doing this, the business model fulfills various functions. Chesbrough (2010) describes seven such functions, including giving insight into the value proposition, market segment and value chain of the firm. It describes how the company is positioned in the value network, showing its customers, suppliers and other stakeholders. Lastly, it outlines the cost structure, describes the mechanism for generating revenues, and shows the profit potential and the competitive strategy of the firm.

2.2. THE RELEVANCE OF THE BUSINESS MODEL FOR THE CURRENT STUDY

The business model has primarily been studied in the setting of technological companies (Kindström, 2010) and in particular in e-businesses (e.g. Afuah & Tucci, 2001 ; Dubosson-Torbay et. al., 2001 ; Lumpkin & Dess, 2004). As technological innovations (such as the emerging of open data) often reveal new customer needs and cause the creation of new or change in existing business models (Teece, 2010) it is particularly interesting to implement the business model for the case of open data. Companies that currently integrate open data into their businesses have previously either (1) not had access to the data, or (2) had various difficulties obtaining it. By making large amounts of data freely accessible, the government, companies and institutions have laid the foundation for incremental and radical innovations, and along with it – new business models.

But developing a business model that would integrate open data into the company's operations in a way that not only creates value for customers but also captures this value in the form of profits for the company is no easy task. And unless businesses do indeed find such a suitable model, they run the risk of not capturing the full economic potential of the new technology (Chesbrough, 2010). This is especially true for the information sector, where products and services are often produced and distributed for near zero marginal cost (Lee, 2001) and customers expect them to be delivered free of charge (Teece, 2010). In this case, the differences between competing firms' business models can often explain why some products and services make it to the market, while others do not. Teece (2010) notes that the reason why great technological achievements often fail commercially is because of not giving enough attention to designing a proper business model and Chesbrough (2010) points out that taking the same technology to the market through different business models leads to different results. In line with this, it is particularly interesting to investigate business models in the open data field, where all companies freely have access to the same resource and have the ability to create nearly identical products. In this case, the specifics of the business model will play a crucial role for capturing maximum value from the company's operations.

All of this makes the business model a very interesting and important unit of analysis for understanding how companies use open data to create value and generate profit and to elaborate on new ways in which open data can be incorporated into the value creation process of businesses in the future.

2.3. OVERVIEW OF GENERIC BUSINESS MODEL FRAMEWORKS

Having considered the benefits of using the business model in the current research, one needs to adopt a specific business model framework, describing the building components of a firm and the relationships between them. With this purpose in mind, researchers have constructed various configurations, often offering similar, yet distinctive ideas into what constitutes a business model. Some of the proposed frameworks include the following:

Table 1: Business model frameworks

Autor	Year	Business Model Constructs
Viscio &Pastemack	1996	Global core, governance, business units, services, linkages
Timmers	1998	Product/service/information flow architecture, business actors and roles, actor benefits, revenue sources, marketing strategy
Donath	1999	Customer understanding, marketing tactics, corporate governance, intranet/extranet capabilities
Markides	1999	Product innovation, customer relationship, infrastructure management, financial aspects
Chesbrough & Rosenbaum	2000	Value proposition, target markets, internal value chain structure, cost structure and profit model, value network, competitive strategy
Mahadevan	2000	Value stream for partners and buyers network, revenue stream, logistical stream, profit stream
Afuah & Tucci	2001	Customer value, scope, price, revenue, connected activities, implementation, capabilities, sustainability
Alt & Zimmermann	2001	Mission, structure, processes, revenues, legalities, technology
Amit & Zott	2001	Transaction content, transaction structure, transaction governance
Applegate	2001	Concept, capabilities, value
Dubosson-Torbay et. al.	2001	Products, customer relationship, infrastructure and network of partners, financial aspects
Gordijn, et. al.	2001	Actors, market segments, value offering, value activity, stakeholder network, value interfaces, value ports, value exchanges
Hamel	2001	Core strategy, strategic resources, value network, customer interface
Linder & Cantrell	2001	Pricing model, revenue model, channel model, commerce process model, internet-enabled commerce relationship, organizational form, value proposition
Rappa	2001	Sustainability, revenue stream, cost structure, value chain positioning
Rayport & Jaworski	2001	Value cluster, market space offering, resource system, financial model
Weill & Vitale	2001	Strategic objectives, value proposition, revenue sources, success factors, channels, core competencies, customer segments, IT infrastructure
Betz	2002	Resources, sales, profits, capital
Osterwalder et. al.	2005	Value proposition, target customer, distribution channel, customer relationship, value configuration, core competency, partner network, cost structure, revenue model
Bonaccorsi, Giannangeli & Rossi	2006	Products and services delivery, customers, cost structure, income
Brousseau & Penard	2006	Cost, revenue stream, sustainable income generation, goods and services production and exchanges

Source: Morris, 2005 ; Zott, 2011 ; own research

The various constructs described above are the components which need to be explained in order for one to understand and describe the business model of a company. And although some have tried to analyze and unify the existing frameworks into one standardized model

to be used by academics and practitioners (e.g. Morris, 2005), there is still no dominant and generally accepted framework.

Nevertheless, some frameworks have been more widely accepted than others. One example of such is the one developed by Shafer, Smith & Linder (2005). After thorough analysis of 12 established publications on business modeling, the researchers identified 42 distinct elements of a business model and clustered them into four major categories: Strategic Choices, Value Network, Create Value, and Capture Value. Some of the elements include Value Proposition, Strategy, Branding, Differentiation, Mission, Customer Information, Information Flows, Profit, and Processes/Activities. Despite the theoretical strength and high citation rate of the framework however, it has rather low practical implications and has rarely been used by managers or business analysts. As this paper emphasizes both the academic and the practical side of open data integration into companies' business models, this framework was not further considered in this research.

The one framework which seems to be most often used both in research and in practice is the so called business model canvas developed by Osterwalder & Pigneur (2009). The canvas was developed by over 470 practitioners from 45 countries and was presented as a tool for the description, analysis, and design of business models. It describes nine interrelated building blocks defining how value is created and captured in organizations:

- *Customer segments:* the groups of individuals/organizations the firm serves;
- *Value propositions:* the products/services created for a customer segment;
- *Channels*: the way a company reaches its customer segments;
- *Customer relationships*: the relationships established with customer segments;
- *Revenue Streams:* the cash generated from each customer segment;
- *Key Resources:* the most important assets used in the value creation process;
- *Key activities*: the most important things done during the value creation process;
- *Key Partnerships:* the network of suppliers and partners involved in the business;
- *Cost structure:* the costs incurred to operate the business.

An interesting aspect of the business model canvas is that it has served as a foundation for several academics constructing open data related business models (e.g. Archer, et. al., 2013 ; Ferro & Osella, 2013 ; Zimmermann, 2015). As these specifically focus on open data, their relevance to the current study was considered to be even higher than the canvas. Therefore, open data related business model frameworks are reviewed in the next chapter.

2.4. OVERVIEW OF OPEN DATA RELATED BUSINESS MODEL FRAMEWORKS

When it comes to open data business modeling, the most commonly used and cited in academic literature are the eight archetypes for public sector information reuse created by Ferro & Osella (2013). The term "public sector information" was used due to the fact that "open government data" was at that time still not developed as a term. The study by Ferro & Osella, however, remains a constant in almost every literature review conducted on the topic of open data related business models. In their research, Ferro & Osella use as a foundation the business model canvas developed by Osterwalder & Pigneur (2009) and add three more components to their framework: Types of Data Elaboration, Role of PSI in the Value Proposition, and Price Mechanism. After analyzing real case studies and how they fit into the developed framework, they even created a typology of open data (or in their case – public sector information) based business models and differentiated between eight distinctive archetypes (e.g. Freemium, Open Source Like, Free as Branded Advertizing etc). One of the drawbacks of this framework is the fact that it does not provide clear guidelines or criteria in order to make it possible for other researchers to also implement the framework.

Later, a handful of other researchers focused on the development of business models specifically for the open data industry (Howard, 2013 ; Ferro & Osella, 2013 ; Musings, 2012) and thus the need for creating a unified theoretical framework emerged and was addressed by Zeleti, Ojo & Curry (2016). Although their study focuses on the analysis of business models for open government data, the researchers also looked into other, rather generic businesses. As a result, they proposed six building elements of a business model. This resulted in the so called "6V framework":

Figure 1: The 6V business model framework (simplified)
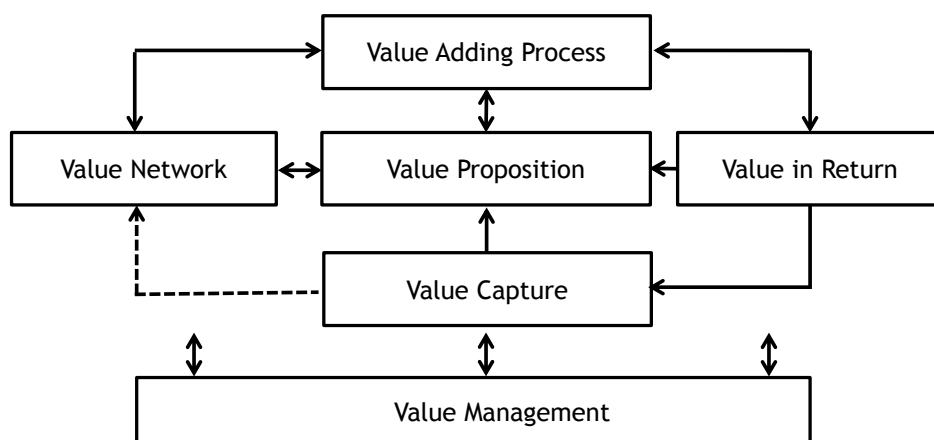
Source: Adapted from Zeleti, Ojo & Curry, 2016

The 6V framework consists of the following core elements:

- *Value proposition*: the specific value created and offered by the business;
- *Value adding process*: the activities required to deliver the value;
- *Value network*: the various actors involved in the value creation process;
- *Value in return*: (non-)monetary value received through the value adding process;
- *Value capture*: the process of retaining some of the value of every transaction;
- *Value management*: the influence of top managers on the value creation process;

Each of these core elements is further divided into second and third level sub-elements guiding the description of the business in more detail:

Table 2: The sub-categories of the 6V business model framework

Value Proposition	Value Adding Process	Value Network

Offer
  o Product/Service
  o Information
 	
Value
  o Price
  o Value for money
 	
Distribution channel
	Operational
	  o Activities/Processes
	  o Technologies/Systems
	  o Resources/Assets
	
	Strategic
	  o Market/Target customer
	  o Logistic systems
	  o Competencies/Capabilities
	  o Profit Model
	  o Revenue Model
	  o Financial Model
	  o Pricing mechanisms
	  o Competitors/Comp. outcomes
	  o Internal value chain structure
	  o Cost structure
	  o Branding/Marketing
	  o Networking/Resource leverage
	  o Differentiation
	  o Legal issues
	  o Mission/Trust
	
	  Knowledge Management
	  o Innovation
	  o R&D
		Actors
		  o Customers
		  o Suppliers
		  o Partner Businesses
		
		Support Infrastructure
		  o Product Flow
		  o Service Flow
		  o Information Flow

Value in Return		**Value Capture**

Income
  o Revenue
 	
Future income opportunities
  o Advertising space
  o Future contracts
  o Rent
  o Commission
 	
Volume of sale
		Market size
		  o Product cost
		  o Product quality
		
		Profit model
		  o Profit
		  o Financial Performance

Value Management		

Structure
  o Organizational structure
	Governance
	
	Administration
	  o Administrative Processes
		Discipline
		  o Mind-set
		  o Dynamic consistency

Source: adapted from Zeleti, Ojo & Curry, 2016

When adding the second level sub-categories to the model, the 6V framework can be depicted through the following graph:

Figure 2: The 6V business model framework (detailed)
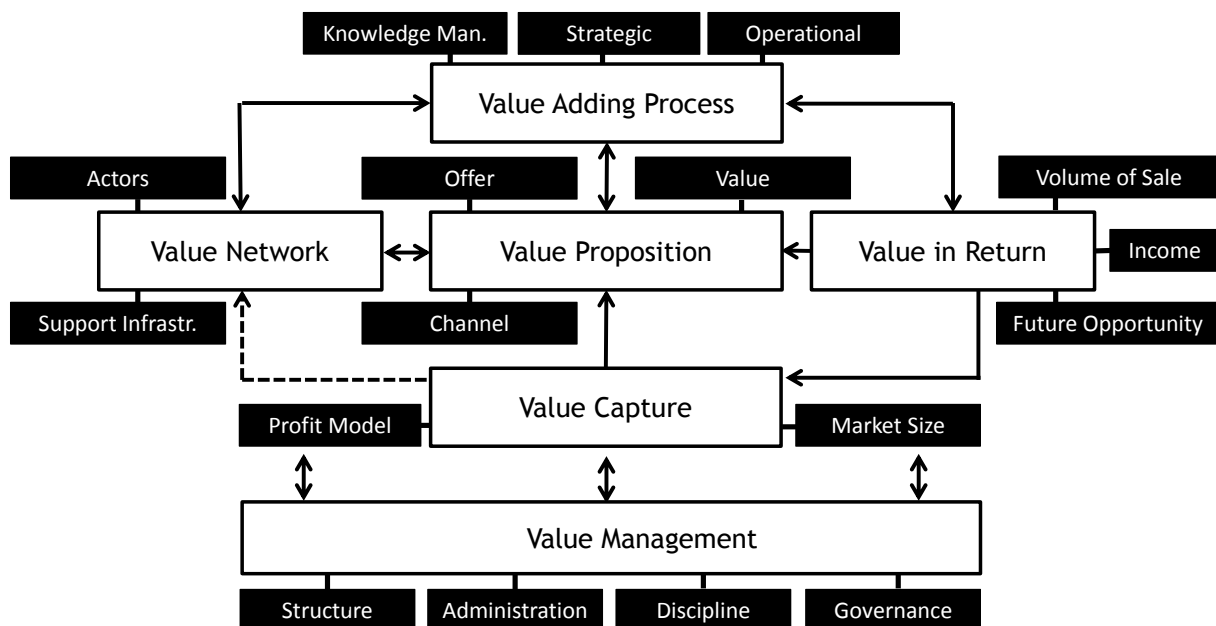
Source: Adapted from Zeleti, Ojo & Curry, 2016

Diving into the specifics of the 6V framework, one important aspect is the specifics of the "Value in Return" component. When describing the 6V components, the authors apply to this category the elements income (revenues), future income opportunities (advertising space, future contracts, rent, and commission) and volume of sale. However, when giving specific examples of what value in return may look like in practice they mention instances such as "higher quality data with increased value" or "availability of data to public". Therefore, the value in return can rather be understood as the value added by the company to the raw open data through implementing the specific business model, or in other words - as the value the customer is paying for when purchasing the products or services. Therefore, the value in return component describes the value added by the company that differentiates the final product or service from the raw data that the customer can otherwise obtain for free. Related to this, the component of "Revenue" belongs to the "Value capture" sub-element, rather than the "Value in return", as it is the main example pointed out by Zeleti, Ojo & Curry when providing instances for "Value Capture" (e.g. "revenue from added value services", "revenue from potential advertisers", "revenue received"). Therefore, in addition to the revenues and value proposition elements which are also mentioned in other frameworks, the 6V framework has the benefit that it provides an opportunity for the researcher to describe the specific value added to the raw data by the company.

2.5. SELECTION OF A BUSINESS MODEL FRAMEWORK

As it has been pointed out, each of the frameworks described has its strengths and weaknesses. The one developed by Shafer, Smith & Linder (2005) has been popular among researchers but its practical application has been scarce. The business model canvas is highly popular but it is not specifically suited for the open data companies. The framework by Ferro & Osella (2013) is indeed related to open data but focuses mainly on data coming from the public sector. Lastly, the framework developed by Zeleti, Ojo & Curry (2016) is highly relevant to the open data field and builds upon some academic work that has been derived from practical observation, but the framework itself has not been tested in practice due to the fact that it has been developed very recently. The following table shows some of the relative strengths and weaknesses of each of the frameworks:

Table 3: Comparison of selected business model frameworks

Author	Theore-tical strength	Practi-cal strength	Relation to generic businesses	Relation to open data	Recent-ness	Level of detail / clarity
Shafer, Smith & Linder (2005)	++	-	++	--	--	+
Osterwalder & Pigneur (2009)	++	++	++	-	-	+
Ferro & Osella (2013)	+	++	--	+	+	+
Zeleti, Ojo & Curry (2016)	++	+	++	++	++	++

In order to proceed with the current research, a decision has to be made in order to choose the most fitting business model framework. In doing so, it needs to be kept in mind that each framework has its weaknesses and that such a decision always includes a component of compromise – accepting some of the weaknesses of a particular framework on account of its relative strength compared to the other frameworks. As a result, the framework developed by Zeleti, Ojo & Curry (2016) was selected to be further used in this research. The reasons for the choice include the following:

- it is the most recent framework developed and builds on the analysis of the majority of important business model publications up to date, both theoretical and practical;
- for the construction of the framework the authors build upon publications related to both general and open-data-specific business models, thus making it highly suitable for the open data industry but also including important insights from general business model literature;
- the detailed categorization of the business model components into distinctive sub-categories provides a clear structure for research.

2.6. FURTHER SPECIFICATION OF THE SUB-QUESTIONS & SCOPE OF THE RESEARCH

Research Sub-questions: The selection of the Zeleti, Ojo & Curry's (2016) framework allows for further specification of the central research question into respective sub-questions. These will guide the research and include the following:

Figure 3: Central research question & Sub-questions
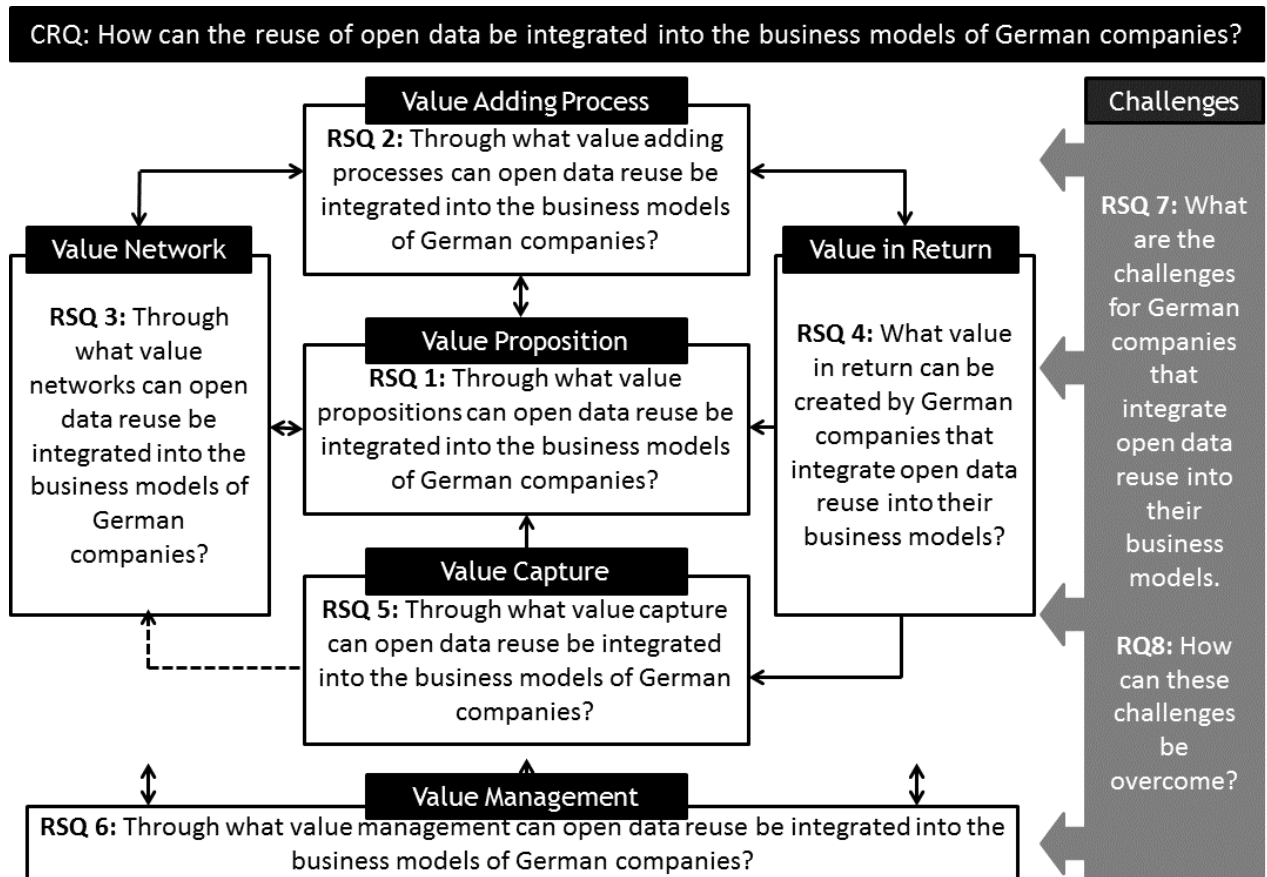
For clarity purposes, each of these research sub-questions will be answered in a respective sub-chapter in this paper, as follows:

Figure 4: Sub-chapters answering the research sub-questions
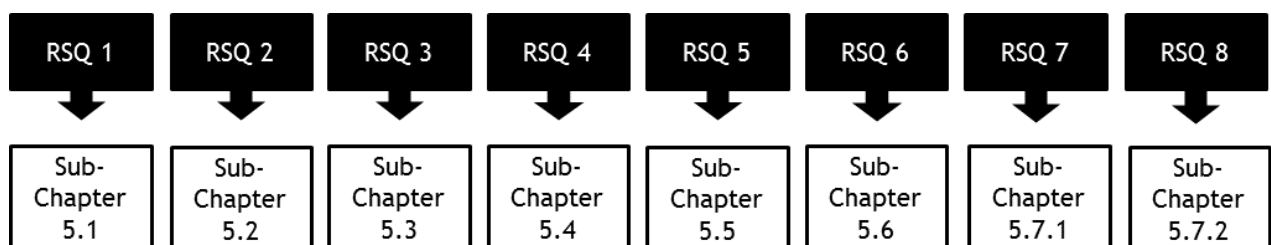
In addition, the results will be synthesized in Chapter 6 "Conclusions".

Research Scope: With the research sub-questions specified, the scope of the research can also be narrowed down. The research will focus only on selected elements of the business model described by Zeleti, Ojo & Curry (2016), as the goal is not to describe the business models of existing open-data related companies in perfect detail, but rather to understand how open data is integrated into such. In the selection of the elements, two main considerations were observed: the element's weight of the importance for the business model and the possibilities of obtaining the data. In their paper, Zeleti, Ojo & Curry (2016) provide an overview of related previous research and indicate the frequency of occurrence of each of the elements in the respective papers. By investigating how often academics have considered a specific element to be important enough to be included in their research, the weight of importance of the elements was determined. Thus, the most often occurring elements in each category were selected. In addition, certain elements, such as profit model, were excluded, as the information was difficult to obtain. As a result, the following categories (underlined ones) were selected to be included in the research:

Table 4: Selected sub-categories of the 6V business model framework

Value Proposition	Value Adding Process	Value Network

▪ *Offer*
  o <u>Product/Service</u>
  o Information
 	
▪ *Value*
  o Price
  o Value for money
 	
▪ <u>*Distribution channel*</u>
	▪ *Operational*
	  o <u>Activities/Processes</u>
	  o Technologies/Systems
	  o <u>Resources/Assets</u>
	
	▪ *Strategic*
	  o <u>Market/Target customer</u>
	  o Logistic systems
	  o Competencies/Capabilities
	  o Profit Model
	  o Revenue Model
	  o Financial Model
	  o Pricing mechanisms
	  o Competitors/Comp. outcomes
	  o Internal value chain structure
	  o Cost structure
	  o Branding/Marketing
	  o Networking/Resource leverage
	  o Differentiation
	  o Legal issues
	  o Mission/Trust
	
	▪ *Knowledge Management*
	  o Innovation
	  o R&D
		▪ *Actors*
		  o <u>Customers</u>
		  o <u>Suppliers</u>
		  o <u>Partner Businesses</u>
		
		▪ *Support Infrastructure*
		  o Product Flow
		  o Service Flow
		  o Information Flow

Value in Return		**Value Capture**

▪ *Income*
  o <u>Revenue</u>
 	
▪ *Future income opportunities*
  o Advertising space
  o Future contracts
  o Rent
  o Commission
 	
▪ *Volume of sale*
		▪ *Market size*
		  o Product cost
		  o Product quality
		
		▪ *Profit model*
		  o <u>Profit</u>
		  o Financial Performance

Value Management		

▪ *Structure*
  o <u>Organizational structure</u>
	▪ *Governance*
	▪ *Administration*
	  o Administrative Processes
		▪ *Discipline*
		  o Mind-set
		  o Dynamic consistency

3. RESEARCH METHODOLOGY AND DESIGN

3.1. SELECTION OF A RESEARCH APPROACH, STRATEGY AND METHOD

For the current study, an **inductive research approach** was selected, seeking to build theory as a result of the data analysis, rather than through the testing of existing theory or hypothesis. One significant benefit of such an approach, pointed out by Saunders, Lewis & Thornhill (2009) is that the researcher is not bound to the limits of the existing theory that is being put to the test, but is rather enabled to discover new patterns and constantly adapt the theory according to new discoveries made during the process of data collection and analysis. The current one is also an **exploratory study**, aiming to find out "what is happening, to seek new insights, to ask questions and to assess phenomena in a new light" (Robson, 2002, p.59). Such studies are typically aiming at researching questions in fields where literature is still scarce or even missing. The research is also concerned with a "how" question (*"How the reuse of open data is integrated into the value creation processes of German companies"*).

In line with this, a **case study research strategy** was selected, which is one of the most often recommended for answering questions of "how" (Yin, 1994), for conducting exploratory research (Saunders, Lewis & Thornhill, 2009) and for researching questions for which the existing theoretical knowledge is rather limited (Siggelkow, 2007). The strategy of case study research was also chosen due to the opportunity it provides to study the business models in depth, and to get insight into the organization and its processes as a whole (further explained in §3.4.2).

Lastly, a qualitative method was selected for data collection and for data analysis. More specifically, by the definition of Saunders, Lewis & Thornhill (2009) this is a **multi-method qualitative study**, as it uses more than one qualitative data collection technique and a qualitative approach for data analysis. Qualitative studies "draw heavily on context, local perceptions, and a holistic understanding of the phenomenon under study" (Bamberger, 2000, p.38). The qualitative data consists of non-numerical data, mainly texts. The data-collection process for this study included various qualitative techniques such as semi-structured interviews and the review of documents such as management and financial reports, and corporate websites.

3.2. DEFINITION OF THE POPULATION & SAMPLING

In order to study how open data can be integrated into the business models of German firms, this study looks into the value creation processes of existing German firms, involved in open data reuse. Due to the small size of the population of such companies, data was collected for all the businesses which fulfilled certain pre-defined requirements. The formulation of such requirements, or "limiting factors", is an important prerequisite for selecting the cases, as is also explained by Benbasat, Goldstein & Mead (1987). In the present paper it was decided upon the following limiting factors:

- **Only legal entities:** In many cases open data was re-used and put into projects and initiatives, created by individual developers or groups of individuals. Such were excluded from the research, as they do not constitute a legal corporate entity, thus having no relevance to the research question.

- **Only private companies:** Public companies, governmental bodies, research institutes and other non-private entities often have different motives and thus obtain different benefits from the reuse of open data, not relevant to this research.

- **Only current projects:** Due to the specifics of open data, some companies only experiment with its use for a short period of time, after which they terminate the project(s). In other cases, companies have developed plans for open data reuse and are close to its execution but there still exists an uncertainty as to when (and if) the project will take place, and how it will generate value in practice as compared to the initial plan. Thus, such projects were excluded.

- **Only companies active in the reuse of open data:** Often it was identified that certain companies are publishing open data but are themselves not using such in their operations for value creation. Such firms were not included in the population.

For all the companies fulfilling the above requirements, initial data was collected from secondary sources such as corporate websites and news articles. As a result, a list of companies was generated, providing information for each of the companies' business models. This resulted in an initial limited overview of the business models involving open data reuse in Germany, which was then presented in §4.1.

At a later stage, all companies were contacted with a request for a deeper study and an interview with a representative of the company. For the companies that agreed to participate, case study examples were developed through using the initially gathered secondary data, the data collected through the interviews, and additional secondary sources studied in more depth as related to the initial research. This data was presented in §4.2.

3.3. DATA COLLECTION

One important feature of the case study research is the analysis of various sources of evidence (Benbasat, Goldstein & Mead, 1987; Eisenhardt, 1989; Yin, 1994). Yin (1987) for example describes six sources of evidence: documents, archival records, interviews, direct observations, participant observation and physical artifacts. Benbasat, Goldstein & Mead (1987) further explain the importance of complementing evidence with the goal to obtain "a rich set of data surrounding the specific research issue, as well as capturing the contextual complexity" (p. 374). In addition, various sources of information are crucial for assuring construct validity of the results (further explained in §3.5). Therefore, the data collection process for this study was roughly divided into four stages.

Stage 1: Literature review: Three information sources were selected for the systematic review of academic literature that set the foundation for the research: "Web of Science", "ScienceDirect" and "Google Scholar". In all of the databases keywords were used to identify relevant literature, including "open data", "business models", "value creation" and combinations of such. The search was limited to scientific articles published after 2005, as the term "open data" did not exist before this year. For the overview of literature related to generic business models, the term "open data" was excluded and the research criteria expanded to include years before 1990. This initial stage provided an overview over existing academic work on the topic, identified gaps in the literature, served for the formation of a theoretical framework for the study and guided the further research.

Stage 2: Data collection through secondary sources: After the review of existing literature and the selection of a theoretical framework for business modeling, relevant information was gathered on existing open data initiatives, projects and companies. This was conducted through search in the "Google" database in both English and German languages, including the respective language equivalents of keywords such as "open data", "open data companies", "open data firms", "open data initiatives", "open data projects", "open data platforms", "open data portal" etc. Through this initial search, sources of information relevant for the existing open data companies were identified, including:

- Corporate websites and other corporate publications;
- Management and financial reports;
- Business analyses conducted by business analysts, consultancy companies, governmental and other institutions;
- Press releases, news articles and blog posts.

The data collected was crucial for the identification of open-data-related companies and prospective interview partners, for gathering initial insights into the business models of open-data firms, and for observing initial patterns to be further confirmed during the expert interviews. Thus, the information obtained in Stage 2 served as a foundation for Stage 3. However, further information from secondary sources was also collected, used and re-examined during Stage 3, as to integrate both sources, and thus generate coherent and systematic conclusions.

Stage 3: Data collection through primary sources: In the last stage, primary data was collected through semi-structured interviews, which is considered to be an appropriate data-collection method for qualitative studies and also recommended in the case of exploratory studies (Saunders, Lewis & Thornhill, 2009). Some of the advantages of conducting interviews in addition to the information obtained through secondary sources included:

- to explore questions for which information was lacking in other sources (e.g. the sources of the open data used by a particular company);
- to get a deeper understanding of the explored research questions (e.g. the reasons behind various decisions such as using open data or choosing a specific organizational structure),
- and to confirm the data from secondary sources first-hand.

In addition, when discussing the significance of establishing personal contact, as compared to other data-collection techniques from primary sources, Saunders, Lewis & Thornhill (2009, p.324) point out the following: *"We have found that managers are more likely to agree to be interviewed, rather than complete a questionnaire, especially where the interview topic is seen to be interesting and relevant to their current work."* As (1) open data is a novel and exciting topic for German companies, (2) very relevant for the selected examples, and (3) the prospective study results were considered to be beneficial for the respondents, interviews were considered as one appropriate source of information.

Face-to-face contact was always preferred. Therefore, for companies based in Berlin, interviews were conducted through personal meetings. For all other respondents, telephone interviews were selected as a necessary approach, due to the geographical difficulty of conducting the interviews face-to-face. Saunders, Lewis & Thornhill (2009) stress the importance of conducting interviews at a location convenient for the participants with the purpose of creating a sense of comfort. Therefore, the interviews were conducted at the respective offices of the selected companies.

Saunders, Lewis & Thornhill (2009) outline some disadvantages of audio recordings, such as the possibility of a technical problem, the possibility of negatively affecting the respondents' answers (because of knowing they are being recorded), and the time required to transcribe the interview. In addition, in the particular case of this study, some of the interviews had to take place in an environment where additional employees were located and would occasionally conduct short dialogues, which would have appeared on the recording, should such one have been conducted. These would not only have been irrelevant to the research but also would have constituted a privacy issue. Mainly for these reasons, audio recordings were not conducted. Instead, notes were taken with the help of a computer device. Due to the typing speed of the note-taker, all answers were possible to be recorded in detail. It was also considered of utmost importance to not only take notes but also to pay close attention to the respondent, to actively engage in the interview, to aim at discovering patterns, and to further ask for clarifications where such were needed or a topic needed to be explored in more depth.

The respondents were selected from companies currently reusing open data. For various reasons, such as the novelty of open data and the small size of some companies, the respondents occupied different positions. Especially in new start-ups with less than 5 employees, there existed no employees solely dedicated to open data. Therefore, respondents were not selected by their position, but rather based on the following criteria:

- The respondent occupies a high position in the company (having various meanings among the various company structure);
- He/She is involved in the daily operations related to the re-use of open data;
- He/She is familiar with the company's strategy in general and as related to open data, e.g. strategic open data plans, benefits for the company from the open data reuse, strategic development of the company and future plans etc.

A full list of the interviewees can be found in Appendix A.

The interviews were roughly oriented around 30 pre-defined questions. However, according to the specifics of each interview, in every case some questions were omitted while others were added or emerged during the interview itself, as recommended by Saunders, Lewis & Thornhill (2009). All interviews were conducted in English and lasted between 60 and 90 minutes. The interviews were divided into two parts, whereas each of the respondents was given the opportunity to participate in the two parts on the same or separate dates. The first part focused on the current reuse of open data in their operations, while the second part was related to the challenges companies face and the future of open data on the German market.

Stage 4: Data collection through the Snowball technique: By using the snowball technique researchers can identify cases relevant to the study which are not possible to discover otherwise. The technique is especially suitable when participants are part of the same social network (Hennink, Hutter & Bailey, 2011). This is the case in the current study, where companies do not always mention on their websites or in other secondary sources that they are active in the reuse of open data. Also, this information is often neither known by the publishers of open data (who are in most cases unaware of who is using their data), nor by analysts (to whom this information remains hidden unless the companies reveal it). Open data related companies, however, tend to have strong bonds between each other and to participate in the same networks, due to the fact that this brings mutual benefits for both sides. For this reason, the snowball technique was considered to be particularly useful for this research.

The process of the snowball is described by Hennink, Hutter & Bailey (2011, p. 100) as:

> … *asking a study participant or a key informant whether they know anyone else in the community who meets the study criteria, and asking them to refer this person to the researcher; then, after interviewing the referred person, asking them whether they also know others in the community with the specific criteria, and so on.*

Thus, interviewees were asked if they were aware of other companies involved in the reuse of open data. In almost all cases, such companies were immediately named. In most cases, these were already included in the research. However, in other cases the technique proved useful for identifying new respondents. A result of particular importance was a list of 200 companies, provided by one of the respondents, "Implisense". The list was generated through the company-developed data analysis software and was used in this research.

After identifying the companies, each was "screened for eligibility for the study", as recommended by Hennink, Hutter & Bailey (2011, p.101). In cases where the companies complied with the study requirements, they were included in the population. For these, the process started again from Stage 2 – collection of data through initial secondary sources, request for an interview, possible interview, analysis of additional in-depth secondary sources, and again questions to identify further companies if such are known.

After collection, the data needed to be analyzed, for which the case study approach, described in the next sub-chapter, was selected.

3.4. DATA ANALYSIS

3.4.1. DEFINITION OF CASE-STUDY-BASED RESEARCH

Case studies are defined as: "an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence is used" (Yin, 1989, p.23). In other words, the researcher looks into a small number of entities in their natural environment and context (Johnston, Leach & Liu, 1999; Gibbert, Ruigrok & Wicki, 2008; Mora et. al. 2012) and uses multiple sources of evidence to study the complex interaction of multiple variables (Easton, 2010; Eisenhardt, 1989). This results in the description of so-called "case studies" used to draw conclusions for the selected topic.

3.4.2. REASONING BEHIND THE SELECTION OF A CASE STUDY STRATEGY

Case studies are often recommended for studying questions of "how", for explorative studies and for topics on which academic literature is scarce. They are highly appropriate in the early stages of management research Gibbert, Ruigrok & Wicki (2008), which applies to open data business models. In addition, they are claimed to be a source of "ground-breaking insights" (Gibbert, Ruigrok & Wicki, 2008, p.1465) for the strategic management field, and are considered to be "likely to produce theory that is accurate, interesting, and testable" (Eisenhardt & Graebner, 2007, p.25-26). Unlike any other approach, they enable the researcher to go beyond studying variables in an isolated environment, and allow for the exploration of the dynamic context in which organizations live and thrive. Thus, they often produce results that cannot be discovered by other means. Lastly, the narrative way of description allows the reader to fully immerse in the story, making it not only a valuable contribution to academic literature, but also an interesting read.

3.4.3. SINGLE VERSUS MULTIPLE CASE STUDIES

Yin (1989) describes that the study of a single case is more appropriate when the case is revelatory, critical, extreme or unique. However, this study aims to investigate various opportunities for the reuse of open data by businesses - both typical and non-typical. Also, Verschuren (2003) notes that single cases present considerable challenges for the researcher, such as the difficulty of creating a detailed analytical case, while also drawing generalizable conclusions from it. In contrast, using multiple cases enables the researcher to investigate if the findings of one case study are confirmed by the results of others (Saunders, Lewis & Thornhill, 2009), thus increasing the results' generalizability. Multiple cases are also most common practice in academic research (Benbasat, 1987). Therefore, a multiple case study approach was selected.

3.4.4. CASE STUDIES FORMULATION PROCESS

The inductive case study approach provides the researcher with a high degree of freedom in regards to the process of cases' formulation and analysis. It allows the researcher to adapt the study to the unique characteristics of the case at hand and to choose the most suitable structure for answering the predefined research question(s). In fact, it even allows for shifts in the research question during the research (Eisenhardt, 1989), for changes in the data collection methods (Benbasat, 1987), and does not require that the variables are specified in advance (Benbasat, 1987). Therefore, it can be regarded as a constant ongoing process of data collection, analysis and reformulation of emerging theory. In this study, the foundational theory of Eisenhardt (1989) in regards to building theory from case studies was used as a guideline for shaping the structure of the research. Short definitions of the process together with chapters relevant to each phase are presented below:

Figure 5: Case study process depiction

Phase 1: Getting Started	Phase 2: Selecting Cases	Phase 3: Crafting Instruments and Protocols	Phase 4: Entering the Field	Phase 5: Analyzing Data	Phase 6: Shaping Hypotheses	Phase 7: Enfolding Literature	Phase 8: Reaching Closure
Chapters 1, 2 & 3.1	Chapter 3.2	Chapter 3.3	Chapter 3.3	Chapter 4	Chapters 5.1 - 5.7	Chapter 5.8	Chapter 6
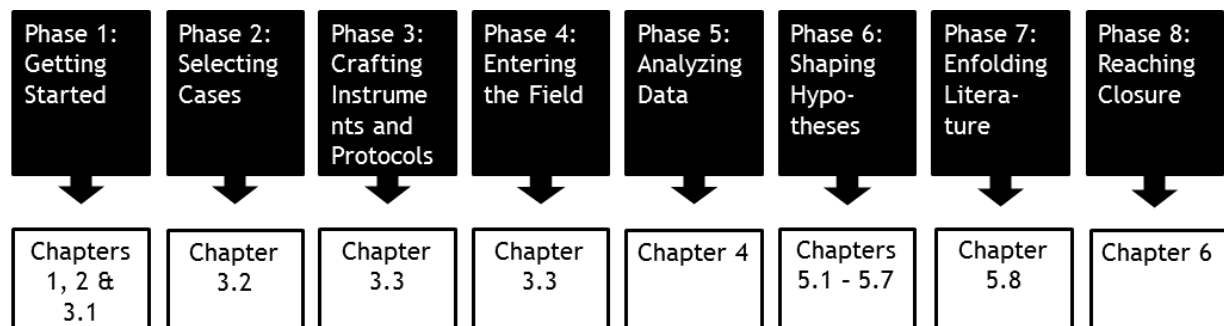
Phase 1: Getting Started: In this stage, the research question and sub-questions are formulated and the initial design of the research is shaped (Eisenhardt, 1989). During this initial stage, the broad topic of open data was selected and literature was reviewed in order to gain insights into the importance and potential of open data, the existing knowledge in the field and the current gap in theory. As a result, the central research question and sub-questions were formulated, and inductive, explorative, qualitative case study-based research was selected for investigating the questions. Academic literature dealing with similar studies was reviewed, as to lay the foundation for the research.

Phase 2: Selecting Cases: Here, the population is identified and the cases selected (Eisenhardt, 1989). For the current research, the population consists of 31 private German companies, currently active in the commercial reuse of open data (described in §3.2).

Phase 3: Crafting Instruments & Protocols: In this stage, the data collection techniques are decided upon (Eisenhardt, 1989). Taking into consideration the need for ensuring construct validity (described in detail in §3.5), various data collection techniques were

selected, including the review of secondary sources, semi-structured interviews and obtaining information through the Snowball technique (described in detail in §3.3).

Phase 4: Entering the Field: This stage encompasses the often overlapping data collection and data analysis processes (Eisenhardt, 1989). Here, the collection of data was initiated and completed. During the process, data began to be distributed into categories, patterns began to emerge and initial theory began to shape. Each category and theory was reshaped according to new evidence. New categories were selected for emerging data that did not fit into the already developed structures. The data collection process is described in §3.3.

Phase 5: Analyzing Data: During this phase the researcher looks first within every single case and then among the different cases, searching for patterns (Eisenhardt, 1989). Similar to the case of all other qualitative studies there is "no standardized procedure for analyzing such data" (Saunders, Lewis & Thornhill, 2009). In the current study, the *Data Display & Analysis* approach, developed by Miles & Huberman (1994) was used. The process consists of roughly three stages – 1) data reduction, 2) data display, and 3) drawing and verifying conclusions. In the beginning, the most relevant data for each case study was selected. The information gathered from the various data collection methods was unified, summarized and reduced, so as to clearly and briefly answer each of the research sub-questions for each case. For instance, for the research sub-question dealing with the value proposition of a firm, the data for each company was summarized into one to two clear sentences, conveying the main message. Then, the so reduced data was added into a table, where each row presented a specific company and each column referred to the specifics of one of the research sub-questions. The table had the following form:

Figure 6: Template for data display and analysis

COMP. CHARACTERISTICS / VAL. MAN.		VALUE PROPOSITION		VALUE ADDING PROCESS		NETWORK		...
Name	Company Details	Products/Services	Channel	Activities	Resources	Partners	Cust.	...
1 365 Farm Net	HQ: Berlin Legal structure: GmbH Founding year: 2013 Employee count: >50 Web: 365farmnet.com	Web-based agricultural software integrating various solutions for farming management.	Website	Data collection Data consolidation Data integration into the solution Additional functionalities	**Open Data:** Environmental, Geospatial **Open Data Sources:** **Other Sources:** Data from partners	Businesses Non-profit organizations	B2B	...
2 3D Content Logistics	HQ: Potsdam Legal structure: GmbH Founding year: 2012 Employee count: <10 Web: 3dcontentlogistics.com	Software solutions for the integration, visualization and use of complex 3D content.	Website iTunes, Google Play, Blackberry App World	Data collection Data consolidation Data visualization 3D Modelling Data integration into various solutions Data analysis Development of additional functionalities	**Open Data:** Geospatial, Demographic **Open Data Sources:** Municipalities **Other Sources:** Various	Businesses Universities Research Institutes	B2B B2C	...
3 Appstretto	HQ: Berlin Legal structure: UG Founding year: 2013 Employee count: 4 Web: appstretto.com	Apps and other software solutions for various purposes. Open data related: Information portal for German politics data.	Website	Data collection Data visualization Data integration into the website and other software solutions	**Open Data:** Elections & Politics data **Open Data Sources:** Government **Other Sources:** Various	Businesses	B2C B2B	...
...	...	...	...	...	...	...	...	...

This represented the "data display" part of the process, described by Miles & Huberman (1994), during which the researcher visualizes the main results into a matrix, giving more clarity and providing comparability of the results. The information was initially entered into the table horizontally – each case was studied, in order to answer each of the research sub-questions. Simultaneously, the data began gain a clear structure, as categories were continuously developed and assigned, in order to describe various business model elements. For example, data related to public transport, routes, timetables and such was called "Transport data". First, the specific cases were looked into, after which they were compared, in order to discover matching patterns across studies. The process was on-going, categories were constantly being added, deleted, changed or reshaped into sub-categories with the collection of new data and comparison of cross-case data. Miles & Huberman's (1994) final stage, "drawing and verifying conclusions" relates to Eisenhardt's (1989) stages 6 & 8, and will be described there.

In addition to the data reduction and display procedures of Miles & Huberman's (1994) analytical process, one more analytical method was used, recommended by Saunders, Lewis & Thornhill (2009) – the *Narrative Analysis*. In addition to the data collected being reduced and entered into a table, a more extended version, providing more in depth insight into the cases, was provided in the form of a Case study narrative. This aimed to complement the data display by adding information that cannot appear in the table, such as reasons behind using a certain business model element, relationships between such, the opinions of managers in regards to using one or another business model elements, etc. The use of more than one analytical approach was also done, in order to ensure the internal validity of the results.

Phase 6: Shaping Hypotheses: As a result of the data analysis, the researcher shapes the new theory. An important step was to ensure that no data collected was left out but that all results were included into the final results. The results were then described in §5.

Phase 7: Enfolding Literature: Eisenhardt (1989) strongly recommends that the reached conclusions are compared to both similar and contrasting results of other researchers. By doing this, both the internal and the external validity of the results are enhanced. Despite the scarce literature on the topic, such comparison was done and provided in §5.8.

Phase 8: Reaching Closure: Finally, after taking consideration of the comparison conducted, the conclusions were synthesized and provided in short in §5.8.

3.4.5. OVERCOMING THE CHALLENGES OF THE CASE STUDY RESEARCH

As a result of its unique structure and process of theory formulation, the case study approach has been challenged in various ways by several researchers in the academic field.

The first question concerns the reasoning behind choosing an inductive study approach (Eisenhardt & Graebner, 2007). The researcher must be able to explain the reasons for the lack of existing theory and to overcome the underlying assumption that the research does not provide a valuable contribution (Eisenhardt & Graebner, 2007). In the current case, the scarce research is due to the novelty of open data and the short time period for researchers to generate theory. However, the large economic potential of open data points to the need for academic and practitioner involvement in the field and in the topic.

Another challenge presented by Eisenhardt & Graebner (2007) concerns the inability of the multiple case study approach to describe the cases in their full richness and to include all the contextual data collected. Here, the researchers stress on the importance of developing extensive summary tables and other visual aids, in order to show the depth of the conducted research Eisenhardt & Graebner (2007). Therefore, important tables have been added in B and C, providing insight into the details of the data collected.

Another issue, pointed out by Flyvbjerg (2006), is also related to the richness of the data collected in case study research. Here the challenge concerns the difficulty of summarizing all the results into a comprehensive and relatively short case study narrative, and selecting which data to include and which to leave out. In addressing this challenge, careful consideration was taken into what should be included in each case study description. Only the most relevant information was included and a word limit of 1000 was considered for the narrative of each case.

Yet another argument related to the richness of data, mentioned by Eisenhardt (1989) claims that the "intensive use of empirical evidence can yield theory which is overly complex" (p. 547). As a result, Eisenhardt (1989) argues that case study research may generate theory of remarkable richness and depth, which however lacks simplicity and comprehensiveness. To overcome this, close attention was paid to giving the research a clear structure – from the research questions framework, to the categorization of each type of the business sub-elements, to the depiction of all results in summary tables.

Nevertheless, by far the greatest concerns raised by academics when it comes to case study research are related to the results' validity, reliability and generalizability.

3.5. ENSURING RESULTS VALIDITY AND RELIABILITY

Siggelkow (2007) rightly describes the struggles of case study researchers, saying that they often feel as if "fighting an uphill battle to persuade their readers" (p. 20). For as long as case studies have been used in academic literature, concerns have been raised about the degree to which the results they provide can be trusted, and if so, if they can be generalized. Gibbert, Ruigrok & Wicki (2008) discuss four criteria for assessing the rigor of case studies in their academic paper called *"What passes as a rigorous case study?"* These include the results' construct validity, internal validity, external validity, and reliability.

Construct validity refers to the data collection phase and is described by Gibbert, Ruigrok & Wicki (2008) as related to "the extent to which a study investigates what it claims to investigate" or in other words "the extent to which a procedure leads to an accurate observation of reality" (p.1466). One of the means they mention for increasing the construct validity of a case study research is the use of various collection techniques and sources of data, also called "triangulation". This is also supported by Benbasat (1987) who discusses the advantages of using multiple data collection methods, namely to provide a greater support to the generated conclusions. Triangulation is indeed also mentioned by Johnston, Leach & Liu (1999) as one of the main strengths of case study research, as such research by definition uses several sources of data. To ensure the construct validity of the results of the current study, various data collection techniques (desk research and interviews) and various sources of data (documentations, management reports, corporate websites, data from interviews etc.) were used.

Internal validity is related to the data analysis phase and deals with the issue of whether or not "the researcher provides a plausible causal argument, logical reasoning that is powerful and compelling enough to defend the research conclusions" Gibbert, Ruigrok & Wicki, 2008, p.1466). In order to ensure internal validity, researchers are recommended to develop a clear research framework and to use theory triangulation. In this case, triangulation is used by examining the results from various points of view and taking contrasting explanations of the results into consideration. Therefore, in the current research, emphasize was put into generating a clearly structured and meaningful research framework before any data collection steps were taken (explained in §2.6). Moreover, in the end stages results were carefully examined and contrasting explanations were taken into consideration, as well as compared to existing literature. In several cases the theory was reshaped after the collection of additional evidence.

External validity deals with the generalizability of the results, or in other words the ability of the results to be applied in cases and settings other than the ones explicitly studied in

the research at hand (Gibbert, Ruigrok & Wicki, 2008). It is also by far the most often discussed challenge in relation to case study research. For example, Eisenhardt (1989) argues that case studies can lead to "narrow and idiosyncratic theory" (p. 547). Nevertheless, there is a way to increase the external validity of case study research and this is by using a multiple case study approach, which was also applied in the current study. The multiple case studies are argued to enable comparisons in order to investigate whether the results are also replicated in several cases (Eisenhardt, 1991) and thus are claimed to enhance the ability for theory building (Yin, 1994). If the results are found to be valid in several cases and studies, the researcher can have more confidence in the findings and they can be considered as "very robust" (Yin, 1994, p.34). This raises the question of how many case studies need to be included, in order to enhance the external validity of the results. Eisenhardt (1989) argues that while there is no ideal number of cases, it is recommendable to use between 4 and 10. In the current research, a multiple case study approach was used and 7 cases were thoroughly examined. In addition, data was collected for all the cases in the population and secondary sources were used to investigate the business model of each. In doing this, the external validity of the results was ensured.

Finally, reliability is concerned with ensuring that subsequent researchers would come to the same conclusions, should they conduct the same study and follow the same steps (Denzin & Lincoln, 1994). To enhance reliability, Benbasat (1987) recommends that data is documented as soon as possible after collection. This ensures that details will be fully and correctly recorded, rather than being left to the memory of the researcher. In the current case, up to 80% of the interviews were transcribed during the interviews themselves, while the rest was added as soon as possible (typically up to 48 hours after). Gibbert, Ruigrok & Wicki (2008) also recommend an emphasis is put on the clear description and careful documentation of the research procedures. Therefore, close attention was paid to describing the methodology of this research in detail (§3.2, §3.3, §3.4.4).

4. DATA ANALYSIS

4.1. INITIAL DESK RESEARCH

As described in §3.3., the initial desk research set the foundation for further analysis. The knowledge gained during this phase was used for conducting relevant in-depth interviews. It also served as basis for deeper research related to the selected case studies. During and after the data collection, the data was categorized, in order to identify emerging patterns and themes. This helped to get a broad overview of the used business models and their elements, as presented in this chapter.

Company Characteristics & Value Management: The majority of German companies currently involved in open data reuse are start-ups and relatively small companies founded after 2010, with up to 20 employees. Most of the companies are based in Berlin, which is the start-up capital in the country. Detailed results can be seen in Appendix B1. When it comes to the value management element of the 6V framework, commonly used structures are GmbH, GbR and UG. The characteristics of these structures and reasons for choosing them are described in Chapter 5.6.

Value Proposition: The products and services developed based on the open data are highly heterogeneous and applicable in various fields, such as transport, environment, leisure, etc. Three major categories were derived from the results: Value-adding software solutions, Value-adding services, and Value-adding products. Each of them is further divided into sub-categories, explained in detail in Chapter 5.1.1. While some companies have specialized in the development of one main product, for many others open data is incorporated into the whole product portfolio. The data collected is described in more detail in Appendix B2.1.

In contrast to the high heterogeneity observed among the products and services, distribution channels used by companies are rather homogenous. In most cases, the companies use their corporate website as their main distribution channel, where they also publish detailed information on the product characteristics, the various pricing plans and other specifics of the business. Direct sales are also very often used, particularly with B2B and B2G clients, for whom the products need to be customized to the specifics of the customer. In these cases, the personal contact offered by the direct sales approach plays a crucial role. Lastly, for companies developing mobile applications, App stores are used to distribute the product. Examples include Google Play, Windows Phone store and Apple App Store. Details on the data collected can be found in Appendix B2.2. A more detailed description and analysis of the distribution channels is located in Chapter 5.1.2.

Value Adding Process: The value adding process is highly complex and can be divided into nine distinctive categories: data sources identification, data collection, data filtering, data processing, data consolidation, data storage, data integration into the solution, product specific activities, and data storage. The detailed data collected is presented in Appendix B3.1. In addition, Appendix B3.2 shows the types of open data used by firms.

Value Network: The character of the open data industry necessitates the cooperation of public institutions and private businesses, leading to mutual benefits and growth in the well-being of society. Broad cooperation networks increase the usefulness of the open data for all partners and lead to the publishing of more data, the generation of new solutions, and the development of deeper know-how. On the one hand, research institutes and universities conduct valuable research; on the other hand, organizations and investors provide funding. In this way, all contribute to the involvement of more companies into the reuse of open data. But apart from being partners, all entities are often in the same time customers and/or suppliers. Governments and municipalities publishing open data can benefit from the products and services developed by businesses and thus can become customers as well. At the same time, companies using open data from other sources tend to give back to society by publishing their own open data and becoming a supplier. All these complex relationships create a unique and inseparable network of interconnected partners. Detailed data collected is described in Appendix B4.

Value in Return: As a result of the companies' efforts (successful value management, compelling value proposition and a well-designed value network) they create value in return that customers are willing to pay for, despite the fact that the raw open data can be obtained free of charge. Such value includes: ease of access to data that could otherwise be difficult to obtain, convenience of using the data at any time and place, understandability to non-the users, and adaptation of the data to the customers' needs. However, most companies go beyond these rather simplified solutions and add unique new functionalities to the data. And in some cases, the open data ends up being just a small fraction of the final product. The detailed data collected is presented in Appendix B5.

Value Capture: The pricing plans used by the various companies are heterogeneous and depend on the specifics of the product or service offered and on the company characteristics. An emerging pattern shows that companies rarely offer a standardized price, and typically use more than one pricing options for their products. In this way, businesses are attentive to the specific needs of their customers. Some companies also finance themselves through sponsorships, donations, and other funding. The data collected is presented in Appendix B6.

4.2. CASE STUDIES

The following chapter is the result of the conducted in-depth analysis of each of the seven selected companies and presents detailed information on the ways in which the firms integrate open data into their business models. For each company, a graph depicting the model is presented, as well as a description of each of the elements of the business model, together constituting a case study for each of the companies. The case studies enrich the data collected through the desk research by providing an opportunity to study the business models in more detail and to understand better the contextual data of the studies, as well as to gain insight into data not obtainable through secondary sources.

4.2.1. THE CASE OF "IMPLISENSE GMBH"

The business model of Implisense can be depicted as follows:

Figure 7: The business model of Implisense GmbH
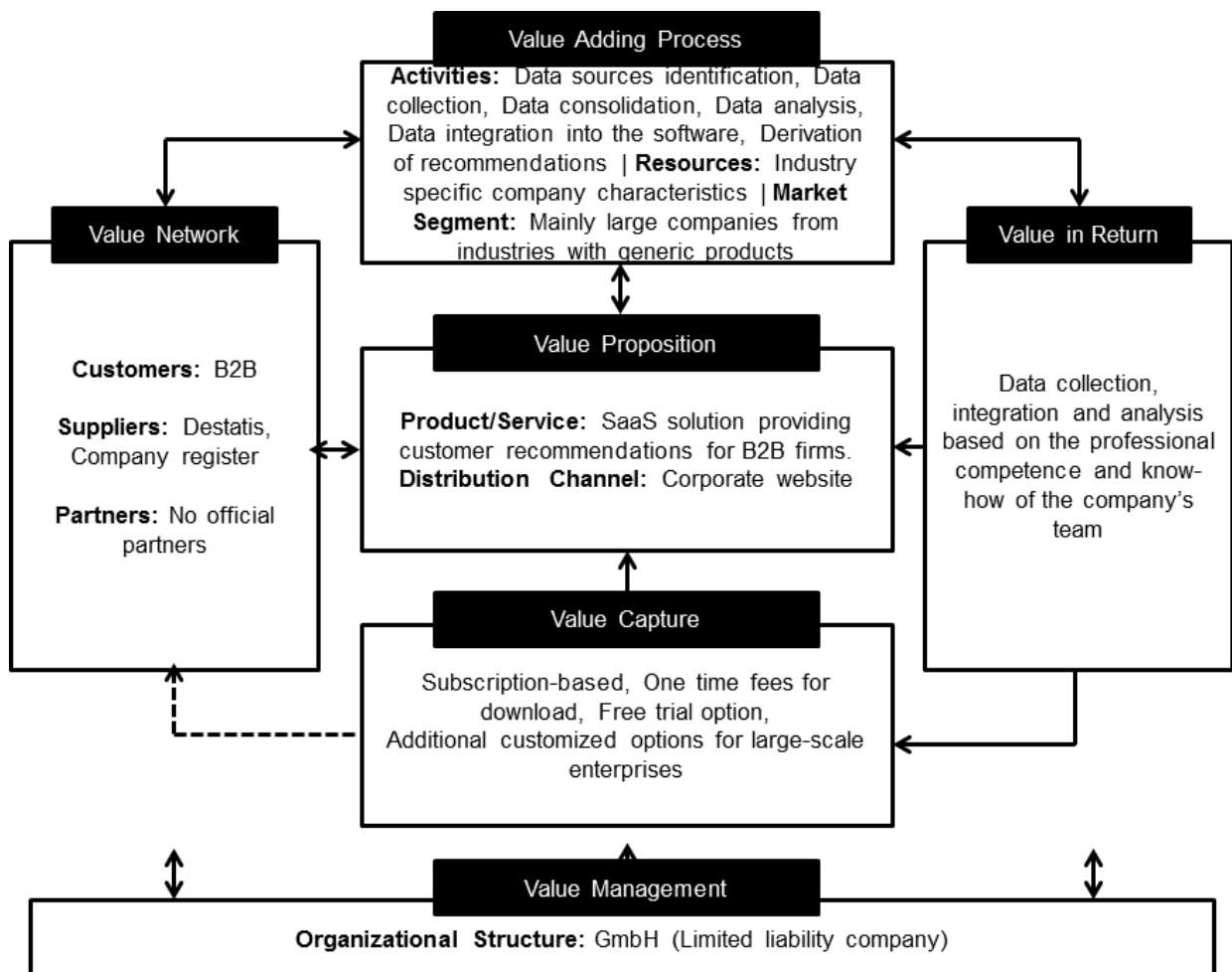
Source: Own depiction

Company Characteristics & Structure: Implisense GmbH is a Berlin-based company established in 2013. It currently has 8 full time workers. The three founders, at that time involved with Fraunhofer, came up with the initial idea during their work at the institute.

Product/Service: Implisense offers a Software-as-a-Service solution that provides their business customers with recommendations for new B2B clients. Based on rigorous data analysis of sample customers provided by the company, Implisense generates lists of companies similar to the initial selection, and thus identifies new potential clients. The recommendations can then be filtered (e.g. by industry or company size), ranked or processed further by the customer. In addition, Implisense offers a set of already created lists of companies, unified by a certain criteria, e.g. a list of start-ups in a given city or firms in a specific industry.

The importance of open data for the business: Open data is a crucial part of all of the products of the company. For Implisense, it is important that open data accelerates the development process. According to Mr. Pankratov, data scientist at Implisense, "Months are typically needed to find and integrate data into the processes and products of the company. But with open data this process can be significantly speeded up." This in turn increases the value of the product to the customers and therefore the readiness to buy.

Open data resources & Suppliers: The main source of open data is the industry data provided by "Destatis" – the official statistical office in Germany. The data includes industry specific company characteristics such as revenues, employee counts, company counts, etc.

Other data resources: Implisense uses a variety of other sources of public data, such as the Company register, corporate websites, job adds, news, and others. According to Mr. Pankratov, corporate website data and open data are most important to the company.

Main Activities: The process starts with identifying sources of the data and finding data that complies with the system standards. In the process, Implisense gathers and uses information on companies from various sources, combines and analyzes it, and derives a list of similar companies to the ones in the initial list provided by the customer. In order to identify similarities among firms, the software uses industry indicators such as average number of employees, average revenues etc. By analyzing the common features of the companies on a given list, Implisense creates a profile and searches for additional companies with similar characteristics. For the business, text analysis is key – the company uses features of companies found in the textual body of featured websites. Once the

analysis is completed, the data is converted into a machine readable format and provided to the client in an accessible way.

Partners: Implisense has no official partners.

Value added to the raw data: The main value added is the professional competence provided by the company's team. Analyzing each of the companies is a highly sophisticated process. Using the services of a provider that is professionally experienced in the task is one of the main reasons why customers are willing to pay for the final product.

Customers: The product is aimed at B2B customers.

Market Segment: Customers include rather big German companies, with sufficient funds to carry out a large project, typically coming from industries with generic products (e.g. telecommunication, banking). Customers would typically have a standardized product that they offer to many companies or a product with a very specific feature (e.g. video conference systems). Nevertheless, the company's products are directed towards various kinds of B2B customers. For example, "Implisense Pro" is offered in three variations, each of which targets a different customer group – from Freelancers and Startups, to SMEs, to large-scale enterprises.

Distribution Channel: The only distribution channel used is the website of the company.

Revenues: Implisense uses various ways for generating revenues from its products and services. The SaaS solution "Implisense Pro" is provided in three variations – Standard, Professional and Enterprise, each of which can be purchased on a monthly fee basis. The price varies according to the features included in the specific version. A 14-day free trial is possible for each of the three. The subscription base also varies – for the Standard version fees are charged per month, the Professional product is offered on a three-month-fee basis, while the conditions of the Enterprise price are negotiated on demand. Additionally, customers can purchase the already developed lists of companies for a set one-time fee. Prices vary for the different lists.

4.2.2. THE CASE OF "GREEN CITY SOLUTIONS GMBH"

The business model of GreenCitySolutions can be depicted as follows:

Figure 8: The business model of GreenCitySolutions GmbH
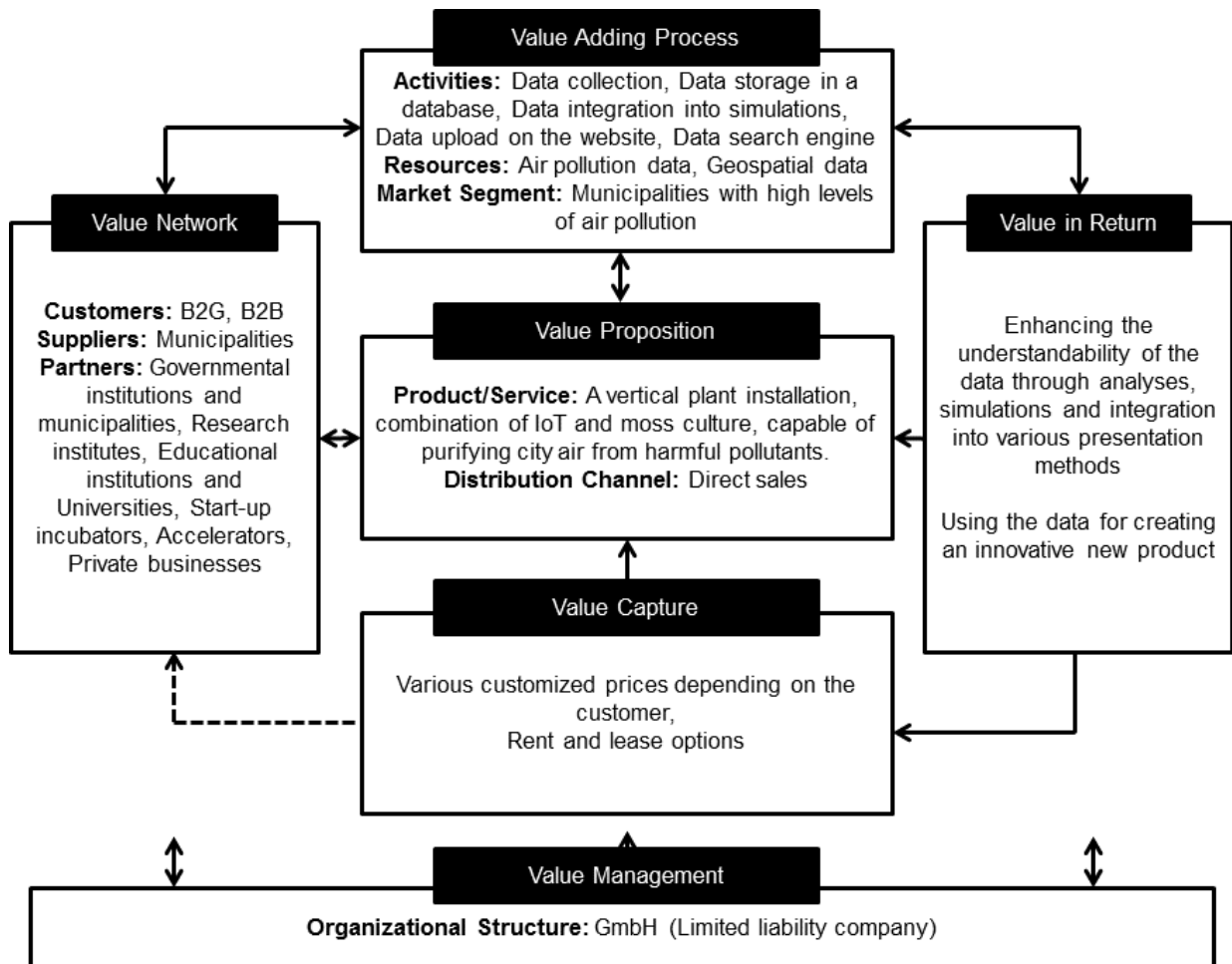
Company Characteristics & Structure: Green City Solutions GmbH was founded in April 2014 and currently has the equivalent of 10 full time employees, including the founders. The founders spent their studies together in Dresden and at a later stage discussed the idea to start a business. The specific business idea was born as one of the founders, current CEO Denes Honus, wrote his diploma thesis on sustainable city development and another, current CTO Victor Splittgerber, conducted research on vertical gardening. The legal structure of a GmbH was chosen as it offers reduced costs for small start-ups and provides limited liability. Today, the company has their headquarters in Dresden and an additional office in Berlin. It operates around the globe and their City Trees are located in various cities such as Paris, Oslo, Dresden and Hong Kong.

Product/Service: The "City Tree" represents a 4m tall vertical plant installation capable of purifying city air from harmful pollutants. It is claimed to reduce air pollution for the equivalent of 275 normal trees, by requiring 99% less space and being 95% more cost effective. To achieve this result, the solution uses a combination of Internet of things technology and a moss culture, attracting air pollution from its surroundings and converting it into its own biomass. Apart from the City Tree product, the company also serves as a consultant for cities on issues related to air pollution.

The importance of open data for the business: Open data is considered an important part of the business model by the founders, and although the business could still exist without it, in the words of CIO Liang Wu, "it would be much harder". One of the main benefits of open data has proven to be the opportunity it creates to provide citizens and prospective clients with accurate information on air pollution and to raise awareness of the issue. Open data is integrated into simulations presented to the customers when discussing the product. With this background information, customers gain a better understanding of the benefits of City Trees and their contribution to environmental protection and society's well-being. In addition, open data on environment indicators helps the company track the performance of their own product and estimate its filter capacity.

Open data resources & Suppliers: GreenCitySolutions uses open data about air pollution provided by the cities where the company operates. According to EU regulations, each city is obligated to purchase measuring stations, monitor their values and provide the information to citizens for free. The data can be found on the websites of the corresponding cities and is in some cases published on open data portals or accessible through an API. GreenCitySolutions also uses geospatial information to construct their simulations. Such data is either accessible as open data or can be obtained from the cities.

Other data resources: Apart from the open data, the company uses information collected through company-owned sensors. As opposed to the high-priced sensors used by cities to track environmental values, GreenCitySolutions develops their own sensors with a lower level of detail and precision but also for a lower cost. By simply using more sensors, they reach the same (or even higher) level of data quality. At a later stage, the company hopes to also share its own open data with the public.

Main Activities: Open data is collected through the municipalities and stored in a database that can be accessed through the homepage of the company. The "Air Care" database can be searched by anyone for free. The open data is also uploaded on the website, used in company videos and in simulations for the customers.

Partners: The company partners with research and educational institutions, such as the Technical University of Dresden and the Dresden University of Applied Sciences. The founders graduated from both universities and were able to gain insight into the type of research conducted there and to access the university knowledge base. They were also provided with working space and additional help during the initial stage of the company. In addition, the company was involved with the Climate-Kic program, a climate innovation initiative by the EU. The program helped the founders in getting entrepreneurial experience and presenting their product in front of prospective customers. GreenCitySolutions is also using the help and funding from start-up incubators, such as ODINE (European incubator for open data companies) and the Gründungsschmiede (the University of Dresden's center for company funding). The company has also taken part in acceleration programs of companies such as Microsoft, Amazon and Samsung and has received additional funding from the European Social Fund. Lastly, the government is a partner and a customer, as all of the company's operations are related to using public space. Many other partnerships are maintained.

Value added to the raw data: The data is integrated into simulations, websites and videos, visualizing it in a way that enhances its understandability. By using their professional competence, the team conducts valuable data analyses and provides clarity on the topic of air pollution.

Customers: The product is directed towards B2G and B2B customers.

Market Segment: The segment consists mainly of municipalities with higher levels of air pollution. Customers are often also private businesses using the product for purposes related to corporate social responsibility and marketing.

Distribution Channel: The company focuses on direct sales. Initially, representatives of GreenCitySolutions were the ones reaching out to prospective customers, aiming to broaden their customer base. Although this is still often the case, customers have also started to contact the company with enquiries.

Revenues: Various models apply, customized to the specific customer and project. The product can be purchased or rented. The company also plans to provide the possibility for free trials in the future.

4.2.3. THE CASE OF "MOTION INTELLIGENCE GMBH"

The business model of Motion Intelligence can be depicted as follows:

Figure 9: The business model of Motion Intelligence GmbH

Source: Own depiction

Company Characteristics & Structure: Motion Intelligence was founded in December 2013 as a GmbH. According to Henning Hollburg, founder and CIO, one of the main reasons for using this legal structure is that it is "the most common structure in Germany" and "the easiest one to establish". Another reason was the fact that it was founded by more than one person. Due to the amount of money brought in, a structure with limited liability was preferred. Currently, Motion Intelligence employs free-lance and part time workers, altogether seven. The initial idea for the company was born while the founders, at that time involved with Uni Potsdam, needed to find a flat in Berlin and explored possibilities to find a place to live in close proximity to the working place. Initially, they used OpenStreetMap data and traffic data from VBB and so developed an algorithm to analyze the data and to find recommended locations for a flat much faster than in the

conventional way. At a later stage, the data was merged with real estate data. As their solutions began to gain popularity, the founders made the decision to start a company.

Product/Service: The main product is an Application Programming Interface (API) that can be integrated into an existing platform or built as a new application serving the purposes of geographic network analysis and route planning. It provides a map with multiple functionalities, integrating data such as population number and growth in a given area, public transportation routes, or noise levels in a given location. Individual customers typically use the service to find the best place for living, working or attending school. For B2B clients, the product helps businesses to conduct travel time analysis (finding the fastest way between two locations), routing (essential for logistics and real estate professionals), or finding a location for a future venture. Motion Intelligence also assists businesses in finding a suiting concept for using the API, designing the infrastructure of the application and extending existing applications.

The importance of open data for the business: Open data has always been one of the main sources of data for the company. Even in the very beginning Motion Intelligence started using OpenStreetMap and VBB information as their initial data sources. Now, open data is part of every product or service the company offers, and it is fully integrated into the business. According to Mr. Hollburg, "It would be very different for the company to do business without open data". Some of the main concerns would be the high price that would need to be paid for purchasing commercial data.

Open data resources: One of Motion Intelligence's main resources is traffic data for streets and public transportation data. Additionally, the product also integrates demographic data (e.g. number of individuals living in a given area, population growth, age structure), noise levels data etc.

Open data suppliers: Motion Intelligence uses open data published by the government but also information published by public-private companies and public companies owned by the government. Such is the case with public transportation data offered by Verkehrsbund Berlin-Brandenburg (VBB) (the public transportation provider in Berlin) and Deutsche Bahn (the German railways). Additional traffic data is used from OpenStreetMap. For offering the product in other countries, the same kind of data is obtained from institutions and organizations abroad.

Other data resources: The open data used is combined with a variety of other non-open data. The company uses many different kinds of data, public and non-public, from various sources.

Main Activities: The first activity that needs to be conducted is finding the data. Then, the data is restructured and prepared for integration into the product. According to Mr. Hollburg, "Often the data is already standardized and can be combined without much effort". However, this step requires a lot of time and effort when the data is coming from various sources. Lastly, the data is implemented in the solution and provided to customers.

Partners: The government is one of the main partners because of providing funding for research, but it is also a customer, as the product is sold to some public agencies and institutions. Motion Intelligence also cooperates with research institutes in developing new technologies and new ways to do business. Currently, the company maintains a partnership with the Hasso-Plattner Institute in conducting a 2,5 years-long research project, funded by the government. Other German companies are part of the network of the company without maintaining a formal partnership. Lastly, a Danish company is partnering with Motion Intelligence in reselling the product.

Value added to the raw data: The data used is highly sophisticated, and in the words of Mr. Hollburg it is "practically impossible" for individuals with no background in Technology Sciences to work with it. In addition, B2B clients usually do not have the capacity and/or know-how to develop a similar solution on their own. Therefore, after collecting the data from various sources, the company visualizes it and makes it accessible through the product developed. The possibility to use it as an app is an additional benefit, as it offers additional convenience. The final product is easy to use and has a user-friendly interface.

Customers: The customer base consists of mainly B2B customers, with few B2C users.

Market Segment: The product is typically used by professionals in the real-estate, location planning, tourism and leisure, market research and media industries. A typical characteristic of the customers is innovativeness.

Distribution Channel: The product is provided exclusively through the company's website.

Revenues: For B2C customers the service is offered for free; charges solely apply for reselling the data. For B2B customers, the product is purchased on a pay-per-click basis. Various plans apply, customized to the individual customer and project. When it comes to development projects, one-time-pay and monthly-fee options exist.

4.2.4. THE CASE OF "CITY CULT GBR"

The business model of "City:Cult" can be depicted as follows:

Figure 10: The business model of CityCult GbR

Value Adding Process
Activities: Data collection, Data processing, Data integration into the app | **Resources:** Events specific data | **Market Segment:** B2C – male individuals in their 20ies or 30ies, B2B – data oriented companies lacking know-how in a certain area of using data

Value Network

Customers: B2C, B2B

Suppliers: City of Leipzig, other public unions and organizations

Partners: No official partners

Value in Return

Increased ease of access and understandability of the data due to visualization; Convenience to use the data at any time and place; Offering additional functionalities based on the data

Value Proposition

Product/Service: An app serving as an event planner for the area of Leipzig.

Distribution Channel: Google App Store, Windows Phone Store

Value Capture

B2C: Free of charge
B2B: Customized pricing plans

Value Management
Organizational Structure: GbR (Civil law partnership)

Source: Own depiction

Company Characteristics & Structure: CityCult is a Leipzig-based company, founded in 2012, currently consisting of three employees. The legal structure of the company is a GbR, a for-profit type of organization, founded by at least two partners.

Product/Service: The main product is a mobile app serving as an event planner for the area of Leipzig. It provides information on events in the city, such as concerts, movies, etc. Users can search for events nearby and use the app to create a personalized events calendar. In addition, the company offers their B2B customers a server environment that uses the same technology as the event planner. Lastly, City Cult offers assistance for companies in finding data and learning to integrate and use the data in their business.

The importance of open data for the business: CityCult started using open data after a year of its founding. It provided the business with information that was not available

beforehand. The main benefit of open data, according to Jörg Kiesewetter, co-founder of the company, is that it provides "reliable and actual information, which is not always the case with other sources". Currently, open data is incorporated into all products.

Open data resources & Suppliers: The open data used is related to events information and is mainly data published by the municipality of Leipzig on their open data portal. The company also uses open data from other public unions and organizations.

Other data resources: CityCult uses any available sources of events information accessible online, including websites, company information etc.

Main Activities: The main activities are related to gathering the information, restructuring it in a way to be used and adding it into the app.

Partners: CityCult currently has no official partners. Nevertheless, according to Mr. Kiesewetter, the company is in constant communication with various organizations and institutions in Leipzig with the purpose of gathering the data for the app and staying up to date with recent events. The city of Leipzig, providing the majority of the open data, can also be considered as an informal partner. For distribution purposes CityCult uses the services of Google ("Google Store") and Windows ("Windows Phone Store").

Value added to the raw data: The main benefit of the product is that the information is integrated from various sources and visualized. In this way, it is easily accessible and can be used on a mobile device, anywhere at any time. Should users attempt to gather the data themselves, it would require of them a lot of time. Also, as not all users are familiar with all the respective sources of events data, certain data would be omitted.

Customers: The product is directed towards B2C and B2B customers.

Market Segment: B2C customers are mainly male individuals in their 20s or 30s, searching for parties or events nearby. B2B customers are such that look for ways to use (open) data in their companies but do not yet possess the necessary know-how.

Distribution Channel: The B2C product can currently be purchased from the Google's App Store or from the Windows Phone Store. A link to both is provided on the official website of the company. Details about the B2B product can be discussed via contacting CityCult.

Revenues: For B2C customers the product is offered for free. CityCult does not obtain revenues directly from the events planner; instead the company aims to test the technology, develop it further and integrate the results to the B2B product. As of this moment, revenues are made from B2B customers, to which the technology is sold.

4.2.5. *THE CASE OF "TERRANEA UG"*

The business model of "Terranea" can be depicted as follows:

Figure 11: The business model of Terranea UG
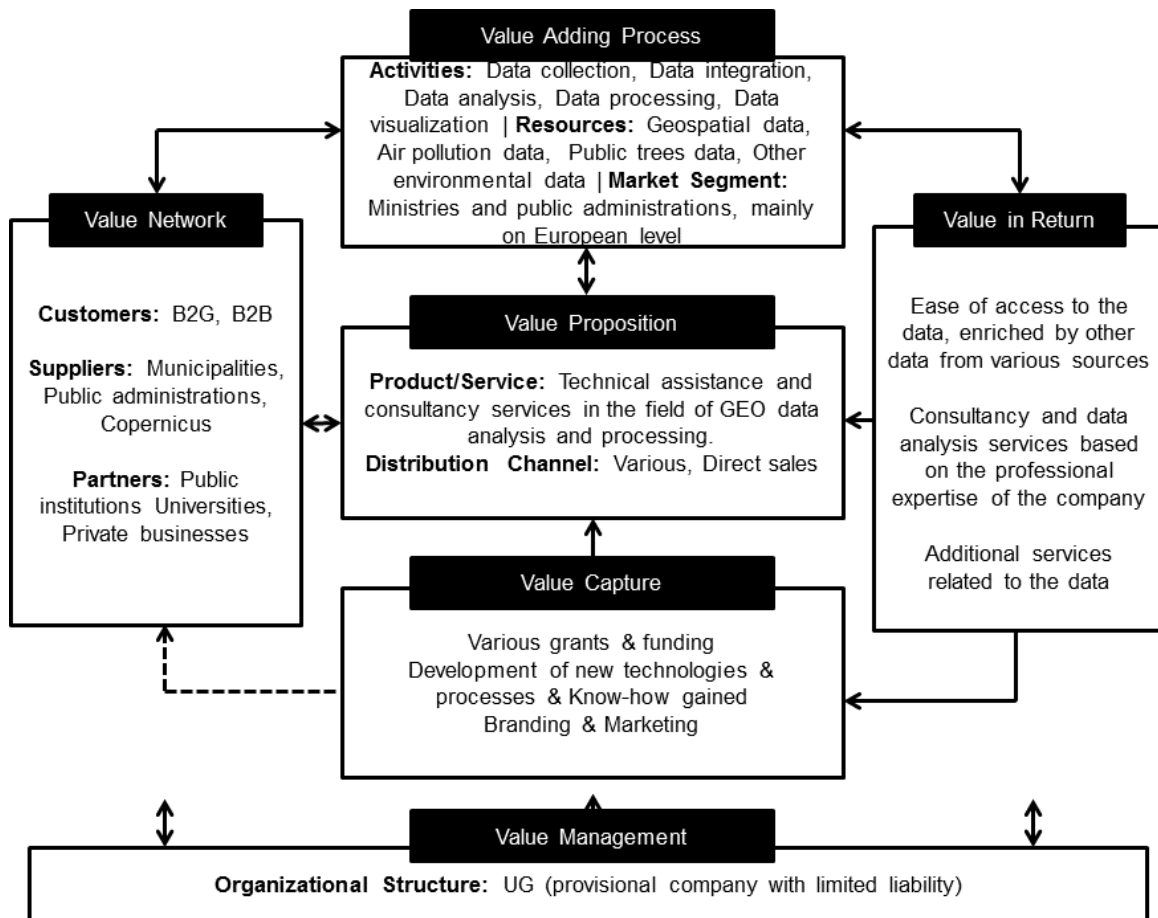
Source: Own depiction

Company characteristics & Structure: "Terranea" was founded in Bürgerstadt in 2012 and currently has 2 permanently hired employees, including the founder. Other consultants and experts also engage in activities of the company. "Terranea" was founded and still maintains the structure of an UG, due to the lower costs of founding as compared to a GmbH. However, according to founder and managing director Gunter Zeug, plans are to convert to GmbH in the future. The first project officially started in 2013, after a time of writing and development since the official founding of the company in 2012.

Product/Service: "Terranea" offers technical assistance and consulting for various global environmental and development challenges, such as the integration of spatial information within an organizational context or different topics related to technologies for the monitoring, collection, analysis and visualization of data. The focus lies in the fields of GEO data analysis and processing, in particular in relation to environmental topics, civil security and risk analysis. In 2012, the company participated in their first open-data-

related project, as part of the FP7 research program. The "Melodies" was a joint research project of 16 partnering businesses and universities, working on developing innovative services, based on open data. "Terranea"'s contribution was related to the investigation of globally available open data sources and the development of a database with reference to crisis disaster hotspots. A second open data project is the iTree, for which the company received a research grant from the European Commission. The app was developed using solely open data, and it offers information on air pollution, oxygen levels and other parameters related to the functionalities of city trees. The chief aim of the project is to raise awareness about the importance of city trees. A third project is conducted in cooperation with the European Environmental Agency, which monitors, maps and produces various environmental data in relation to the Copernicus program. As the data needs to be validated by an independent company, "Terranea" investigates the data and examines possibilities for validating it. Here the company is providing consultancy services, also as a partner in a larger consortium. Lastly, "Terranea" recently began their latest project related to open data, the iReach. This joint research program aims to develop an emergency management system through integrating various components, such as augmented reality technologies and drones. Part of the role of "Terranea" in the project is to investigate how to integrate open data into the whole system.

The importance of open data for the business: Open data has been used by "Terranea" since its founding, although it is not the focus of the company's activities. Founder and managing director Gunter Zeug describes open data as "very important" for the company. Reasons include the low costs of obtaining it, its high quality and reliability, as well as the large number of research programs offering projects related to open data.

Open data resources & Suppliers: "Terranea" obtains open data from the websites of various agencies and governmental institutions, as well as from the Copernicus website. The data is mainly environmental-related, such as air pollution and public trees, but also includes transportation and other data.

Other data resources: The company uses various sources of other data. Some of these include commercial providers, data from satellites, etc.

Main activities: The first step, identified by Mr. Zeug as "a big effort" is the collection of the data. Data is obtained not only through online searches, but also from data platforms already known to the company. Then, the collected data is used in various ways. In some cases the data is aggregated from different sources and then disaggregated to generate new insights. In the case of the iTree, the open data is inserted into a model that provides

information for parameters such as oxygen and air pollution. The parameters are then aggregated with other publicly available data from different sources, such as Wikipedia, and then put into the app. When it comes to other research projects, an important step is to find experts with the needed expertise to be included in the team. After the team is formed, a number of partnering companies cooperate in working on the project.

Partners: "Terranea" often cooperates with universities and businesses on various projects. As explained by Mr. Zeug, "In the GEO field, companies often partner with each other because the contracts are in many cases too big for just one company to do on its own. You also team up with universities and research centers." Another reason for partnerships are the various experiences and backgrounds required for completing the projects.

Value added to the raw data: The raw data is being enriched by professional analysis and by the integration of data from various sources. In some instances, the data can be visualized or further integrated into concepts and models.

Customers: The company focuses on B2G and B2B customers.

Market Segment: Main customers are public administrations and ministries. Terranea works mainly on an European level, e.g. on projects in connection with the European Commission, the European Space Agency, German institutions, and environmental agencies. There is currently no B2C market, apart from the free app.

Distribution Channel: The company applies to various joint (research) programs and works in cooperation with different other companies, also as part of consortiums and other types of partnerships. It also provides consultancy services, for which various channels are used. Lastly, information about the company's services is also available on the website.

Revenues: Monetary benefits are seldom the most important value in return received from open-data-related projects. Important for "Terranea" is the experience in working with various datasets and in developing apps. This knowledge has the potential to be implemented in other projects of the company. As for the current products and services, they are mainly provided to customers for free. However, grants and other funding are received from various sources such as research programs, the European Commission, etc. Some examples include the Horizon and the FP7 research program, which include projects focusing on open data. Other benefits important for "Terranea" are the marketing benefits received from customers of the open data products and services, and also the popularity gained through presenting the projects at various conferences.

4.2.6. THE CASE OF "MR. FRIDGE SOFTWARE"

The business model of Mr. Fridge Software can be depicted as follows:

Figure 12: The business model of Mr. Fringe Software
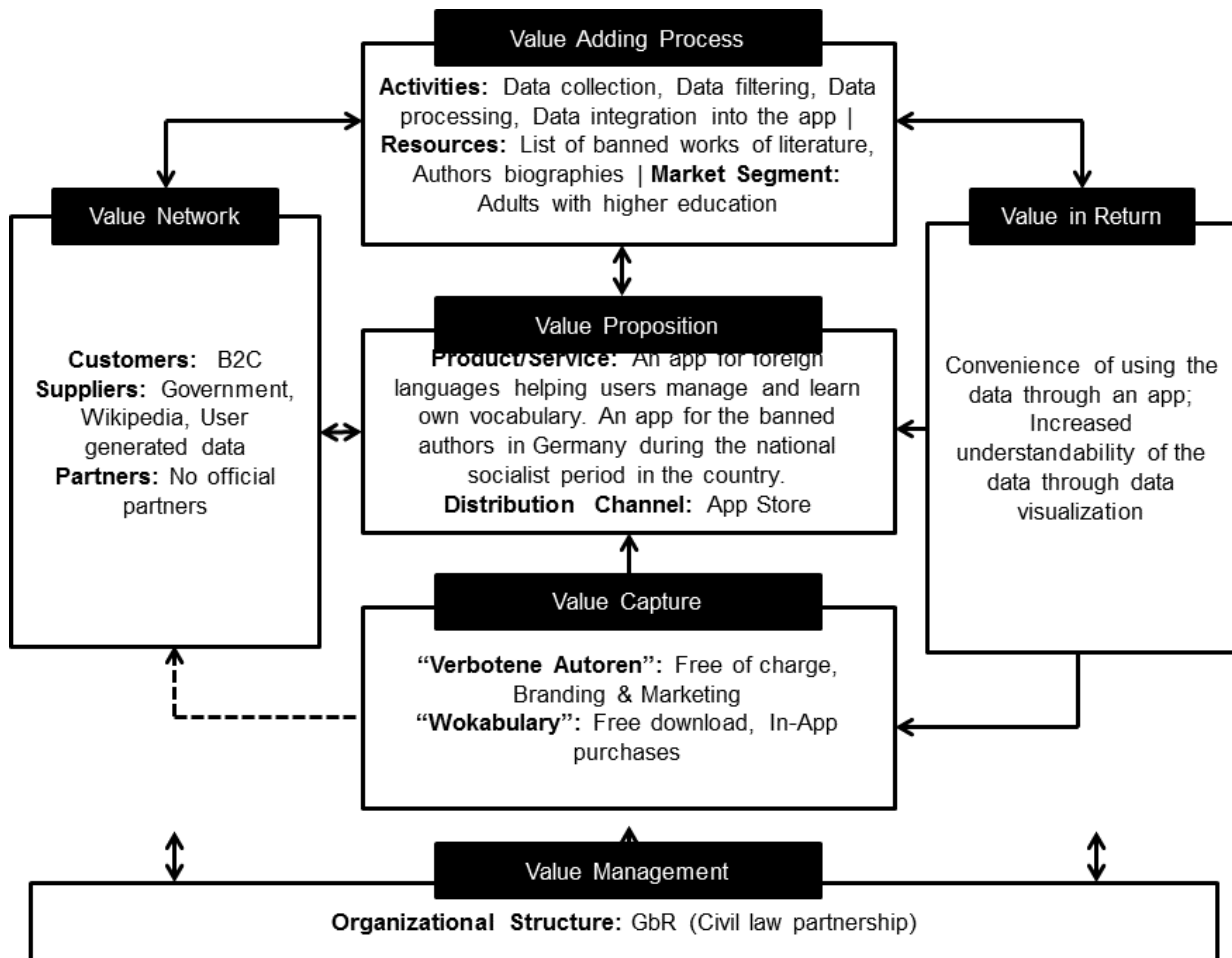
Source: Own depiction

Company Characteristics & Structure: Officially called "Gabriel Reimers, Julius Peinett & Anna Neovesky Software GbR", this Berlin-based company was founded in 2009 and employs the structure of a GbR. A team of three is involved in the firm; they have been with the company since the beginning and are equal co-founders. The idea of the company was born during their student years in Computer Sciences, when they experimented with various projects for developing their practical skills. As one of their projects started to become increasingly popular, the decision came to dedicate professionally to it.

Product/Service: The main product of the company is the "Wokabulary", an app that assists users in studying a language by helping them practice their vocabulary. Users can add new words to a list, group or filter them. The users can then search for specific words in the list or perform quizzes for practicing the language. The app provides an overview of the user's progress and visualizes the learning success. A side project where the company

uses open data is the so-called "Verbotene Authoren" app. It provides information about authors and their works, which were banned by the German state between the years 1933 and 1945. In the app, users can see the list of authors. After selecting a desired author, the app shows a short biography of the author and information about his or her works, as well as which of them were forbidden to read.

The importance of open data for the business: Open data is not currently part of the core business of the company but is being used in side projects. Nevertheless, it proves useful for the business and has been shown to have benefits compared to other data sources.

Open data resources & Suppliers: For the development of the "Verbotene Autoren" app, the company used data about authors and their works. For this, the company integrated open data published by the government with "Wikipedia" information on the biographies of authors and their works.

Other data resources: The main source of data for the company is user-generated data. In "Wokabulary" users would enter their own words and thus create personalized lists that the app uses. Currently, such data is not available as open data, and is not provided by other companies or organizations. Previous research by the company showed that the only open data available is related to endangered languages and is still very limited. One of the intentions of the company is to make their data open to the public at a later stage by offering lists of words or dictionaries. In contrast to the "Wokabulary" app, the "Verbotene Autoren" exclusively uses open data.

Main Activities: In the first stage of development, the data needs to be searched for and discovered. Next, it needs to be restructured in a way that makes it possible to add it to the application. Here, the founders identify one of the main differences between open data and other sources of data. The main difficulty in the process of integrating other data (and especially user-generated data) into the service would typically come from standardizing all the data coming from various sources and unifying it. However, with open data the process is significantly easier. According to one of the founders, Mr. Gabriel Reimers, "the data was in such a good condition that it was almost directly used." Nevertheless, it needs to be noted that the data used in the project was all accessible through one open dataset.

Partners: The company currently has no official partners. Connections are maintained with the Academy of Sciences in Berlin, but no formal cooperation has been established yet. For distribution purposes, the company uses the App Store of "Apple".

Value added to the raw data: In the case of the "Verbotene Autoren" app, the main value added lies in providing the information to the user in a way that is easier to use, as compared to the raw data. The visualized data in the form of an app is easily accessible and can be used by individuals with no background in Computer Science or other technical education. The founders describe the main benefit of the product as simply "convenience" and creating the possibility for the user to make everything possible with "just one click".

Customers: The products are directed towards B2C customers.

Market Segment: For "Wokabulary", the market segment consists of what the company calls "language enthusiasts". They are adults in the process of learning a third, fourth or fifth language, experienced in the process of obtaining knowledge about a new vocabulary. They would typically have high education and would be interested in culture and languages. As for the "Verbotene Autoren" app, the market segment is not yet clearly defined.

Distribution Channel: A link on the website leads to the Apple's App Store, where both apps are available.

Revenues: The "Verbotene Autoren" app is provided entirely free of charge. By popularizing the app, the company benefits from the customers it attracts for the other products. Therefore, the main driver for developing the app is for marketing purposes.

4.2.7. THE CASE OF "MUNDRAUB GUG"

The business model of Mundraub was described as follows:

Figure 13: The business model of Mundraub gUG
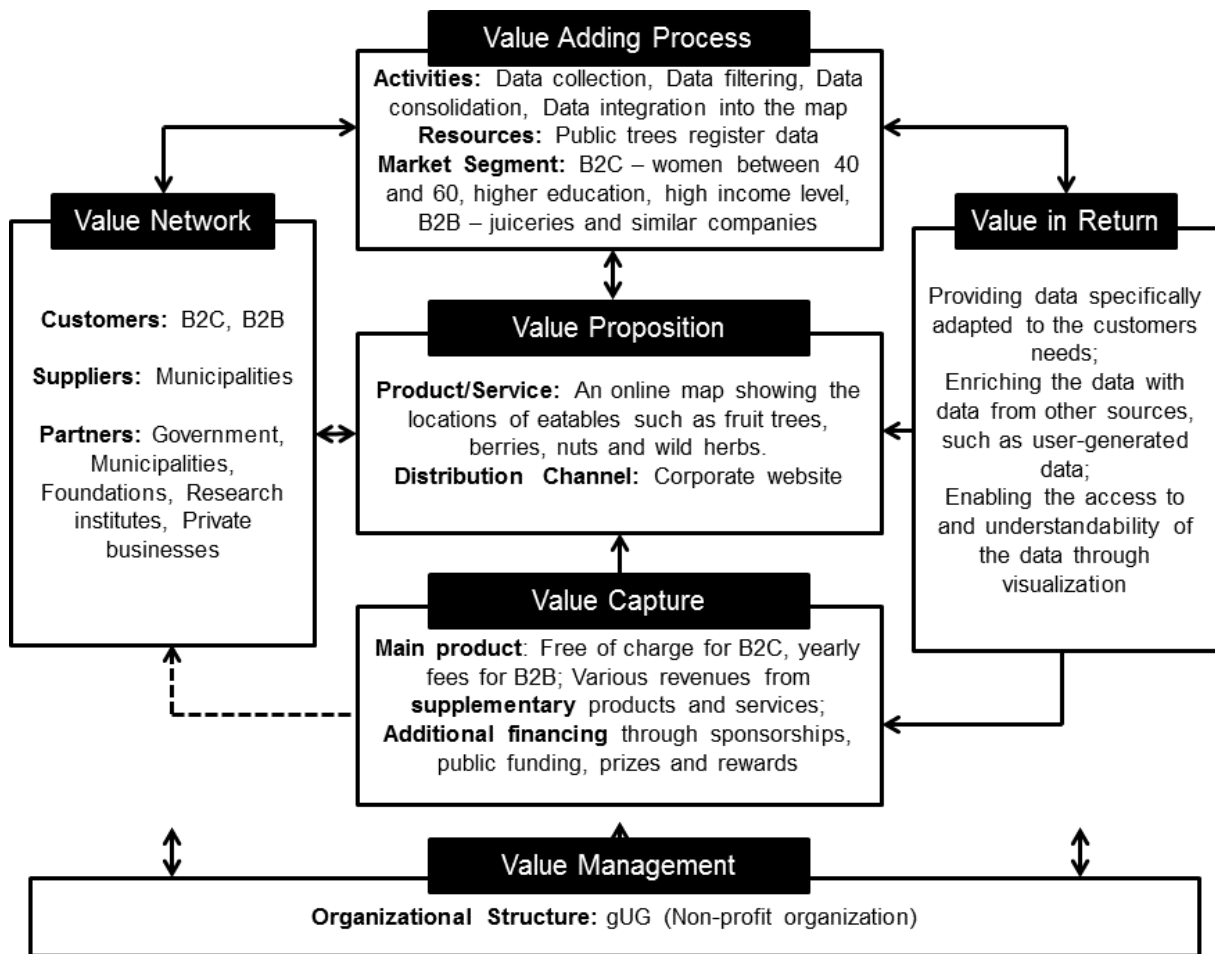
Source: Own depiction

Company Characteristics & Structure: The company was founded in 2009 as a gUG (a German type of a non-profit organization). Apart from the founder, Mundraub currently has 3,5 additional employees. Although the company is known to most of its users as mundraub.com, the legal entity was founded under the name of "Terra Concordia gUG". The latter name is used by the company mainly for representation before municipalities and business partners.

Product/Service: Mundraub develops and provides an online map with the locations of eatables such as fruit trees, berries, nuts or wild herbs that are freely available in public spaces or on private land (subject to the owner's permission). On the map, users can search for trees and other eatables in their region, add data to the map or comment on various related topics. The information from the map is mainly used by private individuals

to harvest small quantities of eatables and use them for private purposes. The website has thousands of active members and millions of hits per year and has developed an online community, where users can comment on locations and discuss environmental issues.

The importance of open data for the business: Open data was not used by the business in the initial stages of the project. In the beginning, information was gathered through circles of friends and was published on Google Maps. In the second year it was discovered that data was often also added to the map from individuals outside the initial friends' circles. Aiming to be independent from Google, the founders made the decision to switch the platform to OpenStreetMap and the company was born. In the words of Andie Arndt, spokes representative of Mundraub, by adding public open data to the map, "the project grew immensely and attracted many more users". Now public open data is considered as a crucial source of information for the organization.

Open data resources & Suppliers: The company obtains public tree register data from the following municipalities: das Hasetal, Hansestadt Hamburg, Stadt Osnabrück, Murnau (Bodensee), Friedrichsdorf (Taunus), Stadt Dortmund, Stadt Braunschweig, Stadt Göttingen, Landesbetrieb für Straßenwesen Oranienburg, Berliner Bezirk Pankow.

Other sources of data: Users of the website and volunteers are also able to identify fruit trees and add the data to the map.

Main Activities: Some of the main activities in creating value include finding new data through research, integrating it into a map and visualizing the whole content. The initial process starts by online research for data that has not yet been incorporated into the existing map. In cases where such is not found, the research is expanded by telephone or email contact to municipalities and other public bodies, aiming at identifying any available open data that has not been found online. Once new data is discovered, an IT specialist reshapes the data in a form suitable to be applied into the map and the data is added, thus contributing to the complete product.

Partners: Research institutions and businesses are important partners and mainly support the business financially. There is one established partnership with a municipality, Berlin Pankow, but the vision is to also start other similar partnerships.

Value added to the raw data: As compared to the raw open data, Mundraub provides an overview of available fruit trees from various regions on a single map. One important benefit is the separation of fruit trees from other types of trees, which are traditionally put together in public open data registers. The data from various open data sources is

combined with additional information provided by users and volunteers. The final result is a clear visualization of all public fruit trees, which unites data from various sources, filters the data required by users and provides it in a clear manner understandable and usable by all.

Customers: The product is mainly aimed at individual users (B2C). Some businesses also benefit from the product (B2B).

Market/Segment: In the B2C sector customers are mostly women between 40 and 60, with higher education, and belonging to the higher class. They typically use the online map to search for available fruit trees, then harvest and use the outcome to create home-made products, such as cakes or dishes. In the B2B sector customers are juiceries and similar companies, willing to popularize themselves among the users of Mundraub. By acquiring the opportunity to add their name and address to the Mundraub map they make themselves known among the users of the Mundraub map.

Channel: The main distribution channel is the company's website.

Revenues: The product itself is provided for free and can be used by anyone with access to the internet. The organization is mainly funded through sponsorships, whereas some of the contributors include foundations, public bodies and private individuals. As an example, recently the company was funded by the Ministry of education. Mundraub also won the Google Impact Challenge, which provided an additional financial support. Another way of financing the business is through supplementary products and initiatives, such as "Das Mundräuber-Handbuch" (a book issued by Mundraub), bicycle tours and a one-time initiative of producing and selling apple juice. Lastly, B2B customers are charged yearly fees, in order for their name and address to appear on the Mundraub map.

5. RESEARCH RESULTS

As a result of the analysis (both the desk research and the case studies), the following business model elements have been identified to be often used in practice by German companies active in the reuse of open data. As an overview, the elements have been listed in the following table and depicted in relation to answering the research sub-questions. However, each of these elements was studied in detail, as well as in relation to its context. Therefore, detailed information on each is provided in the chapters to follow.

Table 5: Research results overview I

VALUE PROPOSITION	
RSQ1: Through what value propositions can open data reuse be integrated into the business models of German companies?	

Products & Services
• Value-adding software solutions
   o Interactive data visualization software solutions
   o Interactive 3D data visualization software solutions
   o Interactive maps & Route planners
   o Data-analysis-based software solutions
   o Data-collection software solutions
   o Other value-adding software solutions
• Other value-adding products
• Value-adding services
   o Consultancy services
   o Software integration services
   o Workshops & Trainings
   o Other value-adding services
	Distribution Channel
	• Corporate website
	• App stores
	• Direct sales

VALUE ADDING PROCESS	
RSQ2: Through what value adding processes can open data reuse be integrated into the business models of German companies?	
Activities • Data sources identification • Data collection • Data filtering • Data processing • Data consolidation • Data storage • Data integration into the solution • Product-specific activities • Data maintenance	*Resources* • Transport, Traffic & Geospatial data • Demographic data • Environmental data • Free time & Leisure related data *Market Segment*

Table 6: Research results overview II

VALUE NETWORK

RSQ3: Through what value networks can open data reuse be integrated into the business models of German companies?

Customers	*Suppliers*	*Partners*
• B2C • B2B • B2G	• Government & Municipalities • Publicly-owned entities • Public-Private companies • Non-profit organizations, Foundations & Associations • Private businesses	• Government & Municipalities • Research institutes, Universities & Educational institutions • Non-profit organizations, Foundations & Associations • Start-Up incubators & Accelerators • Private businesses

VALUE IN RETURN

RSQ4: What value in return can be created by German companies that integrate open data reuse into their business models?

- Ease of access to the data
- Convenience of using the data
- Data adaptation to customers' needs
- Increased understandability of the data
- Perceived value of data-enriching activities
- Perceived value of data-enriching products and services

VALUE CAPTURE

RSQ5: Through what value capture can open data reuse be integrated into the business models of German companies?

- **Monetary**
  - Revenues
    - Freemium pricing model
    - Varying-prices pricing model
    - Customized-prices pricing model
    - Subscription based pricing
    - Pay per download pricing
    - Pay upon receipt
  - Sponsorships, Donations, Prizes & Awards
  - Funding

- **Non-monetary**
  - Branding & Marketing
  - Technology development
  - Networking

VALUE MANAGEMENT

RSQ6: Through what value management can open data reuse be integrated into the business models of German companies?

Organizational structure
- GmbH (Limited liability company)
- UG (Provisional company with limited liability)
- GbR (Civil law partnership)

5.1. VALUE PROPOSITION

5.1.1. PRODUCTS & SERVICES

Companies can use open data to create the following three types of products and services:

Figure 14: Research results for Products & Services

Products & Services		
Value-adding software solutions	Other value-adding products	Value adding services

These can further be divided into respective sub-categories, as follows:

Value-adding software solutions

Figure 15: Products & Services in detail: Value-adding software solutions

Value-adding Software Solutions		
Interactive data visualization software solutions	Interactive 3D visualization software solutions	Interactive maps & Route planners
Data-analysis based software solutions	Data collection software solutions	Other value-adding software solutions

- *Interactive data visualization software solutions:* The data collected is integrated into (simple) software, such as an app, or an online accessible tool that presents the data in a more comprehensible form, such as a graph, a map or a picture. The data is interactive, rather than static, and customers can conduct simple functions such as searching for the data according to a keyword, connecting it with other data, receiving additional information about a point of interest, etc. Although a simple solution, the benefits for the customer are significant, as the multitude of data in raw format is otherwise nearly impossible to comprehend.

- *Interactive 3D data visualization software solutions:* Similar to the above, the data is collected and provided to the customer visualized. However, in this type of product, the emphasis lies on 3D modeling. Whereas in the above type data can be of any kind, these solutions are mostly related to urban planning and architecture.

- *Interactive maps & Route planners:* Transport and geospatial data are combined with additional information such as environmental or political data. Then, they are put together on an interactive map and provided to the customer, offering the user information about various points of interest, such as public trees (in the case of "Mundraub"). In addition, solutions belonging to this category often include navigation to certain locations, distance estimation, generation of alternative routes, etc.

- *Data-analysis-based software solutions:* Apart from being collected and enriched with additional functions, the data is also analyzed by experienced professionals. The customers benefit greatly not only by the fact that the data is collected, integrated with other data, and visualized, but also by the value added through the relevant knowledge and expertise of the company's specialists.

- *Data collection software solutions:* The open data is combined with data received from other sources and then offered to the customer in the form of an accessible database that can be searched with keywords or through browsing pre-developed categories. The benefit lies mostly in the integration of data from various sources that firstly, are not always accessible for all users, and secondly, are scattered among various platforms in their raw format.

- *Other value-adding software solutions:* Various additional software services can be developed based on the open data. In many of the cases, open data is a crucial but small part of the final product, enriched greatly by additional functions and features.

Other Value-adding products: To this category belong physical products such as the CityTree, offered by "GreenCitySolutions". Open data is used as one of many resources, the combination of which contributes to the creation of the final product.

Value-adding services

Figure 16: Products & Services in detail: Value-adding services

Value-adding Services			
Consultancy services	Software integration services	Workshops & Trainings	Other value-adding services
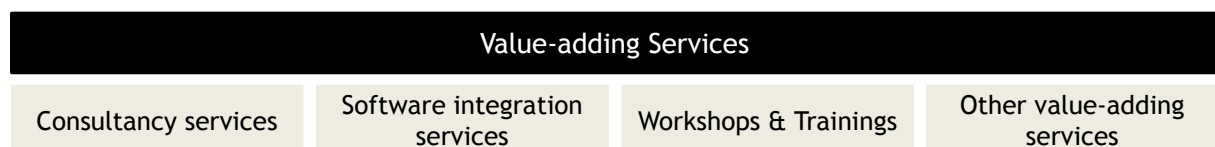
- *Consultancy services:* Experts in various fields use their knowledge and expertise to analyze open data gathered and to use it in their business, in order to enrich the services they provide. In addition, consultancy services can be offered on topics such as how to use, collect or analyze open data.

- *Software integration services:* Businesses or professionals lacking the know-how on how to integrate an open-data-based solution into the IT architecture of their company are often offered the assistance of a company with more experience in this field.

- *Workshops & Trainings:* Businesses and individuals not familiar with open data are offered the opportunity to attend seminars, workshops or trainings where they can gather information, ask questions and gain practical experience.

- *Other value-adding services:* Many additional services of various kinds are provided by companies involved in the re-use of open data.

5.1.2. DISTRIBUTION CHANNEL

The distribution channels used for the business reuse of open data are rather homogenous and have been categorized into three groups, described below.

Figure 17: Research results for Distribution channel

Distribution Channel		
Corporate website	App stores	Direct sales

Corporate website: The main distribution channel for the majority of open data products and services is the web page of the company. In using this channel businesses can benefit in multiple ways. In addition to providing the customers with an opportunity to purchase the product (or service), the corporate web page serves as their main source of information for the product, a marketing tool for the company and a place where contact options can be found. On the website, links can also be provided to additional distribution channels, such as app stores.

App stores: App stores are online or mobile platforms where apps can be purchased or downloaded for free. Some of the most popular app stores include the Apple App Store, the Microsoft App Store and Androids "Play Store". For companies that wish to visualize open data content, integrating the data into an app proves to be one of the simplest ways of doing it while at the same time providing an easy access to the data for customers. In the words of Jörg Kiesewetter, co-founder of CityCult GbR, apps "allow customers to access the information with only a few clicks" and thus prove convenient for users. Should a company engage in creating an app, app stores are the channel for distributing them.

Direct Sales: Direct sales allow companies to be attentive to the specific needs of their customers and to customize their offer according to the case at hand. This distribution channel is particularly useful for companies involved in the B2B sector where the customers' requirements towards the product and service can significantly vary. For businesses in their initial phases of development, direct sales also provide an opportunity to build customer trust in the brand and to broaden the corporate network. It is also often the first distribution channel used for B2B start-up companies that seek to conduct their initial sales.

5.2. VALUE ADDING PROCESS

5.2.1. ACTIVITIES

Through the following activities companies can integrate open data into their products and services, and therefore into their business model:

Figure 18: Research results for Activities

Activities		
1) Data sources identification	2) Data collection	3) Data filtering
4) Data processing	5) Data consolidation	6) Data storage
7) Data integration into the solution	8) Product specific activities	9) Data maintenance

Data sources identification: In the beginning of the process, companies engaging the reuse of open data need to identify sources for obtaining the data. This is often a difficult task, in Germany in particular, as data is scattered among multiple platforms, portals and websites. While discussing the future of open data for GreenCitySolutions GmbH, Liang Wu, co-founder and CIO of the company, identified the difficulty of obtaining open data as one of the main obstacles companies face when engaging in open data activities in Germany. Often, companies are able to identify the sources through an online search. In other cases, companies contact representatives of institutions responsible for the data via email, telephone or in person, in order to gain further information on how to obtain the data.

Data collection: After identifying the necessary sources of data, companies need to collect the data, in order to enable future processing. The data is downloaded and stored on computers, servers or other devices. The open data exists in multiple formats that often vary between platforms and publishing institutions, some of which include CSV, XLS and JSON. For this reason, professionals dealing with data collection need to be familiar with the various formats and their specifics. For conducting this and the subsequent activities, companies need to employ the services of (an) IT specialist(s).

Data filtering: Typically, datasets open to the public include long lists of information, not all of which are relevant to each company. Firms need to filter the data and select the information that is most useful and beneficial for fulfilling the goals of the project. For example, in the case of "Mundraub", open data registers used by the company contain information about multiple types of trees. As the firm is only interested in fruit trees, this information needs to be separated from all the other data included in the dataset. In this way, only data relevant to the business is included in the further processing.

Data processing: The data published in open datasets is often heterogeneous, provided in various formats, and has different structures and incoherent formatting. Even data with the same information type (e.g. air pollution) can be published in various ways by multiple institutions. Due to the fact that companies rarely use only one type of data, they need to edit the data and restructure it in a way to enable further processing.

Data consolidation: As already mentioned, companies use multiple sources of open data and various additional data, such as user generated content, information from websites, and corporate reports or news articles. In order for all of the data to be usable and implemented into the same product, it needs to be consolidated. In many companies' cases this integration of data from various sources into a single solution provides one of the biggest values added for the customers.

Data storage: Companies then often store the so processed and consolidated data in a database. This can also be provided to users, as in the case of "GreenCitySolutions GmbH" and their "AirCare" database displaying air pollution data to all users online free of charge.

Data integration into the solution: Finally, the data is integrated into the product or service offered. Whether the company develops an API, an interactive map, an app, a simulation, or simply uploads the data onto their website, in this final stage the data is visualized and provided to the customer. As compared to the raw data, the so integrated and visualized information is more accessible and easier to understand.

Product specific activities: Adding to the above, various additional activities are performed by companies according to the specifics of the product or service offered. For example, "CityTreeSolutions GmbH" offers consultancy services to municipalities on the topic of air pollution, incorporating information from open datasets. "Implisense" has developed an algorithm to analyze data and derive recommendations for companies. And "CityCult" offers a calendar service that offers customers a possibility to personalize their events plan. All in all, companies rarely stop at the stage of offering the simplified data to customers and develop further their products and services, building up on the open data.

Data maintenance: For many of the products and services developed it is not only the static data provided at a certain point that is relevant but also the current data with its latest updates. Therefore, depending on the product or service, companies need to regularly update the data and provide the customers with the most recent indicators.

5.2.2. RESOURCES

All kinds of open data can be used by businesses, should they find a suitable application for the data and create a sustainable business model. Nevertheless, in the following are described some of the most commonly used types of data by companies.

Figure 19: Research results for Resources

Resources			
Transport, Traffic & Geospatial data	Demographic data	Environmental data	Free time & Leisure related data

Transport, Traffic & Geospatial data: This kind of open data is by far the most commonly used by businesses. Specifically, information about public transportation routes, timetables, navigation and travelling times, as well as addresses or distances between locations are used by many of the companies. Such data is also relatively convenient to use as it is most commonly available. For companies that wish to use such open data but lack the know-how, services offered by other firms assist in developing a company-specific solution or integrating an already developed one into the architecture of the client firm.

Demographic data: Companies also reuse data such as the count of population in a given area, population growth and age, income levels etc. Such is the case, for example, of "Motion Intelligence" that integrates various kinds of demographic data into their solution.

Environmental data: "Mundraub" uses data on planted trees, "GreenCitySolutions" – air pollution data and "Motion Intelligence" – noise levels data. Many companies find applications for environmental indicators and use them in their businesses. However, on GovData.De there are over 2500 datasets published in the category "Environment & Climate", and much of it still remains unused.

Free time & Leisure related data: This is also a type of information that is often used by businesses. For example, the Berlin-based "naturtrip GmbH", with the help of open data, provides recommendations for free time activities based on their distance from a location given by the customer. And, as described in the case studies, "CityCult" and "Mr. Fringe software" use events information and literature-related data respectively.

5.2.3. MARKET SEGMENT

There is no typical market segment for customers of open data products and services. Every company needs to identify their unique target group, according to the specifics of the firm, the industry and the product or service offered.

5.3. VALUE NETWORK

5.3.1. CUSTOMERS

Open data based products and services are seldom offered to only one type of customers. Companies typically differentiate the products and develop various functionalities based on the specific needs and preferences of the targeted client.

The research results show that all three types of customer groups (B2C, B2B and B2G) benefit from open data based products.

Figure 20: Research results for Customers

Customers		
B2C	B2B	B2G

B2C: For individual customers, companies typically offer a simpler variation of the product that is not overloaded with excessive functionalities and does not slow down the overall performance of the solution. B2C products are developed to be easily accessible and the data is adopted to be understandable by individuals from various backgrounds. The product is most often standardized for the mass customer.

B2B: Businesses have much to benefit from open data based solutions, especially the ones operating in data driven industries such as IT or transportation. The majority of companies active in the reuse of open data offer their products and services also to B2B clients and in many cases exclusively to such. The solutions are often customized (in contrast to the standardized version offered to B2C customers) to the needs of the particular customer and the conditions of the sale are discussed separately from the standardized product typically offered on the website.

B2G: In some cases the products are offered to government entities. Such is the example of the "CityTree" developed by "GreenCitySolutions" that has the ability to purify the air from harmful pollutants and offers overall benefits for the society. Companies could also use their professional expertise to consult the government or municipalities, after conducting data analysis.

5.3.2. SUPPLIERS

There is a large variety of open data suppliers in the country and therefore a lot of opportunities for new companies willing to integrate open data into their businesses.

Figure 21: Research results for Suppliers

Suppliers

Government & Municipalities	Publicly-owned entities	Public-private companies

Non-profit organizations, Foundations & Associations	Private businesses
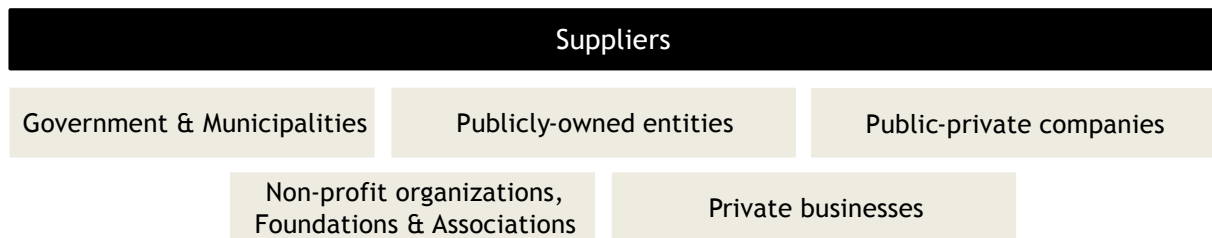
Government & Municipalities: These provide the majority of open data in the country and are in most cases the main open data supplier of open data companies. As mentioned above, the GovData.De portal alone offers more than 25 000 open datasets (GovData, 2016). Other open data portals maintained by state and local governments include:

Table 7: List of local-based data portals in Germany

Region	Link to the open data portal
City of Berlin	http://daten.berlin.de/
City of Cologne	http://www.offenedaten-koeln.de/
City of Leipzig	http://www.apileipzig.de/
City of Hamburg	http://daten.hamburg.de/
City of Rostock	http://www.opendata-hro.de/
City of Bremen	http://transparenz.bremen.de/
State of Bavaria	https://opendata.bayern.de/
State of Baden-Württemberg	https://opendata.service-bw.de/

Source: Own depiction

Publicly-owned entities: Such sources can provide very detailed and up-to date information. One example is "Destatis" - the Federal Statistical Office which collects, analyzes and publishes statistical information on a variety of topics, including country and regional statistics, economy, environment and demographics. Another open data supplier is the German Trade Register, accessible online and maintained by the municipality of Nordrhein-Westfalen (Handelsregister, 2016). The register includes detailed information on all companies registered in Germany.

Public-Private Companies: Public-private partnership-based companies are the second largest provider of open data in the country and the most commonly used by open data businesses after the government and municipalities. Some of the main publishers of open data include the Verkehrsverbund Berlin-Brandenburg GmbH (VBB), the Deutsche Bahn (DB) and Stromnetz Berlin. VBB is the public transport authority in the states of Berlin and Brandenburg and publishes various transport data, such as bus and train timetables,

locations of stations and routes information. Open transportation data is also published by the Deutsche Bahn, a German railway company currently operating in 130 countries (Deutsche Bahn, 2016). DB currently maintains its own open data portal, http://Data.DeutscheBahn.Com/, where it publishes data on locations of stations and various information related to the rail network. Currently, DB also offers three APIs, related to timetables, parking spaces and the digitalization of elevators and escalators technologies. Both the data published by VBB and DB are already in use by open data companies, such as for example Motion Intelligence that integrates them into their API solution for geographic network analysis and route planning. Lastly, Stromnetz Berlin also belongs to the public-private partnership category, due to its concession agreement for Berlin's energy grid (StromnetzBerlin, 2016). The company maintains its own open data portal (Netzdaten-Berlin.De) where information can be found on energy consumption, grid information and much more.

Non-profit organizations, Foundations & Associations: These entities collect various data with non-profit purposes and are often willing to openly share the information with the community. For example, "OpenStreetMap Foundation" is one of the most often cited sources of open data, used by a high number of companies, including "Bike Citizens", "naturtrip", "OSM Buildings", "PTV Group", "virtualitySYSTEMS". According to the foundation's website, OpenStreetMap is "dedicated to encouraging the growth, development and distribution of free geospatial data and to providing geospatial data for anyone to use and share" (OpenStreetMaps, 2016). Companies can either use the open data to integrate it into their own software solution, or they can make use of the maps developed by community members of the foundation. This is a convenient solution for companies lacking their own software. It could also be a preferred option as compared to "Google Maps", as in the case of "Mundraub". In the words of Andie Arndt, spokesperson of "Mundraub", the company used the service of Google in the beginning stages of the firm but switched to OpenStreetMap in order to gain more independence.

Private Businesses: Many of the companies reusing open data are concerned with giving back to society, and thus also publish open data. Such is the case of, for example, 3D Content Logistics, Bike Citizens and Implisense (Seibel, 2016). Other companies have plans to do so in the future. Such is the case of GreenCitySolutions, in the words of co-founder and CIO Liang Wu. The company collects a high amount of data on its own and plans to publish such for open use.

5.3.3. PARTNERS

The partnership network of open data companies typically includes the following:

Figure 22: Research results for Partners

Partners		
Government & Municipalities	Research institutes, Universities & Educational institutions	Non-profit organizations, Foundations & Associations
	Start-up incubators & Accelerators	Private businesses
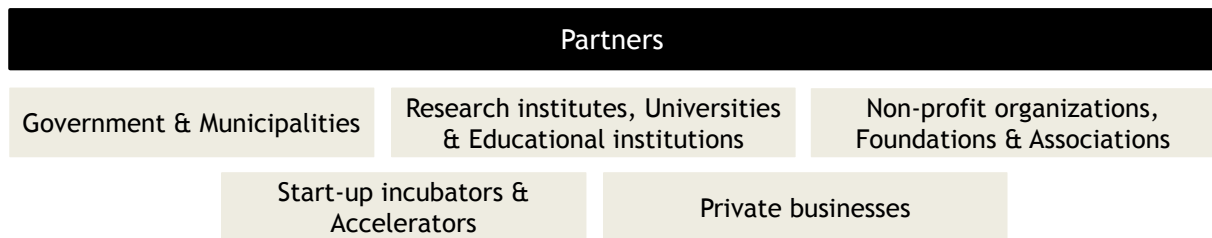
Government & Municipalities: As the government publishes the highest amount of open data in the country, almost every open data company benefits from the data and can thus be considered as partnering with the government. In addition, the government often provides funding for businesses in line of various initiatives and programs.

Research institutes, Universities & Educational institutions: Businesses often cooperate with such institutions in the research and development of new technologies and new ways to do business. Additionally, universities and other educational institutions provide companies with up-to date knowledge in areas where the companies might still be lacking know-how. Lastly, universities develop and maintain their own programs to stimulate entrepreneurial activities by offering new ventures mentoring, networking or even funding.

Non-profit organizations, Foundations & Associations: In line with their vision for increasing the well-being of communities and society as a whole, these entities are often the ones that provide financial assistance to businesses. This is especially true in cases where the vision of the open data company is aligned with the one of the institution, such as environmental protection or stimulating a healthy lifestyle.

Start-Up Incubators & Accelerators: These are of particular importance for new ventures still inexperienced in starting and managing a business. One important incubator for new open data ventures is the Open Data Incubator for Europe (ODINE), as the program is dedicated to distributing funds and supporting innovative businesses based on open data. Many other incubators and accelerators are also available in the country and abroad.

Private Businesses: The nature of the open data movement suggests cooperation among all players involved in the publishing and reuse of open data, including competitors. By building a network among all companies, businesses create synergies which cannot be exploited otherwise and lay the foundation for the smart cities of the future.

5.4. VALUE IN RETURN

The value in return describes the value-added to the raw data and the specific value for which customers pay when purchasing the company's product or service. These are illustrated in the graph below.

Figure 23: Research results for Value in return

Value in Return		
Ease of access to the data	Convenience of using the data	Data adaptation to customer needs
Increased understandability of the data	Perceived value of data-enriching activities	Perceived value of data enriching products and services

Ease of access to the data: A big disadvantage of the raw open data published online is the difficulty of obtaining it. Company representatives often pointed out during the interviews to the great challenge of identifying open data sources and respective datasets, as information is often scarce on where to find such. This proves to be time consuming and, in the case of business customers, cost consuming. Therefore, customers pay for the ease of access to the data that open data firms provide. Companies gather data from various sources and platforms and offer it on a unified website, database or another place saving the customer precious time and money. In addition, private individuals (and professionals from non-open-data related fields) could be unable to find the data themselves, being inexperienced in the field and not possessing the required know-how. For such, the accessibility to the data offered can be of great value.

Convenience of using the data: Apart from making the open data accessible, companies also add the value of usage convenience. Once the data is offered in the form of an app or another software solution, it is adapted to being used by the customer at any time and place. For example, customers can use the "Bike Citizens" app to generate routes while riding a bike, and the "Parkpocket" app to find a fitting parking place while driving. This would be impossible with the open data provided in its raw format.

Data adaptation to customers' needs: Firms clean the data, filter it, and unite similar data in a way to make it usable for customers. Moreover, they delete some of the data and leave only the one useful for customers in the final product. A good example of this is the "Mundraub" software that uses lists of data including various types of public trees, but only uploads information on the eatables in the online map.

Increased understandability of the data: Open data is typically published in a highly sophisticated manner, not understandable by non-tech users. Through various activities such as data visualization companies make it possible for customers with all kinds of backgrounds to comprehend the data and use it as suited for their individual needs. For example, "Webkid" have visualized the 2016 German elections, putting the data on a map of Germany – information which would be difficult to comprehend, should it consist only of names and numbers. Such solutions are often perceived by customers as highly valuable, even in cases where the visualization is provided without any other value-adding functions.

Perceived value of data-enriching activities: Adding to the above, companies also often go one step further in working with the open data. Through performing various activities they enrich the data, adding more value to it. In almost all cases, companies use more than one source of data, re-structure and consolidate the data and then provide an almost completely new dataset to the customer. Another value added is data analysis. Here, the professional expertise of the company is of high importance. Individuals not involved in the same field, lacking the professional experience and know-how would reach different conclusions analyzing the data, as compared to the company offering the service. Therefore, customers are willing to pay for the professional analysis of the firm. All in all, companies perform various activities to enrich the open data and then provide the new product with the value added for a price. As a result, the main product or service is still the open data itself, only enhanced in different ways.

Perceived value of data-enriching products and services: However, cases in which only the above value in return is used are relatively rare. In the majority of cases, companies develop significant additional functionalities. After the open data is integrated into a software solution, these functionalities are added to a product or service and the final outcome is significantly different than the raw open data. In these cases, open data is typically only a fraction of the data used in the process of product development and an even smaller fraction of the final completed product or service. This is for example the case of "GreenCitySolutions" that use air pollution data but their final product is the CityTree, in its core a combination of a moss culture and IoT. Similar is the case of "365 Farm Net"; they indeed use environmental and geospatial open data, but the final product is a highly sophisticated agricultural software for farming management. In such cases, the value added is tremendous and these are indeed the products and services with highest perceived value by the customers.

5.5. VALUE CAPTURE

The value capture can be put into two main categories: monetary and non-monetary. For each category respective subcategories were developed and described.

5.5.1. MONETARY

Revenues can be obtained in various ways and through different pricing strategies, described in the following graph:

Figure 24: Research results for Monetary Returns

Monetary Returns		
Pricing Models	Payment Options	Other Funding
Freemium	Subscription based	Sponsorships, Donations, Prizes & Awards
Varying prices	Pay per download	Funding
Customized prices	Pay upon receipt	

As already discussed in §5.1.5., companies rarely use a standardized price for their open data products and services. Rather, they develop various pricing models, so as to be attentive to the needs of the customers and to provide them with the benefit of choice, as to how much to pay and how many functionalities to make use of. Some of the most commonly used pricing models include the following:

Freemium pricing model: In this model companies offer customers a possibility to use a free trial version of the product, while charges only apply for further upgrades. An upgrade option is typically based on one of the following three criteria:

- *Length of use:* Customers are offered a free trial option for a limited period of time, during which they have the possibility to test the product. After the expiration of this period, users need to decide for or against a purchase.
- *Quality:* A lower quality version of the product can be used for free, whereas customers are offered to purchase additional functionalities against a fee.
- *Customer type:* Companies offer the product for free to B2C customers, but charges apply to B2B clients. In these cases, there also apply variations in the functionalities of the product.

Varying-prices pricing model: Another type of price variation is to offer standardized prices for B2C or smaller-scale customers and customized prices for B2B or larger

businesses. For example, in the case of "Implisense", the "Implisense Pro" product is offered for the price of €99 per month for freelancers and startups, €499 per 3 months for SMEs, while the price for large-scale enterprises is only revealed on demand.

Customized-prices pricing model: Many companies, especially ones dealing with B2B customers, offer the opportunity to customize the price according to the specific needs of the client. The price is then only defined after the specifics of the company and product functions have been specified. This is, for instance, the case with consultancy services, where details (such as duration, specifics of the consultancy service, capacity needed, etc.) need to be explicitly clarified before the price can be calculated.

Once the pricing model is established, companies typically choose from the following types of pricing:

- **Subscription-based:** For many software solutions customers have the possibility to use the product for a limited time and only re-subscribe if they are willing to still continue to do so. Typically, subscriptions are either on a monthly or a yearly basis.
- **Pay per download:** Customers purchase the product once and can use it for an unlimited amount of time. This can be used for apps but also for other products, such as for example the lists of companies developed by "Implisense".
- **Pay upon receipt:** For services such as consulting or transportation, the above mentioned options do not exist. In contrast, customers pay upon or after receiving the respective service.

Lastly, some companies do not gain revenues directly from their open data products. Yet, they still get monetary value in return. Such could be obtained through:

Sponsorships, Donations, Prizes & Awards: Many institutions, initiatives and private individuals offer financial support for promising businesses. For some, the goal is to promote open data or to support a company that creates social value for the community or the society as a whole. This is often the case with donations from private individuals, financing from public institutions and initiatives, funding from research institutes and universities, or support from unions and associations. Furthermore, companies can participate in various competitions and receive awards, part of which can be financial.

Funding: Companies can also get funded through means of investments. In this case, the investors provide financial help (and often non-financial help, such as mentoring or co-working space) to the company expecting to gain future returns. This is often the case of private investors and start-up incubators. As many of the companies included in this study are newly founded start-ups, a large number of them benefit from such financing options.

5.5.2. NON-MONETARY

This is a type of value in return that is rarely mentioned in public sources or published on company websites. Nevertheless, information gained through expert interviews shows that such returns are of high importance for businesses. In some cases, such as "CityCult" or "Mr. Fridge Software", companies do not even obtain direct revenues through their open-data based products. Instead, they rely on the non-monetary benefits that such products bring and the fact that they would indirectly lead to an increase in revenues. Three types of such value in return are described below.

Figure 25: Research results for Non-monetary Returns

Non-monetary Returns		
Branding & Marketing	Technology Development	Networking
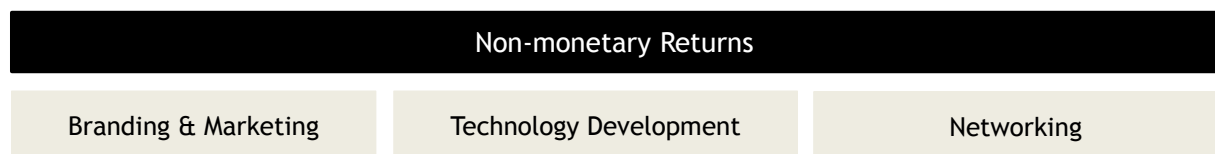
Branding & Marketing: Even in cases where open-data-related products and services bring revenues, marketing benefits cannot be neglected. Due to the innovativeness of business open data reuse and the fact that governments and other public institutions are in the process of popularizing open data, there exist numerous initiatives for companies to engage in and so gain popularity among potential users. In addition, best practice examples are mentioned in various press releases and analyses of the open data industry, such as "Open data in practice" (Seibel, 2016) and "Open data – potentials for the economy" (BMWi[1], 2016). Through such channels, companies engaged in the reuse of open data are able to strengthen their brand and reach out to new customers.

Another way of using open data products and services for marketing is to focus on gaining revenues from supplementary products and services. In this case, businesses often price the open-data-based products at lower prices as related to other products of the company or even provide them for free. In this way, businesses attract new users that are later likely to look into other offers in their portfolio. In such cases, the open data product is often not part of the core business, but rather a side project developed by the firm. This is for example the case of "Mr. Frindge Software", where the "Verbotene Autoren" app is only a branding tool and the effort invested in its development and maintenance is significantly lower as compared to the main product, the "Wokabulary" app. Nevertheless, there are also other examples in which the open-data-related product is the main one, and yet it is provided free of charge in order to gain revenues through related supplementary products. This can be observed in the case of "BikeCitizens", where the main product offered is a navigation app for cyclists incorporating open data. But the company only

gains revenues through supplementary products such as a smartphone mount that helps customers attach their phone to the bike for more convenience when using the app.

However, open-data-related products representing a core offer also have great marketing potential. Current users perceiving such products as high quality are likely to develop a loyalty to the brand and to either look for additional products and services by the same company or to provide positive recommendations to their social group.

Technology development: Products and services reusing open data are often innovative and require the development and testing of new processes and technologies. Therefore, some companies provide a novel open data product at a lower price or free of charge with the intention of testing how such is perceived and to gain feedback on how it can be improved. Moreover, the gained experience and know-how from this "trial product" is then implemented into further open data products and other offerings, thus improving the overall quality of the portfolio of the given business. One example in this regard is the case of "CityCult". During the expert interview with co-founder Jörg Kiesewetter it was determined that the main benefit of integrating open data into the B2C product of the company was to develop the technology and use this in other products which "CityCult" offers to their B2B customers. In addition, when dealing with open data businesses often co-operate with universities and R&D institutes in the research and development of new technologies, later to be used in other products and services.

Networking: Lastly, when engaging in open data reuse companies often develop wide partnering networks, including governmental institutions and municipalities, other businesses, organizations and more. These relationships can be further put into use for other projects, and/or maintained for co-operation options in the future. Through developing and expanding their networks, businesses can also reach out to new customers and discover new business opportunities.

5.6. VALUE MANAGEMENT

Recent study from the Federal Ministry of Economic Affairs and Energy in Germany shows that the most commonly used legal structures in the country are the Sole proprietorship (Einzelunternehmen) (75,4%), the Limited liability company (GmbH) (12,3%), the Civil Law Partnership (GbR) (12,3%), and the Provisional company with limited liability (UG) (3,7) (BMWi[2], 2016). This also resembles the results of the study. The following graph indicates the organizational structures common for open data firms:

Figure 26: Research results for Organizational Structure

Organizational Structure		
Limited liability company (GmbH)	Provisional company with limited liability (UG)	Civil law partnership (GbR)

GmbH (Gesellschaft mit Beschränkter Haftung): A GmbH is founded by at least one person and has a capital requirement of €25,000 (BMWi[2], 2016). It provides a limited liability but has to be established by a contract and entered into the German companies' register (BMWi[2], 2016). It is stated to be the most common form of business association in Germany (Gröger, 2014), apart from Sole proprietorship which does not constitute a legal entity. During the expert interviews, it was confirmed to also be the one mostly used by open data companies. When asked for the reasons of choosing this particular structure, founders often would respond with "because this is what everyone else does" and "because this is what is most common". In some of the cases, other legal structures were not taken into consideration.

UG (Unternehmergesellshaft): The UG is a simplified version of the GmbH, complying with the same legal requirements, only being differentiated by the minimum initial capital of €1. Once a UG reaches a capital of €25,000, it can be converted into a GmbH (BMWi[2], 2016). Generally, companies with this legal structure seek to convert to a GmbH, once they comply with the requirements for a minimum capital.

GbR (Gesellschaft Bürgerlichen Rechts): The GbR can be established without a written contract by at least two individuals (BMWi[2], 2016). There is no requirement to enter the firm into the company register (IFB, 2012). Thus, there are less formal requirements and the process of establishment is significantly easier as compared to the GmbH and the UG. This is often the reason why companies seek such a structure. However, in contrast to the GmbH and UG, the liability of GbR founders' is unlimited, and they are liable with their private assets for all of the company's debts (BMWi[2], 2016).

5.7. CHALLENGES FOR THE REUSE OF OPEN DATA BY BUSINESSES

Companies face multiple challenges when seeking to integrate open data into their businesses. For this reason, this research goes beyond investigating possibilities for reusing open data and looks into the obstacles for doing so and ways for overcoming them. A short summary of the research results on this topic is presented in Table 8.

Table 8: Graphical depiction of the challenges to open data re-use and ways of overcoming them

CHALLENGES FACED BY GERMAN COMPANIES RE-USING OPEN DATA	RECOMMENDATIONS FOR OVERCOMING THE CHALLENGES
• Lacking awareness of open data • Lacking open-data-related know-how • Difficulties of obtaining the data • Lacking open data standardization • Incomplete coverage • Unclear and heterogeneous licenses • Privacy concerns • Static data	• Marketing initiatives • Leading by example • Expressing open data demand • Publishing open data • Open discussion about open data • Motivating country-wide decision for supporting open data • Changing the legislation • Publishing dynamic data

5.7.1. CHALLENGES FACED BY COMPANIES REUSING OPEN DATA

Lacking awareness of open data: Many companies are still not aware of the open data available and the business opportunities it provides. This could partially be attributed to the scarce available information in regards to open data. On the other hand, companies are in some cases lacking initiative and innovativeness, missing opportunities by "not looking into new fields", as noted by Gabriel Reimers from "Mr. Fridge Software".

Lacking open-data-related know-how: Many companies are also lacking the expertise needed to work with open data. They often don't know where to find it, how to use it or how to create value from it. In addition, IT specialists in the field are also still scarce, as outlined by both Andie Arndt from "Mundraub" and Liang Wu from "GreenCitySolutions".

Difficulties of obtaining the data: Even for companies who are already experienced in working with open data, finding the data continues to be a challenge. Open data is still scattered among various websites, platforms and other sources. These are difficult to identify for companies already using open data, and even more challenging for companies that are still in the initial stages of open data reuse.

Lacking open data standardization: Related to the problem described above, the open data published by various institutions and entities is naturally lacking a unified structure. Due to the lack of coordination and the fact that there are no existing standards for publishing the data, open data is incoherent and inconsistent. This creates a "big

difficulty" for companies (in the words of Alexander Pankratov from "Implisense") and "could destroy the whole business concept" (according to Gunter Zeug from "Terranea").

Incomplete coverage: Alexander Pankratov from "Implisense", described the problem with incomplete coverage in the following way: *"Coverage is a crucial issue for businesses. The current state of open data is useful for individual citizens but businesses have higher demands. From a business perspective, there needs to be coverage in the whole country in order for the data to be usable."* Liang Wu from "GreenCitySolutions" classified this as "the biggest challenge for companies", and Henning Hollburg from "Motion Intelligence" mentioned it (along with data inconsistency) as the "main reason why businesses don't use open data". The problem is that while certain public data is open in selected cities or regions, it is not so in others. This poses a great problem for companies, the majority of which operate country-wide or even globally. In cases where they are not able to obtain the data for the whole country, they are faced with the choice of either giving up the use of the open data altogether, or employing the services of a commercial provider. And while public data is open by default in other countries, in Germany it is only partly machine readable. Benjamin Seibel from "Technologiestiftung Berlin" identified multiple reasons on why public administrations are still hesitant on opening the data, including the highly-valued autonomy of German federal states, the lack of experience in publishing open data, the fear of mistakes, and the lack of knowledge of data demand by businesses.

Unclear and heterogeneous licenses: For companies it can prove a difficult task to use the data due to legal reasons; mostly uncertainty about the legal restrictions under which open data is being published. Current licenses prove to be difficult to interpret and businesses need more clarity before they can use the data. In addition, licenses are not harmonized and are often incompatible.

Privacy concerns: Privacy concerns are still a big obstacle in the case of Germany, shared by all actors involved with open data. On the one hand, the government "is still questioning what can be published and what needs to remain closed" (Henning Hollburg from "Motion Intelligence"). On the other hand, individuals "are very concerned about privacy and are always scared when a product is collecting data" (Gabriel Reimers from "Mr. Fridge Software"). Therefore, businesses need to be sensitive in the use of open data.

Static data: Lastly, data published is mostly static (rather than dynamic) and thus often does not serve the needs of companies working with real-time data. It is often the case that open data is being published once and for all, without any further updates.

5.7.2. OVERCOMING THE CHALLENGES RELATED TO OPEN DATA

Although businesses can look for solutions that work around existing issues, the ultimate goal is for the challenges related to open data to be fully overcome. To achieve this, businesses, governments, communities and citizens all need to work together. With that in mind, the following actions were identified as steps toward overcoming the challenges related to open data.

Marketing initiatives: As Jörg Kiesewetter, co-founder of CityCult, points out:

> *"Companies, industries and the government need to provide information on open data, and the media needs to tell everyone about it. Citizens and businesses need to know about the benefits and opportunities of open data."*

Without the needed publicity, many companies will still remain unaware of the existence and benefits of open data, resulting in the lack of involvement of German businesses and consequently, the lack of governmental will to work on resolving the existing issues. Therefore, businesses (and governments) need to take the initiative and openly share information about success stories, best practice examples, and the benefits of open data.

Leading by example: The more companies and other entities are involved with open data, the better the outcomes for all participants will be. Therefore, it would be of mutual benefit if companies already involved in open data reuse would take the initiative and invest into leading others to get involved. Companies can encourage and assist others in sharing their experience and developing mentoring programs and professional networks. In addition, businesses can also partner with administrations and other public bodies in joint projects, thus showing the governments the benefits of open data and how it can be used.

Expressing open-data demand: The administration can lack motivation to publish open data due to the fact that they are simply not aware that such is beneficial and needed by businesses. So far, most of the demands for open data are mainly raised by private individuals. Businesses however have different needs and requirements as compared to citizens. Therefore, companies need to raise their voice and express their desires on what open data is currently lacking and what needs to be published.

Publishing open data: Businesses and citizens can also get involved in publishing open data. Benjamin Seibel from Technologiestiftung Berlin, comments the following:

> *"It doesn't always have to be the government that generates open data. Citizens can also take open data production into their hands. For example, cell phones are*

perfect data generators. If more people would start to do this and contribute, if hundreds or thousands of people get involved, this could make a change."

This is comparable to businesses, many of whom generate an enormous variety of data. Even if a small percentage of it becomes open, the overall open data landscape in the country can be significantly improved. In addition, success stories of open data published by businesses can stimulate administrations to get involved.

Open discussion about open data: "Communication between the different partners, a common vision and especially discussions and getting together about the datasets that exist and for developing new applications" can help in overcoming the challenges related to open data, in the words of Christian Jacob from Stromnetz Berlin. The discussion and regular meet-ups can help companies get involved, obtain the necessary know-how and even develop new open-data based products and services. On the other hand, governments can see the need for publishing open data and the prospective benefits that it can create.

Motivating a country-wide decision for supporting open data: Several of the respondents outlined the limited governmental support as an issue. In addition to the discussions on open data, companies can also facilitate the creation of new initiatives and businesses by pointing out the importance of developing and sustaining an overall national strategy for supporting open data enthusiasts (both individuals and businesses).

Changing the legislation: Should the above actions take place, an ideal outcome would lead to significant changes in the German national laws on open data. First, public data should become *open by default for all cities*, apart from cases where a significant reason for keeping the data closed can be found. As mentioned by Henning Hollburg by Motion Intelligence, "the decision of publishing the data should not be in the hands of the city, but rather in the hands of the government". Second, *common standards* for the publication of open data need to be put in place. In addition, common standards on a European level would significantly benefit a large number of businesses. Third, legal changes in terms of *clear and harmonized licensing* are much needed. Lastly, Bemjamin Seibel from TechnologieStiftung Berlin also mentioned the prospective benefits from a *central institution* (or bureau, or ministry) that would be responsible for open data related coordination, strategy development and implementation, business support, etc.

Publishing dynamic data: Lastly, institutions and businesses publishing open data should be aware of the necessity that the data is constantly up to date. Thus, they need to conduct regular checks and make updates, so as to keep the data applicable to the day-to-day business of companies.

5.7.3. THE FUTURE OF OPEN DATA IN GERMANY

Opinions on whether or not these actions will indeed be implemented and the challenges overcome vary among respondents. So do the viewpoints on the prospective future of open data on the German market. The responses are summarized in the following chapter.

The future of open data in Germany: The majority of respondents were optimistic about the future of open data, but some also hesitated. For example, Jörg Kiesewetter from CityCult mentioned that "A lot is needed before open data can make a difference" and unless companies are being shown the benefits of open data, "it will remain a small thing only used by a selected few". But although companies are aware of the challenges, respondents mostly agree that "sooner or later, open data will have success" (Alexander Pankratov, "Implisense"). Many discussed what is already being done in the open data world and assumed that the trend of open data growth will be sustained or even will increase in the future. One positive factor is the "shift in the thinking paradigm" observed in businesses and public institutions in recent years (Andie Arndt, Mundraub). Organizations and institutions are starting to change their attitudes towards openness and transparency and that is expected to have a positive influence on the growth of open data initiatives. A rapid development of data-driven industries such as autonomous driving has also taken place. For such businesses, the generation and usage of data is of crucial importance, and it can be predicted that open data will become an important source of information. In addition, it is also the case that "it is cheaper to have the data shared with other companies" and businesses realize that "alone they cannot achieve enough data" (Gabriel Reimers, Mr. Fridge Software). Therefore, companies in the near future are expected to have to form alliances and partnerships among each other, in order to sustain their businesses and be able to further develop new data-driven products and services. This would lead to the publication and usage of more open data. Lastly, another promising field is the data analytics industry, especially in the B2B sector, which was described by Alexander Pankratov from "Implisense" as "very dynamic" and "especially growing in other countries". His prediction was that this trend will be sustained in Germany as well.

The future of open data in the selected companies: Respondents were also mainly optimistic about the future usage of open data in their companies. Implisense plan to use "more and more open data", and Mundraub hope to use "more, as much as possible". Mr. Frindge Software and Terranea were also very optimistic about using more open data.

These results show that despite the many challenges in the open data industry, businesses are mainly optimistic about overcoming them. Therefore, the challenges outlined should not stop companies from engaging in open data reuse and creating novel business models.

5.8.   COMPARISON OF THE RESULTS WITH EXISTING LITERATURE

Although it has been pointed out previously that research on the current topic is scarce, the comparison of the results with existing literature is of high importance, particularly in case study research where it contributes to ensuring internal and external validity of the results. Four studies were identified as similar enough to be used for comparison – the research of Zeleti, Ojo & Curry (2016), Ferro & Osella (2013), Janssen & Zuiderwijk (2014), and Zimmermann & Pucihar (2013). However, it needs to be noted that none of the existing literature on the topic provides a complete overlap with the current research.

First, none of the research chosen for comparison was conducted in Germany. For this reason, the results need to be approached with caution when considering integrating open data into the business models of German firms in similar ways. The country component is of high importance due to several factors, such as open data availability in the country, digital infrastructure, legislation, as well as the level of development of the open data network. All these factors could vary strongly among countries, due to which not all results would be applicable for Germany. Furthermore, the research of Ferro & Osella (2013) is not directly related to open data, but rather to its antecedent – public sector information. This shows a relative limitation as compared to open data, much of which is published by non-governmental entities, for example transport companies. Similarly, the research by Janssen & Zuiderwijk (2014) is only concerned with infomediary business models, which is also a limiting factor. Nevertheless, due to the novelty of the research field and the comparatively high relevance of the articles, the above mentioned were selected for comparison. The detailed comparisons of all results are provided in Appendix C.

In regards to the Value Proposition component of the 6V framework (Appendix C1.1), the results of Janssen & Zuiderwijk (2014) and Zimmermann & Pucihar (2013) are mainly concerned with software solutions developed through the reuse of open data. This confirms the high importance of such products, as also outlined in the current paper and defined as "Value-adding software solutions". On the other hand, Ferro & Osella (2013) and Zeleti, Ojo & Curry (2016) take another approach and describe the products and services by outlining how the value proposition is related to the components price and quality. They mainly focus on generic value propositions and do not study the products and services in detail, as has been done in this paper. In this regard, the current research adds to the previously conducted ones, providing new insight.

And in regards to the Distribution Channel component, the results of all papers are comparable, pointing towards confirmation. The detailed results are provided in Appendix C1.2.

Similarly, it can be concluded that the Value Adding Process results provide additional insight as compared to the existing literature. For example, for the "Activities" sub-element the components "Data sources identification" and "Data filtering" were not described in any of the examined papers, despite the fact that no open data product or service can be created without such. "Data storage" was also only mentioned by Ferro & Osella (2013). A probable reason is that the focus of the other research was to understand how the components relate to each other and to create a typology of business models, rather than to study the specific elements (e.g. Activities) in depth. The rest of the results, however, tend to confirm the so described in Chapter 5.2.1. Of particular interest are the product-specific activities described by Zeleti, Ojo & Curry (2016). In the current paper emphasis was not put into describing examples for each of the activities, but rather generalization was sought. Nevertheless, specifics such as "guarantees on data availability", "timely help for customers using the data", and "bug fixes" might provide interesting examples for practitioners looking for new ways to enrich the open data. These can be found in Appendix C2.

When it comes to the second component of the Value Adding Process, the resources, these were only shortly mentioned by Zimmermann & Pucihar (2013), confirming the results of this study. Similarly, the Market segment component was highly heterogeneous, as also described in the current paper.

Appendix C3.1 shows similarities in the results of all studies in regards to the Customers component of the Value Network. Interestingly, the Government was only mentioned as a customer by Zeleti, Ojo & Curry (2016) and omitted by the other researchers. In this paper however, it was observed that the government, as well as other public entities, is an important customer for German open data companies. This could be due to the fact that open data is still a novelty in Germany and the government is engaging actively in stimulating open data reuse by businesses. Therefore, despite the fact that it has not been mentioned by other researchers, it is an important factor for German businesses.

The Suppliers were also a business model component studied very scarcely in the papers selected (Appendix C3.2). They were only mentioned by Janssen & Zuiderwijk (2014) and Zimmermann & Pucihar (2013), in which very limited information was provided. In this regard, the current study provides important new insight. One new supplier was however mentioned by Janssen & Zuiderwijk (2014) that was not taken into consideration in this research – the citizens. They are able to provide so called "user-generated data", which can then be consolidated with and enrich the already existing open data. Interestingly, this was also observed in this research in the case of "Mr. Fringe Software"; however, in a

product that was not open data related. Perhaps, seeking to engage information from citizens could be a new opportunity to be exploited by German open data businesses.

Similarly, information on the Partners sub-element is also very scarce but can be said to confirm the results of the current study. Details are provided in Appendix C3.3.

Further, results related to the Value in Return were compared and depicted in Appendix C4. It can be concluded that the current research provides valuable new insight. For example, the value "Data adaptation to customer needs" and "Convenience of using the data" was not previously discovered. The rest of the results can be said to be aligned. Interestingly, it can be observed that the cost and time saving component (described in this research as "Ease of access to the data") was especially emphasized by other researchers (Zeleti, Ojo & Curry (2016) ; Ferro & Osella (2013) ; Zimmermann & Pucihar 2013)). In using raw data, users spend a significant amount of time (also related to costs for businesses) obtaining the data and processing it themselves. Because of this value added even the simplest visualization tool with no additional features could be seen as useful by users and provide opportunities for value creation and capture.

Lastly, a comparison of the Value Capture results was provided in Appendix C5. Previous researchers emphasize on the monetary returns from open data products and services, mainly revenues. Nevertheless, the current research has shown that other sources of revenues such as sponsorships and funding can be particularly important, especially in the first stages of new open data products development. In these crucial stages, the non-monetary returns are also of high importance – to gain know-how and to build a sustainable network and a brand that would generate monetary returns in the long term. It is probable that these were less studied in the other papers as the results come from countries with well-developed open data infrastructure.

As no information was provided for the component Value Management, and the Challenges element is highly dependent on the country, no respective comparison was possible.

All in all, the conducted comparison confirms the stated results. Important insights from the current study are shown to contribute to the existing literature. Also, as a result of the comparison one new component can be added – Citizens to Suppliers, as they can generate content to be used by open data companies.

6. CONCLUSIONS

The current study shows that there are many different ways to utilize the great economic potential for the reuse of open data in Germany. Although there are still significant challenges related to commercial open data reuse, the pioneer cases presented in this study confirm that it is possible for companies to create and capture value by integrating open data into their operations. Moreover, there are numerous ways for doing so and a great majority of opportunities for companies wishing to engage in such activities. For such businesses, the cases provided are to serve as examples to be followed. The results can also stimulate businesses to think of new ways to use open data in their operations.

In order to achieve this, various ways were identified to integrate open data into the business models of German companies. These were divided into 6 main categories according to the 6V business model framework developed by Zeleti, Ojo & Curry (2016): Value proposition, Value adding process, Value network, Value in return, Value capture, and Value management. For each of these categories, subcategories were selected to be studied and respective ways for integrating open data into them were identified during the research. As a result, an overview of current practices for open data related business modeling was developed.

The first category "Value Proposition" consisted of two sub-categories: Products & Services and Distribution Channel. When it comes to the first sub-category, it was identified that companies currently involved in open data reuse are developing highly heterogeneous products and services. These were divided into three main groups: "Value-adding software solutions", "Value-adding services", and "Other value-adding products" with respective sub-groups. This is to show that there are numerous opportunities for companies wishing to engage in open data reuse when it comes to products and services to be developed. The industries in which companies operate were also highly heterogeneous, as well as their sizes. Therefore, it can be concluded that the open data industry is welcoming of all kinds of companies, regardless of their size, industry or niche. Knowing that the businesses studied in this research are able to generate monetary and non-monetary returns from their operations, this is an indication for all German companies that it is appropriate to consider the possibility of integrating open data in their operations. Companies can integrate the open data into many various kinds of products and services – from simple visualization of the data, to consulting services and workshops on how to use data, to highly complex products where open data is only a fraction of the final proposition. With this vast majority of opportunities, companies would need to assess their core competencies, strengths and weaknesses and make a decision into what product or service

would be most suitable for their particular business. Then, according to the specifics of their case, they could use mainly (although not exclusively) three distribution channels: the corporate website, app stores or direct sales. By far, the majority of cases observed used the corporate website as the main distribution channel, which could be an indication that this is an appropriate option to take into consideration.

However, in order to develop a product or service to distribute to its customers, a company needs to obtain the open data and process it, creating its own value. The category "Value adding process" describes how this process takes place. As identified during the research, the most commonly used open data (or "Resource") by businesses comes from four major types: "Transport, Traffic & Geospatial data", "Demographic data", "Environmental data", and "Free time & Leisure data". This is not to say that other types of data cannot be used for creating products and services, but rather that these represent the typical example and a good starting point for companies that wish to engage in using open data but are still unaware of what type of data could be appropriate. Furthermore, this research was also concerned with what activities need to be performed in order for this data to be transformed into a product. In short, companies would start by identifying the sources of open data, and then collect, filter and process it. This would be conducted for each dataset that has been identified as being relevant for the company. After that, the so processed data, which is often collected from various sources, would be consolidated into a new set and stored for further access. The data is then ready to be integrated into the final product or service that the company develops, for instance to create a visualization tool or to use the data for consultancy services. Various other activities could be performed, applicable to the specific case at hand. Finally, the data needs to be maintained and kept up to date. The so created product or service with the open data integrated into it is then ready to be distributed to a selected market segment. Although the process is different for each company, it is crucial for firms considering engaging in open data reuse to acquaint themselves with these steps and to carefully examine which of these are applicable in their specific case.

Another component of the business model that was investigated in this research was the "Value network" category of the 6V framework, and specifically the sub-categories "Customers", "Suppliers", and "Partners". In this regard, the study aimed to investigate through using what types of suppliers, through cooperating with what types of partners, and through offering the final product to what types of customers companies can integrate open data into their business models. In investigating the current practice, it was concluded that open data related products can be offered to all types of customers – B2B,

B2C and B2G, although the B2G aspect was less commonly applied as compared to the other two. In creating the product, businesses can cooperate with various kinds of partners: Governments & Municipalities, Research institutes & Universities, Non-profit organizations, Incubators & Accelerators, as well as other Businesses. Each of these plays a specific role as a strategic partner. For example, partnerships with research institutes and universities are often initiated with the purpose of using their knowledge base for the development of the product and/or processes. When it comes to private businesses, it is often needed for companies to cooperate with such in creating the various components of the final product. At the same time, incubators and accelerators, as well as the government, tend to provide crucial financial support. This leads to the conclusion that companies wishing to engage in open data reuse rarely can do so isolated from the other participants. Instead, open data publishers and users are interconnected in a network which necessitates the cooperation of each of the partners. This is also true for the "Suppliers" sub-element, where often the suppliers are at the same time users of the data and the other way around. Types of suppliers identified include: Government & Municipalities, Publicly-owned entities, Public-private companies, Non-profit organizations, Private businesses, and Citizens. Companies willing to engage in reusing open data need to take into consideration these tight connections between the industry partners and make strategic decisions in regards to choosing the right partners and suppliers, so as to not miss out on crucial network connections needed for the functioning of their business in the open data environment.

The fourth business model category included in this research was the "Value in return", describing the value added by companies to the raw data. Studying this category was important in order to show what value can be created by companies through open data reuse, and what is the value (added specifically by the company) for which customers could be willing to pay despite the fact that they can obtain the raw open data for free. Results show that such value includes the ease of access and convenience of using the data (e.g. time and cost savings), the adaptation of the data to the specific needs of the customer, as well as the increased understandability of the data and the perceived value of data-enriching activities, products and services. A company managing to offer such value to its customers, as complementing the freely accessible open data, can expect its customers to be willing to pay in return for receiving the product or service.

When it comes to the "Value capture", or the value received by companies in exchange for the product or service offered, it was divided into two categories: monetary and non-monetary. The study results show that the majority of companies receive at least some

kind of monetary returns for their offer in the form of either revenues, sponsorships, donations, prizes or other funding. This explicitly shows that there is indeed an economic potential behind the reuse of open data that companies can unlock through integrating open data into their operations. In addition, businesses active in open data reuse also benefit from non-monetary returns – Branding & Marketing, Technology development, and Networking. This is to show that even if a company has not yet developed an idea on how to generate revenues from its open data product, it can still harvest high returns from it. This can be achieved by using it as means to promote their other products and the brand, to develop a new technology or know-how that can later be implemented in other products, or to build valuable partnerships that would benefit the company in the long run.

Lastly, the "Value management" component studied the organizational structures commonly applied by companies engaged in open data reuse. The results show that the most commonly used structure is the limited liability company (GmbH), followed by the provisional company with limited liability (UG) and the civil law partnership (GbR). It was concluded that the UG option was most commonly applied by companies that still do not answer the requirements for establishing a GmbH and therefore change to the latter structure whenever this becomes possible. Therefore, the research results point to the GmbH structure as the most appropriate for companies that wish to integrate open data into their business models.

Finally, after considering the benefits and ways of integrating open data into the business models of German companies and concluding that such an endeavor can be highly profitable for businesses, this study investigated some of the reasons that may currently be preventing companies from engaging in such activities. The results show that there are numerous challenges companies currently face: lacking awareness of open data and know-how, difficulties in obtaining the data and incomplete coverage, lacking standardization and unclear licensing, as well as privacy concerns and the fact that the data is not always kept up to date. All of these make it difficult for companies to engage in open data reuse, despite the promising economic perspective. There is still much that needs to be done in order for these challenges to be overcome. Some recommendations were provided in this research: to conduct marketing initiatives, to lead by example, to openly express open data demand, to publish more open data, to create an open discussion about open data, to motivate a country-wide decision for open data, to express a demand for changing the legislation, and to demand the publishing of dynamic and recent data. In order to achieve these, businesses and the government will need to work together for the common good.

7. RESEARCH IMPLICATIONS & LIMITATIONS

7.1. PRACTICAL IMPLICATIONS

The research results described above provide valuable implications for practice. First, the current study shows that German companies can greatly benefit from the business reuse of open data, as it is able to generate great monetary and non-monetary returns. The presented data collected and research results can be used by companies to assess the benefits which open data could have for their business. It could also be used by companies to compare the specifics of their case with existing examples and assess whether or not and under which circumstances it would be beneficial to engage in open data reuse. The research results encourage the engagement of all types of companies in creating open data products and services, regardless of their size, stage of development or industry. Nevertheless, managers need to assess their resources and capabilities, strengths and weaknesses in order to develop an appropriate business model for their case.

In terms of identifying ways in which open data can be integrated into business models, this study has provided much information. Companies are to examine each of the research results in detail and to consider whether the current ways identified are to be used or new ideas are to be developed. In any case, due to the detailed results provided in the results section, companies have countless opportunities to get inspiration and ideas on how to reuse open data and create their first open data business model.

Last but not least, managers are encouraged to review and consider the challenges for open data reuse and the recommendations for overcoming them before stepping onto the open data scene. The study shows that there is still much to be done in regards to the open data infrastructure in Germany. Yet, professionals engaged in open data reuse are optimistic about its future. Businesses are recommended to actively engage in open data networks and discussions, and in the popularization of open data, which would lead to mutual benefits of all players.

Still, probably the most valuable recommendation comes from words of Andie Arndt, spokes representative of Mundraub. When asked to describe recommendations for businesses not yet engaged in open data reuse, she simply said "Just do it!" In line with all the countless opportunities on how to use open data in a business context, there is surely much to benefit of open data for each and every company in Germany.

7.2. THEORETICAL IMPLICATIONS AND FUTURE RESEARCH

In addition to their practical contribution, the results of this study offer valuable new insights in a novel field of research where literature is still scarce. In contrast to existing literature where the business models and their elements are product of theoretical hypotheses and limited empirical data, the current paper collected and analyzed qualitative interview data from 7 existing open data companies and secondary data from additional 22. In addition, the study implemented the theoretical framework developed by Zeleti, Ojo & Curry (2016) to real-life companies and investigated how it is applied in practice. The result is an overview of ways to integrate open data into the business models of German firms, helping to overcome the challenge pointed out by Bonina (2013) that knowledge on how to utilize the economic potential of open data is still very limited.

In terms of specific theoretical contributions, the study provides new information in areas where such was completely lacking, such as value management in open data companies, non-monetary value capture, as well as details on the value adding process. It also complements existing literature by enriching the existing knowledge on elements such as types of products and services, customers, suppliers, partners etc. Last but not least, through comparison of the results with previous research, the study also provides an overview of existing literature on the topic and structures the existing results into the 6V framework.

Nevertheless, the current paper focused on selected elements of the 6V framework. Future researchers can investigate the business models in further detail, building knowledge in exciting areas such as R&D, logistic systems, cost structure etc. In addition, it was the goal of this paper to focus on one country – Germany. Future investigators can follow the described methodology and apply it in other settings. In this way, valuable new knowledge can be built by comparing the results provided in this study with results from other countries. Moreover, future researchers can use the provided results and further data and develop a typology of business models in Germany. As a further step, the success of each model can be measured, indicating which business models are to be preferred and under which circumstances. Lastly, it could be of interest to study the reasons behind and the competencies needed for implementing a specific business model element in one case and not in another.

All in all, open data business modeling is an exciting field with countless opportunities for future research. As literature in the field is still scarce, each contribution would be of immense value for academics and practitioners.

7.3. RESEARCH LIMITATIONS

Despite all the efforts that were taken in order to overcome the challenges related to the current research and to ensure results validity and reliability, this research still has its limitations. First, due to the novelty of the research field, literature on the topic is still scarce, not allowing for an in-depth comparison of the results with the results of other researchers, as is recommendable for the case study methodology. For the same reason, some of the literature used was not published in top journals. Second, presumably not all companies involved in open data reuse announce this publicly, which is why it is possible that some doing so were omitted from this research. For overcoming this, companies were identified through several different sources – through online research, by scanning business and government analyses, through implementing the Snowball technique, through examining corporate websites following to company partners and more. Third, due to the large amount of data collected, as typical for the case study methodology, it was impossible to include all the information on the pages of this research. Therefore, considerations needed to be made in regards to the importance of each piece of data collected and its relevance to the research question. As a result, not all data collected was published in the paper, although some of it might be of interest for individuals with strong interest in the topic.

Lastly, limitations also exist in regards to the chosen scope of the paper. As it is impossible to include everything in a single research, aspects of open data business modeling such as evaluating the success of the models or further business model aspects such as profitability and logistic systems were omitted. This is a consideration that needs to be made in every research in order to achieve the specific goal set and to answer the central research question. This could however provide ideas for future research.

APPENDIX

APPENDIX A: LIST OF RESPONDENTS

Company	Interview partner	Position
GreenCitySolutions GmbH	Liang Wu	CIO
Motion Intelligence GmbH	Henning Hollburg	Founder & CIO
Implisense GmbH	Alexander Pankratov	Data Scientist
City Cult GbR	Jörg Kiesewetter	Co-Founder
Terranea UG	Gunter Zeug	Founder & Managing Director
Mr. Fridge Software	Gabriel Reimers	Co-founder
Mundraub gUG	Andie Arndt	Spokesperson
Stromnetz Berlin GmbH	Christian Jacob	Network Innovation
Technologiestiftung Berlin	Benjamin Seibel	Data Driven Innovation

APPENDIX B: DATA COLLECTED

APPENDIX B1: OPEN DATA COMPANIES & COMPANY CHARACTERISTICS

N	Company Name	Legal Structure	Founding Year	Headquarters	Web page
1	365FarmNet	GmbH	2013	Berlin	365farmnet.com
2	3D Content Logistics	GmbH	2012	Potsdam	3dcontentlogistics.com
3	Appstretto	UG	2013	Berlin	appstretto.com
4	Avantgarde Labs	GmbH	2004	Dresden	avant-garde-labs.de
5	BerliTec	GmbH	2009	Berlin	berlitec.de
6	Bike Citizens	GmbH	2011	Berlin	bikecitizens.net
7	City Cult	GbR	2012	Leipzig	citycult.org
8	Con terra	GmbH	1993	Münster	conterra.de
9	Datenfreunde	GmbH	2013	Hamburg	opendatacity.de
10	Door2Door	GmbH	2014	Berlin	allyapp.com
11	Esri Deutschland	GmbH	1979	Kranzberg	esri.de
12	Geofabrik	GmbH	2007	Karlsruhe	geofabrik.de
13	Green City Solutions	GmbH	2014	Dresden	greencitysolutions.de
14	Implisense	GmbH	2013	Berlin	implisense.com
15	Iosphere	GmbH	2010	Köln	iosphere.de
16	Klaus Benndorf	E.U.	1990	Bonn	benndorf.de
17	Mapegy	GmbH	2012	Berlin	mapegy.com
18	Motion Intelligence	GmbH	2013	Berlin	route360.net
19	Mr. Fridge Software	GbR	2009	Berlin	mr-fridge.de
20	Mundraub	gUG	2009	Berlin	mundraub.org
21	Naturtrip	GmbH	2014	Berlin	naturtrip.org
22	OpenOil	UG	2011	Berlin	openoil.net
23	Parkpocket	GmbH	2013	München	parkpocket.com
24	Plasmap	GbR	*-No data-*	Düsseldorf	plasma.io
25	PTV Group	AG	1979	Karlsruhe	ptvgroup.com
26	Remote Sensing Solutions	GmbH	2000	Baierbrunn	rssgmbh.de
27	Viomedo	UG	2015	Berlin	viomedo.de
28	VirtualCitySystems	GmbH	2005	Berlin	virtualcitysystems.de
29	Vista	GmbH	1995	München	vista-geo.de
30	Webkid	GmbH	2014	Berlin	webkid.io

APPENDIX B2.1.: VALUE PROPOSITION DATA I – PRODUCTS & SERVICES

N	Company Name	Product(s)/Service(s)	Product/Service Category
1	365FarmNet	Web-based agricultural software integrating various solutions for farming management.	Value-adding software
2	3D Content Logistics	Software solutions for the integration, visualization and use of complex 3D content.	Interactive data visualization SW Interactive 3D visualization tools Value-adding software
3	Appstretto	Apps and other software solutions for various purposes.	Value-adding software
4	BerliTec	General: App for backing up photos and videos and synchronizing such among various devices. Open data: App providing information on criminal activity cases in a given area.	Interactive data visualization SW
5	Bike Citizens	App generating cycling routes in urban areas.	Interactive maps & Route Planners
6	City Cult	An app serving as an event planner for the area of Leipzig.	Interactive data visualization SW
7	Con terra	Integrating Geo-IT solutions into the IT structures of private businesses and public administration agencies.	Consulting services Software integration services Interactive maps & Route planners Data collection software Value adding software Value adding services
8	Datenfreunde	Data visualization and analysis, often related to journalistic projects.	Interactive data visualization SW
9	Door2Door	General: Apps and services providing transportation and urban planning solutions. Open data related: App for urban transport planning, comparing travel options based on price and time.	Interactive maps & Route planners Value-adding services
10	Esri Deutschland	Geo-information solutions and related consulting services.	Consulting services Workshops & Trainings Value adding services Interactive maps & Route planners Value-adding products
11	Geofabrik	Maps and other mapping solutions, as well as consulting and training for businesses dealing with OpenStreetMap, made possible through the selection, extraction and processing of open geodata.	Interactive maps Consultancy services Software development and integration services Workshops & Trainings
12	Green City Solutions	The City Tree, reducing city air pollution, equaling up to 275 trees in its ability to purify city air of harmful pollutants.	Consulting services Value-adding software Data collection software
13	Implisense	Intelligence SaaS software helping businesses in finding and retaining customers by providing recommendations for new clients.	Data-analysis-based solutions Value-adding software
14	Iosphere	General: Apps,software solutions & consulting Open Data: App with offline maps, public transport information and travel guides for regions and cities in over 150 countries.	Interactive maps & Route planners
15	Klaus Benndorf	Geoinformation System (GIS) related products and services, such as development of maps and other IT solutions, consulting and trainings.	Data analysis services Workshops & Trainings Interactive maps & Route planners Software integration services Data-adding software Data-adding services

16	Mapegy	Intelligence tools for measuring and tracking innovation, competition and technology trends.	Interactive data visualization SW Data-analysis-based solutions
17	Motion Intelligence	Software solutions providing route planning and travel time algorithms and visualization.	Interactive data visualization SW Interactive maps & Route planners
18	Mr. Fridge Software	General: App for practicing and learning vocabulary. Open data related: App for the banned authors and books during the national socialist period in Germany.	Interactive data visualization SW
19	Mundraub	An online map showing the locations of eatables such as fruit trees, berries, nuts and wild herbs.	Interactive data visualization SW
20	Naturtrip	An online platform and an app serving as a free time planner offering information on types of activities and transportation possibilities.	Interactive data visualization SW Interactive maps & Route planners
21	OpenOil	Consultancy services, corporate networks creation, financial models development and a search engine service, based on data from oil, gas and mining companies.	Consultancy services Value-adding services Data collection software
22	Parkpocket	A parking app enabling users to find available parking spaces and compare prices.	Interactive data visualization SW Interactive maps & Route planners
23	Plasmap	An API solution and query language designed for location search based on set criteria.	Data-analysis-based solutions
24	PTV Group	Software solutions, consulting and research for the purposes of traffic and transport planning and optimization.	Interactive data visualization SW Interactive maps & Route planners Value-adding software Consulting services Value-adding services
25	Remote Sensing Solutions	Support for environmental projects and spatial data services, such as consulting, GIS mapping, image analysis, data acquisition and 3D visualization.	Interactive data visualization SW Interactive 3D data visualizat. SW Consultancy services Other value-adding services and software solutions
26	Viomedo	Online platform helping patients find matching clinical trials by providing access to clinical trials information.	Data collection software
27	VirtualCitySystems	Software solutions and consulting on the creation, processing, distribution and usage of 3D geospatial data.	Various value-adding SW Consultancy services
28	Vista	Data processing based products and services in the fields agriculture, hydrology and environment.	Various value adding SW Various value adding services
29	Webkid	Data visualizations, interactive maps and storytelling applications for journalistic projects.	Interactive data visualization SW Interactive maps & Route planners

APPENDIX B2.2.: VALUE PROPOSITION DATA II – DISTRIBUTION CHANNEL

N	Company name	Distribution Channel
1	365FarmNet	Company website
2	3D Content Logistics	Company website, App sores
3	Appstretto	Company website
4	BerliTec	App stores
5	Bike Citizens	App stores
6	City Cult	App stores
7	Con terra	Company website
8	Datenfreunde	Company website, Direct sales
9	Door2Door	App stores
10	Esri Deutschland	Partnership models
11	Geofabrik	Direct sales
12	Green City Solutions	Direct sales
13	Implisense	Company website
14	Iosphere	Company website, App stores
15	Klaus Benndorf	Company website, Direct sales
16	Mapegy	Company website, Direct sales
17	Motion Intelligence	Company website
18	Mr. Fridge Software	App stores
19	Mundraub	Company website
20	Naturtrip	Company website
21	OpenOil	Company website
22	Parkpocket	App stores
23	Plasmap	Direct sales
24	PTV Group	Company website, Direct sales
25	RSS	Direct sales
26	Viomedo	Company website
27	VirtualCitySystems	Company website
28	Vista	Direct sales
29	Webkid	Company website

APPENDIX B3.1: VALUE ADDING PROCESS DATA I – ACTIVITIES

N	Company name	Activities
1	365FarmNet	Data collection, filtering, consolidation, integration into the solution; Product-specific activities
2	3D Content Logistics	Data collection, consolidation, analysis, visualization, integration into various solutions; 3D modeling; Product-specific activities
3	Appstretto	Data collection, visualization, integration into the solution; Product-specific activities
4	BerliTec	Data collection, processing, integration into the app; Product-specific activities such as text analysis
5	Bike Citizens	Data collection, analysis, integration into the app, maintenance; Product-specific activities such as generation of bike routes
6	City Cult	Data collection, processing, integration into the app, maintenance; Product-specific activities such as calendar services
7	Con terra	Data collection, consolidation, integration into the products and services, analysis; Development of additional products and services; Product-specific activities
8	Datenfreunde	Data collection, filtering, visualization, analysis, integration into the solution; Product-specific activities
9	Door2Door	Data sources identification; Data collection, filtering, consolidation, integration into the app; Product-specific activities such as price and time calculations based on the data
10	Esri Deutschland	Data collection, consolidation, integration into the solution, maintenance; Product-specific activities
11	Geofabrik	Data sources identification; Data collection, processing, integration into the solutions and services; Product-specific activities
12	Green City Solutions	Data collection, storage, integration into the solution, upload on the website, maintenance; Data search engine; Product-specific activities
13	Implisense	Data sources identification; Data collection, consolidation, analysis, integration into the API, storage; Product-specific activities such as derivation of recommendations based on data
14	Iosphere	Data collection, processing, consolidation, integration into solutions, maintenance; Product-specific activities
15	Klaus Benndorf	Data sources identification; Data collection, filtering, analysis, integration into products; Development of data-based services; Product-specific activities
16	Mapegy	Data sources identification; Data collection, filtering, integration into a software solution, analysis; Product-specific activities such as technology trading and scouting
17	Motion Intelligence	Data collection, filtering, processing, integration into the API; Product-specific activities such as development of travel time algorithms
18	Mr. Fridge Software	Data collection, filtering, processing, integration into the app; Product-specific activities such as data enrichment
19	Mundraub	Data collection, filtering, consolidation, integration into the map, maintenance; Product-specific activities
20	Naturtrip	Data sources identification; Data collection, filtering, consolidation, maintenance; Product-specific activities such as distances calculation & route planning based on the data
21	OpenOil	Data sources identification; Data collection, processing, storage, maintenance; Text analysis; Data integration into the search engine; Product-specific activities
22	Parkpocket	Data sources identification; Data collection, integration into the app, maintenance; Product-specific activities such as prices comparison
23	Plasmap	Data sources identification; Data collection, integration into the API; Product-specific activities
24	PTV Group	Data collection, consolidation, processing, analysis, integration into the products and services; Product-specific activities
25	RSS	Data collection, consolidation, processing, analysis, integration into

N	Company name	Recources (see how this was analyzed in the text)
26	Viomedo	Data collection, filtering, processing, integration into the solution; Product-specific activities
27	VirtualCitySystems	Data collection, processing, analysis, integration into the solution; Product-specific activities
28	Vista	Data collection, processing, analysis, integration into the solutions; Product-specific activities
29	Webkid	Data sources identification; Data collection, consolidation, integration into the solution; Product-specific activities

APPENDIX B3.2: VALUE ADDING PROCESS DATA II – RECOURCES

N	Company name	Recources (see how this was analyzed in the text)
1	365FarmNet	Environmental data, Geospatial data
2	3D Content Logistics	Geospatial data, Demographic data
3	Appstretto	Politics-related data
4	BerliTec	Criminal activity data
5	Bike Citizens	Geospatial data, Transportation data, Public transport data
6	City Cult	Data related to events
7	Con terra	Geospatial data, Environmental data, Transportation data
8	Datenfreunde	Geospatial data, Demographic data, Environmental data, Culture-related data, Politics-related data
9	Door2Door	Transportation data, Geospatial data
10	Esri Deutschland	Geospatial data
11	Geofabrik	Geospatial data
12	Green City Solutions	Environmental data on air pollution
13	Implisense	Industry specific data on company characteristics
14	Iosphere	Geospatial data, Transport data, Leisure-related data
15	Klaus Benndorf	Geospatial data, Transport data
16	Mapegy	Data on patents, technical standards & company-related data
17	Motion Intelligence	Transportation data, Demographic data, Environmental data
18	Mr. Fridge Software	Literature and history related data
19	Mundraub	Data on public trees
20	Naturtrip	Geospatial data, Transportation data
21	OpenOil	Financial data, Corporate filings
22	Parkpocket	Transportation data, Parking-related data
23	Plasmap	Geospatial data
24	PTV Group	Transportation data, Geospatial data, Demographic data
25	RSS	*-No data-*
26	Viomedo	Health data
27	VirtualCitySystems	Geospatial data
28	Vista	Geospatial data
29	Webkid	Transport data, Geospatial data, Environmental data, Economic data, Education data, Demographic data, Leisure-related data

APPENDIX B4: VALUE NETWORK DATA

N	Company name	Customers	Suppliers	Partners
1	365FarmNet	B2B	*-No data-*	Businesses, Non-profit organizations
2	3D Content Logistics	B2B, B2C	Municipalities	Businesses, Universities, Research institutes
3	Appstretto	B2C, B2B	Government	Businesses
4	BerliTec	B2C	Public institutions	No official partners
5	Bike Citizens	B2C	OpenStreetMap	Businesses, Municipalities
6	City Cult	B2C, B2B	Municipalities, Businesses	No official partners
7	Con terra	B2B, B2G	Government Municipalities	Businesses, Non-profit organizations, Research institutes, Universities
8	Datenfreunde	B2C, B2B	Municipalities Destatis, Eurostat	Businesses & Media, Non-profit organizations
9	Door2Door	B2C, B2B	BVG, VBB, DB	Businesses
10	Esri Deutschland	B2B, B2G	Research institutes Partners	Businesses, Government, Non-profit organizations, Associations & Unions
11	Geofabrik	B2B, B2G	OpenStreetMap	Organizations
12	Green City Solutions	B2G, B2B	Municipalities Government	Businesses, Government, Municipalities, Research institutes, Universities, Start-up incubators, Accelerators
13	Implisense	B2B	Company register Destatis	No official partners
14	Iosphere	B2C, B2B, B2G	OpenStreetMap, Wikipedia	No official partners
15	Klaus Benndorf	B2B, B2G	OpenStreetMap	Businesses
16	Mapegy	B2B	Various institutions	Businesses, Research institutes, Universities, Public institutions
17	Motion Intelligence	B2B	Government, VBB, DB, OpenStreetMap	Businesses, Government, Public institutions, Research institutes
18	Mr. Fridge Software	B2C	Government	No official partners
19	Mundraub	B2C, B2B	Municipalities	Businesses, Municipalities, Non-profit organizations, Foundations, Research institutes, Private sponsors
20	Naturtrip	B2C, B2B	VBB, OpenStreetMap	Businesses, Non-profit organizations, Associations & Unions, Accelerators
21	OpenOil	B2C, B2B, B2G	Corporate Fillings, Stock exchange markets	Foundations, Incubators
22	Parkpocket	B2C	Municipalities	Businesses, Accelerators, Associations
23	Plasmap	B2B	Government, EU Open data portal, OpenCellID, OpenStreetMap	No official partners
24	PTV Group	B2B, B2G	Municipalities, Transp. Companies, OpenStreetMap	Businesses, Government, Public institutions
25	RSS	B2B	NASA	Universities, Businesses, Non-profit organizations, Foundations
26	Viomedo	B2C	Destatis, DRKS	Accelerators, Start-up incubators, Business angels, Doctors & Patient advocacy groups, Pharmacies, Research institutes
27	VirtualCitySystems	B2B	Municipalities, OpenStreetMap	Businesses, Universities, Research institutes
28	Vista	B2B, B2G	Copernicus	Businesses, Universities, Non-profit organizations
29	Webkid	B2C, B2B	Municipalities Public institutions, OpenStreetMap	Businesses & Media

APPENDIX B5: VALUE IN RETURN DATA

N	Company name	Value in Return
1	365FarmNet	Ease of access to data from various sources | Convenience of using the data at any time and place | Perceived value of data-enriching activities such as data visualization | Perceived value of data-enriching products and services such as documentation function, weather and calendar function, inventory management functionality
2	3D Content Logistics	Increased understandability of the data through complex data visualization | Adaptation of the data to customers' needs | Perceived value of data-enriching activities
3	Appstretto	Increased understandability of the data through data visualization | Increased ease of access to the data
4	BerliTec	Increased understandability and ease of access to the data through data visualization
5	Bike Citizens	Convenience of using the data while riding | Perceived value of data-enriching products and services such as generator of cycling routes | Perceived value of data-enriching activities such as consolidation of data from various source | Adaptation of the data to customers' needs
6	City Cult	Increased ease of access and understandability of the data due to visualization | Convenience to use the data at any time and place | Perceived value of data enriching functionalities
7	Con terra	Perceived value of data-enriching activities such as data integration into various IT structures | Perceived value of data-enriching products and services such as consultancy and software engineering services | Data adaptation to the specific customer needs
8	Datenfreunde	Increased understandability of the data through data visualization | Perceived value of data-enriching activities such as data analysis
9	Door2Door	Convenience of using the data on the go | Perceived value of data-enriching functionalities such as generation of routes and comparison of travel options
10	Esri Deutschland	Perceived value of data-enriching products and services such as consulting enabled by the professional expertise, know-how and wide partner network of the company
11	Geofabrik	Perceived value of data-enriching activities such as data consolidation from various sources | Perceived value of data-enriching products and services such as consulting and training | Data adaptation to customers' needs
12	Green City Solutions	Enhancing the understandability of the data through analyses, simulations and integration into various presentation methods | Using the data for creating an innovative new product
13	Implisense	Perceived value of data collection, integration and analysis based on the professional competence and know-how of the company's team
14	Iosphere	Data customization to customers' needs | Data visualization | Convenience of using the data | Perceived value of data-enriching products and services
15	Klaus Benndorf	Perceived value of data-enriching activities such as consolidation of data from various sources | Perceived value of data-enriching products and services such as consulting, technology development and trainings
16	Mapegy	Ease of access to and increased understandability of various and highly complex data, difficult to obtain otherwise | Perceived value of data-enriching activities such as integration of the data from various sources and data analysis with high level of professional expertise | Perceived value of data-enriching services such as analyses of technology trends and competition
17	Motion Intelligence	Providing ease of access to highly sophisticated data | Providing the data to the customer after integrating it with data from other sources | Professional data analysis
18	Mr. Fridge Software	Increased understandability of the data through data visualization | Ease of access to the data

19	Mundraub	Providing data specifically adapted to the customers' needs | Enriching the data with data from other sources, such as user-generated data | Enabling the access to and understandability of the data through visualization
20	Naturtrip	Increased understandability of the data through visualization | Convenience of using the app at any time and place | Perceived value of data-enriching activities such as consolidation of data from various sources | Perceived value of data-enriching services such as identification of a matching free time activity and public transportation planning
21	OpenOil	Data-enriching activities such as data consolidation, data processing, text and data analysis | Data-enriching services such as a search engine service
22	Parkpocket	Convenience of using the data on the go and while parking | Ease of access and understandability increased through data visualization | Additional functionalities such as a navigation service
23	Plasmap	Ease of access to data consolidated from different sources | Perceived value of data-enriching activities & products and services
24	PTV Group	Perceived value of data-enriching products and services such as consulting, research and software development | Perceived value of data-enriching activities such as data visualization and analysis
25	RSS	Perceived value of data-enriching products and services such as consulting, mapping, capacity building | Perceived value of data-enriching activities such as data analysis and consolidation from various sources | Data visualization | Ease of access to the data | Increased understandability of the data
26	Viomedo	Data-enriching activities such as aggregating clinical trial information from various sources | Data-based products and services such as accelerating the development of new medicine and therapies, and helping new medical advancements reach patients faster
27	VirtualCitySystems	Perceived value of data-enriching services such as consulting and development of software solutions enabled by professional expertise
28	Vista	Data visualization | Perceived value of data-enriching products and services | Perceived value of data-enriching activities
29	Webkid	Ease of access to data from various sources | Increased understandability of the data through visualization

APPENDIX B6: VALUE CAPTURE DATA

N	Company name	Value Capture
1	365FarmNet	Free trial & Subscription-based pricing for additional functionalities
2	3D Content Logistics	Customized pricing plans
3	Appstretto	Open data product: Free of charge Other products: Free trial & Customized pricing plans for full version
4	BerliTec	Open data product: One-time-pay Other products: Free download & In-app purchases
5	Bike Citizens	Open data product: Free download & In-app purchases Revenues from supplementary products
6	City Cult	For B2C: Free of charge, For B2B: Customized pricing plans
7	Con terra	Large variety of products and services with different pricing models
8	Datenfreunde	Customized pricing plans, Awards
9	Door2Door	Apps: Free of charge Services: Pay per receiving the service
10	Esri Deutschland	Large variety of products and services with different pricing models
11	Geofabrik	Subscription-based, Varying prices depending on quantity purchased, Customized prices after defining the specific needs of the customer
12	Green City Solutions	Free trial & One-time-pay / Rent & Lease options
13	Implisense	Free trial & Subscription-based / One-time-fees Customized pricing plans
14	Iosphere	Free trial, Pay-per-download, Subscription-based
15	Klaus Benndorf	Large variety of products and services with different pricing models
16	Mapegy	Customized prices depending on the specific needs of the customers
17	Motion Intelligence	For B2C: Free of charge, For B2B: Pay-per-download / One-time-pay / Subscription-based / Customized pricing plans
18	Mr. Fridge Software	Open data product: Free of charge Other products: Free download & In-app purchases
19	Mundraub	For B2C: Free of charge, For B2B: Subscription-based Revenues from complementary products and services
20	Naturtrip	Government support & Private funding
21	OpenOil	Search engine: Free of charge, Other services: Customized plans Sponsorships, Funding
22	Parkpocket	Product free of charge, Other funding
23	Plasmap	Customized prices depending on the specific needs of the customers
24	PTV Group	Large variety of products and services with different pricing models
25	RSS	Customized prices depending on the specific needs of the customer
26	Viomedo	Sponsorships
27	VirtualCitySystems	Free trial & Additional pricing options
28	Vista	Customized prices depending on the specific needs of the customer
29	Webkid	Variety of products free of charge Customized pricing models Awards

APPENDIX C: COMPARISON OF THE RESULTS WITH EXISTING LITERATURE

APPENDIX C1.1: VALUE PROPOSITION RESULTS COMPARISON I - PRODUCTS & SERVICES

Research Results	Zeleti, Ojo & Curry (2016) Results	Ferro & Osella (2013) Results
Value-adding software solutions	**[Value]** Useful data for the public Useful data services and apps Availability of higher quality data Open data supporting strategic business objective High value adding data service Sustainable publishing solutions Scalable infrastructure Meeting specific customer data need Efficiency Cost avoidance	**[Value]** Product/Service with a high intrinsic value

Value-adding services
 	
Other value-adding products
	[Price/Quality Relation]
	Free data and useful for public
	Free but limited data services
	High quality data at some cost
	Free but limited data services &
	    High quality data at some cost
	Free data for non-corporate use &
	    High quality data for corporate use
	Free data for non-commercial use &
	    High quality data for commercial use
	Incomplete data at low cost &
	    Complete data at higher cost
	Higher quality and reliable data at some cost
		[Price/Quality Relation]
		Freemium Product/Service (Basic features/Refined features)
		Attractive inexpensive offer & Consumables

Research Results	Janssen & Zuiderwijk (2014)	Zimmermann & Pucihar (2013)
Value-adding software solutions	Single-purpose apps providing real-time information Interactive apps providing users the opportunity to add content Information aggregators Comparison models Service platforms	Language learning app Transport information app Software and SaaS solutions Decision support tools Field health tools
Value-adding services		Insurance services
Other value-adding products		

APPENDIX C1.2: VALUE PROPOSITION RESULTS COMPARISON II - DISTRIBUTION CHANNEL

Research Results	Ferro & Osella (2013)	Janssen & Zuiderwijk (2014)	Zimmermann & Pucihar (2013)
Corporate website	The Web		Web
App stores	A mobile channel	App stores	App, Mobile Google Play Store
Direct sales			Dealer/co-op network

APPENDIX C2: VALUE ADDING PROCESS RESULTS COMPARISON

Research Results	Zeleti, Ojo & Curry (2016) Results	Ferro & Osella (2013) Results
Data sources identification		
Data collection	Collecting and cataloging data Data retrieval	Data collection
Data filtering		
Data processing	Standardization of formats Refining datasets Cleansed data	Cataloguing data Converting datasets in data streams
Data consolidation	Enhancement of the data with additional information Mashing with other data Harmonizing data	Harmonizing formats
Data storage		Data storage - on cloud computing platforms - on proprietary servers
Data integration into the solution	Publishing Publishing data as linked data Data visualization App making & upgrading Providing APIs / APIs and GUI Availability of machine-readable formats Provision of data on DVDs or hard disks rather than over the net Access to data dumps Automated external exposure of data via	Exposing the data through APIs
Product-specific activities	Data analysis Guarantees on data availability Prioritization of bug fixes Timely help for customers using the data Services around data visualization Unconstrained number of API calls More sophisticated querying rather than through an API Early access to the data	
Data maintenance	Data maintenance Update data Provision of feeds of changes to the data Feedback	Maintenance of data
Research Results	Janssen & Zuiderwijk (2014) Results	Zimmermann & Pucihar (2013) Res.
Data sources identification		
Data collection	Data collection from various sources	
Data filtering		
Data processing	Data processing	Data refining
Data consolidation	Data aggregating	
Data storage		
Data integration into the solution	Displaying the data in an app Data visualization	Data visualization
Product-specific activities	Adding ratings and complaints Provides opportunities to add content	Data mining & scraping
Data maintenance		

APPENDIX C3.1: VALUE NETWORK RESULTS COMPARISON I - CUSTOMERS

Research Results	Zeleti, Ojo & Curry (2016) Results	Ferro & Osella (2013) Results
B2C	Clients (mostly consumers B2C) Clients (as an active player) (Software) Developers Lawyers, Academics	B2C ("high-end-market") Scientists not driven by commercial intent
B2B	Companies Mostly business clients Technology companies Publishers selling data (Software) developers Lawyers	B2B ("high-end-market") Profit-oriented developers
B2G	Government	
	Mixed clients (B2B, B2G, B2C)	
Research Results	**Janssen & Zuiderwijk (2014) Results**	**Zimmermann & Pucihar (2013) Results**
B2C	Citizens	Private users
B2B	Companies	Corporate clients
B2G		

APPENDIX C3.2: VALUE NETWORK RESULTS COMPARISON II - SUPPLIERS

Research Results	Janssen & Zuiderwijk (2014) Results	Zimmermann & Pucihar (2013) Results
Government & Municipalities	Government	Government
Publicly-owned entities	Public agencies Public organizations	Public transport companies
Public-private companies		
Non-profit org., Foundations & Associations		
Private businesses		
	Citizens	

APPENDIX C3.3: VALUE NETWORK RESULTS COMPARISON III - PARTNERS

Research Results	Janssen & Zuiderwijk (2014) Results	Zimmermann & Pucihar (2013) Results
Government & Municipalities	Government Public agencies Public companies	Government
Research institutes, Universities & Educational Institutions		
Non-profit organizations, Foundations & Associations	Societal organizations	Global open data community
Start-up incubators & Accelerators		Incubators
Private businesses	Businesses	Consultants

APPENDIX C4: VALUE IN RETURN RESULTS COMPARISON

Research Results	Zeleti, Ojo & Curry (2016) Results	Ferro & Osella (2013) Results
Ease of access to the data	Perceived value of data Cost Savings Savings in development time Savings in development budget Improved business outcomes Availability of data to public Recognition and attribution from data made freely available	Easier access to PSI resources Ease of retrieving the data Ease of access to various data through one supplier Minimizing search costs Minimizing transaction costs
Convenience of using the data		
Data adaptation to customers' needs		
Increased understandability of the data		
Perceived value of data-enriching activities	Perceived value of data not freely provided Higher quality data with increased value Commoditization and democratization of data	License variations Commoditization of data Democratization of data Enriching the data Cloud storage External exposure of data via APIs Tagging with metadata Standardization of formats Rapid upload of new datasets
Perceived value of data-enriching products and services	Perceived value of additional data services	Value of added services Advanced features
Research Results	Janssen & Zuiderwijk (2014) Results	Zimmermann & Pucihar (2013) Results
Ease of access to the data		Cost saving Time saving
Convenience of using the data		
Data adaptation to customers' needs		
Increased understandability of the data	Visual presentation for the ease of the users	
Perceived value of data-enriching activities	Data integration from various sources	
Perceived value of data-enriching products and services	Added ratings information Added complaints information Comparison opportunities Features for searching information Features for importing information Features for cleansing information Features for processing information Features for visualizing information	Less risk Better crop performance Diverse learning modules Connecting businesses and learners

APPENDIX C5: VALUE CAPTURE RESULTS COMPARISON

Research Results	Zeleti, Ojo & Curry (2016) Results	Ferro & Osella (2013) Results
Revenues	Revenue Revenue received Revenue from data Revenue from added value services Revenue in exchange for advanced services and refined datasets or data flows Revenue from the small percentage of free users Revenue from potential advertisers Revenue from Adverts Lump sum revenue Charges for additional data or advanced features Sustainable publishing practice Proactive data release	Revenues from PSI reuse ("Bread and butter") - Pay per use - Recurring fee / Periodic fee - Basics version for free & Additional features charge Revenues from - supplementary business - added-value services - advanced services - license variations - refined datasets - data flows
Sponsorships & Donations	Revenue from sponsors	
Funding		
Branding & Marketing	Presence in the service market Client satisfaction Customer satisfaction	PSI as "Attraction tool" - Brand visibility - Reputation boost - Paving the way for complementary lines Advertizing
Technology Development		
Networking		"Attraction tool" for new partnerships
Research Results	**Janssen & Zuiderwijk (2014) Results**	**Zimmermann & Pucihar (2013) Results**
Revenues	Revenues through - Payment per use	Revenues through - Usage fees - Adds
Sponsorships & Donations		
Funding	Funding	
Branding & Marketing		
Technology Development		
Networking		

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