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The utilization of key registry open data intermediaries by real estate development professionals in the Netherlands

An analysis of the creation and capturing of value

final thesis

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Summary

This study analyses the extent to which key register open data intermediaries, utilized by real estate development professionals, create and capture value. By creating specific products or services, intermediaries create value in the sense that their product or service adds something to the data, that makes it more valuable. Furthermore, they capture value by gaining something from providing their products or services.

The methodology applied in this study can be generalized into two steps. Firstly, semi-structured interviews were conducted with ten different real estate development professionals to analyse which intermediaries of key registries were used, and why utilizing these intermediaries was valuable from their perspective. Subsequently, these intermediaries were interviewed in a semi-structured manner to provide context regarding value-creation and analyse the applied revenue models to capture value.

In general, the intermediaries featured in this study created value by bridging (1) a legal gap; providing access to key registry data which the end-user otherwise is prohibited from accessing and (2) a technical gap; allowing end-users to view the specific key registry data without any technical knowledge regarding web services or APIs

The extent of the value that is created by bridging these gaps is dependent on (1) the findability and (2) the specificity of an intermediary. Firstly, the findability is a derivative of the bounded rationality of the end-users, as most end-users are attracted to the first intermediary they can find, regardless of how well it satisfies their needs. Secondly, the specificity of an intermediary is of essential importance, as the interviewed end-users are extrinsically motivated to find an intermediary that lowers their transaction costs. In other words, end-users indicated that they valued the intermediary that gave them their data "with as little clicks as possible" the highest.

Furthermore, intermediaries capture value in a different manner depending on the specific characteristics of the intermediary. Public sector intermediaries captured value through the budget financing of overarching organisations that benefited from their existence while private sector intermediaries captured value through subscription- and fee-based revenue models.

Based on the findings of this study, the following recommendations were formulated:

1. Utilizing a binary distinction between open and closed data is counterproductive, as data is positioned on an open data spectrum somewhere in between these extremes.
2. Although it is the intermediary that creates the value, the value is constructed through the perspective of a user and should therefore not be seen in isolation.
3. For intermediaries aspiring to specify their product for real estate development professionals, it is recommended to focus on (1) lowering transaction costs by making the product as specific as possible and (2) ensuring findability of the product.
4. For end-users, many of the described problems regarding the usage of intermediaries can be solved by either (1) investing in technical (GIS-)expertise to utilize API connections of key registries or (2) inquiring an organisation with technical expertise to build a GIS-viewer specific to the requirements of the end-users within an organisation.

Preface

This document features the master thesis *"The utilization of key registry open data intermediaries by real estate development professionals in the Netherlands"*. It has been written to comply with the requirements for completing the master 'Geographical Information Management and Applications' at a combination of the University of Utrecht, Enschede, Wageningen and Delft.

I would like to thank my supervisor dr. Frederika Welle Donker for the guidance and feedback during the thesis process and dr. ir. Bastiaan van Loenen for being the responsible professor during the process and also supplying feedback. Additionally, I would like to thank Ashraf Shaharudin, MSc. for feedback regarding my conclusions. Furthermore, I would like to thank everyone who participated in the interviews for their useful contributions. Lastly, I would like to thank family and friends for the support during the thesis process.

I am grateful to be able to write that after the submittal of this thesis, I will be able to further the research conducted in this thesis on a more specified scale. In the form of an internship, I will be testing the formulated theories in practice, by conducting a large-scale research concerning value creation at a specific intermediary.

I hope that you enjoy reading this master thesis.

Ruben Welkers,
Utrecht, 23th of February 2024

List of abbreviations

Abbreviation	Definition
(D)DoS	(Distributed) Denial of Service
ACM	Authority Consumers and Market
API	Application Programming Interface
BAG	Key registry Adresses and Buildings (Basisregistratie Adressen en Gebouwen)
BGT	Key registry Large-Scale Topography (Basisregistratie Grootschalige Topografie)
BRK	Key registry Cadastre (Basisregistratie Kadaster)
BRO	Key Registry Ground (Basisregistratie Ondergrond)
BRP	Key registry Persons (Basisregistratie Personen)
BRT	Key registry Topography (Basisregistratie Topografie)
CBS	Statistics Netherlands (Centraal Bureau voor de Statistiek)
DIKW	Data-information-knowledge-wisdom
DSO	Digitaal Stelsel Omgevingswet
EU	European Union
FAIR	Findability Accessibility Interoperability Reusability
GDPR	General Data Protection Regulation
HVD	High Value Dataset
KvK	Netherlands Chamber of Commerce
KWB	Key Figures Districts and Neighbourhoods (Kerncijfers Wijken en Buurten
OD	Open Data
ODI	Open Data Institute
PDF	Portable Document Format
PDOK	Public Services on the Map (Publieke Diensten op de Kaart)
PSI	Public Sector Information
RQ	Research Question
RvIG	National Office for Identity Data (Rijksdienst voor Identiteitsgegevens)
URI	Unique Resource identifier
URL	Uniform Resource Locator
WFS	Web Feature Service
Who	Wet Hergebruik van Overheidsinformatie
WMS	Web Map Service
WMTS	Web Map Tile Service
Wob	Wet Openbaarheid van Bestuur
Woo	Wet Open Overheid
WOZ	Key Registry Property Value (Waarde Onroerende Zaken)
XML	Extensible Markup Language

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1. Introduction

The contemporary housing landscape in the Netherlands is marked by a pronounced shortage, with a need to construct 981.000 housing units before 2030 to meet the rising demand (de Jonge, 2023). By extrapolating the 2022 housing-construction rate of 75.000 housing units per year (CBS, 2023-a), this goal of constructing 981.000 new housing units would not be reached. From a simple supply-demand comparison, it would therefore be expected that construction rates would rise substantially to match the demand (Lisi, 2015). However, rather than an increase, 2023 saw a substantial decrease of the newly constructed housing rate and 2024 is expected to see another decrease (van Sante, 2023). Furthermore, long-term projections compound this concern as the number of issued building permits has decreased similarly to construction rates (Primos, 2023).

While the cause of the inability of the supply to match the demand is multifaceted, the fundamental determinant is the costs of developing real estate being lower than the expected yield (Lisi, 2015). Developers are faced with escalating construction costs (Michielen, 2022) while simultaneously experiencing a top-down accumulation of demands regarding sustainability and affordability (Heezen & Schepman, 2023). These pressures and market-trends are narrowing profit margins for real estate developers, often making future projects financially infeasible and halting current projects (de Boer, 2023).

Enhancing construction rates should, therefore, be intrinsically linked to increasing the financial feasibility of real estate development. While macroeconomic trends and top-down policy initiatives are difficult to influence, it is possible to influence internal aspects in the preparation phase of real estate development. For example, by applying a more *data-driven* approach to determining the relevant conditions and requirements in the preparation phase of real estate development projects (Braesemann & Baum, 2020). One of the first steps within the notion of a data-driven approach is the identification and efficient retrieval of relevant data (Pentland, 2013). Streamlining this process implies a lesser time spent searching for and gathering relevant data. In other words, the *transaction costs* of data (Welle Donker & van Loenen, 2016) can be reduced, reducing the overall costs of the plan preparation phase, and having a, however marginal, effect on the financial feasibility of projects.

While an abundance of relevant data exists for real estate development professionals, organisations often opt for the application of *open*[1] data in their data-driven approaches (Park, 2020; Donner et al., 2018). The inherent characteristic of open data, allowing unrestricted usage, maintains minimal costs for real estate developers, rendering it an interesting concept for enhancing financial efficiency. Within the context of the Netherlands, a substantial portion of this (open) data that could be relevant to real estate development professionals is provided in the form of *key registries* (Dutch: Basisregistraties). These key

[1] The concept of 'open data' can be defined in short as "*…content that can be **freely used**, **modified**, and **shared** by **anyone** for **any purpose***" (Open Knowledge Foundation, n.d.).

registries entail ten different interlinked 'base' datasets that contain data about, among others, all buildings, people, businesses, and vehicles[2] (Benner, 2014).

However, although these key registries are supplied by specifically appointed entities (Rijksoverheid, n.d.-d), end-users within the real estate development sector do not always access these data suppliers directly. In certain instances, they access (open) data *intermediaries* that act as third-party actors between the data supplier and end-user and enhance the supply, flow, and/or use of open data through the provision of specialized resources and capabilities (Shaharudin et al., 2023).

While not deterministically the case in all situations, intermediaries frequently emerge in response to specific challenges identified in the connection between the data supplier and the end-user. In this context, they serve to "*bridge the gap*" (van Loenen et al., 2021) and dissolve barriers between the end-user and the data supplier (Den Haan, 2018). Although the scope of these gaps and barriers is diverse, a straightforward example can be provided. For instance, open data from key registries is often provided through a complex web-API such as a web feature service [WFS] connection (PDOK, n.d.), which could be beyond the technical expertise of a real estate development end-user. An intermediary can mitigate this technical disparity by transforming the WFS-connection into a data format that is more accessible to non-technical end-users, such as an Excel file.

The intermediary business model operates along two fundamental principles. Firstly, the intermediary creates value through its activities, products, or services, enhancing the value of the (open) data supplied by the data supplier. Secondly, as altruism is not an intrinsic property of intermediaries, they often apply measures to *capture* value by gaining something from providing their activities/products/services (Vancauwenberghe et al., 2018).

1.1 Problem statement

While the academic literature has extensively explored the specifications of creating and capturing value by intermediaries (Attard, 2016; Shaharudin et al., 2023, Balvert & van Maanen, 2019; Dove et al., 2023), it is imperative to not overlook the contextual dependencies inherent to social phenomena (Hayek, 1989, de Pater, 2014). This contextual dependency implies that the gaps in which intermediaries operate (Shaharudin et al., 2023) differ on a case-by-case basis. In other words, although the general academic literature is able to provide a generic idea concerning how intermediaries create and capture value, the ensuring of a credible perspective regarding the specific case of real estate development professionals accessing key registries in the Netherlands, requires research centred around this specific group (Lindgaard et al., 2006).

[2] The degree to which a key registry is 'open' differs per registry. A further explanation of the system of key registries is provided in chapter 3 (case description).

The absence of a theoretical framework regarding how value is created and captured by intermediaries accessed by real estate development professionals is problematic, as this absence entails complexities regarding understanding the positioning of these intermediaries within the wider (open) data ecosystem[3]. Understanding this positioning is relevant for various actors within this open data ecosystem in different manners. For example, through an analysis of how value is created in the perspective of real estate development end-users, intermediaries can structure their products/services in a demand-driven manner[4] (van Loenen et al., 2021). On the other hand, discerning how value is captured by intermediaries can for example be essential in developing policies that stimulate or discourage the presence of intermediaries for real estate development related data (Welle Donker, 2009). Both above-mentioned examples are challenging to base on the existing body of contemporary academic literature that addresses a generic perspective on value creation and capture by intermediaries. Successfully operationalizing these examples becomes more feasible by applying a theoretical framework specific to the case of real estate development professionals.

1.2 Research questions

The primary emphasis of this study therefore lies in identifying (1) the manner in which intermediaries *create* value and bridge gaps between the real estate development professional and key registries, and (2) the reasoning for the intermediary to create this value, i.e. how they *capture* value. In other words, the central research question is:

> *"To what extent do intermediaries of key register open data used by real estate development end-users in the Netherlands create and capture value?"*

To enhance the likelihood of comprehensively addressing the central research question, the research objective is split up into several sub-objectives (Scheepers et al., 2016). Firstly, to provide an answer to a question assessing the specifics of a phenomena, it is necessary to first analyse if (and to what extent) that phenomena happens (Sinek, 2011). Currently, the degree to which real estate development end-users utilize intermediaries is primarily assessed through the lens of basic economic supply-demand theory (Gale, 1995). This presupposes that the presence/supply of open data intermediaries suggests a corresponding demand for their services. In other words, the existence of open data intermediaries signifies that they are being used.

However, as is the case with theoretic economic models, often the reality can differ from what a model predicts (Thaler, 2000). This discrepancy necessitates empirical verification regarding the extent to which real estate development end-users utilize key register open data intermediaries. In other words,

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[3] An open data ecosystem is (1) user-driven, (2) circular, (3) inclusive, and (4) skill-based (van Loenen et al., 2021). This is elucidated further in the theoretic framework.

[4] It is worth noting that most intermediaries presumably already develop their own market-scans or user needs assessments, but the problem described here is the absence of an academic and theoretic framework.

at this stage of the research it is still uncertain whether the specific end-users are indeed utilizing intermediaries or not. Consequently, the first sub-research question [RQ] is:

> ***Sub-RQ1:*** *"To which extent are real estate development end-users accessing key register open data intermediaries?"*

The second sub research question relates to the first concept within the central research question, the *creation* of value. Here, it is of importance to note that this value is not created in an objective sense, but through the perspective of the real estate development end-user (Haksever et al., 2004). This subjective perspective of the end-user concerning what intermediaries do that creates value is limited by the bounded rationality of the end-user themselves (Simon, 1990; Conlisk, 1996) as they do not possess every possible bit of information (Puranam et al., 2015; Kolodny, 2005). Therefore, this sub research question emphasizes the creation of value by intermediaries in the perspective of the end-user. Consequently, the second sub-RQ is:

> ***Sub-RQ2:*** *"What characteristics of the intermediary create value in the perspective of the end-users?"*

The third sub research question concerns the other section of the central research question, namely the process of value *capturing* by intermediaries. As mentioned before, intermediaries do not intrinsically act in an altruistic manner, and it can be expected that these intermediaries require a return on their products or services (Welle Donker, 2009). Thus, where Sub-RQ2 is focussed on the motive to access intermediaries from the perspective of the end-user, Sub-RQ3 is centred around an analysis of the motives of intermediaries to create their products or services. The third and last sub-RQ is:

> ***Sub RQ3:*** *"To what extent do intermediaries capture value from their activities?"*

1.3 Scientific and societal relevance

Answering the above research question and accomplishing the research objective holds both a scientific and societal relevance. The scientific relevance is multifaceted. Firstly, this study contributes empirical evidence towards the more 'global' idea regarding the positioning of the intermediary within the open data ecosystem (Shaharudin et al., 2023). This 'positioning' relates not only to the location between the data supplier and the end-user, but also encompasses its role within data value chains (Schalkwyk et al., 2016). By contributing empirical evidence regarding specific open data intermediaries and the value they add for these specific end-users, this study complements the global framework surrounding what open data intermediaries do and ought to do. As the radically pluralistic nature of society implies that no two end-users are identical due to the societal context of every individual harnessing different technological capabilities, norms, values and other need-producing factors (Hayek, 1989; Alexander et al., 2012), empirical evidence towards this positioning is never redundant. In other words, theories regarding intermediaries are never *finished,* as every single observation of humans has the possibility to produce new insights.

Secondly, this study holds scientific relevance by advancing knowledge regarding the user needs of real estate development end-users concerning key registry (open) data. Again, although the needs of real estate development end-users are context-dependent (Waite & Logan, 2011), this study can contribute to the more universal theory regarding end-users by supplying empirical evidence.

Furthermore, this study bears a societal relevance in two different manners. Firstly, an analysis towards how value is *captured* can help intermediaries better understand and structure their method of value capturing (Welle Donker & van Loenen, 2016). Subsequently, this more efficient manner of capturing value can lead to the possibility of investing more resources to enhance products/services so that more value can be *created* in the perspective of the end-user. Furthermore, understanding the techniques of capturing value from key registry (open) data by intermediaries can also help the data suppliers of these key registries in developing policies that assist structuring the open data ecosystem to their preferences. For example, by stimulating or discouraging the ability of intermediaries to capture value from their products/services.

The second societal relevance relates to understanding how value is *created* in the perspective of the real estate development end-users of key registry (open) data intermediaries. Firstly, as it becomes clear to intermediaries what it is that they do that is valuable in the perspective of their end-users, they can develop their products/services along a more demand-driven method. This could entail more value for their end-users, and therefore (for example) more resources that the end-user is willing to pay for the products/services of the intermediary. This increased value that is created by tailoring products/services to end-users' needs can lead to a more efficient workflow for real estate development professionals. Consequently, this optimization results in reduced data transaction costs and therefore a (slight) decrease in plan preparation costs. Ultimately, this contributes to a diminished overall cost in real estate development, consequently alleviating the aforementioned pressures in the housing market (Michielen, 2022; de Boer, 2023).

1.4 Reading guide

Next to this introduction, Chapter 2 delves into the theoretical framework, offering a comprehensive literature review on relevant topics to establish a solid foundation for the research. Furthermore, Chapter 3 provides a detailed description of the case analysed in this study, while Chapter 4 outlines the methodology employed to conduct the research. In Chapter 5, the findings of this study are provided, followed by a thorough discussion in Chapter 6 that interprets these findings and discussed any limitations. Finally, Chapter 7 serves as the culmination of this study, presenting conclusions together with recommendations for data suppliers, intermediaries and end-users.

2. Theoretic framework

In the following chapter, the theory relevant to this study is elucidated. This elucidation is executed through a dissection of the central research question. The first concept that is required to be theoretically delimited is '(open) data' itself. Subsequently the concept of 'value' is elucidated, with a focus on value creation and capturing. Lastly, The positioning of the relevant actors (data supplier, intermediary, end-user) within the open data ecosystem is theoretically described.

2.1 The theory behind open data

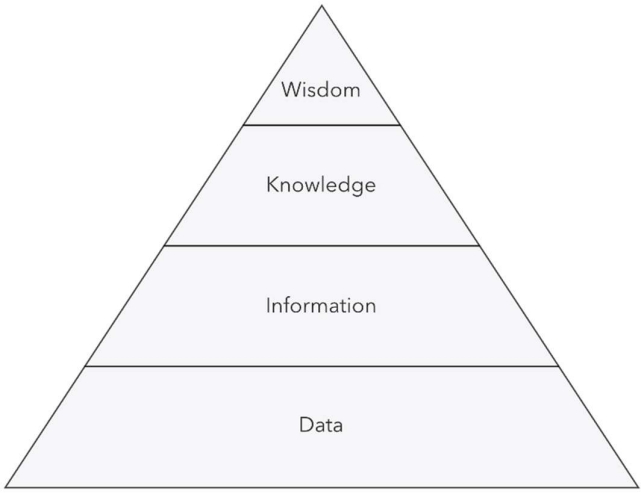
The following section is dedicated to a description of (open) data. Firstly, the more generic concept of 'data' is elucidated, with subsequently, a description of *open* data.

2.1.1 The definition of data and the DIKW-hierarchy

Data – the plural of *datum* – are discrete, objective facts or observations (Pearlson et al., 2019). By themselves, data have no meaning or significance beyond their existence. An example of data can be a list of numbers [5, 8, 3, 10] or a sequence of grouped letters ['abc', 'acb', 'adb'] (Bellinger et al., 2004). As data in their rawest form are difficult to utilize for further analysis, it is generally considered in relation to other forms of entities. An often cited framework for describing these relations is referred to as the *data-information-knowledge-wisdom* [DIKW] hierarchy (Figure 2.1), where the concept of 'data' is found on the base level (Rowley, 2007).

Figure 2.1

The Data, Information, Knowledge, Wisdom [DIKW] Hierarchy



Note. A model illustrating the hierarchy between data, information, knowledge and wisdom. Adapted from "The wisdom hierarchy: representations of the DIKW hierarchy" by J. Rowley, 2007, *Journal of information science*, *33*(2), p. 165.

According to the DIKW hierarchy, data only become meaningful as certain *metadata* (data *about* the data) are added. By contextualising this data, the data are then transformed into *information,* moving up one row on the DIKW-hierarchy (Rowley, 2007). Where data are deemed to be mere symbols, information is able to provide answers to certain questions surrounding the *"…'who', 'what', 'where' and 'when' questions."* (Bellinger et al., 2004, p.1). For example, where data resembles

[5, 8, 3, 10]

Information resembles;

[5 people ate in the restaurant in the street on the first of January 2023,
8 students studied in the library on Tuesday,
3 individuals bought products in the store this month,
10 employees came in late to work in 2024]

Furthermore, where data and information are objective in the sense that they are identical for all readers, *knowledge* is about drawing meaningful conclusions from information (Rowley, 2007). In other words, knowledge is about being able to transform information into instructions by – for example – recognizing certain patterns (Frické, 2019). As a concrete example, from a dataset containing the number of individuals that visit a restaurant per day (information), the pattern can be recognized that a certain day in the week is the most popular and thus should have longer opening hours (knowledge).

The last layer of the DIKW-hierarchy contains the *wisdom* entity. In general, this layer is considered to be the human-centred layer as this concerns ideological/philosophical discussions which computers are unable to make (Rowley, 2007; Bellinger et al., 2004; Frické, 2019). Where knowledge is related to 'objective' pattern recognition, wisdom relates to ideological dilemmas such as *why* one should use the knowledge (Jifa & Lingling, 2014). Expanding on the previous concrete example, where knowledge is extending opening hours on busy days for profit maximization, wisdom is the ideological reflection surrounding the maximization of profit over obligating employees to work longer hours on busy days. Computers cannot answer such ideological dilemmas as there is no objective measurement comparing employee exploitation and profitability (Frické, 2019). Ultimately, it is a human actor that applies its specific norms and values to a dilemma making the characteristics of wisdom those *"…that differentiate man from machines."* (Ackoff, 1989, p. 7).

2.1.2 *Open* data

After having defined data and contextualised them relative to the DIKW-hierarchy (as described in Section 2.1.1), it is possible to theoretically outline *open* data. As mentioned in the introduction, open data can be defined as *"…content that can be* ***freely used, modified, and shared*** *by* ***anyone*** *for* ***any purpose***" (Open Knowledge Foundation, n.d.). However, exclusively abiding by this predominantly technical- and legal definition can cause the neglection of additional relevant factors such as the

machine-readability or accessibility of the data (Welle Donker, 2016). Therefore, to not be limited by an incomplete definition of open data, it is also possible to adhere to the ten principles of open data (Welle Donker & van Loenen, 2017). These ten principles – as created by the Sunlight Foundation (2010) – are;

1. *Completeness:* Data should be published in full, together with metadata and explanation how the data were retrieved or calculated.
2. *Primacy:* Data should be primary source data, including details on how the data was collected.
3. *Timeliness:* Data should be as real-time as possible.
4. *Ease of Physical and Electronic Access:* Users should be able to access the data through interfaces, Application Programming Interfaces [APIs], etc.
5. *Machine readability:* Machines should be able to easily parse the data.
6. *Non-discrimination:* Everyone should be able to access the data (so no memberships etc.).
7. *Commonly owned or open standards:* Non proprietary formats are preferred (e.g. .csv over . xlsx)
8. *Licensing:* No restrictions on the (re-)use of data.
9. *Permanence:* Data should be online permanently, with version-tracking over time.
10. *Usage costs:* There should be no fees for the data.

However, it is worth noting that unequivocally adhering to the above illustrated principles can cause problems within the serving of open data. For example, as point 6 notes that *nobody* can be excluded from accessing the dataset, also those that misuse the open dataset cannot be excluded (Janssen & Zuiderwijk, 2014). An example of misuse could be a *Denial of Service [DoS]* where a program purposely sends a substantial amount of requests per second to the open dataset with the intent to overload the server (Hoque et al., 2015). Adhering to the non-discriminatory principle, *"any person can access the data at any time without having to identify him/herself or provide any justification for doing so"* (Sunlight Foundation, 2010). The actual blocking of the IP-addresses performing the DoS implies a slight deviation from this principle, as IP-blocking requires the user to identify themselves with their IP-address beforehand (Fedorov et al., 2021). Therefore, often, providers of open datasets deviate from the non-discriminatory principle and block DoS attacks on the grounds of criminal law (Sharieh & Ferworn, 2021).

Further issues with the principles include privacy concerns with publishing the primary source data (principle 2). Sometimes, data is required to be presented in an aggregated/anonymised form to protect the privacy of individuals (Floridi, 2014). Also, avoiding proprietary formats for the distribution of the data (principle 7) can interfere with the ease of electronic access (principle 4). Proprietary formats are, despite their limitations, often more user-friendly and therefore easier to use (Wang et al., 2020). Nonetheless, it is noteworthy that the principles of open data remain a widely applied framework for evaluating data openness (Sayogo et al., 2014). In recent assessments of open data, the framework of 10 principles are frequently applied with additional principles (Junior et al., 2023).

Relating the principles of open data to the DIKW-hierarchy, it becomes clear that true open data materializes as open *information.* Adhering to the principle of completeness (principle 1), the data should be published with sufficient metadata, so that it is clear what the data entails. However, for purposes of simplicity and harmonization, in this study the concept is still referred to as open data.

2.1.3 The open data spectrum

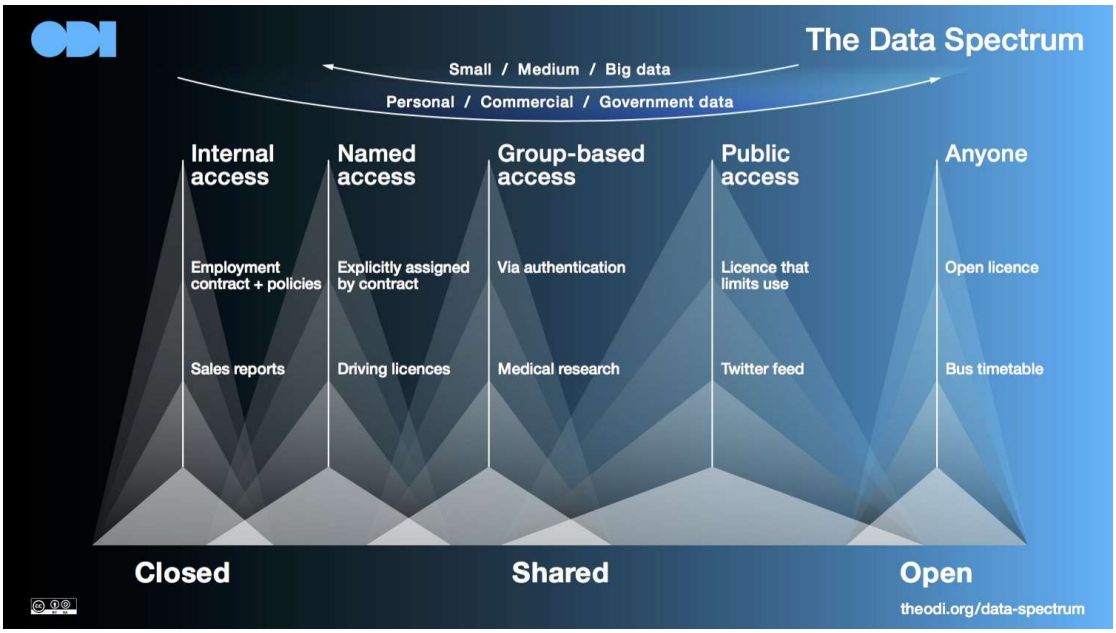
As illustrated by the above examples, fully adhering to the principles of open data is a difficult process for certain datasets. However, it would be unfair and theoretically ineffective to classify datasets along a binary distinction of open data (adhering to all principles) or closed data. In contrast to the binary distinction between open/closed data, the Open Data Institute [ODI] has developed *the data spectrum,* which illustrates the spectrum of possible access to data (Figure 2.2; Open Data Institute, n.d.). Instead of exclusively differentiating between open and closed data, this spectrum illustrates that there exist many forms of data access in between fully-open and fully-closed, namely:

- Internal access (closed data)
- Named access
- Group-based access
- Public access
- Anyone (open data)

For data suppliers, it is important to be aware of this spectrum, and the degree of 'openness' one desires to apply to their data. For example, Walker (2017) illustrates how an "all or nothing" approach regarding open data supply is ineffective. In their research they found that when sharing data, medical researchers often either applied a fully closed access policy or a fully open access policy. Where the first approach led to data redundancy as researchers did not communicate their data to each other, led the second approach to privacy concerns as the subjects of research were withdrawn from their anonymity by external actors for illicit purposes. Walker (2017) therefore suggested to for example (1) supply data based on a group-based access policy, with medical professionals having exclusive access to the data or (2) supply the data along the 'public access' policy with the constraint that the data is exclusively published in an aggregated form.

Figure 2.2

The Data Spectrum



Note. A figure illustrating that the access policy of data is found on a spectrum between closed and open data. From *The Data Spectrum,* by the Open Data Institute, 2020. (https://theodi.org/insights/tools/the-data-spectrum/).

2.1.4 The open data ecosystem

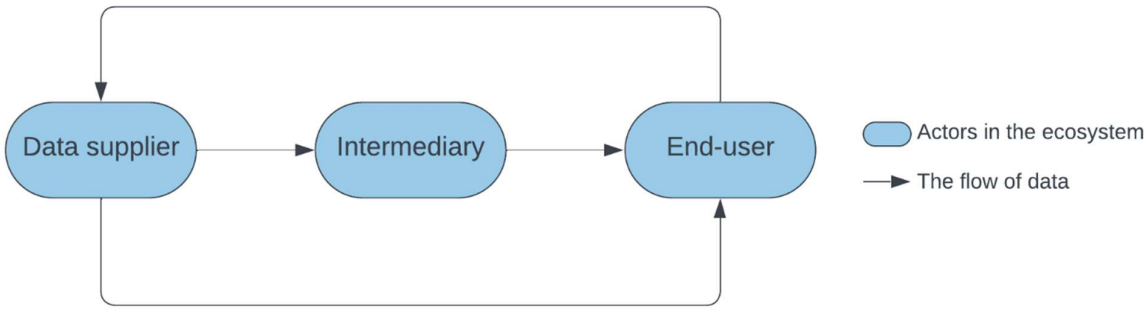
Next to the fact that data can be found on a spectrum ranging from closed to open, it is also worth noting that (open) data does not exist as an independent entity, but in a system of actors that are essential to the flow of data. Within the academic debate, this system is often referred to as an *open data ecosystem* (Welle Donker & van Loenen, 2017, Kitsios et al., 2017; Heimstädt et al., 2014). This concept borrows from the biological domain where the ecosystem can be characterized as a system where actors/entities are interdependent including a (cyclical) stream of resources between the actors with the supply being encouraged by the demand. Within the open data ecosystem, actors of the ecosystem include data suppliers and users, with the open data flowing between these actors (Heimstädt et al., 2014). The scale of open data ecosystems can differ from, for example, a European ecosystem to a smaller open data ecosystem within an organisation (van Loenen et al., 2021).

Further drawing from biological ecosystems, open data ecosystems also feature certain *keystone species*. While these species are not necessarily the drivers of the ecosystem, they are essential pieces that enable the functionality of the ecosystem. In terms of the open data ecosystem, while the suppliers and end-users of the data can be considered the drivers of the ecosystem, *intermediaries* are the keystone species as they enable the data to flow properly through the actors in the system (Schalkwyk et al., 2016). As

illustrated in figure 2.3, these intermediary actors are positioned between the supplier and end-user of the data.

Figure 2.3

Relation between data supplier, intermediary and end-user



Note. Figure illustrating the relation and flow of data between data suppliers, intermediaries and end-users. Own work.

However, it is worth noting a nuance derived from van Loenen et al. (2021) concerning the labelling of an open data ecosystem. According to van Loenen et al. (2021), an open data system of actors and data flows is only an *eco*system when it is (1) user-driven, (2) circular, (3) inclusive, and (4) skill-based. After analysing five different open data systems in five different European countries, they considered none of the cases truly open data ecosystems as they did not meet the described four characteristics. Therefore, these systems were exclusively open data *systems* instead of true ecosystems (van Loenen et al., 2021). However, for the purpose of simplicity, in this study the system in which the actors operate and data flows is still referred to as the open data *ecosystem,* regardless if the researched system meets the set criteria by van Loenen et al. (2021).

2.2 The concept of value

The delineation of the concept of 'value' has been present within the academic debate since antiquity (Perry, 1914; Neap & Celik, 1999; Bowman & Ambrosini, 2000; Osterwalder & Pigneur, 2010). Firstly, it is worth noting that "*…value is adjectival rather than substantive.*" (Perry, 1914, p. 143), implying value is not an independent entity, but is interlinked with the entity it describes. In other words, 'value' is not a self-sufficient concept, but is inherently attached to an entity (e.g. something *has value*).

However, what constitutes as 'value' cannot be determined in an objective manner. Applying a more philosophical perspective, value can be "*…any type of good, service, or act that satisfies a need or provides a benefit…*" (Haksever et al., 2004, p. 292). In other words, value exists not in an objective sense, but

through the perspective of the user. For example, an apple holds a higher value from the perspective of an individual experiencing hunger, than an individual that does not experience hunger (Juechems & Summerfield, 2019). Relating this concept to this study, an intermediary providing a platform with tools to perform calculations and measurements with certain datasets can be of substantial value to real estate development professionals, while being worthless in the perspective of other sectors (Longhorn & Blakemore, 2008).

The above two examples illustrated how the value that a user assigns to a product is dependent on different characteristics of the user. In the first example the hungriness of an individual determined the value of the product, while in the second example the sector that the individual works in determined the value of the product. In reality, the value of a product/service/object is determined by a plethora of these characteristics, such as beliefs, perceptions, interests (Lai, 2011). These characteristics are on the one hand shaped by biological capacities (nature) such as hunger, but on the other hand the societal context which shaped the individual (nurture) such as the sector they work in. Although the nature of different individuals can be (relatively) similar, the nurture is shaped by an unlimited amount of interdependent complex factors and actions (Collins et al., 2022). In other words, complex societal contexts imply that no two humans have identical beliefs, perceptions, interests and actions (Hayek, 1989), and therefore no two humans perceive products/services/objects to have the same value.

Furthermore, while value is often used as a synonym for *economic* value, the concept of value ranges broader than exclusively economic value (Bowman & Ambrosini, 2000). As noted in the above citation of Haksever et al. (2004), value can be anything that satisfies *any* need or provides *any* benefit, implying that value can be both market-related or non-market-related (Haksever et al., 2004). For example, when an actor provides a platform that allows for data to be readable by the visually impaired, the increased *social* value of stimulating principles of equality can be considered of higher importance than the slight increase of economic value.

Value is therefore a highly ambiguous concept in various respects. Firstly, it can take on any form, ranging from economical/monetary value to social value, political value, etc. (Attard et al., 2016). Secondly, value is subjective and constructed through the perspective of an end-user, ensuring that the same entity can have a different value to different people (Haksever et al., 2004; Juechems & Summerfield, 2019). Furthermore, this dynamic characteristic of value is further emphasized as this subjective perspective of an end-user is also dynamic. Over time, the perspective of an end-user regarding an entity and how valuable it is to them is subject to change based on external factors such as for example market conditions, but also internal factors such as the technical capability of an individual (Bowman & Ambrosini, 2000).

However, the importance of value is not found in the product itself, but what activities value evokes. In general, value is closely related to the concept of *motivation,* in the sense that individuals are generally motivated to retrieve something that they perceive to hold a significant value (Lai, 2011). In other words,

the perceived value of an object determines the motivation of an individual to utilize/retrieve/etc. that object. Referring to the example of the apple and the hungry individual; as the apple is considered to be of a higher value to a hungry individual than a non-hungry individual, that hungry individual will be more motivated to purchase that apple than the non-hungry individual (Juechems & Summerfield, 2019).

The manner in which an individual has constructed the value of an object through their subjective lens also determines the type of motivation of that individual to do something. Here, it is of importance to distinguish between *intrinsic* and *extrinsic* motivation. Where *extrinsic* motivation concerns external rewards for (not) doing something such as monetary benefits, *intrinsic* motivation arises from internal 'rewards' such as fulfilling a purpose or satisfying a curiosity (Bénabou & Tirole, 2003). For instance, does an end-user attach a high-value to an intermediary out of a curiosity and passion for a data-driven workflow (intrinsic motivation) or is the end-user determining the value of an intermediary based on the potential of cutting costs by lowering the time spent searching for data (extrinsic motivation)?

As an example of the relation between value and intrinsic/extrinsic motivation, a classical experiment can be utilized. In this experiment one group of students was paid to work on a puzzle while another group of students was not paid. For the first group, the value of working on this puzzle was expressed in the monetary benefits they would receive, making them extrinsically motivated to work on the puzzle. After the experiment stopped, they were not paid anymore, implying that they did not consider working on the puzzle to be valuable, resulting in them not finishing the puzzle. The other group did not receive any payment for working on the puzzle, and therefore, from their perspective, the value of working on that puzzle did not include the monetary benefits. However, by working on the puzzle, they started attaching a value to completing the puzzle out of sheer passion, making them intrinsically motivated to complete the puzzle. In other words, they *wanted* to complete the puzzle after the experiment finished (Bénabou & Tirole, 2003).

From the above example, it becomes clear that with similar individuals and an identical puzzle, external factors can still determine how much (and what kind of) value the individual attaches to an object. With this example, the external factor could be isolated due to the laboratory setting, but in the societal reality these 'external factors' are built up out of an infinitely-wide number of interdependent factors, shaping the beliefs, perceptions, and interests of this individual (Hayek, 1989; Lai, 2011).

2.2.1 Value creation

The first characteristic of the business model of entities is how they *create* value, entailing the actions that an entity executes to generate value for other actors (Vancauwenberghe et al., 2018). In the terms of (open) data, creating value implies doing something with data (e.g. developing a product/service) that increases the perceived benefit of data (Haksever et al., 2004). For example, an intermediary creating a platform visualising an open dataset is creating value for other actors that want to retrieve the geographical context. Before this intermediary created a visualisation platform, the original information

would be less valuable as the end-user would not be able to see this context. Therefore, the intermediary has *created* value by providing this platform (Bowman & Ambrosini, 2000).

As noted in the previous section, value can take on many forms. Therefore, the value that is created by entities can also take on various forms. Specific to data, Attard et al. (2016) specify four different types of value that can be created.

1. **Technical value:** As the quality of data is enhanced (e.g. through the implementation of standards), value is created for users as they can build better applications.
2. **Economic value:** Specific interventions within the data (e.g. publishing it in a nicer looking format) can cause the worth of the data to be higher based on market conditions.
3. **Social/cultural value:** These same interventions can also have non-economic results. For example, creating a platform for road accident data can help increase road safety.
4. **Political value:** As data relevant for making decisions by citizens becomes more accessible, they can make more-informed decisions resulting in democratic gains.

It is worth noting that the creation of a specific product/service does not necessarily create one isolated form of value, but has the ability to create multiple forms of value. For example, an intermediary creating a platform visualising road accidents along open standards (technical value) could result in safer roads (social value), lesser costs for car repairments (economic value), and better citizen decision making regarding new road policies (political value).

However, the creation of value is required to be nuanced by the inherent characteristic of value, the subjective character of value. Although in the above example the intermediary is the entity that creates value (by creating a platform), the intermediary cannot determine 'how valuable' their platform is. Rather, the extent of this value is determined through the subjective perspective of the user of the platform (Haksever et al., 2004).

Therefore, the first step in creating value is assessing exactly what an expected user considers to be of value. What the user considers as valuable however, requires a side note. Adhering to the Austrian school of economics[5], the subjective value of a product or service is intrinsically interlinked with the *utility* of that product or service for a specific consumer (McKnight, 1994). This school of thought assumes that consumers always act in a rational manner, carefully and systematically assessing different options before purchasing a product or service (Bowman & Ambrosini, 2000). However, contemporary economists often reject this assumption of omniscience of the consumer, and therefore reject the possibility of acting in a fully rational manner. Rather, all actions and decisions are confined by the inherent *bounded rationality* of the user. This implies that the complexity of a decision can cause a user to not always make the most optimal decision that is closest to their needs (Simon, 1990). In other words, whatever the user

[5] A school of economic thought founded by Carl Menger centred around the relation between the subjectiveness of utility and its relation to value (Hall, 2021)

might perceive to be the rational choice, might be irrational due to the user constructing their ostensibly rational choice on inaccurate or incomplete information (Puranam et al., 2015) To demonstrate this principle of bounded rationality, an example can be given surrounding a user manually accessing and aggregating individual datasets, despite the fact that an already aggregated dataset is openly available. In the mind of the user, manually aggregating this data is the rational choice as they simply do not know of the existence of the already aggregated dataset.

Therefore, when assessing the value one aims to create for their users, it is essential to differentiate between user needs and *desires* (Welle Donker, 2022; van Loenen & Welle Donker, 2014). In the above example, the user claimed to need (desired) the individual datasets, while actually needing the available aggregated dataset. While a user might perceive their desires to be rational and correlate with their needs, their actions sometimes prove otherwise (Kolodny, 2005). So, although the intermediary might have 'objectively' created more value for the user by aggregating the dataset, because the user is limited by their own bounded rationality, they do not know about this intermediary with an 'objectively' higher value and make a suboptimal choice. In other words, users are not motivated to access an intermediary which holds the highest value for them, but which intermediary they *think* holds the highest value for them.

To summarize, value is created by intermediaries by creating specific products/services. The extent/type of this value is constructed through the perspective of the end-user, often based on a bounded rationality and limited information.

2.2.1.1 Transaction costs

For many economically-stimulated users of data, the extent of the value that is created is often based on the perceived *transaction costs* of utilizing the data (Welle Donker et al., 2016). These transaction costs can be widely defined as *"the costs resulting from the transfer of property rights."* (Allen, 1991). In other words, in every exchange of a product or service, both parties have certain costs that they are required to make (Williamson, 1989). This concept of transaction costs is especially noteworthy within the field of open data as while there are no direct fees being paid, users are still required to make transaction costs to utilize the data. For the user to utilize the data, they need to search for data, acquire it, download it, operationalise it, etc. These are all activities that cost resources such as capital or staff-hours to conduct (Welle Donker et al., 2016).

Therefore, it can be concluded that the created economic value is often interlinked with the reduction of associated transaction costs for the user. As a concrete example, making an intermediary platform more navigable for users reduces the time spent searching for data, and therefore the transaction costs, implying that this increase in navigability of the platform is of a certain value in the perspective of the user.

2.2.2 Value capturing

The second characteristic of the business model relates to the manner in which an entity *captures* value (Vancauwenberghe et al., 2018). Rejecting the assumption that entities act in a purely altruistic manner (Welle Donker, 2007), it can be expected that for their products and services, the entity expects some sort of value in return (Janssen & Zuiderwijk, 2014). Here, the key difference between value creation and value capturing is that the entity creates value for others, but captures value for themselves.

Although what an entity considers to be value for them to capture can differ substantially based on the perspective of this entity (Juechems & Summerfield, 2019), often the capturing of value comes down to retrieving a financial gain to cover production costs. Specific to open data, it is worth noting that although a key principle of open data is that the data is freely accessible, it does not mean that there are no costs associated with supplying open data. Somebody, somewhere, has to pay for the data to be gathered, published, analysed, and products or services to be developed (Welle Donker, 2016). Entities therefore often apply a certain revenue model to capture value for themselves, to fund their products or services that in turn create value for other entities. As described by Welle Donker & van Loenen (2016), several revenue models exist to cover the costs of a data supplier;

(1) **Budget financing:** No direct revenue stream is set up and any costs regarding the supplying of data are covered by the budget of the organisation. However, although a direct revenue stream is absent, indirect benefits are present such as a better public perception of the organisation supplying the data (Kucera & Chlapek, 2014), a more-informed and therefore stronger economic climate (Welle Donker et al., 2017), well-informed decision-making for citizens (Mellouli et al., 2014), but also transaction-cost-reducing benefits such as a lesser need for administrative personnel (Kucera & Chlapek, 2014).
(2) **Legal instruments:** Public institutions have the possibility to use legal instruments to generate revenue, for example by levying specific taxes whereby the revenue directly flows to the institute or organisation. This differs from *general* taxes where general taxes are collected as General Revenue, and public organisations receive revenue from General Revenue as (part of) their budget financing (Welle Donker & van Loenen, 2016).
(3) **Subscription model:** In the subscription model, a user is required to pay an upfront fee for a specific period of time. This ensures a constant revenue stream, regardless of the frequency of usage of the data (Welle Donker & van Loenen, 2016)
(4) **Utility model:** In the utility model or pay-per-use model, users pay each time they use a service, often on a per-session basis, per data unit, or depending on the size of the data.
(5) **Royalty model:** In the royalty model the user pays a specific fee depending on the revenue generated by the product or service developed by the user.
(6) **Razor & Blades model:** In the razor and blades model the 'razor' is supplied for free while the 'blades' are supplied for a certain fee. This metaphor refers to the lack of utility of a razor without

its blades. In terms of data, this means offering a dataset that is impossible to re-use without paying an extra fee for the required proprietary software.

(7) **Open Source Like model:** In this model the dataset is offered for free (also for re-use), and offering extra services for a certain fee.

(8) **Freemium/premium:** This model offers both a free version and a fee-based version of the dataset. The fee-based version offers superior features, such as more frequent updates or more attributes, compared to the free version.

(9) **Community model:** The costs of the data supplier are covered by donations, for example through a trust-fund, crowd funding or members of the community donating their services for free.

(10) **Advertising model:** Data is supplied for free but includes a certain level of advertising. Revenue from these advertisements covers the costs for the data supplier.

While various models of value capture are available, not all actors have the flexibility to choose from every revenue model listed above. The selection of a revenue model depends on specific characteristics of the actor (Welle Donker & van Loenen, 2016). For instance, Section 2.4.1.1 outlines how certain characteristics of the data supplier influence the choice of a revenue model.

2.3 The actors in the information value chain

Within the open data ecosystem, all actors execute their business models implying that they (1) create value and (2) capture value to fund their products or services that create this value. Often, these actors do this by utilizing value that is created by other entities, implying that an *information value chain* (also referred to as *data* value chain) is facilitated where every actor creates value for the data (Kitsios et al., 2017). The usage of the word chain stems from the fact that the actors within the open data ecosystem create value to the data subsequently. Instead of all actors accessing the source data independently, they utilize the value created by prior actors on the information value chain and create more/different value (Coiera, 2019).

The positioning of an actor on the information value chain is highly dependent on the business model that this actor adopts. While there are various business models and organisations often create value in a unique way, these business models can be categorized along five archetype roles[6] (Welle Donker & van Loenen, 2016);

1. *Suppliers:* The source provider for the data.
2. *Aggregators:* Organisations that collect and aggregate data.
3. *Enablers:* Organisations that facilitate the usage of data instead of using it themselves
4. *Developers:* Organisations that develop applications based on the data.

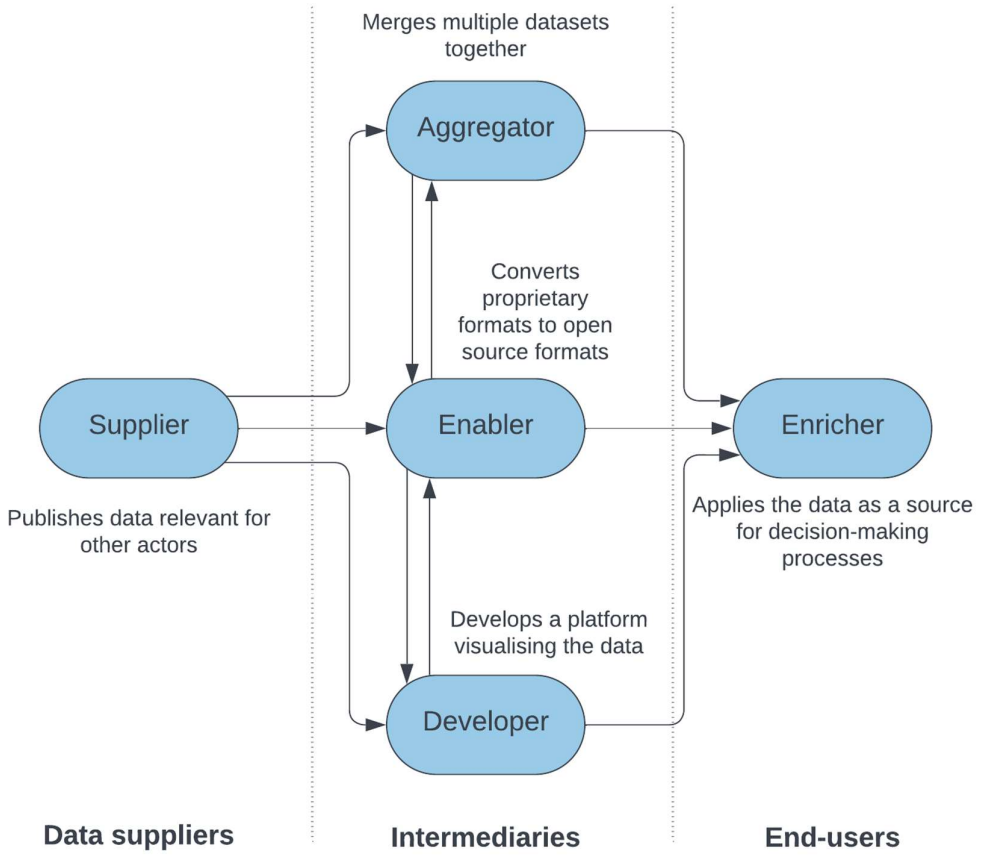
[6] However, in practice it is difficult to distinguish between these categories, as these roles often overlap (den Haan, 2018).

5. *Enrichers:* Organisations that enrich their own products with this new data.

The three different actor-groups within the open data ecosystem (The data supplier, the intermediary, and the end-user) all have a business model that they adopt, and can therefore be categorized in one (or multiple) of these archetype roles. Figure 2.4 illustrates an information value chain with the three actor groups and the roles that they can take on, together with an example of value that these entities can create. Furthermore, in the following sections the different actor groups within the information value chain are elucidated further. This is done in combination with the roles they take on and the correlation value components of the business model.

Figure 2.4

The actors in the information value chain, including the role they can take on together with an example of value creation.



Note. Figure illustrating the actors in the information value chain, including the role that they can take on together with an example of value creation. Own work.

2.4.1 The data supplier

The data supplier is the driver of the open data ecosystem, as their role is to provide the data that is being used throughout the ecosystem (Schalkwyk et al., 2016). The archetype role that data supplier actors take on, is being the supplier in the information value chain (Welle Donker & van Loenen, 2016). However, it is worth noting that in a properly functioning open data ecosystem, the data supplier does not exclusively function as a 'starting point' in the information value chain. Adhering to the principle of a *user-driven* cyclical flow of data (van Loenen et al., 2021), data suppliers should base their workflow on a feedback provided by their users. These feedback loops are essential for the data suppliers as they can function as a basis for determining the demand for certain data streams (Zuiderwijk et al., 2014).

2.4.1.1 Value capture of data suppliers

Data suppliers have the ability to capture (economic) value along one or more of the specified revenue models (see: Section 2.2.2). However, often, the applied revenue model is determined by the characteristics of the organisation supplying the data. For example, public institutions will refrain from applying an advertising model as allowing commercial advertisements might affect the integrity and impartiality of the public institution (van Huffelen, 2023). On the other side, private organisations supplying data are unable to use legal instruments to retrieve revenue.

Furthermore, the selection of a revenue model also influences the position of the data on the open data spectrum. For example, applying a revenue model such as the subscription, utility, or royalty model implies that the 'freely accessible' open data principle is not being met (Sunlight Foundation, 2010). Other business models such as the razor & blades and freemium models can be used to provide semi-open data, as it might be in conflict with certain principles of open data. For example, Esri Netherlands, a very large spatial software company, converts open government key register data from an open source format to their proprietary format of shapefiles and supplies the data for free (razor) to entice customers to use their software for a certain fee (blades) (Cheragi, 2018). If a governmental organisation would apply this razor and blades model, this would be in conflict with the 7th principle of open data stating that data should be published in a non-proprietary format (Sunlight Foundation, 2010). However, this does not make the data supplied by, the private organisation, Esri Netherlands fully closed, but just slightly behind fully-open when looking at the open data spectrum (Open Data Institute, 2020).

2.4.1.2 Value creation by data suppliers

The main value that a data supplier creates is that they are publishing the data that other actors in the information value chain use (Welle Donker & van Loenen, 2016). However, the extent of how valuable the data is to users is determined by the manner in which the data is published. In literature, the value of published data is often assessed through the lens of the FAIR principles [Findability, Accessibility, Interoperability, Reusability] (Jacobsen et al., 2020).

Firstly, the findability relates to the degree to which the data is findable for both humans and machines. For example, a proper cataloguing service increases the findability for humans, while structured ordering of different Uniform Resource Locators [URLs] for different data increases the findability for machines (Lamprecht et al., 2020).

The principle of accessibility refers to the removal of any boundaries to use the data (Jacobsen et al., 2020). This relates to publishing the data using conventional data format standards and allowing the data to be retrieved through standardized communication protocols for machines (Lamprecht et al., 2020). For example, a data supplier publishing their tabular data in the form of an image or a Portable Document Format [PDF] might make it accessible for humans, but not so for machines. Publishing the data in a machine-readable format returns a higher value for the same data as the degree to which intermediaries or end-users can depend on machines for using the data increases.

Thirdly, value is created when the published data is interoperable (Jacobsen et al., 2020). This entails ensuring that multiple sets of data relating to the same subject could potentially be merged. In creating interoperability, one of the main concepts is the usage of identifiers such as 'Unique Resource Identifiers' [URIs]. In doing so, no semantic confusion can arise regarding which specific piece of information is referred to. For example, a dataset containing information about all municipalities in the Netherlands has a higher value if, per municipality, it also contains the municipal code. Some municipalities have a dynamic name in the sense that it is written differently in certain languages (e.g. municipality 'de Friese Meren' (Dutch) & 'de Fryske Marren' (Frisian)), but their municipal code is static (GM1940). Merging different datasets based on the municipal name might return problems, while merging based on the unique identifier of the municipal code is uncomplicated (Scott-Willson, 2004).

Fourthly, the principle of reusability refers to the ease of reusing the data published by the data supplier for other purposes (Lamprecht et al., 2020). Similarly to the extent of value (Haksever et al., 2004), the degree to which data are reusable is dependent on the user that aims to reuse the data (Wolf et al., 2021). For example, a user using Esri software would consider data published in shapefiles to be of a high value due to them being able to reuse it with ease. However, a user utilizing software from a different organisation that does not allow the proprietary shapefile format might perceive a lower value as they are required to apply a conversion tool first (Cheragi 2018).

2.4.2 The intermediary

The intermediary is situated between the data supplier and the end-user. While the exact definition of an intermediary is relatively ambiguous, in this study the definition of Shaharudin et al. (2023) is used. This definition states that open data intermediaries are: "*Third-party actors who provide specialized resources and capabilities to (i) enhance the supply, flow, and/or use of open data and/or (ii) strengthen the relationships among various open data stakeholders.*" (Shaharudin et al., 2023, p. 14). Dissecting this definition, it becomes clear that open data intermediaries aspire to bridge the gap between data suppliers

and end-users (van Loenen et al., 2021). These intermediaries strive to do this by fitting the data better towards the needs (or desires) of the user (Welle Donker et al., 2019).

2.4.2.1 Value capture by intermediaries

The bridging of gaps, however, is required to be nuanced by discussing the rationale of the intermediary. It would be naïve to assume that every intermediary acts in a purely altruistic manner, bridging gaps without expecting value in return. The majority of intermediaries have a certain business model that they need to sustain (Janssen & Zuiderwijk, 2014), implying that they *need* the barriers on which they have developed their product/service. Therefore, it would be economically disadvantageous if those same barriers that the intermediary has build their business model on would disappear (Grant & Stuartz, 2022). The security of existence of these intermediaries is dependent on the inability (or reluctance) of the data suppliers to overcome the barriers. As a concrete example, if an intermediary has created a platform that visualises a certain open dataset because they observed the lack of visualisation as a barrier experienced by end-users, it is not in the best economic interest of the intermediary that the data supplier overcomes the barrier and develops their own visualisation platform. If the data supplier is successful in developing a (qualitatively-equal) visualisation platform, this might draw end-users away from the visualisation platform provided by the intermediary.

While the inherent characteristic of open data intermediaries implies that they do not have to pay license fees, there are other transaction costs associated with gathering data. For example, intermediaries need to invest in developing a method of retrieving open data and transforming it into a product or service for end-users or other intermediaries (Janssen & Zuiderwijk, 2014). To institute a sustainable business model, it becomes imperative for these expenditures to be offset by a consistent revenue stream. Much akin to data suppliers, intermediaries have the option to adopt one of the revenue models outlined in Section 2.2.2 (Welle Donker & van Loenen, 2016) to establish this revenue stream. Expanding on the example of the visualisation platform; the intermediary can recoup the investment of developing this platform by, for example, levying a subscription fee for the end-users who make use of this platform.

2.4.2.2 Value creation by intermediaries

In theory, an intermediary creates value as a result of a cause-effect-relation, where the intermediary produces a product/service (effect) to overcome certain barriers that end-users observe when accessing the source dataset (cause) (Den Haan, 2018). The specifics of these barriers are found on a wide spectrum of possible barriers and are all user-specific, implying that some users might identify something as a barrier while other users might not. Therefore, the value that these intermediaries create is also dependent on the perspective of the user (Juechems & Summerfield, 2019). For example, if an end-user detects that the transaction costs (e.g. time spent for searching the data) of accessing data is lower at an intermediary than at the data supplier, the rational economic decision would be to utilize the intermediary over the data supplier (Welle Donker & van Loenen, 2016). This thought-process often

happens subconsciously and materializes in, for example, an end-user simply finding an intermediary before finding the data supplier.

To garner end-user interest in opting for a specific intermediary, it is crucial for the end-users to perceive added value in utilizing these intermediaries. As mentioned before, intermediaries create value for end-users by removing barriers (Shaharudin et al., 2023). These intermediaries remove barriers and therefore create this value along different methodologies based on the role they assume in the information value chain.

Open data intermediaries that have embraced the role of **aggregators** are engaged in collecting data and aggregating it in, for example, a geographical or sectoral manner (Welle Donker & van Loenen, 2016). Often, these aggregators also create value by combining open datasets with other (non-)open datasets, and resupplying it to end-users (Janssen & Zuiderwijk, 2014). In aggregating this data, intermediaries create value by lowering the transaction costs for end-users, as they then do not have to search multiple datasets for related data (Jupp et al., 2014; Maio & Czarnota, 2017). Brackel et al. (2018) describe an example of an intermediary that has embraced the role of aggregator. They describe how an organisation has created value by facilitating a platform where all open data related to the drilling of well sites comes together. End-users in the construction sector use this platform to fill their needs for open data, and can efficiently work in a data-driven manner (Brackel et al., 2018).

Open data intermediaries that enable the end-user to access the open data provided by the data supplier are referred to as **enablers**. These intermediaries create value by facilitating the usage of data supplied by the data supplier (Berends et al., 2020). According to Schalkwyk et al. (2016), these enabling intermediaries are the keystone species within the open data ecosystem, as they enable the end-user to interact with the data supplier, allowing the flow of open data through the ecosystem. An example of an enabler is illustrated by Schalkwyk et al. (2016). As South African universities had a difficult time interpreting the complex form of open data in which the South African government was serving their open data, an intermediary organisation *"bridged this gap"* (Shaharudin, 2023, p. 5) between the end-users and the data supplier. In this case, bridging the gap meant transforming the difficult-to-read open data into a more easy to read format for universities (Schalkwyk et al., 2016).

Open data **developers** are open data intermediaries in the sense that they apply open data to build an application, of which they sell licenses to end-users (Welle Donker & van Loenen, 2016). For example, Grabowski et al. (2015) describe an application made by Finnish developers that helps users track the decision-making of the Finnish government by retrieving information about bills that are currently in consideration. The data about these bills is openly available, but usually not in a comprehensible form. Furthermore, the application also adds comments of the social media of politicians related to the bill for further context (Grabowski et al., 2015).

In executing their activities, intermediaries often influence the openness of data, causing a shift on the open data spectrum. Referring back to the example of Esri as an intermediary, the organisation often

(re-)publishes open data in their proprietary format of shapefiles (Cheragi, 2018). This republishing implies that (1) value is created as a shapefile can be considered easier to apply by some users (Esri, n.d) and (2) that the data slightly shifts towards the 'closed'-end of the open data spectrum, as a proprietary format is being used instead of an open-source format (Runeson et al., 2021).

2.4.3 The end-user

The end-user is on the opposite end of the data supplier. To properly distinguish the end-user from the intermediary, it is of importance to emphasize the *end* in end-user, implying that the actor is found at the end of the information value chain. The end-user is the consumer of open data with the intent to analyse the data, draw conclusions from data, base policy on the data, etc. (Zuiderwijk et al., 2014). In other words, they are **enrichers** in the sense that they enrich their own products, services, decisions, etc. with data flowing from an intermediary or data supplier. This differs from the intent of intermediaries (which are *re*-users, but not *end*-users), as their intent is to add value to open data and distribute it to the end-users or other intermediaries (Shaharudin et al., 2023).

2.4.3.1 Value capture by end-users

Due to the intrinsic positioning of the end-user at the end of the information value chain, the end-user does not *create* any value for the information. The end-user exclusively *captures* the value produced by other actors on the information value chain. However, it is worth noting that 'the end-user' is in reality not a singular concept. Often, a data supplier does not publicize an open dataset with the intent to exclusively approach one singular end-user, but requires a significant user base to come to a sustainable business case (van Loenen et al., 2021). In other words, in the open data ecosystem there are several end users of the same open data. Expanding on this, suggesting the existence of *identical* end-users is also inaccurate due to the societal context of every individual harnessing different technological capabilities, norms, values and other need-producing factors (Hayek, 1989). In other words, the radically pluralistic nature of society implies that no two humans are identical (Alexander et al., 2012), which can therefore also not be expected from their needs as an end-user. Furthermore, adhering to the sixth principle of open data, Open data should be non-discriminatory, implying that *anyone* should be able to access the open data (Sunlight Foundation, 2010). This implies that potentially, the end-user base of the open dataset could be endless. This implication therefore entails that the manner that the end-user captures value, can also differ in an endless number of ways.

This potentially limitless list of end-users of open data capture value from open data for a multitude of different end-uses and have different technological capabilities, which induces the complexity of aggregating all different requirements of users in a concept of *user needs* (Waite & Logan, 2011). Regardless of this complexity, it is of essence to create user-driven open data ecosystems based on these user needs in an effort to streamline data supply-demand relations and create a sustainable open data ecosystem (van Loenen et al., 2021).

2.5 Key takeaways of chapter 2 (summary)

In Chapter 2, the theories relevant to answering the research questions were delineated. Three major theoretical concepts were relevant: (1) (open) data, (2) value creation, and (3) value capturing.

Firstly, the degree to which data is open is dependent on various factors and can be measured along the open data principles. However, it is worth noting that data is found on an (open) data spectrum, ranging from fully closed to fully open data.

Furthermore, value is created by an individual or organisation, but is constructed in the perspective of a user. Important to note here is that the perspective of the user is not static, and differs per user. Therefore how (and if) valuable the products or services of an individual or organisation differ per user. The manner in which intermediaries create value depends on the role that the intermediary takes on within the information value chain.

Value capturing entails the return that an individual or organisation retrieves for the provision of their products or services. Often, this value is expressed in terms of revenue. There exist several revenue models that an intermediary can apply to retrieve this value.

3. The case: real estate development end-users within the (open) data ecosystem of the Netherlands

In this chapter, a comprehensive analysis of the (open) data ecosystem of key registries relevant to end-users in the real estate development sector in the Netherlands is provided. This analysis involves an examination of the roles and distinctive characteristics of the three actor-groups within this system, namely the real estate development professionals (end-users), the data suppliers of the key registries, and the intermediaries between the end-users and key registries. Before discussing all relevant actors, first the legal framework of the Netherlands regarding (open) data is elucidated in the following section.

3.1 Legal framework of (open) data in the Netherlands

In the following section, the legal framework of (open) data in the Netherlands is discussed. Firstly, European directives and regulations are discussed, with subsequently the implementation within the national legislation. Lastly, certain future developments regarding the open data landscape are discussed.

3.1.1 European legislation

For more than 20 years, the (open) data policy climate in the Netherlands has primarily been shaped by European Union [EU] directives and regulations[7] (Calzati & van Loenen, 2023). The Netherlands is, by European law, obliged to implement these directives and regulations into their national legislation in a timely manner (European Commission, n.d.-a). The primary directives and regulations include the 2003 (and in 2013 revised) public sector information [PSI] directive (2003/98/EC; 2013/37/EU), the 2007 INSPIRE directive (2007/2/EC) (Vancauwenberghe & van Loenen, 2018), the 2016 General Data Protection Regulation [GDPR] (2016/679), and the 2019 Open Data [OD] Directive (2019/1024) (Kević et al., 2023).

3.1.1.1 the PSI directive (2003/98/EC & 2013/37/EU)

The PSI directive states that all documents held by public sector bodies of EU-states should be reusable, unless access is restricted due to other legislation[8] (Vancauwenberghe & van Loenen, 2018). However, it is worth noting that a key point of this directive is that it *promotes* rather than *obliges* open data for public sector bodies (Vancauwenberghe & van Loenen, 2018; Kević et al., 2023). For example, article 5 of the PSI directive states that public sector bodies should make their information 'available', but only open "*where possible and appropriate*". (art. 5 2013/37/EU). Contemporarily, the PSI directive has been replaced by the open data directive (see Section 3.1.1.4). However, as the PSI directive is the EU-

[7] A *directive* concerns a goal that EU countries must achieve, with the individual countries able to devise their own laws to reach these goals. A *Regulation* concerns a binding legislative act that is to be applied in its entirety across the EU (European Union, n.d.).

[8] For example, public sector information regarding personal data is generally exempted from the implementation of this directive due the conflict with the GDPR 2016/679 (Raad van State, 2022)

legislative ground for the Dutch Reuse of Public Sector Information Act [Who] (see Section 3.2), the directive still influences the Dutch policy climate (Slaghuis, 2020).

3.1.1.2 the INSPIRE directive (2007/2/EC)

The 2007 INSPIRE directive expanded on the movement initiated by the PSI directive by obliging an EU-harmonized form of data publishing with sufficient metadata, viewer services and download possibilities. The INSPIRE directive was therefore centred around removing barriers regarding the reuse of data (Vancauwenberghe & van Loenen, 2018). The main principles of the INSPIRE directive correlate with the FAIR-principles, in ensuring that data should always be findable, accessible, interoperable (between countries), and reusable (European Commission, n.d.-b)

3.1.1.3 The General Data Protection Regulation (2016/679)

Although not directly centred around open data, the GDPR does shape the open data landscape in EU-states as it functions as an impediment to the push for open data. The GPDR directive sets forth a set of rules concerning the use of personal data by (among others) public bodies (European Commission, n.d.-c). For example, although other directives such as the PSI- and INSPIRE-directive pushes public bodies to publish their data in an open format, prohibits the GDPR directive the provision of personal data as open data. This is the case as reuse of personal data is only allowed for pre-agreed purposes, which is unable to be guaranteed with open data (Raad van State, 2022).

3.1.1.4 The Open Data Directive (2019/1024)

The OD Directive (2019/1024) was created as the PSI directive (2003/98/EC) was amended several times. The Open Data Directive therefore also serves as a replacement of the PSI directive, implying that the PSI directive was repealed after the introduction of the OD Directive (art. 19 2019/1024). The main difference between the directives is that where the PSI directive promoted public bodies to open their data, the OD Directive obliges them to open up data. In the OD directive, several high-value datasets [HVDs] are identified that could have a major impact on human activities. Due to the great benefit that these datasets could have on society, the environment, and/or the economy, the OD directive determines that these datasets should be published as open data (Kević et al., 2023).

While the 2019 OD directive exclusively assigned six general categories of datasets of being of high value[9], a recent implementation regulation laid down a list of specific high-value datasets together with arrangements for their publication and re-use (European Commission, 2022-b). For real estate development professionals, especially the first category, geospatial data, is of importance as it contains data about addresses, buildings, cadastral parcels, and administrative units. Furthermore, the other five categories of data also contain relevant datasets for real estate development professionals such as data

[9] The six categories are (1) Geospatial data, (2) Earth observation and environmental data, (3) Meteorological data, (4) Statistical data, (5) company data, and (6) mobility data (2019/1024).

concerning land cover (earth observation and environmental data), population (statistics), and transport networks (mobility) (2023/138).

3.1.2 Contemporary open data policy climate in the Netherlands

Although the European directives and regulations substantially influence national legislation regarding (open) data, the implementation of those directives regulations through legislation is what actually provides the policy climate in the Netherlands.

Firstly, the implementation of the PSI directive took the form of the Dutch Reuse of Public Sector Information Act [Wet Hergebruik van Overheidsinformatie, Who] (art. 1(a) Who). In general, this act sets forth a set of rules surrounding the manner in which public bodies are to publish their data, focussing on ensuring that the data are reusable (art. 5(1) Who). In practice, this implies that individuals can request public data to be made available in an open reusable format. If providing this data is not in conflict with other legislation, the public body in question is then required to publicize this data for reuse (Rijksoverheid, n.d.-L).

Furthermore, while the Who concerns the *reusability* of published data, the Open Government Act [Wet Open Overheid, Woo] concerns the overall openness of government information (van Huffelen, 2023). Before the PSI directive was implemented, the openness of the government of the Netherlands was determined by the Government Information Act [Wet Openbaarheid Bestuur, Wob]. Due to the added requirements set forth by the PSI directive (and a variety of administrative reasons (Dunhof-Lampe, 2022)), the Wob was replaced by the Woo in 2022[10]. The main difference between the Wob and Woo is that where the Wob relied on passive open disclosure of government information, the Woo enforces a more active approach to publishing government information. In other words, where the Wob was centred around individuals asking the government for information, the Woo concerns the government actively publishing information (Rijksoverheid, n.d.-m, van Huffelen, 2023).

The INSPIRE-directive (2007/2/EC) led to the implementation of the 'Implementation Act EC-directive infrastructure geographic information' [Implementatiewet EG-richtlijn infrastructuur ruimtelijke informatie, IIRI]. To conform with the INSPIRE-requirement of having findable datasets, this act obliges the creation of an INSPIRE-geoportal (art. 8(a) IIRI). This requirement resulted in the creation of the national georegister[11] where all INSPIRE-harmonized data of public organisations in the Netherlands are catalogued (van Buuren, 2023).

The GDPR (2016/679) has been implemented in the Netherlands in 2018 through the 'Implementation Act General Data Protection Regulation' [Uitvoeringswet Algemene Verordening Gegevens bescherming, AVG]. This act is often cited in Who- or Woo-requests to ensure a sufficient protection of

[10] Before the implementation of the Woo in 2022, the Wob was also amended several times to fit the requirements from the PSI directive.

[11] https://www.nationaalgeoregister.nl/

personal data. The AVG influences the open data policy context of the Netherlands in the sense that its definition of *personal data* functions as a framework for coordinating what data should be open and what data should not be open. With all open data directives obliging an 'as open as possible' data climate of countries, the AVG was necessary to determine the limits of these 'open possibilities'. In other words, the AVG determines what data is personal data, and should therefore not be open (van Huffelen, 2023).

Lastly, while not directly pushed by an EU directive, the Netherlands has implemented legislation obliging the creation and upkeep of *key registries.* These registries were created in an effort to contain all information that was most frequently being used by governmental bodies in an efficient and unambiguous registry (van Boxtel, 2001). Contemporarily, the roles and responsibilities per actor regarding the key registries have been recorded in legislation (Rijksoverheid, n.d.-d). The key registries are utilized throughout both the public[12] and private sector, and are considered to be relevant to, among others, real estate development professionals (Rijksoverheid, n.d.-n).

3.1.3 Future policy climate

However, it is worth noting that the (open) data policy climate is dynamic. As of writing, multiple policies are being created that are expected to influence the future reuse of (open) data in the Netherlands. Firstly, the OD-directive (2019/1024) is expected to be implemented as the 'Implementation Act Open Data Directive' [Wet Implementatie Open Data Richtlijn, WIODR] in the near future (Rijksoverheid, n.d.-o). After several extensions, the government of the Netherlands has not met the EU-deadline for implementing the directive, which was set at the 17th of July 2021 (European Commission, 2022). The WIODR implies the following changes to the Who (van Huffelen, 2023);

1. Minimizing the ability of governmental institutions to charge more than the marginal fee for data products.
2. Publicly funded institutions such as research institutions and utility providers will also be included in the act
3. Increasing transparency regarding public-private partnerships of data reuse.
4. Promoting the supply of dynamic information through APIs
5. Legally obliging the open provision of the high-value datasets through machine-readable APIs.

Although as of writing no date has been set concerning the implementation of the act, the government of the Netherlands has stated that they want to set a date in the near future to avoid fines from the EU (Rijksoverheid, 2023).

The second policy development expected to influence the open data landscape is the Spatial Planning and Environment Act [Omgevingswet]. This act obliges the creation of a digital system [DSO] streamlining the process between governmental bodies and initiators of change in spatial environment

[12] Adhering to the principle of 'collect once, reuse many time', the public sector is legally obliged to utilize the key registries. They are prohibited from collecting data that is already in a key registry themselves (Benner, 2014)

(IPLO, n.d.-a). This streamlining is expressed in the form of a website titled 'Omgevingsloket'[13], where users can (1) see legislation applicable to their geographic position, (2) check if they need a permit for a specific intervention in the spatial environment, and (3) request a permit for this intervention (IPLO, n.d.-b). However, next to the purely legislative function, the DSO is also expected to be able to provide anyone with information relevant to the physical living environment. This includes data about air and water quality, but also archaeological data (van Angeren, 2021).

3.2 End-user: real estate development professionals

In this study, the end-user is delineated as an individual in an organisation that is *primarily* engaged in practices that concern creating or transforming real estate. This, for example, excludes organisations concerned with investment or the transaction-side of real estate such as pension funds or real estate brokers. Rather, organisations directly involved with the development of real estate such as project developers, financial consultants, construction companies, architects, housing corporations, etc. are considered to be end-users in this study. However, it is worth noting that the end-users are not being categorized along their role within real estate development, but simply as general 'real estate development professionals'.

The role of these end-users is accessing key registry data suppliers or intermediaries and effectively integrating the acquired data into their real estate development practices. These end-users are the final recipients of the data, using it for their operational activities. The end-user captures the value of the data and enriches their decisions into well-informed, practical decisions integral to their real estate development undertakings.

3.3 The key registry data suppliers

In the Netherlands, governmental actors play a significant role in providing substantial amounts of data to their citizens (Safarov, 2019). The primary repository for this data is the website data.overheid.nl (Rijksoverheid, n.d.-a). This platform serves as a comprehensive catalogue, hosting links to over 15.000[14] datasets supplied by over 190 different public organisations (Rijksoverheid, n.d.-b).

Adhering to the Who and Woo (see Section 3.1.2), the majority of data published on data.overheid.nl is published in an open format. Supposing that the repository is fully comprehensive, 87% of all

[13] The 'Omgevingsloket' is at the time of writing (25th of January, 2024) available in demo version on https://pre.omgevingswet.overheid.nl/home

[14] it is worth nuancing this number as not all datasets are independent entities. For example, some municipalities publish a subset of a national dataset only pertaining to their territory. Despite this, a substantial portion of the datasets available on this platform can be attributed to the respective 'data owners,' who effectively function as data suppliers.

governmental datasets are open data[15] (Rijksoverheid, n.d.-a). The definition of which datasets are considered 'open' is based on the principles of open data as set up by the government itself (Rijksoverheid, n.d.-e). While these principles do distinguish between closed, semi-open and open, it does not incorporate the entire open data spectrum. For example, some datasets that are exclusively published in an aggregated form are defined as fully 'open', even though the aggregation of data implies a deviation of the primacy[16] principle of open data (Sunlight Foundation, 2010).

Regardless of this substantial number of datasets, this study exclusively focusses on the system of ten different *key registries* in the Netherlands. (referred to as 'basisregistraties' in Dutch). This system contains datasets that consist of data about individuals, organisations, real estate, parcels, etc. By collecting this data in a system of key registries and saving it in one place, it is aspired to mitigate data redundancy, minimize the demand for administrative resources, and decrease the likelihood of inaccuracies or outdated information (Benner, 2014).

The creation, upkeep and provision of the key registries is legally obliged by registry-specific acts such as the Act key registry addresses and buildings [Wet basisregistratie adressen en gebouwen, WBRAG] (art. 2(1) WBRAG). Next to the legal obligation of the provision of key registries, governmental entities are also legally obliged to *utilize* these registries and are prohibited from gathering data that is already recorded in a key registry (Rijksoverheid, n.d.-f). Therefore, it can be assumed that the data that is in the key registries is not available in another governmental source.

Another key concept with key registries is that the 10 datasets do not exist in isolation, but form an interconnected system. Figure 3.1 illustrates how the data in the key registries is linked together. The 10 different key registries that are depicted in this figure are (Rijksoverheid, n.d.-c):

1. **Key registry Persons [BRP]** *(Basisregistratie Personen):* personal information such as names, birthdates, etc. of all residents of the Netherlands.
2. **Business register [HR]** *(Handelsregister):* Information concerning organisations
3. **Key registry addresses and buildings [BAG]** *(Basisregistratie Adressen en Gebouwen):* (geo-)information about every address and building in the Netherlands
4. **Key registry topography [BRT]** *(Basisregistratie Topografie):* The (small-scale) topographic dataset of the Netherlands

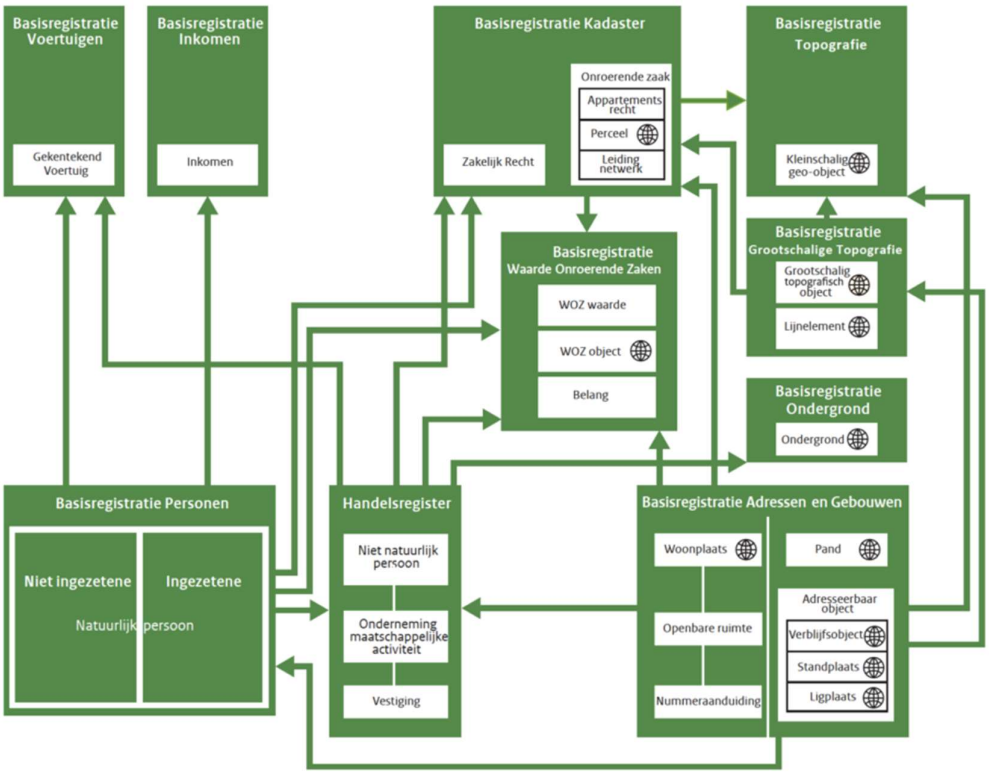
[15] This supposition, however, is far from comprehensive as the concept of 'data' covers a wider spectrum than just those datasets published on data.overheid.nl. For example, the 'data' from a Woo-request also includes letters, reports, policy documents, and governmental e-mail conversations which are not present on data.overheid.nl (Justis, n.d.).

[16] Although an argument can be made that an aggregated dataset is a 'new' dataset implying that the data *does* adhere to the primacy principle of open data, this is in conflict with paradigm utilized in this study regarding intermediaries. Following the definition of Shaharudin et al. (2023), any actor in between the original data supplier and the end-user is considered to be an intermediary. If this intermediary aggregates a dataset in any way, it is therefore deviating from the primacy principle of open data.

5. **Key registry Cadastre [BRK]** *(Basisregistratie Kadaster):* Dataset containing cadastral borders and proprietary information
6. **Key registry Vehicles [BRV]** *Basisregistratie Voertuigen):* Information about vehicles, license plates, and ownership
7. **Key registry Income [BRI]** *(Basisregistratie Inkomen):* Information per resident surrounding the taxable income
8. **Key registry value of real estate [WOZ]** *(Basisregistratie Waarde Onroerende Zaken):* The value of a property together with which person or organisation is responsible for it
9. **Key registry large-scale Topography [BGT]** *(Basisregistratie Grootschalige Topografie):* A precise map containing the location of buildings, roads, water, and other terrain
10. **Key registry Subsoil [BRO]** *(Basisregistratie Ondergrond):* A dataset containing all information surrounding the subsurface.

Figure 3.1

The system of key registries in the Netherlands



Note. Figure illustrating the system of the different key registries in the Netherlands. From *Stelselplaat gegevens en basisregistraties,* by Rijksoverheid, n.d.-g. (https://www.digitaleoverheid.nl/overzicht-van-alle-onderwerpen/stelsel-van-basisregistraties/stelselplaat/).

Although uniformity is a prevalent theme in the realm of key registries, significant disparities exist in terms of access policies across various registries. According to the catalogue data.overheid.nl, the BAG, BRT, BGT, & BRT are completely open, the BRV, BRK, HR, & WOZ are semi-open, and the BRI and BRP are fully closed (Rijksoverheid, n.d.-a). The open key registries can be requested through APIs, while the semi-open key registries have a more complex access policy. For example, in the BRK cadastral parcel geo-information is provided as open data, but a small fee is charged for proprietary information (Kadaster, n.d.-a). Furthermore, privacy legislation (art. 2(1g) Who) prohibits large-scale requests of the WOZ, and the WOZ of buildings can exclusively be viewed on a per-case basis through a website with limited access[17] (Rijksoverheid, n.d.-h). Lastly, the fully-closed datasets can only be accessed by public institutions such as municipalities, tax authorities, hospitals, etc. Due to privacy concerns, every consultation of the BRP or BRI by one of these institutions is recorded in order to prevent misuse (Rijksoverheid, n.d.-i).

The access policy per key registry also influences the location where the data is being supplied (referred to as 'knooppunten' in Dutch). The open key registries of the BAG, BRT, BGT, BRT, and part of the BRK are being supplied through the website of *public services on the map* [PDOK] (PDOK, n.d.) along web-APIs. For example, by constructing a specific URL, a WFS-request can be issued that returns a specific subset of a key registry based on the parameters of the URL[18]. Furthermore, the BRV, HR, WOZ, and the closed part of the BRK are accessible through specifically equipped websites (RDW, n.d.; KvK, n.d.; Waarderingskamer, n.d.; Kadaster, n.d.-a).

Although the system of key registries originated from an initiative of the ministry of internal affairs (Donner, 2010), they are not the exclusive source holder or provider. Rather, the system of key registries is set up with careful considerations regarding which organisations are the supervisor, supplier and source holder of each registry. This distribution of roles and responsibilities per key registry is found in table 3.1. Upon consulting this table, it becomes evident that 'Kadaster'[19] emerges as a significant supplier of key registry data. In addition to Kadaster, other notable suppliers include the National Office for Identity Data (Dutch: Rijksdienst voor Identiteitsgegevens [RvIG]), the Netherlands Chamber of Commerce (Dutch: Kamer van Koophandel [KvK]), Netherlands Organization for Applied Scientific Research (Dutch: Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek [TNO]), Netherlands Vehicle Authority (Rijksdienst voor het Wegverkeer [RDW]), and the Taxation Authority.

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[17] *Limited access* in the sense that the website only allows a limited number of inquiries within a specific time frame to prevent web-scraping (Waarderingskamer, n.d.).

[18] E.g. the following URL returns information about several buildings featured in the BAG in JSON format: https://service.pdok.nl/lv/bag/wfs/v2_0?service=WFS&version=2.0.0&request=GetFeature&typeName=bag:pand&outputFormat=json

[19] The prevalence of 'Kadaster' as a main data supplier of key registries is unsurprising as the organisation is the national cadastre, land registry, and mapping agency.

Table 3.1

The roles and responsibilities per key registry

Registry	Client	Supervisor	Data supplier	Source holder(s)
BRP	BZK*	AP, BZK, Municipalities	RvIG	Municipalities, BZK
HR	EZK**	EZK	KvK	KvK
BAG	BZK	BZK	Kadaster	Municipalities
BRT	BZK	-	Kadaster	Kadaster
BRK	BZK	-	Kadaster	Kadaster
BGT	BZK	BZK, Source-holders	Kadaster	Municipalities, Provinces, ProRail, EZK, BZK, etc.
BRO	BZK	BZK	TNO en PDOK	Municipalities, provinces, etc.
BRV	I&W***	I&W	RDW	RDW
BRI	Finance	-	Taxation authority	Taxation authority
WOZ	Finance	Waarderingskamer	Kadaster	Municipalities

Note. Table illustrating the roles and responsibilities per key registry. *Ministry of the Interior and Kingdom Relations, **Ministry of Economic Affairs and Climate Policy, ***Ministry of Infrastructure and Water Management. From *Rollen,* by Rijksoverheid, n.d.-d. (https://www.digitaleoverheid.nl/overzicht-van-alle-onderwerpen/stelsel-van-basisregistraties/rollen-stelsel-basisregistraties/)

For every key registry, and therefore for every data supplier, a case could be made that accessing the key registry might aid decision-making in real estate development. However, as *open* data is primarily key to real estate development data-strategies (Park, 2020), it is reasonable to assume that real estate development professionals primarily access the open key registries such as BAG, BRT, BGT, BRO, and a portion of BRK. Among these datasets, Kadaster serves as the primary public data supplier for real estate development professionals due to its role as the data supplier for four out of these five datasets.

Nevertheless, it is imperative to acknowledge that the key registries do not encompass the entirety of publicly supplied data. Various relevant datasets exist beyond the key registries. For instance, the national government provides a daily-updated dataset containing all energy-labels in the Netherlands (Rijksoverheid, n.d.-j), the inter-provincial consultation supplies a yearly-updated dataset containing all business parks and their characteristics (IPO, n.d.), the province of North-Holland provides a dataset with all future housing development locations (Province of North-Holland, 2020), and a combination of

governmental entities supply a national dataset covering all elevation levels in the Netherlands (AHN, n.d.). Furthermore, next to publicly supplied datasets, it can also be expected that real estate development professionals utilize a number of private data suppliers. One notable example is the Dutch Association of Real Estate Brokers and Valuers (Dutch: De Nederlandse Coöperatieve Vereniging van Makelaars en Taxateurs in onroerende goederen [NVM] (NVM, n.d.). This cooperation collects data on all transactions done by NVM-licensed brokers, which is relevant for real estate development professionals to determine market conditions. Based on these market conditions the real estate development professional can determine the need for certain types of real estate, influencing the decision to develop (Lisi, 2015). Another example is found on the construction-side of the real estate market. Market prices of real estate are compared to construction costs to evaluate if the development of that specific real estate is financially feasible (Guan & Cheung, 2023). Contractors that execute construction projects are therefore important data suppliers with supplied quotations for their services. Based on these costs, real estate development professionals can have a clearer overview regarding the financial feasibility of executing projects (Bouwkosten, n.d.).

The above list is far from comprehensive, but illustrates the existence of, potentially relevant for real estate development professionals, data beyond the key registries. Nevertheless, these datasets are beyond the scope of this study, as the exclusive focus lies on the key registries.

3.4 The intermediaries

The explorative character of this study implies that there is no comprehensive list of possible intermediaries yet. The delineation of which intermediaries exist and are being used by real estate development professionals is a result of answering the first sub-research question. While an exact delineation of intermediary organisations is impossible in this stage of the research, certain elements regarding the policy context can be elucidated.

In general, the existence of data intermediaries is encouraged by public data suppliers. The general ideology in the Netherlands is that governmental entities only create products/services in case that a market-actor is not able to deliver this in a desired manner (Ministry of Economic Affairs, 2012; van Loenen et al., 2009). This ideology has been legally anchored by articles 25(g) to 25(n) of the resolution markets and governments within the Competition Act (Dutch: 'Mededingingswet'). Relating this to intermediaries, if a third-party actor is able to properly bridge the gaps between the end-user and the data supplier (Shaharudin et al., 2023), this is encouraged by the public data supplier. This encouragement is demonstrated by the fact that in the publicly supplied data catalogue of the Netherlands, 'impact stories' of intermediaries using publicly supplied data are featured on the website (Rijksoverheid, n.d.-k)[20]. For example, one of these featured intermediary applications is the 'new

[20] However, the production of 'impact stories' was also pushed by 'impact' being an assessment criterium in the European open data maturity ranking (European Commission, 2022; Rijksoverheid, n.d.-p).

construction monitor' developed by the University of Groningen[21]. This intermediary application utilizes data from the BAG (one of the key registries) to illustrate the relative percentage of new construction per municipality in the Netherlands.

However, on the other hand, in some cases the government intervenes in certain intermediary organisations. An example is the Netherlands Authority for Consumers and Markets [ACM] imposing a fine on a private organisation for owning several websites that acted as an intermediary between end-users aiming to request a declaration (e.g. declaration of urgency or behaviour) and governmental institutions providing these declarations. On these privately owned websites, an end-user was required to pay an extra fee, while these websites exclusively linked the end-user through to the official governmental website (Bierling, 2021). On the official governmental website, applicants are even warned for these private websites charging extra fees (Ministry of Justice, n.d.). In 2023, the court determined that ACM was correct in their judgement and verified the legality of the imposition of the fine (ACM, 2023).

While the above example does not relate to key registry data, it does illustrate the perspective of the government of the Netherlands regarding intermediaries. On the one hand, organisations that develop applications and create a certain value to (open) data are encouraged. But on the other hand, the ACM example illustrates that organisations that charge an extra fee while exclusively linking a user through to the official government website are looked down upon. In other words, intermediary organisations that do not actually create any value are disapproved of. As a concrete example, A private organisation offering an exact copy of the BAG for a fee without creating any value to this dataset and misleading consumers into thinking that this is 'the better option', would presumably also be frowned upon.

3.5 Key takeaways of chapter 3 (summary)

In the Netherlands, the determining factor in the open data policy climate is the interplay between open data regulations pushing for open data and privacy legislation ensuring the protection of personal data.

The subject of this study, the key registries, are large datasets containing information surrounding issues that were deemed to be 'of a substantial importance' for governmental activities such as information regarding buildings, people, and vehicles. These key registries are supplied by a specific data supplier. The essence of the key registries is that this data supplier is the sole supplier of the data, with intermediaries creating products based on this data. In general, these intermediaries of key registries are encouraged by the data suppliers of the key registries, and successful intermediary products are praised through 'success stories' on data.overheid.nl

[21] https://geodienst.xyz/nieuwbouwmonitor/

4. Methodology

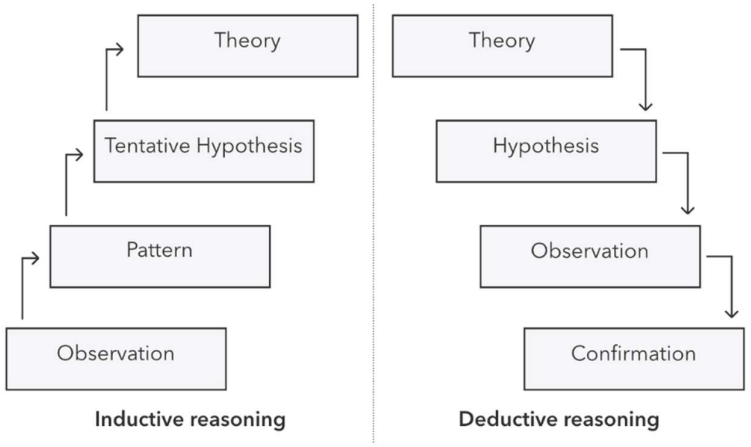
In the following chapter, the methodology required for answering the research question in a grounded manner is elucidated. This chapter is divided into (1) a section where the research philosophy is delineated, (2) a section where the research design and structure is illustrated, and (3) lastly, an insight into the methodological limitations of the execution of this study.

4.1 Research philosophy

This study is centred around answering a question regarding the value capture and creation of intermediaries. The concept of value inherently entails a subjective component, as the value created by intermediaries is constructed in the perspective of the end-user (Haksever et al., 2004; Juechems & Summerfield, 2019; Section 2.2). Specifically, the focus lies not on conducting a quantitative analysis regarding, for example, the number of intermediary users, but rather on gaining a deeper understanding of *why* end-users in the real estate development sector utilize a specific intermediary (Fossey et al., 2002), and *why* these intermediaries even provide this product or service. Given the absence of established theories surrounding the creation and capturing of value by intermediaries between end-users in the Dutch real estate development sector and key registries, this study is positioned on the inductive end of the deductive-inductive cycle (Yilmaz, 2013; figure 4.1). The goal of this study is thus to form a theory regarding a specific case, which can be quantitatively / deductively tested in future research. Therefore, this study is not concerned with confirming a theory through a representative sample, but using observations and patterns to form a possible theory (Aliyu et al., 2015).

Figure 4.1

The difference between inductive and deductive reasoning



Note. Figure illustrating the difference between inductive and deductive reasoning in research. Adapted from Research framework development on the effect of intangible location attributes on the values of residential properties in Jos, Nigeria. By A. A. Aliyu et al., 2015, *Dev. Ctry. Stud. 5*(16), p. 12.

Adhering to the research philosophy of interpretivism[22], this study is executed in a qualitative manner to provide *"richness and depth, offering insights into how individuals interpret and make sense and meaning of their experiences"* (Bleiker et al., 2019). Referring back to the theories of bounded rationality and the subjectiveness of value (Simon, 1990; see chapter 2.2,1), it is not expected that the research subjects would be able to formulate the true 'objective' rationale for accessing a specific intermediary, as they are limited by their own knowledge. The research subjects could exclusively produce their own subjective socially constructed truth regarding their motivation for accessing an intermediary (Ryan, 2018). Therefore, this study concerns interpreting these motivations for accessing intermediaries and dissecting the potential effects of the bounded rationality of the research subjects. This could best be completed by applying a qualitative research design through an interpretivist lens.

Furthermore, regarding the *capture* of value by intermediaries, this interpretivist lens is also essential. As 'the intermediary' is not a predefined concept in this study due to the list of specific intermediaries accessed by end-users is a result of this study, the assumption of a limited number of revenue models would be naïve. Therefore, also the manner in which intermediaries capture value is researched through an explorative and interpretivist lens to ensure an open-minded approach towards how intermediaries capture value.

4.2 Research design

To further this aspiration of developing theory surrounding the creation and capturing of value by intermediaries of key registry data, the choice was made to conduct ethnographic research[23]. As the goal is to draw conclusions about what end-users consider to be valuable in intermediaries and the value that these intermediaries extract, the data required for this study is acquired through interviews where the interviewees can describe the value through their perspective (Ploder & Hamann, 2021). Furthermore, the ethnographic study was executed in a cross-sectional manner, as this is more feasible within the given time constraints and a longitudinal study was not expected to deliver any further conclusions due to the absence of a hypothesis regarding a change in behaviour (Rindfleisch et al., 2008).

The interviews were conducted in a semi-structured manner to allow the discussion to flow in an explorative style (Schmidt, 2004). As theory surrounding this specific case about the interaction between end-users in the real estate development sector in the Netherlands and intermediaries is non-existent, it is impossible to – prior to the interview – integrally formulate answers that encompass all possible workflows of end-users. Interview questions were therefore required to be formulated in an open

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[22] Interpretivism concerns the counterpart of *positivism* (translating observable reality into generalisations), implying that interpretivism is about the context of these observations and the subjective interpretation surrounding what they mean (Alharahsheh & Pius, 2020).

[23] *Ethnography* involves the studying of what people say and do through open ended interviews designed to understand people's perspectives (Hammersley, 2006).

manner, with the possibility of follow-up questions based on the answers given by the interviewee (Adams, 2015).

Within this study, two rounds of interviews were conducted. In the first round, to answer the first two sub research questions, end-users were interviewed to analyse (1) the extent to which intermediaries were being accessed by end-users and (2) how these intermediaries create value in their perspective. In the second round, interviews were conducted to answer the third sub research question. These interviews were conducted with the intermediaries named by the end-users in the first round of interviews. The main goal of these interviews was to analyse (3) how these intermediaries capture value from their activities.

4.2.1 Interview round 1: End-user interviews

In this round ten different end-users were interviewed in an interview ranging from 45 minutes to an hour. After these interviews, it was concluded that the *data saturation point*[24] had been met as no new intermediaries or reasons to access intermediaries were being named.

In sampling the ten different end-users, the following considerations were made. Firstly, it is worth noting that the main theme of conducting interpretive qualitative research, is the rejection of the positivist requirement for a generalisable sample (Alharahsheh & Pius, 2020; Hammersley, 2006; Bleiker et al., 2019). Instead of striving to generalize findings, this study contributes by providing in-depth explanations and meanings (Carminati, 2018). In this field of the deductive-inductive cycle, it was more important to act in an explorative manner, forming theories that can be tested in a representative or generalisable manner in future research (Yilmaz, 2013). As representativeness and the degree of generalisability was not a subject, participants were selected in a convenience / network-sampling manner (Suen et al., 2014). The criteria for selecting these end-users was based on if their *primary* workflow was related to real estate development (see: Section 3.2). Table 4.1 illustrates the list of 10 real estate development professional end-users, together with the date they were interviewed and the abstract role their company takes on in the real estate development process.

[24] The *data saturation point* is the point in qualitative research where enough data has been collected to draw necessary conclusions, and any further data collection would not provide new value-added insights (Fusch & Ness, 2015).

Table 4.1

List of end-user interviews

Interviewee	Abstract role of company in the real estate development process	Date of interview
Real estate development professional 1	Financial location- and real estate consultancy	09/10/2023
Real estate development professional 2	Social housing corporation	10/10/2023
Real estate development professional 3	Social housing corporation	13/10/2023
Real estate development professional 4	Municipal policy creator	17/10/2023
Real estate development professional 5	Financial location- and real estate consultancy	31/10/2023
Real estate development professional 6	Urban architect	03/11/2023
Real estate development professional 7	Project developer	16/11/2023
Real estate development professional 8	Project developer	25/10/2023
Real estate development professional 9	Municipal policy creator	24/11/2023
Real estate development professional 10	Construction	07/11/2023

Note. Table illustrating the interviewed end-users.

The interview questions were structured to provide an integral answer to the two sub research questions. In the first section questions were asked to delineate the daily activities of the respondent and to inspect which sources they utilize to acquire their data and information. As the respondents are real estate development professionals and not necessarily data professionals, the possibility of a respondent being unsure of data utilization was predicted. In this case, it was sometimes required to ask the respondent if they utilized frequently-accessed datasets such as one of the key registries. After the utilization of data was clarified, the respondent was then asked from which source they gather this data[25]. This was then followed up by questions such as how frequently the respondent accesses this source, how long it takes them to use the source as intended, and for what purpose they use the data. By asking these questions a clear idea can be formed regarding the extent to which the respondent utilizes intermediaries for accessing the required data.

Subsequently, in the second section, questions were asked to determine the degree to which these intermediaries create value. The interviewee was asked about their likes, dislikes, points of improvement, etc. per every named intermediary. Furthermore, any specific problem / benefit was zoomed in upon to further delineate the specifics. For example, if the respondent named any issues with the data quality the specifics of a data feedback loop were discussed. Another important element of this section of the interview was the analysis surrounding how this perspective of the end-user regarding the creation of

[25] Specifically asking if the interviewee "used intermediaries" would be futile, as the end-users are from the real estate development field, and not the data field, implying that a lack of knowledge regarding intermediaries could be expected.

value came to be. More specifically, the extent to which the bounded rationality of the interviewed end-user had an influence on their selection of a specific intermediary. Firstly, per source of data used by the respondent, the respondent was asked if they knew of any alternatives for gathering this same data. This was then followed up by questions surrounding why they then use this specific source, over other sources. From the answer to this question, it could become clear if the selection of an intermediary is done out of careful consideration, or simply because they do not know of any alternatives. The full list of semi-structured questions are to be found in appendix table 7.1.

4.2.2 Interview round 2: Intermediary interviews

In the second round, nine intermediaries were interviewed. The selection of these intermediaries was based on the data sources named by the interviewees in interview round 1. In other words, in this study it is not claimed that this list of nine intermediaries is a representative sample of all intermediaries in the Netherlands, but merely that they are being used by the interviewed end-users. It can therefore be concluded that a *snowball sampling* method was applied, implying that new respondents arose out of the interviews held with the end-users. This, again, is a non-probability sampling method implying that the focused was cantered around contextualising over providing generalisable claims (Parker et al., 2019).

Furthermore, although the central research question of this study is focussed on *key registry* data intermediaries, some intermediaries of non-key registry data were also interviewed to add further context to the findings. Table 4.2 features the full list of interviewees, and appendix figure 7.2 features the semi-structured interview questions.

Table 4.2

List of intermediary interviews

Interviewee	Type of intermediary	Date of interview
Intermediary 1	BRK & BGT intermediary	21/11/2023
Intermediary 2	BRK intermediary	23/11/2023
Intermediary 3	BRK intermediary	27/11/2023
Intermediary 4	BAG intermedairy	14/11/2023
Intermediary 5	WOZ intermediary	28/11/2023
Intermediary 6	Spatial plans intermediary	30/11/2023
Intermediary 7	GIS viewer developer	22/11/2023
Intermediary 8	Key registry data consultancy	09/01/2024
Intermediary 9	Housing transactions intermediary	28/11/2023

Note. Table illustrating the interviewed intermediaries.

4.2.3 Data analysis

After having conducted both interview rounds, the data stemming from the interviews were analysed. This analysis was conducted along the structure of a thematic content analysis, implying that overarching

impressions of the data were established through the identification of common themes (Erlingsson & Brysiewicz, 2017). Through an aggregation of the data a comprehensive answer was formulated to the sub research questions, which subsequently led to an answer to the main research question.

4.3 Methodological limitations

The main two methodological limitations of this study are found in the underlying research philosophy. As the main focus is on explorative theory-building rather than theory-testing, the choice was made to design this study in a non-generalisable manner. This therefore implies that no generalisable conclusions could be made based on the findings. In other words, it was impossible to conclude matters such as: *"the general real estate development professional is more likely to access intermediary x."*. These conclusions would not be grounded, as the 'general' real estate development professional was not interviewed. Rather, a specific subset of participants were interviewed which were selected based on convenience sampling.

While this limitation does imply the absence of the possibility of any positivist claims to factuality, it also implies the possibility for an interpretivist expansion of a deeper understanding of why the end-users access intermediaries. For instance, claims such as: *"Most interviewees mentioned x to be an important factor in the selection of an intermediary due to reason y."* can be used to create a conceptual understanding of the motivations of end-users.

4.4 Change of scope

The methodology applied in this study was finalized during the study itself. The initial scope of this research was focussed on analysing the motivation of end-users for accessing intermediaries over data suppliers. However, during the end-user interviews (see Section 4.2.1.) it became clear that an analysis of the business model of intermediaries (value creation & capturing) was more relevant for contributing to solving the illustrated problem statement (see Section 1.1). As the motivation of end-users is closely related to the value-creation of intermediaries (see Section 2.2), the data stemming from the end-user interviews was still usable.

4.5 Key takeaways of chapter 4 (summary)

In this study, the main research question; "To what extent do intermediaries of key register open data used by real estate development end-users in the Netherlands create and capture value?", was researched. This study was executed in an inductive and interpretative manner. The focus was centred around building theories based on observations retrieved from interviews with end-users and intermediaries. It is therefore important to emphasize the non-representative character of this study. The in this study built theories can be tested in a deductive manner in future research.

5. Findings

The following chapter contains a description of the findings. Per key registry, the intermediaries are described including a description regarding how these intermediaries create and capture value. Finally, this chapter concludes with a figure containing all accessed key registries and intermediaries.

From the first round of interviews, it became clear that five out of ten key registries were accessed by the interviewed real estate development end-users either directly, or through an intermediary;

1. **Key registry Persons [BRP]** (Basisregistratie Personen)
2. **Key registry value of real estate [WOZ]** (Basisregistratie Waarde Onroerende Zaken)
3. **Key registry Cadastre [BRK]** (Basisregistratie Kadaster)
4. **Key registry addresses and buildings [BAG]** (Basisregistratie Adressen en Gebouwen)
5. **Key registry topography [BRT]** (Basisregistratie Topografie)

5.1 Key registry Persons [BRP]

As the BRP contains personal identity information for every individual in the Netherlands, the GDPR obliges that this dataset is protected properly. As such, the BRP is characterized as a 'closed' key registry, only accessible by a select few public organisations (Rijksoverheid, n.d.-q). Nevertheless, the interviewed end-users often mentioned that they utilized the BRP, even though they are not included in the select group of public organisations that have access. This is the case because these end-users access the BRP through Statistics Netherlands (Dutch: Centraal Bureau voor de Statistiek [CBS]) as intermediary. CBS aggregates the BRP-data in a manner making it impossible to trace the data back to a specific person. Specifically, the end-users mentioned that they applied the 'Key figures for districts and neighbourhoods' [KWB]-dataset (Dutch: 'Kerncijfers wijken en buurten'), which – among other datasets – aggregates the BRP on the neighbourhood, district, and municipal scale. With this dataset, it is for example possible to see the number of people that reside in a specific neighbourhood per specific age group (CBS, n.d.).

The manner in which the CBS-dataset with the aggregated BRP data was applied differed slightly per respondent. For example, real estate development professional 6 indicated that they sometimes accessed the CBS website to look through the dataset. CBS encourages this behaviour as they have developed the 'StatLine' data portal in which every user can view and reuse every public CBS-dataset, including the KWB-dataset (CBS, 2023-b). Furthermore, real estate development professional 8 indicated that they accessed the KWB-dataset (among other CBS datasets) through an API connection with Microsoft PowerBI[26]. This allowed the organisation of the respondent to be constantly aware of developments within the CBS datasets, and use the data for their specific projects.

[26] https://powerbi.microsoft.com/nl-nl/downloads/

Furthermore, real estate development professionals 3, 4, 9, and 10 accessed the KWB-dataset through their organisation-wide GIS-viewer. This GIS-viewer is connected to the PDOK-service specified for the KWB-dataset[27]. These GIS-viewers either applied the offered WFS or WMS connections to supply the interviewed end-users with their data. However, it is worth noting that the interviewed end-users themselves were not concerned with WMS/WFS connections, and simply utilized the GIS-viewer provided by their organisation.

Lastly, real estate development professional 7 utilized a GIS software to access the BRP through the KWB-dataset. This respondent indicated that they applied QGIS[28] to utilize the WFS-connection of PDOK to retrieve the relevant KWB data. The benefit of both the GIS-viewer and applying QGIS is the ability to visualize the data from CBS.

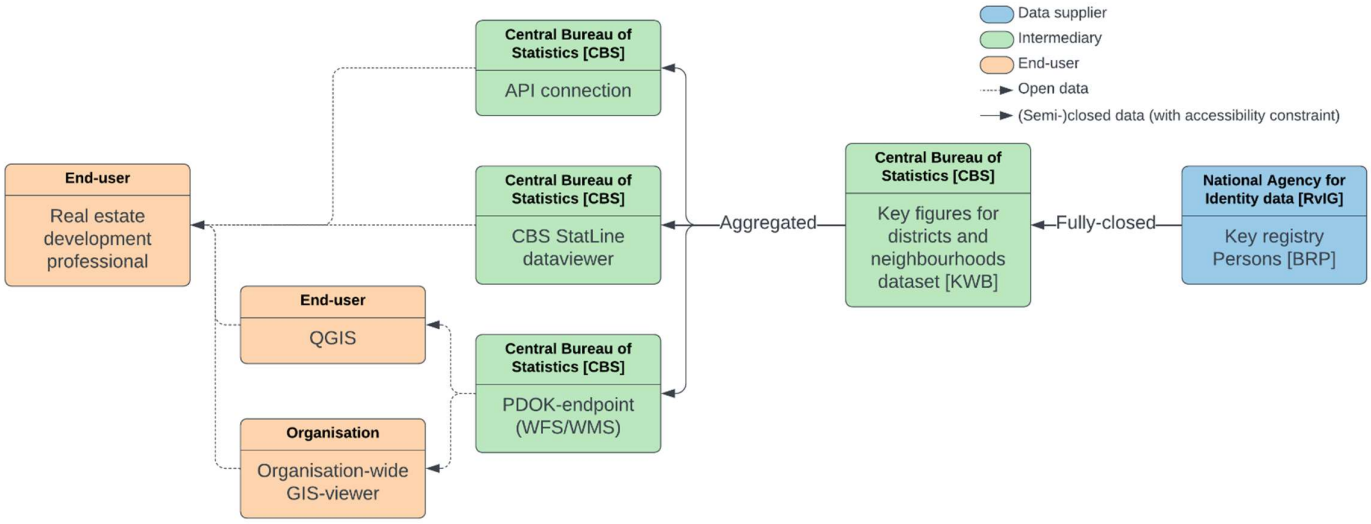
Figure 5.1 illustrates the relation between the data supplier, intermediary and the end-user regarding the BRP. The original data supplier of the BRP is the National Office for Identity Data [RvIG] (Rijksoverheid, n.d.-d), which exclusively supplies the BRP to a select group of public organisations, including the CBS (Rijksoverheid, n.d.-q). From the perspective of the open data spectrum, this connection between the RvIG and CBS can therefore be considered to be fully closed. Subsequently CBS (the intermediary) aggregates this data on the neighbourhood, district, and municipal scale and publishes the BRP data in the form of the KWB-dataset. In this aggregated form, the real estate development professionals then access this data through the CBS-supplied StatLine viewer, an API, or the PDOK WFS/WMS connections (either themselves through QGis or through an organisation-wide GIS-viewer).

It is worth noting that although CBS has set up various methods to 'supply' the data, they remain an intermediary. Referring to the definition of an intermediary (Shaharudin et al., 2023), the services of CBS facilitate the flow of data between the BRP (and other source datasets) and the end-user. CBS therefore does not act as a 'data supplier' on the information value chain, but as an intermediary between the data suppliers and end-users.

[27] https://www.pdok.nl/introductie/-/article/cbs-wijken-en-buurten
[28] https://qgis.org/en/site/

Figure 5.1

the relation between the data supplier, intermediary and the end-user regarding the BRP.



Note. Figure illustrating the relation between the data supplier, intermediary and the end-user regarding the BRP.

5.1.1 BRP intermediaries creating value

The intermediary of the BRP creates value for the end-users in a variety of ways. Firstly, as obliged by GDPR-legislation, CBS aggregates the BRP data. Although this implies a deviation from the primacy principle of open data[29] , this also holds a certain value. For the end-users, it becomes easier to draw conclusions based on the neighbourhood or municipal scale. Most respondents indicated that they applied the KWB-dataset to get a quick and general idea about the population composition of a neighbourhood or municipality. Therefore, they do not require the individual BRP data and actually benefit more from the aggregated form, creating value. CBS therefore creates value as an **aggregator.**

Furthermore, CBS also creates value by acting as an **enabler.** As the BRP is not publicly available, CBS provides exclusive insight into population data. They therefore enable the relation between the end-user and the data supplier, as end-users are prohibited from accessing the data supplier directly. CBS embraces this role of being an enabler by providing several services to access the KWB-dataset. From

[29] The argument can be made that for the public, the BRP-data in the KWB dataset is primary source data as the 'original' BRP supplied by the RvIG is inaccessible. However, this would make CBS the data supplier, not an intermediary. In this study this relation is analysed holistically and the legally defined division of roles regarding the supply of key registry data is adhered to. This implies that the RvIG is supplying the primary source data, and any aggregation by CBS entails a deviation of this primary source data. Therefore, although CBS claims to supply *open* data, analysing this claim strictly through the principles of open data it can be stated that this is not completely true. However, labelling the KWB dataset as 'closed' would also not do it justice, further emphasizing the need to analyse data through the (open) data spectrum (see Section 2.1.2).

the interviews, it became clear that four different services[30] were used to access the KWB-dataset. Although some respondents did have some points of improvement regarding data quality, no respondent mentioned any difficulties regarding the retrieval of the data from the KWB-dataset.

5.1.2 BRP intermediaries capturing value

The BRP intermediary (CBS) is an 'independent administrative body' (Dutch: Zelfstandig Bestuursorgaan [ZBO], implying that they execute governmental tasks but are not directly related to a ministry (CBS, n.d.). By law, CBS is obliged to gather data and publish certain statistics, including the aforementioned KWB-dataset (art. 3, act CBS). Abiding by this legislation implies that substantial costs are required to be made to be able to properly produce these statistics.

Next to providing these statistics without charging a fee, CBS also executes certain extra fee-based services for municipalities. However, with these extra fee-based services the CBS can exclusively cover a small percentage of all made costs. The remainder of these costs are covered by the Ministry of Economic Affairs and the Climate [EZK] (CBS, 2023). Therefore, it can be concluded that the BRP intermediary (CBS) captures value through the budget financing revenue model. As the CBS creates value for the public, EZK finances them with public funds to be able to execute their tasks.

5.2 Key registry value of real estate [WOZ]

The second key registry of which real estate development professionals indicated that they accessed it is the key registry value of real estate [WOZ]. This dataset contains the monetary value of each 'property'[31] in the Netherlands. The municipality where the property is located conducts an annual appraisal of its value. This property value determines the amount of taxes that the property owner has to pay (Klamer et al., 2019). In general, valuators apply either (1) the *comparative taxation method,* where a property is appraised based on market-transactions of similar properties or (2) in case of absence of transactions of similar properties, either on the rental income of a property or the transformation or replacement costs of that property. In general, municipalities apply the comparative taxation method to appraise owner-occupier residential properties, while for non-residential properties either the rental-income or replacement cost methods are applied, depending on the complexity of the building (Waarderingskamer, n.d.). The WOZ, thus, contains the appraised value of every property in the Netherlands.

From an interview with the supervisor of the WOZ, the Netherlands Council for Real Estate Assessment (Dutch: 'Waarderingskamer') (Rijksoverheid, n.d.-d), it became clear that the policy context regarding the push for open data and privacy legislation stemming from the GDPR has resulted in a complex field regarding the openness of WOZ data. Firstly, it was noted that the value of owner-occupier residential properties can be considered personal data as the residential property belongs to a specific person. From

[30] (1) StatLine viewer, (2) APIs, (3) QGis WFS/WMS, (4) GIS-viewer WFS/WMS
[31] An 'property' can be an apartment, single-family home, business, office building, etc.

this perspective, the value of residential properties must therefore, be protected. Furthermore, as the value of non-residential properties is often appraised based on competitively sensitive information such as the rental income, releasing the value of non-residential properties could be harmful towards the market-position of individual companies.

Due to the above reasons, the WOZ is closed to the public. However, the WOZ is accessed through intermediaries that have been granted access by the data supplier of the WOZ. These organisations – as indicated by the interviewed end-users[32] – are CBS and WOZ-waardeloket[33].

Firstly, similar to the BRP (see Section 5.1), The interviewed end-users accessed the WOZ through the KWB-dataset of CBS. In this dataset, the average value of all residential properties in a municipality, district, or neighbourhood is given. Therefore, similar to how the KWB handles the BRP, data concerning the WOZ is exclusively provided in an aggregated manner to prevent privacy issues (CBS, n.d.).

Besides CBS's KWB dataset, the WOZ-waardeloket is the second intermediary that the interviewed end-users indicated they consulted. With the WOZ-waardeloket it is possible to view the property value of residential properties on a disaggregated scale. From an interview with one of the supervisors of this intermediary product, it became clear that the WOZ-waardeloket originated from the tension between the GDPR and the need for government transparency and open data. For owner-occupiers, the value of their property (and therefore the extent of property tax they pay) is mostly determined based on comparable properties (Klamer et al., 2019). Therefore, with respect to government transparency, the Netherlands Council for Real Estate Assessment determined that the value of these properties should be visible to the owner-occupiers. On the other end of the tension field, adhering to the GDPR implies that viewing the – privacy sensitive – property value should be limited. Therefore, the Netherlands Council for Real Estate Assessment set up the WOZ-waardeloket in a manner that individual property values of residential properties can be viewed. However, exclusively as a viewing service without a download option or invokable by APIs. Furthermore, users of the WOZ-waardeloket can exclusively view a limited number of property values within a specific timeframe[34].

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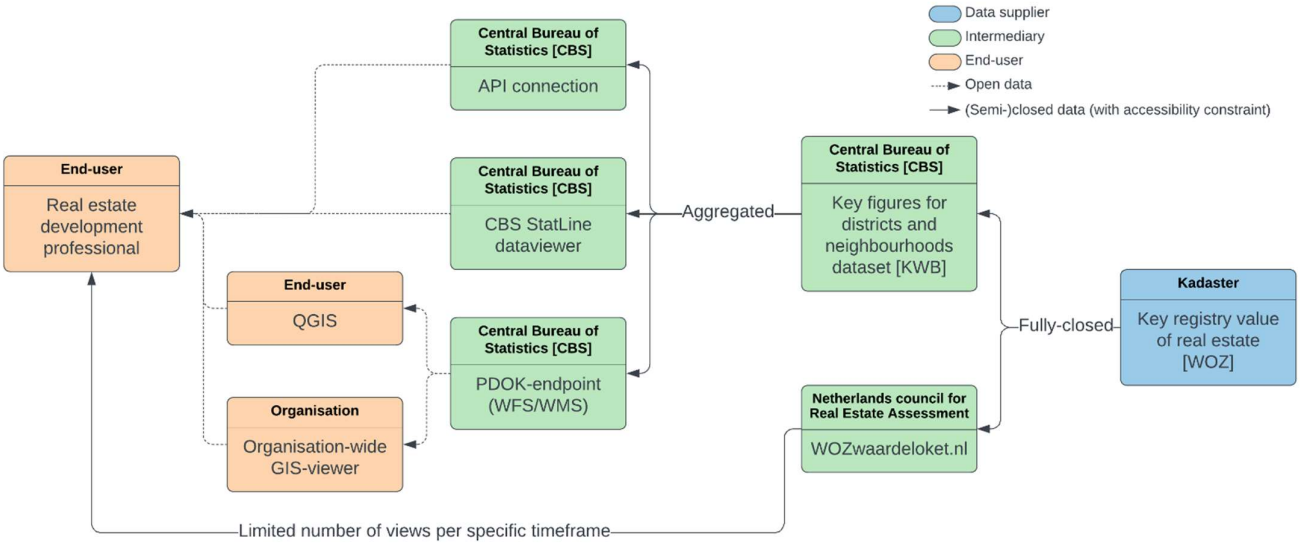
[32] Although this study exclusively focusses on the intermediaries of the WOZ accessed by the interviewed end-users, there are more institutes with a legal right to the WOZ. These institutes include (next to the WOZ-waardeloket and CBS); ACM, provinces, governmental real estate companies, and more (Waarderingskamer, n.d.-b)

[33] https://www.wozwaardeloket.nl/

[34] Setting a limit of views per specific timeframe prevents automated 'web-scrapers' from bypassing the access constraints and retrieving the full WOZ-dataset (Tabaku & Ali, 2021).

Figure 5.2

the relation between the data supplier, intermediary and the end-user regarding the WOZ.



Note. The relationship between the data supplier, intermediary, and the end-user regarding the WOZ.

5.2.1 WOZ intermediaries creating value

The two intermediaries utilized by the interviewed end-users create value in two different ways. While the CBS KWB dataset creates value by aggregating and enabling access to the data (see Section 5.1.1), the WOZ-waardeloket creates value by *not* aggregating the data. In general, the value of the WOZ-waardeloket stems from the transparency of citizens being able to compare the value of their property, to the value of other comparable properties.

However, emphasizing the subjectiveness of value (Juechems & Summerfield, 2019), this is not the value that is being created for the interviewed real estate development professionals. For them, the value is found in being able to determine the contribution value of a specific property in an area development plan, or grasp what the property value of a similar property that is to be constructed might be.

Due to the variety of property characteristics having a potential influence on the property value, it is difficult to determine the contribution value or specific property value based on an aggregated WOZ value on, for example, the neighbourhood scale. Therefore, the WOZ-waardeloket functions as an **enabler** on the information value chain, as they enable the end-user to access to the WOZ on a disaggregated scale. Without this intermediary, the end-user would not be able to access the WOZ on the disaggregated scale.

Furthermore, the WOZ-waardeloket is not only an enabler of this disaggregated data. The WOZ-waardeloket contains a GIS-viewer where the value of properties is linked to actual addresses (BAG). A

user, therefore, can scroll around through the map and click on specific buildings to retrieve the property value. Furthermore, with a limited number[35] of properties, the user is also able to apply filters such as the construction year, surface area, and property value to get a quicker overview of similar properties. Therefore, the WOZ-waardeloket not only creates value as an enabler, but also as a **developer.**

5.2.2 WOZ intermediaries capturing value

The WOZ intermediaries also capture value in a different manner. While both CBS (see Section 5.1.2) and the Netherlands Council for Real Estate Assessment rely on budget financing of governmental entities (Waarderingskamer, 2023), the relation between the developed intermediary and the financing differs. CBS has developed the KWB-dataset to adhere to their legal obligation of publishing relevant statistics (art. 3, act CBS). Adhering to this legal obligation justifies the Ministry of Economic Affairs and Climate in maintaining the budget financing of CBS. It can therefore be said that CBS captures value from publishing the KWB dataset because it implies that they adhere to their legal obligation, further securing their financing.

However, the Netherlands Council for Real Estate Assessment did not necessarily develop the WOZ-waardeloket for this same legal obligation. The created value regarding transparency for users of the WOZ-waardeloket (see Section 5.2.1), also has consequences for the municipalities who are responsible for funding the Netherlands Council for Real Estate Assessment. As citizens of municipalities can easily check the property value of their residence and that of comparable properties, the number of requests for municipalities to provide this information decreased substantially. This implies a decrease in the administrative burden for municipalities regarding WOZ-requests, reducing overall staff-hours at municipalities[36].

This reduction in costs for municipalities due to the WOZ-waardeloket further justified the financing streaming from municipalities to the Netherlands Council for Real Estate Assessment. Therefore, it can be concluded that the Netherlands Council for Real Estate Assessment *captures* value with the WOZ-waardeloket by assuring the revenue stream from their clients (the municipalities).

5.3 Key registry Cadastre [BRK]

The third key registry that the interviewed end-users indicated that they accessed is the key registry Cadastre [BRK]. This dataset contains the geometry of all parcels in the Netherlands, accompanied by

[35] This number of properties that can be filtered is limited by the zoom level. Only from a certain zoom level the 'filter' option becomes available, implying that a user cannot filter through the entire dataset.

[36] Furthermore, municipalities frequently became flooded with WOZ-objections by companies specialized in objecting the property value of residential properties. As they were not able to respond to these objections in time, they often were required to pay penalty fees to the WOZ-objection companies (VNG, 2023). Initially, the WOZ-waardeloket was also partly set up to undermine these companies, aiming to further reduce the administrative burden and paid fines.

certain attributes such as the legally binding cadastral surface area[37], the parcel name, and proprietary information. The BRK is considered to be semi-open (Rijksoverheid, n.d.-a) as the geometry, cadastral surface area, and the parcel name are openly accessible, but the proprietary information is closed. To retrieve the proprietary information of a parcel, a user is required to pay a fee of € 3,35 per parcel (2024 price) to Kadaster. In international comparison, this approach of allowing anyone to purchase the proprietary information of a parcel is considered to be very liberal (Berlee, 2018). This liberal approach to supplying proprietary information is critiqued by both ends of the privacy-transparency spectrum. Firstly, some argue that the legal obligation for the government of the Netherlands to provide proprietary information to 'anyone who asks' is outdated, and stems from a time when "*…the internet and search engines were still in their infancy*" (Berlee, 2018, p. 248). In modern times, the burden of having to physically go to a land administration office is discarded, implying that the proprietary information of other individuals is too easy to access (Berlee, 2018). On the other end of the spectrum, critics argue that the privacy of personal data argument does not withstand. They argue that the small fee of € 3,35 does not provide any protection of privacy, and therefore the BRK should adhere to open data directives and be completely free to access.

Due to the different access policies within the BRK, the specific components are also supplied through different channels. The data supplier of the BRK, Kadaster, hosts two different ways to access the BRK (that were relevant for the interviewed end-users). For the open component of the BRK, users can utilize the PDOK service for the BRK[38] and retrieve the data through a webservice (WMS/WFS/WMTS), API, or a download viewer. Regarding the proprietary information (closed component), users are required to purchase the proprietary information for € 3,35 per parcel from the Kadaster webshop[39].

The interviewed end-users indicated that, next to accessing the BRK directly through a GIS-viewer, QGIS, or the Kadaster webshop, certain intermediaries were utilized. The intermediaries that the interviewed end-users pointed out were Kadastralekaart.com (Geogap), Kadastralekaart.nl (PropertyInfo), and Perceelloep.nl (Geoloep). These three intermediaries are similar in the sense that they provide a viewer to see the locations and attributes of parcels. Furthermore, next to the viewer all three intermediaries provide extra (fee-based) services related to these parcels. The three intermediaries differ from each other in the set-up of these services, the output, and pricing. Categories of services include, among others, (1) geometric calculations, (2) linking to other (open) datasets, (3) proprietary information, and (4) on-location cadastral border reconstructions. Figure 5.3 illustrates the relation between the data supplier, intermediary and the end-user regarding the BRK.

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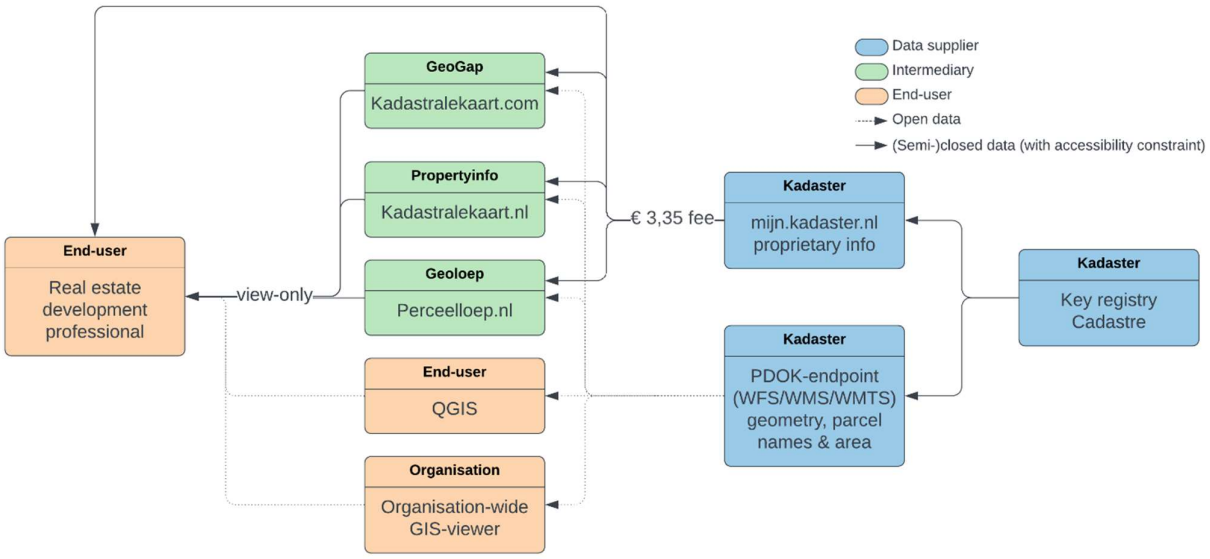
[37] The geometry of parcels in the BRK is purely indicative to see how parcels are positioned relative to other parcels. The geometrically calculated surface area of a parcel based on the BRK, can therefore slightly deviate from the when the parcel was established determined surface area. This latter surface area is labelled as the cadastral surface area, and is legally binding in judicial cases (Kadaster, n.d.; Kadaster, 2019).

[38] https://www.pdok.nl/introductie/-/article/kadastrale-kaart

[39] https://mijn.kadaster.nl/

Figure 5.3

The relation between the data supplier, intermediary, and the end-user regarding the BRK



Note. The relation between the data supplier, intermediary, and the end-user regarding the BRK.

5.3.1 BRK intermediaries creating value

Due to the product of the three intermediaries being relatively similar, the general way that they create value is also similar. Although the fee-based extra services and products offered by the website differ slightly in output, methodology, and price, the interviewed end-users indicated that they did not make use of these extra services[40], making them irrelevant for this specific analysis of value creation. The only fee-based service regarding the BRK that the interviewed end-users utilized was the purchase of proprietary information. However, while this is possible to purchase through the intermediaries, the end-users indicated that they preferred to bypass the intermediary and purchase it directly from the Kadaster webshop. The interviewed end-users indicated that the reasoning behind this choice was based on (1) the fact that purchasing proprietary information from an intermediary is more expensive than from the Kadaster webshop[41] and (2) their respective organisations had a commercial Kadaster webshop account, simplifying the transaction process.

However, when the end-users were asked about what moves them to access these intermediaries, it became clear that for most interviewed end-users, the intermediary-data supplier difference was unclear.

[40] The fact that the 10 interviewed end-users mentioned that they did not make use of the fee-based extra services does not imply that the extra services are not being used. From interviewing the intermediaries, it became clear that a percentage of their users do utilize the extra services.

[41] As of 2024, Kadaster charges a fee of € 3,35 (Kadaster, n.d.) for the proprietary information of a parcel, while at the intermediaries this same product ranges from € 5,99 to 11,95.

Most end-users were unaware or indifferent regarding whether they were utilizing an intermediary as they were exclusively utilizing the free functions of the intermediaries. For example, real estate development professional 5 argued that they utilize a lot of free web applications such as the BRK intermediaries and just click away as soon as they have to pay for something.

Nevertheless, from the interviewed end-users it became clear that the free functionalities of the intermediaries (the ability to view parcels and their attributes) were seen as highly valuable. Even though, in theory, every end-user can download QGIS and apply a WFS connection to the PDOK-service for free, this requires some technical knowledge. This technical knowledge is missing for most real estate development end-users, implying that there is a gap between the end-user and the data supplier, that the three intermediaries are able to fill. Therefore, the three BRK intermediaries create value as an **enabler.** Furthermore, even though the intermediaries do create value as a developer (the fee-based extra services), these were not applied by the interviewed end-users.

While it is clear that these intermediaries create value, the existence of multiple intermediaries that do about the same thing allows for a comparative analysis concerning what specific features result in value for the end-users. In other words, why an end-user (for example) uses Kadastralekaart.com instead of Perceelloep.nl, or even any other source to view BRK data such as the PDOK Viewer[42]. For the interviewed end-users, the reasoning for this came down to a comparison of transaction costs. This 'transaction' being the time that it costs to gather the data from one of the intermediaries, and copy it to their local Excel file. Elements that created value in the perspective of the end-user included (1) specificity; if an end-user was searching for parcels, they only wanted to see parcels, and (2) ease of copying; lay-out decisions made by the intermediary that make copying information about (multiple) parcels easier.

However, from an external perspective it became clear that the bounded rationality of most of the interviewed end-users was the deciding factor for the selection of an intermediary. When asked about alternatives for retrieving BRK data, the interviewed end-users were either unaware or indifferent, citing that their selected intermediary works fine. Based on these observations, it can be concluded that the findability of an intermediary creates substantial value in the perspective of the end-user. Most interviewed end-users simply googled 'parcel' or 'cadastral map' and utilized the first search result. Subsequently, this is the intermediary that they become familiar with, and keep using this intermediary.

Furthermore, the bounded rationality of most of the interviewed end-users also became clear based on their use case. End-users indicated that they often require a list of parcels, and individually click on different parcels and manually copy their attributes to a local Excel sheet. Exclusively real estate development professional 7 indicated that they applied QGIS to establish a WFS connection to the PDOK-service of the BRK, in which they made selections and systematically retrieved parcel data to

[42] https://app.pdok.nl/viewer/

their Excel sheets. Paraphrasing real estate development professional 7, manually selecting and copying is feasible for maybe 10 parcels, but if you require 100 or 1000 parcels this becomes a waste of time.

5.3.2 BRK intermediaries capturing value

All three intermediaries capture value in the same manner. They attract end-users with free services such as the viewer where the end-user can view the geometry and attributes of parcels. Subsequently, they capture (monetary) value by providing extra fee-based services such as (re-)selling proprietary information, calculating geometry, and providing further open data. As mentioned by the intermediaries, the recognition of their fee-based services is dependent on end-users first searching for the free functionalities. This is a clear example of the 'Open source like model' (see Section 2.2.2) where extra fee-based services pay for the upkeep of the free functionalities. Interestingly, due to the inherent characteristic of open data implying that the operational costs of the intermediaries are relatively low (no data acquisition costs), all three intermediaries indicated that the (very) modest number of users that utilized the fee-based extra services were enough to sustain the free functionality of the intermediary.

It can therefore be said that the intermediaries create value by bridging the gap between the end-user and the data supplier for free, but also make sure to 'leave some holes' in the bridge that require an extra payment. For example, in the above described use case (end-users manually copying the information of a number of parcels) the intermediaries do make this possible for free, but allow a GIS-intersection and systematically exporting multiple parcels exclusively for a fee. Relating the metaphor to the stated revenue model, it becomes clear that it is financially beneficial to only just slightly bridge a gap for free, and fully bridge a gap as a fee-based service.

5.4 Key Registry Addresses and Buildings [BAG]

The fourth key registry that is being accessed by the interviewed end-users is the Key Registry Addresses and Buildings [BAG]. This dataset contains information about every building and address[43] in the Netherlands. The BAG can be considered to be a fully open dataset (Rijksoverheid, n.d-a). The main access node of the BAG is the PDOK-service[44], where the BAG can be accessed through webservices (WFS/WMS) OGC APIs (Vector tiles), and an ATOM download service. Similar to the BRK, some interviewed end-users indicated that they utilized an organisation-wide GIS-viewer that is connected to this PDOK-service, and one interviewed end-user indicated that they accessed the PDOK-service directly through QGIS.

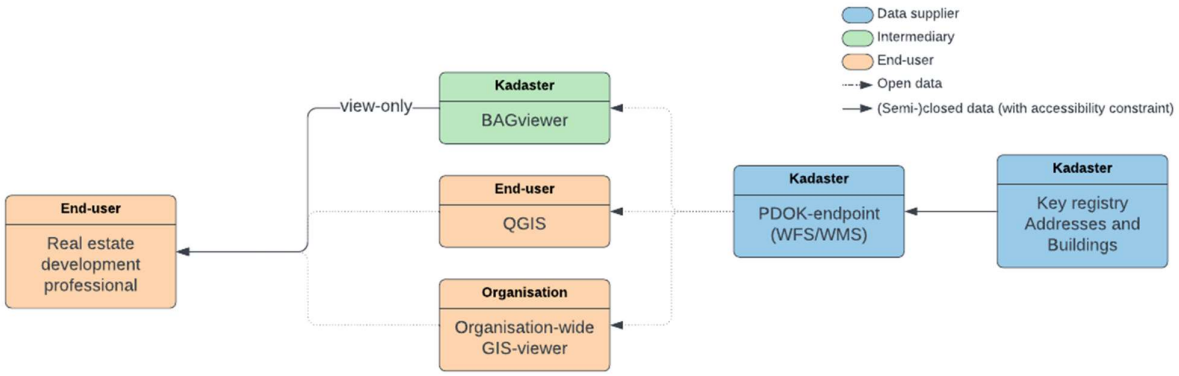
[43] For example, one apartment complex (building) can contain multiple addresses. The BAG hosts information about both the building, and all individual addresses.

[44] https://www.pdok.nl/introductie/-/article/basisregistratie-adressen-en-gebouwen-ba-1

From interviews with the end-users, one BAG intermediary could be identified. This intermediary is the website BAGviewer[45], which hosts a viewer with information about the specific BAG-attribute of every individual address and building[46] in the Netherlands. In this viewer, all buildings and addresses are plotted on a map and the user can scroll around through this map. When a building or address is clicked, the viewer shows the attribute information concerning that specific address or building. Furthermore, this intermediary also provides the possibility to filter based on specific attributes, resulting in only those features fitting the filter to be shown in the GIS-viewer.

Figure 5.4

The relation between the data supplier, intermediary, and the end-user regarding the BAG



Note. The relation between the data supplier, intermediary, and the end-user regarding the BAG.

5.4.1 BAG intermediaries creating value

The manner in which the BAGviewer creates value differs from the other key registries due to the access policy of the BAG. For example, where it is impossible to access the WOZ directly – *requiring* the usage of an intermediary – the BAG is accessible as open data through the PDOK-service. In other words, where end-users are obliged to utilize WOZ intermediaries to view disaggregated WOZ data, the usage of a BAG intermediary can be considered a deliberate choice. From the interviews with end-users, it became clear that the value of the BAGviewer relates to the bridging of the technical gap between end-users and the BAG. Most end-users indicated that they were not technically capable enough to utilize PDOK-services to retrieve the BAG, implying that they preferred using the BAGviewer. Furthermore, some of the interviewed end-users indicated that they accessed BAG-information through a GIS-viewer

[45] https://bagviewer.kadaster.nl/

[46] The BAGviewer stretches the in this study applied definition of an intermediary (Shaharudin et al., 2023) as the intermediary is created by the same organisation as the data supplier (Kadaster). However, from an interview it became clear that the team within Kadaster that supplies the BAG is different from the team that developed the BAGviewer, justifying the identification of the BAGviewer as an intermediary.

that their organisation provided, and one interviewee indicated that they accessed the PDOK-service through QGIS themselves.

Out of the ten interviewed end-users, nine lacked the technical capability to utilize the PDOK-service themselves to access the BAG. For some of the interviewees this technical gap was bridged by their organisation, providing them with a GIS-viewer in which they can access the BAG. For others, they are required to utilize the BAGviewer intermediary to retrieve information about the BAG. Therefore, it can be concluded that the BAGviewer creates value as an **enabler,** in the sense that they enable access to the BAG for those lacking the technical capability to connect to the PDOK-service themselves (or have their organisation connect them through a GIS-viewer). The use case of these interviewees accessing the BAGviewer included searching for a building, clicking on it and manually copying the attribute information such as size to a local Excel sheet. Even though the BAGviewer could also create value as a developer through their 'filter' options, the interviewed end-users did not indicate that they used this feature.

5.4.2 BAG intermediaries capturing value

Although the appearance of the BAGviewer is similar to the BRK intermediaries, the business model is different. Where the BRK intermediaries fund their operations through the provision of fee-based extra services, the BAGviewer does not have any of these services. The revenue model utilized to sustain the intermediary is more complex.

By law, the supplier of the BAG (Kadaster) was required to start providing the BAG in an open format. However, simply setting up an endpoint with web services that could be utilized by end-users was not enough, as most end-users lacked the technical capabilities to do so. Subsequently, Kadaster was met a substantial number of requests of users that required help with accessing the BAG. Therefore, Kadaster decided to set up the BAGviewer intermediary, where end-users could easily access the BAG without additional administrative burdens for Kadaster. The BAGviewer is thus sustained through a budget financing revenue model, where the general administrative burdens are lowered due to the BAGviewer.

5.5 Key registry topography [BRT]

The last key registry utilized by the interviewed end-users differs from the other key registries as it is not searched for in isolation. The key registry topography [BRT] provides a scalable basemap of the Netherlands, which can be used to give a context to visually plotted data. From the interviews, it became clear the BRT is used throughout the intermediary GIS-viewers such as the 'Kadastralekaart', 'BAG-viewer' and 'WOZ-waardeloket', but also in GIS-viewers created by the organisation of the end-user.

The BRT is retrievable through its respective PDOK-service[47], exclusively in the form of a Web Map Tile Service [WMTS] connection. Developers behind the mentioned intermediaries utilize web-development libraries such as Leaflet[48] or OpenLayers[49] to load in the tiles from the WMTS-connection and provide a basemap. Over this retrieved basemap, they then plot their respective data (BAG, WOZ, BRK) to illustrate the geographical context of this data.

5.5.1 BRT intermediaries creating value

All intermediaries that utilize the BRT to give geographical context to their data are therefore also creating value as an **aggregator**. By aggregating the data that an end-user searches together with a basemap, the geographical context of the data becomes clear. For the end-users, the value of this aggregation is that they can promptly recognize the surroundings of a specific feature, without requiring the knowledge of the location of the exact coordinates associated with this feature. For many end-users, this value is underestimated as the existence of a basemap is considered to be a given.

5.6 Key takeaways of Chapter 5 (Summary)

From interviews with the real estate development end-users, it became clear that five different key registries are accessed (BRP, WOZ, BRK, BAG, BRT). These key registries are either accessed directly through the respective PDOK-services utilizing GIS software such as QGIS or organisation-wide GIS-viewers, or through an intermediary. The identified intermediaries are illustrated in Table 5.1.

[47] https://www.pdok.nl/introductie/-/article/basisregistratie-topografie-achtergrondkaarten-brt-a-
[48] https://leafletjs.com/
[49] https://openlayers.org/

Table 5.1

The intermediaries and their respective key registries (identified by the interviewed end-users)

Key Registry	Intermediary (intermediary product)
BRP	CBS (KWB-dataset)
WOZ	CBS (KWB-dataset)
	Netherlands Council for Real Estate Assessment (WOZ-waardeloket)
BRK	Geoloep (Perceelloep.nl)
	Geogap (Kadastralekaart.com)
	PropertyInfo (Kadastralekaart.nl)
BAG	Kadaster (BAG-viewer)
BRT	Netherlands Council for Real Estate Assessment (WOZ-waardeloket)
	Geoloep (Perceelloep.nl)
	Geogap (Kadastralekaart.com)
	PropertyInfo (Kadastralekaart.nl)
	Kadaster (BAG-viewer)

Note. The by the interviewed end-users identified intermediaries and their respective key registries.

In general, the intermediaries create value through a combination of being an aggregator and enabler. Aggregation in the sense of combining basemaps with the relevant data, and enabling by bridging two specific gaps. These two gaps include (1) a legal gap, providing access to data which the end-user otherwise does not have access to and (2) a technical gap, allowing end-users to view the specific data without any technical knowledge regarding, for example, WFS/WMS connections.

The extent of the value that is being created by the intermediaries in the perspective of the end-users is dependent on various factors. The two main factors that could be recognized are (1) the findability and (2) the specificity of an intermediary. Firstly, the findability is derivative of the *bounded rationality* of the end-users, as most end-users are attracted to the first intermediary they can find, regardless of how well it satisfies their needs. Secondly, the specificity of an intermediary is of essential importance, as the interviewed end-users are extrinsically motivated to find an intermediary that lowers their transaction costs. In other words, end-users indicated that they valued the intermediary that gave them their data *"with as little clicks as possible"* the highest.

Furthermore, intermediaries *capture* value in a different manner. Where private sector self-sustaining intermediaries relied on subscription and open source like revenue models, the public sector intermediaries mostly aimed to reduce administrative burdens and aspire a stronger transparency.

6. Discussion & recommendations

In this study, an analysis was conducted surrounding the manner in which key registry intermediaries utilized by real estate development professionals create and capture value. From this analysis it became clear that the common purpose of intermediaries, the bridging of gaps (Shaharudin et al., 2023; van Loenen et al., 2021), also fits the value-creation model of the intermediaries within this study. Through an analysis of the end-user perspective[50] of the products of intermediaries, it became clear that intermediaries create value by bridge two specific gaps. Firstly, *technical value* (Attard et al., 2016) is created by intermediaries as the technical gap between end-users and the data suppliers is bridged. As connecting to a webservice on a PDOK-service is often too technically complex for the interviewed end-users, the intermediaries providing a GIS-viewer where an end-user can easily scroll through data is valuable to the interviewed end-users. Secondly, the intermediaries analysed in this study bridge a legal gap for certain key registries. As the access policies of the different key registries are found throughout the open data spectrum (Open Data Institute (n.d.)), some intermediaries function as the exclusive channel through which an end-user can access the data. For example, as the BRP is only accessible to a specified group of organisations, a legal gap is created for end-users desiring to access the BRP. The CBS (intermediary) bridges this gap by providing a dataset with the BRP in aggregated form, creating, for example, *political value* (Attard et al., 2016) as end-users can now cross this legal boundary.

Furthermore, the intermediaries analysed in this study took on multiple archetype roles in creating value (Welle Donker & van Loenen, 2016). Firstly, as intermediaries bridged certain gaps, all intermediaries functioned as an enabler, facilitating the usage of data between the end-user and the data supplier. This is in line with the findings of the research of Den Haan (2018), in which all analysed intermediaries also functioned as enablers. Furthermore, as almost all intermediaries applied the BRT basemap for their GIS-viewers to provide geographical context, they also created value as an aggregator. Lastly, although most intermediaries aspired to create value as a developer by facilitating filter or calculation options, these were not utilized by the interviewed end-users. However, from interviews with the intermediaries, it became apparent that these features were utilized by other users. This implies that although these intermediaries do not create value as a developer in the perspective of the interviewed end-users, they can still create value as a developer in the perspective of other users (Haksever et al., 2004).

Next to the specific type of value, the manner in which the product of an intermediary is structured can also determine the *extent* of the value. From the findings in this study, it became clear that products become more valuable to real estate development end-users as they are more (1) specific and (2) findable. Firstly, the specificity of a product relates to the fact that the interviewed end-users preferred to use an intermediary that had as little features as possible, only having the features that they required. Any other data or features/buttons were considered to be clutter. This finding is in line with theory regarding

[50]In this study, value-creation was researched from the perspective of the end-user to adhere to the theories regarding the subjectiveness of value (Haksever et al., 2004; Juechems & Summerfield, 2019)

transaction costs (Welle Donker et al., 2016; Allen, 1991), implying that rational end-users prefer to utilize an intermediary that allows them to retrieve their required data with *"as little clicks as possible"*.

However, this analysis of the extent of value also indicated the importance of taking the theory of bounded rationality into account (Simon, 1990; Puranam et al., 2015). While all end-users indirectly indicated that the reduction of transaction costs were a key aspiration for them in determining which intermediary they accessed, the second principle determining the extent of the value (findability) was unknowingly of a higher importance to them. In determining the method of extracting key registry data, end-users did not possess information about every possible method to do this (Puranam et al., 2015), implying that they could not carefully weigh different options. Rather, end-users simply preferred to utilize the first intermediary that they could find and kept using it out of a familiarity with the interface. Therefore, although the extent of value that an intermediary creates is partly determined by rational decision-making of the end-user regarding the lowering of transaction costs, it is also partly determined by the bounded rationality of the end-user, implying that they are unaware of other suitable intermediaries or methods to extract data.

Regarding the manner in which intermediaries *capture* value, this study further emphasized the fact that intermediaries do not act in a purely altruistic manner (Welle Donker, 2007). For their products and services, the intermediaries expected some value in return (Janssen & Zuiderwijk, 2014). The found revenue models utilized to capture value in this study fit in the open data revenue model framework by Welle Donker & van Loenen (2016). It was found that the private sector intermediaries applied a combination of the subscription model and open source like model, while the public sector intermediaries applied the budget financing model. Intermediaries in the public sector created their intermediary products in aspiration of reducing the administrative burden of the overarching organisation or organisations directly financing them.

6.1 Theoretic implication of results

The above demonstrated interpretation of the results have implications for certain theories discussed in the theoretic framework. Firstly, next to creating and capturing value (Vancauwenberghe et al., 2018), intermediaries also influence the positioning of the data on the open data spectrum (Open Data Institute, n.d.). In this study, the shift of data through the open data spectrum was observed in both directions. With some key registries on the closed side of the spectrum (BRP & WOZ), the intermediaries facilitated a shift making the data more open to the public[51]. With the (partly) open key registries (BRK, BAG, BRT) the intermediaries shifted the positioning on the open data spectrum more

[51] Although these intermediaries ensure a more open access policy, they are still not fully open. For example, the CBS intermediary not adhering to the primacy principle of open data by aggregating the BRP and the WOZ-waardeloket not adhering to the Ease of electronic access principle of open data by not providing an API or download-link, and limiting the number of requests per a specific timeframe (Sunlight Foundation, 2010).

towards the closed side. Intermediaries of these key registries provided GIS-viewers where end-users could exclusively view the data. This view-only modus of data implied a removal of the 'ease of electronic access' principle of open data (5th) as no APIs or download links are provided (Welle Donker & van Loenen, 2017; Sunlight Foundation, 2010).

6.1.1 The destruction of value

This shift in the open data spectrum has the potential to result in two consequences. Firstly, value can be created, as non-technical end-users lacking the capability to utilize APIs might identify an API as clutter in the way of reducing transaction costs. The decision to not implement an API could therefore imply a creation of value in the perspective of these specific end-users. However, shifting the positioning on the open data spectrum can also result in the *destruction* of value. This concept is best demonstrated through an example found throughout the end-user interviews. The BAG is an open dataset which is supplied through an API at the PDOK-service. However, as noted in the findings, the intermediary product BAG-viewer was created to bridge the technical gap as end-users were not able to utilize the API. The BAG-viewer, however, shifts the positioning of the BAG data from open to slightly less open, as the BAG-viewer itself does not provide an API or download link. Interviewed end-users of the BAG that utilized the BAG-viewer indicated that a use case was that they frequently needed to retrieve attribute data of hundred or more buildings. In their bounded rationality (Simon, 1990; Puranam et al., 2015), they assumed that the only possible method of extracting this data was to individually click on all hundred buildings, and manually copy the attribute data to a local Excel sheet. The end-users were not aware of the possibility of requesting the API of the BAG provided on the PDOK-service in a specific manner so that this process would become automated. Therefore, exactly due to this bounded rationality of the end-user implying that they think that the BAG-viewer is the sole source to gather BAG-data, the intermediary product (BAG-viewer) is actually *destroying* value in the perspective of the end-user by not adhering to the open data principles and providing an API.

With the above example, it is of importance to emphasize the importance of the bounded rationality in the destruction of value. The BAG-viewer does not necessarily 'remove' the API from the PDOK-service, implying that a fully-rational end-user can always choose to access the PDOK-service instead of the BAG-viewer. However, for some end-users, the mere existence of the BAG-viewer entails that they are not aware of other methods of extracting BAG-data, resulting in them acting in their bounded rationality and manually copying attribute data of hundreds of features. This, in turn, costs more time and therefore increases the transaction costs of retrieving the data, acting *against* their (boundedly) rational beliefs, and thus destroying value.

In literature, the effects of value destruction are often overlooked to focus on the more 'positive' value-creation aspect of intermediaries within the information value chain (Shayam et al., 2023). This is the case because most organisation aim to provide products or services for their customers that bridge gaps, making their products or services desired by their customers (Osterwalder, 2004). However, when an

integral analysis is conducted surrounding the positioning of intermediaries, it is of importance to take into account the above discussed complexities regarding the destruction of value. Although unintended, the mere existence of an intermediary has the potential to *destroy* value in the perspective of the end-user.

Whether or not the destruction of value should be added in academic frameworks regarding the business model of intermediaries (Osterwalder, 2004; Vancauwenberghe et al., 2018) deserves its own research. The bounded rationality of end-users causing value to be destructed by intermediaries could be relegated to an unintended consequence, but could also be part of the business strategy of an intermediary. For some intermediaries, the usage-rate of their products is dependent on the limited knowledge of their users. Referring to the example of the BAG-viewer, if end-users were aware of where and how to request the BAG API the usage-rate of the BAG-viewer would decrease substantially with end-users looking to retrieve data about multiple buildings at the same time.

Therefore, for intermediaries requiring a certain usage-rate for their value capture, it could be of importance to ensure that they exclusively *bridge* a gap between an end-user and a data supplier by providing products and services (Shaharudin et al., 2023). It is not in the best interest of these intermediaries to completely *fill* the gap by, for example, teaching end-users how to access the data supplier directly. As end-users become aware of accessing data suppliers themselves, the value of the intermediary decreases in their perspective. Using the same metaphor; as a gap is filled, the need for a bridge is reduced.

The destruction of value and keeping the end-user ignorant of alternatives (confining them to their bounded rationality) can be an essential component of the business model of intermediaries. The importance of this component in the business model, however, is dependent on how the intermediary aims to capture value. The intermediaries that depend on a stable usage-rate because they apply a subscription or open source like revenue model (Welle Donker & van Loenen, 2016) benefit from the bounded rationality of their end-users. However, intermediaries capturing value from reducing the administrative burden of their financers (e.g. with the WOZ-waardeloket) do not necessarily benefit from this bounded rationality. For these intermediaries, if an end-users utilizes their product or the API provided by the data supplier is inconsequential. In both cases, the main goal (reducing the administrative burden of the financer) is reached.

6.1.2 The rejection of a binary distinction of open- and closed data

The effects of a shift in the positioning of a dataset on the open data spectrum further emphasize the need to reject the binary distinction between open- and closed data. It should rather be common to note the degree of how open a dataset is, for example by positioning it on an open data spectrum. This could solve a number of problems and allow for a better understanding and analysis of the business model of intermediaries.

For example, CBS claims that they manage an *open* data portal, as all data is freely available and for example provided through APIs. However, by analysing the KWB dataset of CBS through a strict lens of the open data principles (Sunlight Foundation, 2010), this claim of CBS can be questioned. In developing the KWB dataset, CBS aggregates (among others) data from the BRP supplied by the RvIG. As the RvIG is legally designated to be the 'data supplier' of the BRP (Rijksoverheid, n.d.-d), in this study the BRP data supplied by the RvIG is considered to be the primary source data. Any aggregation of this data by CBS thus implies a deviation from the primary source data, and therefore a deviation from the primacy principle. If data can only be considered to be open if all 10 principles of open data are met, it can be concluded that the KWB dataset is not open data.

However, utilizing this very strict binary definition of open data is futile and counterproductive in research. Classifying the CBS KWB dataset in the same category as the original BRP supplied by the RvIG ("not open") would not do the KWB dataset justice. Rather, it would be more productive to classify the 'openness' of data along the open data spectrum (Open Data Institute, 2020). Through the utilization of an open data spectrum, it becomes possible to rightfully claim that although not all principles of open data are (fully) met by the CBS KWB dataset, it is still *more* open than the BRP dataset supplied by RvIG.

Furthermore, next to the data being on a spectrum between open and closed data, the principles of open data determining the positioning on the open data spectrum can also be analysed through the lens of a spectrum. In other words, next to rejecting the binary distinction of open and closed data, the binary distinction between meeting or not meeting an open data principle should also be rejected. To illustrate this argument, the following examples can be used.

Firstly, as mentioned before (see Section 2.1.2) fully meeting the 6th principle of open data (non-discrimination) can result in performance issues. As the principle states that anyone should be able to access the data *"…without having to identify him/herself…"* (Sunlight Foundation, 2010) It is impossible to block the IP-addresses of, for example, those engaging in criminal activities. To prevent a blocked IP-address from accessing the data, every user first needs to identify themselves with their IP-address before accessing the data (Fedorov et al., 2021). Therefore, blocking IP-addresses implies a deviation from the non-discrimination principle of open data. However, it would again be counterproductive to categorize data as 'not-open' when they exclusively block those IP-addresses that engage with criminal activity. For example, comparing (1) a dataset that is accessible by a small group of members with (2) a dataset that is publicly accessible (except for a small group of users with criminal intent), it would be productive to be able to claim that second dataset is *more* open than the first dataset.

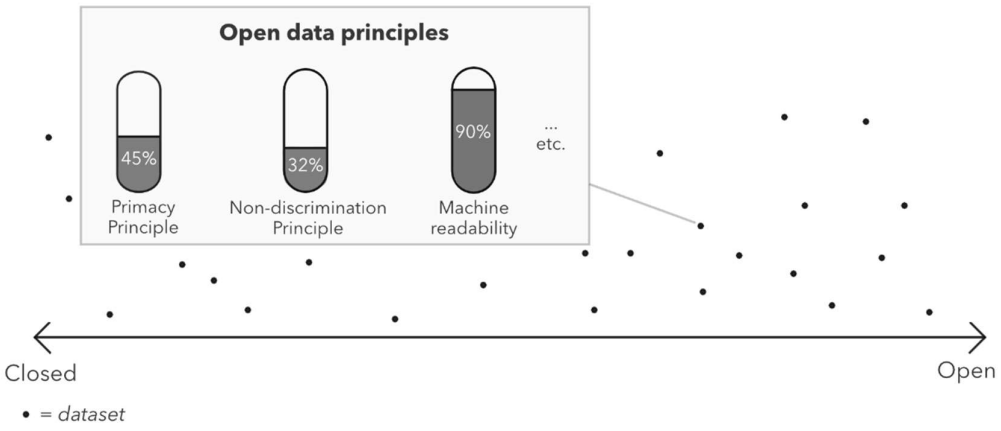
Secondly, strictly assessing the primacy principle of open data through the lens of molecular science, questions can arise regarding what exactly constitutes as 'primary source data'. In a sense, every geographical occurrence is an aggregation of a 'layer' below it, up until the molecules that create the geographic occurrence. As a concrete example, data from the BAG is generally defined as open data as the buildings/addresses are considered to be the primary source data. However, is a building truly the

primary source data? It can be argued that data about a building is an aggregation of data per floor, or even data per specific brick of that building (or even the molecules within the brick). However, while theoretically interesting, the aspiration of gathering data on the most disaggregated scale possible is practically unnecessary in most cases. The usability of the BAG would reduce if it featured data per brick[52] instead of data about the entire building. It should still be possible to consider data to be open even though the primacy principle is (technically) not fully met. This, again, emphasizes the importance of rejection the binary distinction between open and closed data.

In summary, it is of importance to acknowledge that datasets are found on a spectrum, somewhere in between the extremes of fully-open and fully-closed. Furthermore, reaching these extremes of fully-open and fully-closed is difficult, as the principles of open data that determine the position of datasets on this spectrum, are also found on a spectrum. Fully meeting certain principles of open data is complex, and should not be expected of datasets. Figure 6.1 illustrates the above relation between the principles of open data and the open data spectrum. In an ideal situation, every dataset would be assessed in a similar manner to improve the academic comparison of the openness of datasets. It is worth noting that to utilize this assessment framework, it is not mandatory to apply the open data principles of the Sunlight Foundation (2010). Any set of principles that determine the openness of data can be applied (Rijksoverheid, n.d.-e; ODC, 2015; Datagov, n.d.)

Figure 6.1

The open data spectrum and open data principles



Note. This figure illustrates the extent to which a dataset adheres to various open data principles determines the position on the open data spectrum. Key in this figure is that aspiring one of the extremes (fully open or closed) is difficult due to intrinsic complexities regarding the open data principles. Own work.

[52] For 'data per brick', Building Information Modelling [BIM] datasets are frequently utilized (Volk et al., 2014).

6.1.3 The importance of the end-user in analysing value-creation of intermediaries

Another theoretical implication of this study is the importance of consistently discussing the value-creation of entities (such as intermediaries) in relation to whomever they create value for. Although the creation of value is often related to the entity that creates it (Vancauwenberghe et al., 2018), the findings of this study have illustrated that both the type of value and the extent of the value are determined by the individual preferences, motivations, characteristics, etc. of an end-user (Juechems & Summerfield, 2019; Haksever et al., 2004). In other words, although the intermediary bridges a gap between an end-user and the data supplier (Shaharudin et al., 2023), it does not mean that this gap is the same for every end-user. More concretely, this study has shown that the analysed key registry intermediaries do bridge a technical gap for some users unable to access PDOK-service APIs, other end-users do utilize these APIs or have their organisation develop GIS-viewers that utilize these APIs. The *subjectiveness* of the value (McKnight, 1994) created by these intermediaries by bridging gaps should therefore not be ignored.

Understanding how value is created by intermediaries should therefore go hand in hand with understanding the preferences, motivations, characteristics, etc. of the end-user. From this study, it became clear that real estate development professionals are motivated to access an intermediary if it can lower their transaction costs. This pragmatic approach and extrinsic motivation of real estate development professionals implies that a product that allows an end-user to retrieve data from an intermediary *"with as little clicks as possible"* is considered to be valuable. However, it cannot be assumed that this construction of value out of the extrinsic motivation of real estate development professionals is similar for other user groups.

For example, the interviewed end-users sometimes complained about the quality of BAG-data. If, for example, the attribute data of a specific building was incorrect, an interviewed end-user would try to utilize another source to figure out the correct attribute information. This specific end-user would then utilize the correct attribute information in their own calculations, without utilizing the feedback system of the BAG-viewer to try and correct the dataset[53]. This end-user was extrinsically motivated to retrieve the data to complete their calculations, but lacked the intrinsic motivation to actually *solve* the data problem in the dataset. The actual solving of the problem in the BAG by this specific end-user would not lower their transaction costs, and therefore would not be valuable to them.

However, if another user group (instead of real estate development professionals) was selected for this study, the motivation to access data, and therefore the value that intermediaries create could differ. For example, in researching Open Street Map [OSM]-contributors, Spinoza Andreo (2022) found that these users were intrinsically motivated to contribute to OSM and value was created by how accessible this

[53] Although this is a singular anecdote of the feedback system of the BAG not being utilized, from an interview with Kadaster it became clear that the user-rate of the BAG feedback system has not satisfied expectations.

contribution system was. For these users the potential decrease of transaction costs is less relevant, and therefore creates less value in their perspective.

The aim of the above example is to emphasize to importance of analysing the specific user-group when conducting research about value-creation. All conclusions about the creation of value in this study, should therefore not be utilized in isolation of the research user group (real estate development professionals).

6.2 Limitations and research recommendations

As is inherent to research, the applied methodology possesses its share of limitations, which are discussed in this section. Furthermore, a recommendation for future research is added to solve these limitations.

Firstly, a limitation of this study is that it is not conducted in a generalisable and deductive manner. The results of this study can exclusively be utilized to *create* a theory, while the testing of this theory would require another deductive analysis. However, the creation of a theory was a necessity because of the subjective character of value, and the not-yet researched group of real estate development professionals in the Netherlands. In other words, it was impossible to test a theory based on the perspective of the 'general' end-user regarding the usage of key registry intermediaries, as this general end-user does not exist. As was illustrated in Section 6.1.3, the subjective character of value determines the outcome of this study, and this theory was first required to be formed. Therefore, subsequent to this study, it could theoretically be possible to conduct a deductive research to test the in this study formed theories.

However, to conduct this deductive research it is of importance to note that gathering a representative sample of key registry end-users is difficult due to privacy concerns regarding accessing a full database of users. It could therefore be more feasible to conduct this deductive research in a more sealed pool of end-users. A recommendation for future research would thus be to conduct this study within the user base of one specific key registry or intermediary.

Another limitation is found in the scope of this study. Firstly, although the interviewed end-users exclusively indicated that they utilized the five key registries mentioned in the findings, other key registries also exist that could potentially be relevant to the end-users. For example, the Key Registry Large-scale Topography [BGT][54] and the Key Registry Ground [BRO][55] contain information about the soil and land-use of land, which could be relevant to real estate development end-users. Furthermore, next to key registries, end-users also indicated that they utilized other data than just key registry data. For example, the interviewed end-users noted that they frequently used (residential) transaction data,

[54] https://www.pdok.nl/introductie/-/article/basisregistratie-grootschalige-topografie-bgt-
[55] https://www.pdok.nl/basisregistratie-ondergrond

construction cost data, spatial plans, elevation data, etc. While outside of the scope of this study, the manner in which the intermediaries of these datasets create and capture value can also be of interest.

6.3 Practical recommendations

Next to recommendations for future research, certain practical recommendations can also be derived from this study. These recommendations are split up in between recommendations for data suppliers (and governments in general), intermediaries, and end-users.

6.3.1 Recommendations for data suppliers

The main recommendation for the data suppliers included in this study relates to reflecting on the role of public sector organisations within the open data ecosystem of key registries. In short, the results of this study have indicated that the bounded rationality of end-users frequently causes end-users to utilize an intermediary, even though this might not be the most optimal choice. For these specific end-users, their transaction costs would decrease if they utilized APIs provided by the data supplier. However, the results of this study also indicated that they are unable to do so, mainly because their bounded rationality implies that they are unaware of these data suppliers and are not technically capable in utilizing the provided APIs and webservices.

The main question on which data suppliers have to reflect is an ideological question. Is it the role of the public sector to reduce the effect of this bounded rationality on end-users? Concretely, is it the role of key registry data suppliers to educate citizens in (1) the existence of key registries (findability gap) and (2) how to use the APIs or web services applicable for the key registries (technical gap)?

The system of key registries was initially set up as a means to create 'public value' through the utilization of the key registries by organisations[56]. The focus of the utilization of key registries is therefore mostly centred around professional users of both public and private organisations (Rijksoverheid, n.d.-n). In other words, educating general citizens on how to apply these key registries has not yet been included within the aspirations of the suppliers of the key registries.

However, as the development of the key registries started over 20 years ago in 2003 (Benner, 2014), it could be possible to re-evaluate the desired user base of the key registries. Since 2003, various open data regulations have been implemented (see: Section 3.1) which have altered the political climate regarding open data. For example, The OD Directive (2019/1024) specifying various HVDs that are of great benefit to society, the environment, and/or the economy. The directive states that these datasets ought to be publicly accessible (Kević et al., 2023). The question then becomes if users exclusively utilizing the HVDs through intermediaries in a sometimes suboptimal manner is sufficient. Or if governments should

[56] The 'public value' of key registries is created as organisations apply the key registries for the execution of activities. Resulting in for example, (1) more efficient, effective, and legitimate government services and (2) economical value as the key registries can lead to all sorts of practical applications (Rijksoverheid, n.d.-n).

allocate resources towards ensuring that the key registries (which include data from the HVDs) are directly usable for *every* citizen.

To relate this issue to the metaphor of 'bridging gaps' (van Loenen et al., 2021; Shaharudin et al., 2023), key registry data suppliers could apply two different strategies. Firstly, the dedication of resources to *fill* the gap between data suppliers and end-users, ensuring the non-existence of gaps that could be bridged. This 'filling' of gaps entails educating citizens on where to find the key registries and how to utilize the provided APIs and web services. The second strategy is to continue the current aspirations of the key registries and focus on professional users / intermediaries , and aid them in bridging the gaps between the end-users and the key registries. As noted before, the application of this second strategy can result in *partially* bridged gaps, with a possibility of a suboptimal application of the key registries by end-users.

With the results of this study, an integral recommendation regarding which strategy government ought to apply cannot be formulated. It would for example require a comprehensive analysis of the jurisprudence of the OD directive and its definition of what it means to be accessible for the general public. Furthermore, it would require a study through a political/ideological lens regarding the role of the government in providing key registries. Therefore, all that can be recommended in this study is that the data suppliers of key registries and the overarching governmental institutions reflect on this role of the data supplier within the open data ecosystem of key registries.

3. Recommendations for intermediaries

From this study recommendations can be formulated for both creating and capturing value. Firstly, for intermediaries aiming to specify their product for real estate development professionals, this study has shown that it is beneficial to take into account the following two points. (1) Ensuring the findability of the product. The bounded rationality of end-users implies that they do not carefully weigh every possible method to extract data from a dataset. Therefore, investing resources into ensuring, for example, the product appearing on top of certain Google searches can be of substantial effect on the usage-rate of a product. (2) This study has shown that intermediaries create value by reducing the transaction costs of real estate development professionals by making the product as specific as possible for the needs of the users. The recommendation regarding this point is therefore to know the user base of the product. By knowing the use cases of the end-users, it becomes possible to develop the product in such a way that it specifically connects to those needs, creating value for the end-users (Lindgaard et al., 2006).

Secondly, regarding the capture of value, for an intermediary it is of importance to reflect on which kind of value is captured by the product and which revenue model is applied to capture this value. Based on this reflection, it can be possible to make adjustments to the intermediary product to ensure an effective method of value capturing.

For example, certain public sector intermediaries (e.g. BAGviewer) analysed in this study mostly captured value by reducing the administrative burden of their overarching organisations that directly

finance them. They are therefore not necessarily dependent on retaining a certain usage-rate for their value capture. Rather, their value capture is dependent on *preventing* the usage of other channels of information, such as requesting it from a municipality. For these intermediaries, it would be effective to provide URLs or tutorials on how to systematically retrieve the visualised data through APIs, instead of having the end-users individually clicking each feature in the viewer.

However, this is not the case for intermediaries capturing value through subscriptions or fee-based services. These intermediaries are dependent on a certain usage-rate, and therefore partially benefit from the bounded rationality of end-users. In other words, it is beneficial for these intermediaries if end-users remain unaware of the location of key registries and do not learn the technical skills to access these key registries directly themselves.

6.3.3 Recommendations for end-users

In general, the results of this study show that there are several ways to get the same data. However, based on the functionalities, some applications can be considered to satisfy the needs of real estate development end-users better than others. The main point is that most of the issues described by the interviewed end-users can be solved through the application of a proper GIS-system. There, however, are two different choices for a GIS-system based on the needs of the organisation/end-user.

Firstly, in case that an organisation requires the flexibility of adding different datasets and the usage of various GIS-tools, it is recommended to invest time and capital in GIS-software such as QGIS or ArcGIS Pro. With GIS-software, employees have various possibilities of adding, analysing, presenting, etc. However, an important side effect of this flexibility is that it might be overwhelming for non-technical employees. If this is considered to be a problem, it might be better to choose the second GIS option. This second option is hiring a GIS-company to develop a specific GIS-viewer which exclusively features buttons/tools that are relevant to the employees. While this does mean a reduction of flexibility, some specificity is gathered in return.

Furthermore, next to the application of GIS-methodology, another recommendation is to be aware of all available data. Some example datasets that could be highly relevant to the field of real estate development (but were not named by the interviewees) are the IBIS industrial park dataset[57], the key registry surface[58], energy labels[59], etc. However, as illustrated by the substantial number of datasets featured on data.overheid.nl (Rijksoverheid, n.d.-a) this list of potentially relevant datasets is much larger.

[57] https://data.overheid.nl/dataset/ibis-bedrijventerreinen
[58] https://basisregistratieondergrond.nl/
[59] https://www.ep-online.nl/

7. Conclusion

As a conclusion, the research questions formulated in the introduction are answered with the results of this study.

The first sub research question was: *"To which extent are real estate development end-users accessing key register open data intermediaries?"*. In general, all interviewed end-users indicated that they frequently utilized one or more intermediaries[60]. The answer to this sub research question implied that there was a sufficient base for answering the latter sub research questions.

The second sub research question was: *"What characteristics of the intermediary create value in the perspective of the end-users?"*. The findings in this study confirm prior theories regarding value-creation in the sense that intermediaries create value by bridging gaps between data suppliers (key registries) and the end-users (real estate development professionals). Specifically, it was found that end-users encounter (1) a legal gap, where directly accessing certain key registries is legally impossible and (2) a technical gap, where end-users are unable to utilize APIs or web services. The intermediaries analysed in this study bridged this gap by for example aggregating personal data (legal gap) and developing GIS viewers (technical gap). The amount of value that was created for the end-users by these intermediaries depended on two different factors. Firstly, the specificity of the product; entailing how well the product connected to the needs of the user, consequently decreasing the transaction costs of the end-user. Secondly, the findability of the product; entailing how findable the intermediary is relative to other methods to extract the same data.

The third sub research question was: *"To what extent do intermediaries capture value from their activities?"*. The findings of this study indicate that the analysed intermediaries captured value from their activities. The intermediaries captured value in a different manner, depending on the goal of their intermediary product. It was found that the private sector intermediaries depended on subscription- and fee-based models while public sector intermediaries aspired a decrease of administrative burden and stronger governmental transparency. These public sector intermediaries therefore captured value from the direct financing of overarching organisations that benefited from the existence of these intermediaries.

Combining the findings of answering the above sub research questions leads to an answer on the main research question: "To what extent do intermediaries of key register open data used by real estate development end-users in the Netherlands create and capture value?". Intermediaries of key register open data used by real estate development end-users in the Netherlands create and capture value. The extent to which they create value is determined by the gaps between the end-user and data supplier, and the manner in which this gap is bridged by the intermediary. However, this gap is not identical for every

[60] Here, it is worth noting the inductive theory-building character of this research. This research was not conducted along the principles of deductive theory-testing research, implying that no generalizable conclusions can be given regarding a specific 'extent' to which intermediaries are being utilized (see Section 4.3).

real estate development professional, emphasizing the subjective character of value. The extent to which value is captured depends on specific characteristics of the intermediary. Public sector intermediaries captured value through budget financing of overarching organisations that benefited from their existence while private sector intermediaries captured value through subscription- and fee-based revenue models.

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Appendix

Table 7.1

Interview questions end-user interviews.

Section	Question nr.	Main question	Follow up questions
1	0	What would you describe to be the role of your company?	
	1	What kind of activities do you conduct on a daily basis?	(a) Are you primarily focussed on real-estate development activities? (b) …
	2	Would you say that for these activities, you apply data or information?	(a) What kind of data? (b) if interviewee is unsure: Do you ever use information about parcels, buildings (BAG), energy labels, spatial plans, etc.?
	3	Where do you retrieve this data? -> If interviewee gives different sources for different data, ask the following questions for all sources	(a) Do you always use this method / website / program to retrieve the data? (b) How frequent would you say that you use these places? (c) How much time do you spend on retrieving this data? (d) Also go in to detail per data form. For example: In searching for parcel data, how much time does it cost you to retrieve the relevant information?
	4	What do you use the data for?	(a) Does the application of the data vary? Or are you always applying it for the same goals? (b) How does the application of data contribute to the goals of your organisation?

2	1	Why do you use this source?	(a) What do you like? (b) If interviewee is unsure: Do you like the viewer, the computational speed, the aggregation of data, the format of data, download possibilities, etc.? (c) What are the specific elements of this source that you use?
	2	Is this the official/government source for this data?	(a) Important to ask this question in a neutral manner to figure out if the interviewee THINKS that this is the case. (b) Why would you think this?
	3	Do you know of other websites/sources for this data?	(a) Have you ever used these sources? (b) Why / why not? (c) Why do you prefer this source over those sources?
	4	Do you know of PDOK/PDOK-viewer?	(a) if they know it: Have you ever used PDOK? (b) Why / why not? (c) Why do you prefer this source over those sources?
3	1	What do you like about this source?	(a) Are these factors why you would use this source? (b) If unclear: Why do you like these elements of this source? (c) If these factors were missing, would you then use another source?
	2	What do you dislike about this source that you use?	(a) Why do you dislike these factors? (b) Have you considered looking for another source because of this dislike? (c) Why/why not?

	3	What would you like to see added/removed?	(a) Have you looked for other sources if they have these features?
	4	(if the user knew about PDOK) What do you think of the PDOK website to gather your data?	(a) if they have used it before: Why do you use your specified source instead of PDOK? (b) What are you likes and dislikes about PDOK? (c) Could PDOK fit your daily requirements for data retrieval? (b) Do you think it is user-friendly enough for you to use it for your daily activities of data retrieval?

Note: Because of the semi-structured character more questions were asked during the interview that appeared organically

Table 7.2

Interview questions intermediary interviews.

Main question	Follow-up question
How would you describe your company?	1. What do you do? 2. What kind of products do you make? 3. What is the overall goal of the company?
Say: "from the end-user interviews, it became clear that your product x is being used frequently by real estate development end-users"	
How would you describe this product?	1. What does it do 2. What kind of services does your product provide?
How do you get your data?	1. Through PDOK (WFS connection)? 2. Or do you download it and put it on your own server?
What do you know about the user base of this product?	1. What kind of users does it serve 2. What sectors do these users come from 3. How many users do you serve
Do you know of any competitors that make the same product for the same user base?	
What kind of business model have you set up for your product?	1. Does your product rely on ad revenue

	2. Does it rely on freemium/premium, extra services, etc. 3. Or for example a 'visitekaartje' to draw customers?
Why do you think that these end-users access your product instead of the 'original' source within the key registries / PDOK	1. What *value* do you think that you add to the open data provided by the government? 2. Do you think that you *bridge any gaps?* As in; do you think that PDOK / the PDOK-viewer has certain problems that make the user go to your service?

Note: Because of the semi-structured character more questions were asked during the interview that appeared organically