Identifying and overcoming the barriers to private sector geospatial data sharing in the Netherlands, according to the impact of level of openness on them

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Contents

1 Introduction

The rapid developments of the last 30 years in automated data collection and communication technologies created the basis for the vastly increase of the number of the data collected, analyzed and stored (Tenopir et al., 2011). The use of data has started to become crucial in the process of decision making, while data sharing has been acknowledged as a mean to transparency, reproducibility of research, cost-efficiency and acceleration of innovation (van Panhuis et al., 2014).

According to Fassnacht et al. (2023), a significant amount of the data are accumulated and managed by the private sector, which renders the private sector as an important actor in data sharing. Additionally, data sharing barriers in academic and public sector context have already been researched extensively, while research on data sharing barriers for the private sector started to become significant the last few years (Priego and Wareham, 2020). In 2019, the European Commission realized the importance of the private sector data and involved public undertakings in the Open Data Directive (Directive (EU) 2019/1024, 2019), which are private companies that perform task for public service. This importance of private sector data could involve the private sector as a next step in the sharing of open data. Additionally, geospatial data were recognised by the European Commission (2020), as high-value datasets, which could be private sector geospatial data.

Data sharing can be challenging to realise, which is why the barriers that may effect it should be recognised and analysed further. Regarding open data it is important to recognize the barriers that affect the sharing of data towards an more open level. The state of open data has been researched from various perspectives, and assessment frameworks of open data were developed in the last 10 years. The assessment frameworks are developed by Berners-Lee (2009) on the interconnection of datasets, by the Open Data Institute (n.d.) on the Data Spectrum of licences, by the Open Knowledge Foundation (2013) on access and reuse and by Boone and van Loenen (2022) on a multi-dimensional model. The identified levels of openness that were identified by the literature review on the aforementioned open data frameworks will be used in relation with the barriers of open data sharing to try and assess the current state of barriers in moving towards an open data policy for the private sector and how to address each barrier in the process.

According to the OECD OURdata Index (OECD, 2019), the Netherlands is placed on the 13th place among 36 countries regarding data availability, data accessibility and government support for data reuse. Specifically, for 2019 data availability, the Netherlands is above the average OECD index 0.20, with 0.22, for data accessibility is above the average of 0.23, with 0.24 and for government support it is above the average of 0.17, with 0.19. While the existence of the Dutch OGD portal data.overheid.nl, promotes an open approach for valuable government data with over 21,348 datasets (Overheid.nl, nd). With already good practice in providing open government data, the Netherlands could be a good indication for the state of the private sector open data.

The barriers for private sector data sharing have not been researched sufficiently. This research will focus on *"What are the barriers to private sector data sharing of geospatial data in the Netherlands?" and "How can those barriers be addressed in relation to the impact of the level of openness on them?"*. Section 2 presents the related work to the research topic, about data sharing, open data, barriers of data sharing for the private sector and levels of openness, followed by section 3 where the research question and sub- questions are presented, next to the scope of research. In section 4 the methodology of the research is described, followed by the planning of the research through a Gantt chart. In section 6 the tools and datasets that will be used are stated.

2 Related work

In this section, the theoretical background of the topic is presented, by explaining how the data sharing of the private sector evolves from the existing literature. While the levels of openness of geospatial data are researched through existing open data assessment frameworks.

2.1 Data Sharing

The European Commission (2022a) recently acknowledged the importance of data sharing and presented two situations in which it can be addressed, business-to-business (B2B) and business-to-government/public sector (B2G). Fassnacht et al. (2023), on their research for B2B defines data sharing as "a collection of practices, technologies, cultural elements and legal frameworks that are relevant to transactions in any kind of information digitally, between different kinds of organizations". Waterman et al. (2021), on their research of a flood resilience system that consists of B2B and B2G data sharing refers to it as a process of data and technologies that are used to gather, process and share data, based on a set of skills, tools, privacy and data sharing capacity.

The primary role of data sharing is to provide access for use and reuse of data, while it can bring more advantages that are connected to verification of data, different secondary uses according to purpose, maintaining data integrity for reuse, minimizing of resources used for recollection of data, and availability of data that promotes transparency and trust (Tenopir et al., 2011).

2.2 Private, Public, Semi-Public Sector and Public Undertakings

When describing the stakeholders taking part in data sharing, the public sector is consisted of the government, public agencies, municipalities and other local authorities. The public sector's jurisdiction is to set a framework for the private sector to innovate through investments, partnerships, regulations (Sanchez and Bermejo, 2006).

The private sector can be described as organizations with a majority of private ownership seeking to generate profit and not being owned or controlled by the government (Cambridge Dictionary, n.d.). For example in the case of a resilient flood management system the private sector consists of water companies, insurance organizations, consultancies, technology, infrastructure, utilities, communications. catastrophe modelling consultancies, flood management technology industries, insurance companies, re-insurance companies and environmental consultancies (Waterman et al., 2021).

While the main goal of the private sector is to generate profit there are different types of partnerships created to achieve innovation, a public undertaking is one of them. As described by the European Parliament (1997), a public undertaking is a non-government party that carriers out a service, which can be a public service that is economic activity of general interest and is defined by public authorities, or it can be a service in areas that are entirely market based where the public authorities play no part. Van Veenstra and van den Broek (2013), refer to a semi-public organization which performs public services for the public authorities by providing their datasets to the national data portal to achieve the benefits of transparency and re-use, while developing a business model for its data to achieve their own commercial purposes. Some examples of semi-public organizations are cultural heritage foundations, public transport organizations and research institutes.

The type of services that they provide might have an impact on how restricted the policies they follow are. The organizational structure of each sector differentiates in order to achieve its individual goals that may have an effect on the barriers that are created in data sharing and research on the matter could provide a framework to achieve the benefits of data sharing.

2.3 Open Data

In the last decade open data has played an important role in generating social and economic opportunities, while contributing in solving public problems and allow citizens to make better decisions (Verhulst et al., 2020). While it is expected to contribute in stimulating citizen participation and innovation, transparency (Zuiderwijk and Janssen, 2014). Additionally, the importance of open data has been recognised from the European Union as a tool in the socio-economic development of the society (European Commission, 2020).

The majority of the most valuable data are owned by the private sector, and are collected and managed only for internal use (Verhulst et al., 2020). The growing demand for open data has started to have an effect of the open data policy of the European Union. The scope of open data has started to expand from to public entities to also private entities. While the European Directive (2013), recognised geospatial datasets as datasets of high value for the society.

In continuation of the Directive of 2013, that was focused on the re-use of information from the public sector (Directive (EU) 2013/37, 2013), in 2019 the Open Data Directive (ODD) was developed where open data and Public Sector Information (PSI Directive) was enacted (European Commission, 2020; Directive (EU) 2019/1024, 2019). Building on the public sector documents, the ODD applies also to public undertakings, a specific type of private entities that collect, produce, reproduce and disseminate documents to provide services in the general interest (Boone and van Loenen, 2022). The provisions of the new directive does not consider involving the private sector yet, but considering the amount of valuable data that are held by them, their involvement may be needed in the future.

2.4 Literature Review

To address the existing literature on the barriers for the private sector to share their data, a literature review was conducted. The search keywords that were used were: "data sharing" + "barriers", "data sharing" + "private sector", "private sector" + "data sharing" + "barriers". From the research through keywords, data sharing in the private sector is very limited, while most literature is about public sector data sharing. The search for "public sector data sharing barriers" gives 140 results in Scopus, while private sector data sharing barriers" gives 67 results. Additionally, in IEEE Explore, the first search gives 8 results, while the second one gives 2 results. For AIS Electronic Library, we get the results 3275 and 1966 accordingly. Therefore the search term is not further limited to private sector data sharing.

At the time of the literature review, February of 2023, only the first 40 results from Google Scholar of the search based on "keywords" were selected, to have a first understanding of the barriers and then continue by relevant literature from those articles. A manual assessment of each articles relevance was made based on first reviewing the abstract, the result was 20 articles, which were then reviewed based on their full-text, that resulted in 10 articles. The reduction of articles is mostly based on data sharing not being the main focus of them and articles with a strong technical focus of data exchange, which only describes the technical transmission of data, ignoring the organizational, legal and cultural aspects of data sharing (Awada and Kiringa, 2015). At this stage of the research, the term "open data" was completely neglected to have a general idea of data sharing barriers. After the review of the 10 aforementioned articles, only 2 of them were referring to "open data sharing". A new search term was created to incorporate "open data", "open data" + "sharing", without specifying the sector again, due to the limitation in the private sector data sharing literature. Only 3 articles were chosen based on their relevance after reviewing the abstract.

Although, the keyword "private sector" was removed from the search term, 2 articles were specifically about "private sector data sharing". Those were used as a starting point to find relevant articles based on the references used, the result was the addition of 4 more articles. The final result of articles from the literature review was 17 articles. The analysis of the literature review led to the identification of 24 barriers to data sharing for the private sector, which were divided into 5 categories.

2.5 Barriers to Data Sharing of the Private sector

Many organizations in the private sector have enormous resources to provide for whatever issue they care to focus on (Coetzee et al., 2021), but they seem to not participate in data sharing activities. In the following section, an overview of 24 barriers will be presented divided into five perspectives: strategic, technical, legal, economic, and cultural. This analysis focuses on the barriers for individual companies to share their data. The barriers can be derived from the Tables 1, 2, 3, 4, 5 and are described in more detail in the following subsections.

2.5.1 Strategic barriers

Strategic barriers appear to take place in the highest level of the organizations as they affect the strategic direction, design and decision-making to participate in data-sharing activities (Fassnacht et al., 2023). The strategic barriers that may exist are connected to lack of organizational motivation to enable data sharing, which can lead to management commitment and corporate strategy integration.

- *Lack of organizational motivation to enable data sharing:* Developing a data sharing strategy requires organizational transformation, with changes taking place on multiple levels (van Veenstra and van den Broek, 2013). Organisational siloes may need deeper evaluation to enable data sharing (Waterman et al., 2021). The motivation to enable data sharing should occur at a managerial level, but due to risk-averse culture data sharing is usually avoided, without it being transferred to other levels of the organization, while more focus is given to the barriers of data sharing and not the opportunities that might be created (Janssen et al. 2012; Barry and Bannister, 2013).

- *Lack of management commitment and corporate strategy:* In van Panhuis (2014) and Sane and Edelstein (2015), the lack of management commitment is presented as lack of political will and commitment to promote data sharing. While in Fassnacht et al. (2023) the barrier is translated for the private sector. Specifically, data sharing in most companies is not part of the core business, for many private sector organizations data sharing is project-based and driven by individual departments, to benefit from the potential of data sharing, a top-down commitment is needed so the organization could have a long-term strategic direction (van Veenstra and van den Broek, 2013). The lack of a corporate strategy could result in unclear responsibilities and decision-making processes (Fassnacht et al., 2023).

- *Lack of policy coherence:* After the organizations makes a management commitment for the sharing of their data, a strategy needs to be created. A policy should be created and implemented for the private sector, with the lack of a framework there is a risk of inconsistent policies across the private sector, because each organization developed its own based on their characteristics (Waterman et al., 2021). Janssen et al. (2012), when they are referring to sharing of open data, mention even the lack of a uniform policy specifically for publicizing data, which can create technical barriers regarding standards of data for publications. When referring to sharing of open data, the choice of policy is connected to the core decision of the organization to become an open organization (Martin et al., 2013). A lack of consistency and perseverance in political behaviors can also affect the sustainability of an open data policy, which could effect the update and availability of datasets (Janssen et al., 2012).

- *Lack of use case identification:* Identifying use cases for data sharing for the private sector is a time-consuming and complex process and incentives should be found to persuade the private sector in participating (van Veenstra and van den Broek, 2013). No approaches exist to identify use cases systematically, as the complexity of the process is connected to challenges such as lack of transparency about existing data, creativity for novel value-added services, unclear benefits for each participant, and scalability of potential use cases (Fassnacht et al., 2023; Barry and Bannister, 2013).

- *Lack of revenue models and scalability:* According to Janssen et al. (2012), in the Netherlands some organizations' revenue models are based on creating income from the dissemination of data. The process of opening up their data could harm their existing business model. While semi-public organizations open up their data with the support of funding from the government, there is a lack of business cases for generating revenue from reuse that could be used for the development of new business models for the private sector (van Veenstra and van den Broek, 2013).

- *Lack of feedback process:* The feedback process, specifically the lack of it, appears only on the papers of open data barriers, and not in the general data sharing barriers. That is related to open systems requiring an understanding of the external world as they must consider the feedback and insights of users in order to continuously improve (van Veenstra and van den Broek, 2013). The lack of a feedback process to realize the needs of the user and adapt the business model accordingly, could create barriers in understanding the value of some datasets, while the development of a feedback process would be helpful to avoid economic damage related

to the publishing of datasets that are not reused, and as a result do not create value (Janssen et al., 2012).

Perspective	Barrier	Dataset	Sector	Literature
Strategic	Lack of organizational motivation to enable data sharing	geospatial data, flood risk data, transportation data, geological data,	private sector, semi-public sector	Waterman et al. (2021); van Veenstra and van den Broek (2013); Janssen et al., (2012); Barry and Bannister (2013);
	Lack of policy coherence	geospatial data, flood risk data	private sector, public sector	Waterman et al. (2021); Martin et al. (2013); Janssen et al., (2012); Barry and Bannister (2013)
	Lack of management commitment and corporate strategy	public health data, geospatial data	private sector, public sector	Fassnacht et al. (2023); van Panhuis (2014); Sane and Edelstein (2015)
	Lack of use case identification	geospatial data	private sector, public sector	Fassnacht et al. (2023); Barry and Bannister (2013)
	Lack of revenue models and scalability	transportation data, geological data	private sector, semi-public sector	Fassnacht et al. (2023); van Veenstra and van den Broek (2013); Janssen et al. (2012); Martin et al. (2013)
	Lack of feedback process	geospatial data	private sector, public sector	Janssen et al 2012; Martin et al. (2013); van Veenstra and van den Broek (2013)

Figure 1: Strategic barriers for private sector data sharing, result of the literature review

2.5.2 Technical Barriers

The second category constitutes of five technical barriers that are connected to the coordination and alignment of data models, the technical barriers could be connected to interoperability of data, inconsistent formats, data availability, data quality or a lack of metadata, all of them connected to IT infrastructure where data is a digital asset that can be shared (Fassnacht et al., 2023; Waterman et al., 2021).

- *Lack of data standards:* While data has been extensively collected by the private sector, there is not one framework for standardization of the data that can be used all the variations of data quality, that is based on the purpose of re-(use) of the data (Welle Donker and van Loenen, 2016). For example for geospatial data the quality may need to be increased (Waterman et al., 2021; van Veebstra and den Broek, 2013; Adair et al., 1998), or in the case of public health data it might need to be aggregated for privacy concerns (Sane and Edelstein, 2015; van Panhuis 2014). Additionally, there is a lack of metadata describing the content, data quality quality, date of collection, which limits secondary data usage (Fassnacht et al., 2023; van Panhuis, 2014; Boone and van Loenen, 2022; Martin et al., 2013). Furthermore, different datasets often are collected by in a local language, such as public health data (van Panhuis, 2014; Sane and Edelstein, 2015), making difficult both the access and the re-use of the data (Martin et al., 2013). Standardization of methods and the development of robust metadata can increase data access (Janssen et al., 2012).

- *Lack of accessibility and management:* Even if the private sector is willing to share their data, the lack of standards has an effect on the technical infrastructure that is not often available connected to the accessibility and management. To access the data you come across a fragmented data landscape of historically developed databases, systems and applications that lacks transparency (Waterman et al., 2021; Fassnacht et al., 2023). Moreover, connected to the access of data, many datasets are collected for a specific purpose without being maintained, due to lack of data science skills for management of data and lack of the needed software and hardware for data management (Tenopir et al., 2011; Boone and van Loenen, 2022).

- *Lack of data processing and validation:* For the dissemination of the data in an open manner a prior processing and validation of the data is needed, which can create a lot of challenges to the private sector. Data processing requires data formatting and interoperable infrastructures, when there is not a universal framework to be followed, as well as data science skills that the employees may not be familiar with (Martin et al., 2013; Fassnacht et al., 2023). Additionally, the validation process may differ depending on the purpose of re-use of the data and there is a lack of a support system that endorses feedback from the user to help in the validation process, and better realize the needs of the user, especially for open data (Martin et al., 2013).

- *Lack of data security mechanisms:* For the secure dissemination of data the security of databases and systems is important both for the private sector providers and the secondary users (Fassnacht et al., 2023). Moreover, when the data is shared in a open manner and the user is not known, there might be issues of unauthorised third-party access, cyber crime that requires data encryption, anonymization to promote trust (van Veenstra and van den Broek, 2013).

- *Lack of technical infrastructures and compatibility:* There is a lack of reference architectures and models to connect all technical infrastructure in an interoperable system that connects the different incompatible organizational systems (Waterman et al., 2021; Fassnacht et al., 2023). Additionally, for open data the value of the data is increased with the use of data, the creation of a data portal to find and access the data is important, this is connected to databases, systems, applications, software, hardware that may be needed to maintain the data portal (Janssen et al., 2012).

Perspective	Barrier	Dataset	Sector	Literature
Technical	Lack of data standards	geospatial data, flood risk data, transportation data, geological data	private sector, semi-public sector, public sector, public undertaking	Waterman et al. (2021); Fassnacht et al. (2023); van Panhuis (2014); van Veenstra and van den Broek (2013); Adair et al. (1998); Sane and Edelstein (2015); Martin et al. (2013); Boone and van Loenen (2022); Barry and Bannister (2013)
	Lack of technical infrastructure and data compatibility	geospatial data, flood risk data, utility data, ship data	private sector, public undertaking	Waterman et al. (2021); Tenopir et al. (2011); Fassnacht et al. (2023); van Panhuis (2014); Boone and van Loenen (2022); Martin et al. (2013); Janssen et al. (2012); Barry and Bannister (2013)
	Lack of data accessibility and management	transportation data, geological data, utility data, ship data	private sector, public undertaking	Waterman et al. (2021); Fassnacht et al. (2023); van Veenstra and van den Broek (2013); Adair et al. (1998); Sane and Edelstein (2015); Boone and van Loenen (2022); Tenopir et al. (2011); van Panhuis (2014)
	Lack of data processing and validation	utility data, ship data	private sector, public undertaking	Fassnacht et al. (2023); Sane and Edelstein (2015); Boone and van Loenen (2022); Martin et al. (2013); Janssen et al. (2012); Tenopir et al. (2011)
	Lack of data security mechanisms	transportation data, geological data	private sector, semi-public sector	Fassnacht et al. (2023); van Veenstra and van den Broek (2013); Barry and Bannister (2013)

Figure 2: Technical barriers for private sector data sharing, result of the literature review

2.5.3 Legal Barriers

The second category consists of five legal barriers that are connected to the development of data sharing infrastructure to enable sharing of sensitive data and manage the risk of economic loss, loss of data, loss of reputation (Waterman et al., 2021).

- *Restrictions by law:* The restrictions by law can be on a regional, national and international level. The differences in restrictions and the lack of a harmonization of the different levels create additional barriers in creating an open system that is interoperable (Waterman et al., 2021; Sane and Edelstein, 2015). The ambiguous legal framework can lead to ownership and privacy constraints (Sane and Edelstein, 2015). For open data specifically, the opening of a dataset should abide by the existing competition laws in order not to disturb the business model of another private organisation with a similar dataset (Waterman et al., 2021).

- *Privacy constraints:* While there are attempts by the European Commission (2022b) with the European Data Act, to open the barriers for data sharing for the access and use of the data by the public, at the same time the General Data Protection Regulation (GDPR) imposes restrictions on data sharing (van Veenstra and van den Broek, 2013; Boone and van Loenen, 2022; Sane and Edelstein, 2015) and access to the data (Adair et al., 1998; van Panhuis, 2014). Moreover, for open data the cleansing and anonymisation of data can create delays that could affect the business model of the private sector, those delays could be connected to the process of obtaining consent from data owners and members of the community (Waterman et al., 2021, Martin et al, 2013).

- *Ownership constraints (Licensing and Copyright):* The quality of the data is relevant to the purpose of re/use of the data, if shared data are used in others ways than those intended that might create liability issues connected to the quality of data (Tenopir et al., 2011). Specifically for open data, there is a higher liability risk due to errors in the data, after the data is shared as open it is often not clear who to hold liable for them (Boone and van Loenen, 2022; Janssen et al., 2012). This can lead to conflicts of data ownership and usage rights (Fassnacht et al., 2023). In order to open data without liability risks, the framework of the existing intellectual property rights and restrictive licenses should be taken into account for the adoption of open licenses (Waterman et al., 2021). For the adoption of open data licenses, there are already different frameworks such as the Open Data Commons (Open Knowledge Foundation), the Community Data License Agreement (CDLA) and the Creative Commons (CC) that allow the data to be

open, open under conditions, or not open at all (Boone, 2021). A framework of all the open licenses should be created to take into account all the variations that can affect data sharing.

- *Contractual boundaries (standards, frameworks):* The lack of standards and a framework for contract design can create barriers related to a secure and trustworthy data sharing, although there is an attempt to create those standards with the project GAIA-X (Choi and Kröschel, 2015). This lack of a framework, leads to data sharing through existing contracts from the private sector, where especially in the process of sharing data as open it might lead to breaches of existing contracts (Boone and van Loenen, 2022). Moreover, this lack of contract design framework for open data sharing, and the reuse of previous restrictive contracts could limit the re/uses of geospatial data (Waterman et al., 2021; Janssen et al., 2012).

Perspective	Barrier	Dataset	Sector	Literature
Legal	Restrictions by law	non-personal data, transportation data, geological data, public health data	private sector, semi-public sector, public sector	Waterman et al. (2021); Fassnacht et al. (2023); van Veenstra and den Broek (2013); Boone and van Loenen (2022); Sane and Edelstein (2015)
	Contractual boundaries	non-personal data, public health data	private sector	Waterman et al. (2021); Fassnacht et al. (2023); Sane and Edelstein (2015); Boone and van Loenen (2022); Choi & Kröschel (2015); Janssen et al. (2012)
	Privacy constraints	personal data, public health data, utility data, ship data	public sector, private sector, semi-public sector, public undertaking	Waterman et al. (2021); Fassnacht et al. (2023); van Panhuis (2014); van Veenstra and van den Broek (2013); Adair et al. (1998); Sane and Edelstein (2015); Boone and van Loenen (2022); Martin et al. (2013)
	Ownership contraints (Licensing and Copyright) liability	personal data, public health data	public sector, private sector	Waterman et al. (2021); Fassnacht et al. (2023); Boone and van Loenen (2022); van Panhuis (2014); Adairs et al. (1998); Martin et al. (2013); Tenopir et al. (2011); Janssen et al., (2012); Barry and Bannister (2013)

Figure 3: Legal barriers for private sector data sharing, result of the literature review

2.5.4 Economic barriers

Economic barriers are usually connected to commercial losses that might occur. It is a result of companies treating data as confidential in order to protect their commercial model or competitiveness in the market (Waterman et al., 2021).

- *Fear of economic damage:* Data sharing for the private sector could cause economic damage to the data providers that could result to loss of brand reputation , financial losses, and legal penalties due to misuse of data (Fassnacht et al., 2023; Barry and Bannister, 2013). Waterman et al. (2021) specifically refers to insurance claims that might be affected by the sharing of flood related data. Although the private sector might decide to share their data as open data to enhance their value with reuse, this should not hinder their commercial purposes (van Veenstra and van den Broek, 2013). The economic damage could be related to errors in the data and liability issues related to the quality of the data, if they are not clearly stated in the license of the data, that is especially important for open data that the end-user is not known (Martin et al., 2013).

- *Loss of income from change in business model:* For the private sector their revenue system is based on creating income from data (Janssen et al., 2012). Their income is related to a cost recovery policy, in order to open up their data, they have to change to an open data policy that may cause loss of income (Boone and van Loenen, 2022). To change to an open data policy it means to provide data for free or charge at the basic cost of making the data available, which can cause the organization's business model to fail, especially when referring to high value datasets, with high demand, such as geospatial datasets (topographic maps, addresses, utility) (Barry and Bannister, 2013).

- *Uncertainty about the value of data:* Many organizations are in the beginning of recognizing data as an asset and have a difficulty in determining their value as intangible assets (Fassnacht et al., 2023). The lack of successful business cases where the value of open data is showcased, prevents private organizations from sharing their data (Barry and Bannister, 2013). As the value of open data is strongly connected to the reuse of them, it is more difficult to be determined (Janssen et al., 2012).

- *Lack of resources:* For most private organizations, data sharing is not part of their business core, which translates to additional human and technical resources that are needed to realize data sharing (Fassnacht et al, 2023; van Panhuis, 2014; Sane and Edelstein 2015). This resources are connected to the collection, maintenance, processing, validation and distribution of data (Boone and van Loenen, 2022). These could be entirely new for open data, as there are standards (metadata, quality, language), licences and security processes (anomyzation) that need to be followed for the data to be open (Janssen et al., 2012; Barry and Bannister, 2013). For Small and Medium companies (SME) the resources with which to publicize data might be nonexistent (Janssen et al., 2012).

Perspective	Barrier	Dataset	Sector	Literature
Economic	Fear of economic damage	non-personal data, transportation data, geological data	private sector, public undertaking	Fassnacht et al. (2023); van Veenstra and van den Broek (2013); Adairs et al. (1998); Boone and van Loenen (2022); Martin et al. (2013); Barry and Bannister (2013)
	Loss of income from change in business model	utility data, ship data	public undertaking	Boone and van Loenen (2022); Martin et al. (2013); Barry and Bannister (2013); Janssen et al. (2012)
	Uncertainty about the value of data.	geospatial data	private sector	Fassnacht et al. (2023); Barry and Bannister (2013); Janssen et al. (2012)
	Lack of resources	non-personal data, public health data, utility data, ship data	private sector, public sector, public undertaking	Fassnacht et al. (2023); van Panhuis (2014); Sane and Edelstein (2015); Boone and van Loenen (2022); Janssen et al. (2012); Barry and Bannister (2013)

Figure 4: Economic barriers for private sector data sharing, result of the literature review

2.5.5 Cultural barriers

Socio-cultural aspects of an organization and its employees can hamper the willingness to share data, risk-averse attitudes and siloed thinking towards sharing data across different sectors can amplify their unwillingness to share data (Waterman et al., 2021).

- *Cultural differences:* Cultural differences might exist between different regions or countries and even different organizations, that led to restrictive data access policies and bureaucratic hurdles, which prevent the private sector from data sharing (Sane and Edelstein, 2015; Waterman et al., 2021). The organizational cultural differences between historic openness versus restrictions to sharing may magnify the barriers to data sharing between different organizations (Fassnacht et al., 2023; Barry and Bannister, 2013).

- *Unwillingness to share data:* The unwillingness could be connected to the lack of political will and commitments to promote data sharing in the country where the private sector acts (Sane and Edelstein, 2015). The lack of consistency in political behaviours can even hinder open data sharing, when the established policy is not considered sustainable, as it can affect the maintenance and availability of open data (Martin et al., 2013). The culture of risk aversion to data sharing for competitive reasons, has been set in the past and it remains as part of the culture of the company on a managerial level (Fassnacht et al., 2023).

- *Lack of trust:* The lack of trust is mainly focused on the usage of the shared data, as the further processing and analysis of the data is not known to the data providers, which is linked to fear of inappropriate use, such as misinterpretation of data (Sane and Edelstein, 2015), inference with core business (Fassnacht et al., 2023), or economic, reputational, or social harm (Waterman et al., 2021; van Veenstra and van den Broek, 2013). Especially for open data, the misuse of data imposes an important risk in data sharing, if the terms of use are not explicitly stated in the license of the data (Boone and van Loenen, 2022).

- *Fear of loss of control:* Private organizations tend to think that loss of control of their data through sharing, might result to loss of power that comes with information, to prevent that, they tend to guard their data (Barry and Bannister, 2013). Fassnacht et al. (2023) go more into detail on the loss of control being connected to external dependencies on data and infrastructure, but also about lack of knowledge about data usage or even potential. Sharing their data as open data might create new connections in the network with advantages for the private sector which might come at the expense of less control (Janssen et al., 2012).

- *Fear of transparency and disclosure of competitive knowledge:* Many organizations are reluctant to share data due to fear of transparency related to confidential knowledge about their products and the disclosure of competitive knowledge (Fassnacht et al., 2023). The inference of knowledge about research and development of the private sector through the release of their data as open can even interfere with their business model (van Veenstra and van den Broek, 2013).

Perspective	Barrier	Dataset	Sector	Literature
Cultural	Cultural differences	transportation data, geological data	private sector, semi-public sector	Fassnacht et al. (2023); van Panhuis (2014); van Veenstra and van den Broek (2013); Sane and Edelstein (2015); Barry and Bannister 2013
	Unwillingness to share data	geospatial data, flood risk data, public health data	private sector, public sector	Waterman et al. (2021); Tenopir et al. (2011); Sane and Edelstein (2015); Martin et al. (2013); Janssen et al. (2012)
	Lack of trust in data usage	transportation data, geological data, public health data, utility data, ship data	private sector, public undertaking	Waterman et al. (2021); Fassnacht et al. (2023); van Veenstra and van den Broek (2013); Sane and Edelstein (2015); Boone and van Loenen (2022); Barry and Bannister (2013)
	Fear of loss of control	geospatial data	private sector, public sector	Fassnacht et al. (2023); Janssen et al. (2012); Barry and Bannister (2013)
	Fear of transparency and disclosure of competitive knowledge	transportation data, geological data	private sector	Fassnacht et al. (2023); van Veenstra and van den Broek (2013); Barry and Bannister (2013)

Figure 5: Cultural barriers for private sector data sharing, result of the literature review

2.6 Levels of open geographical data

The emergence of open data is evident in the research the last few years. Open data are data in a machine readable format that require a minimum of technical, economic and legal barriers for the re-use to achieve societal and commercial purposes (van Veenstra and van den Broek, 2013). With the development of the ODD (Directive (EU) 2019/1024, 2019) that takes into account non-government data and the amount of valuable data that are held by the private sector (Verhulst et al., 2020), it is important to research the state of the open data for the private sector, through existing open data assessment frameworks.

2.6.1 Open data assessment frameworks

Open data frameworks are developed from different perspectives; it may be from a technical perspective, an organisational perspective, or a holistic perspective (Boone, 2021). Since the goal of this chapter is to identify the state of open data within organisations, from different perspectives, open data assessment frameworks are introduced to this research. Through this, different levels of open data can be identified for the private sector.

There are four open data assessment frameworks that are relevant to this research, each presenting a different point of view of open data. The four assessment frameworks are:

- Data Spectrum of the ODI

- Five-Star model of Berners-Lee

- Open Knowledge Foundation

- Multi-dimensional model of Boone and van Loenen

The Data Spectrum of ODI

The Open Data Institute, created the Data Spectrum (Fig. 6) as a common graph that gives an understanding of small, medium or big data, whether they are personal, commercial or government data and their place in a spectrum from fully closed, only for internal access data to fully open, accessed by anyone, and the main connection to them all is how they are licensed (Open Data Institute, nd). It is a general open data model that identifies five levels of open data that is focused only on the legal part of data sharing. The levels are described as follows:

- Internal access, for an organization, between different departments where the access is defined by the employment contract and the internal policies.

- Named access, can refer to a data sharing by request, and the conditions of the process are explicitly defined in the contract.

- Group-based access, can refer to a group of experts related to the shared data, for geographical data these could be topographers, data scientists. The access to those is guaranteed through a process of authentication in relation to the data shared.

- Public access, on that level the data are available through a geodata portal only for view, as they are limited by licenses that limit reuse. The users in this level do not have to be experts on the field.

- Anyone, this is the fifth and final level, the open licence of the data allows for access and reuse without limitations.
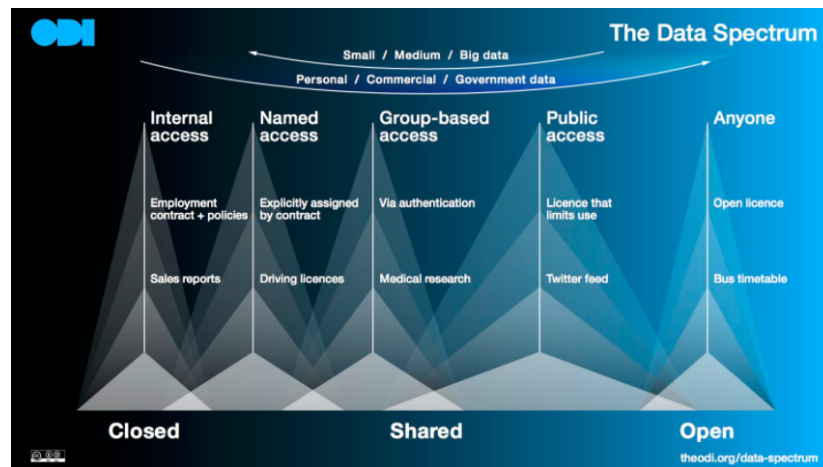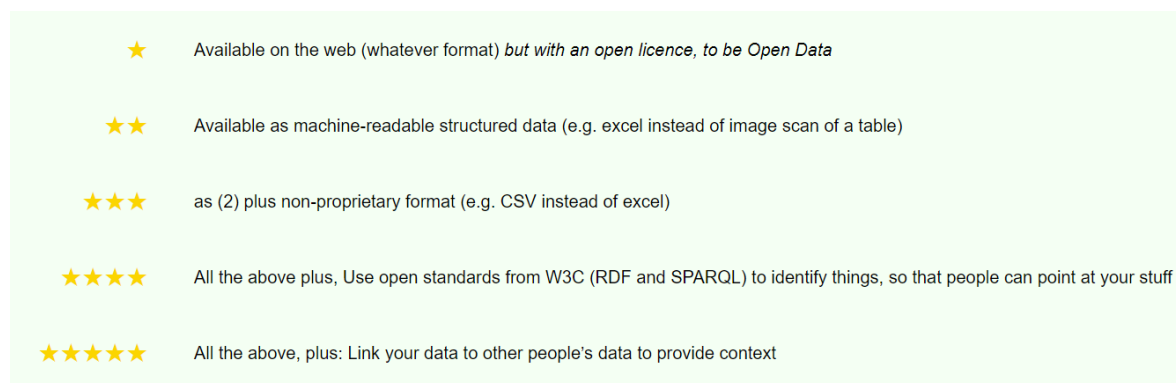

Figure 6: The Data Spectrum (Open data Institute, nd)

Five-Star model of Berners-Lee

The main focus of the Berners-Lee model is the interconnection with other datasets that is used as a mean to classify its openness. In addition, interconnected datasets can be reused in a variety of usages, that can contribute to the value that is added on the information on the internet (Berners-Lee, 2009). The description of the model is straightforward and it is presented in Figure 7. The datasets are rated from one to five stars based on the model by Berners-Lee (2009), where one star is the lowest and five stars is the highest score a dataset could get.

Starting from one star, the dataset should be available on the web, in any format, but with an open licence. For the dataset to get two stars, it should be in a machine-readable structure, such as an excel spreadsheet, which is a limited propriety format. For three stars, the dataset should be in a machine-readable format that is non-proprietary, which is an open format, such as CSV. The fourth star is given when all of the above are true and the dataset uses open standards from the World Wide Web Consortium (W3C). The open standards that need to be followed are referring to using Resource Description Framework (RDF) with the query language SPARQL. The data is stored as RDF and SPARQL is used to perform queries across different data sources (W3C Recommendation, 2008). The fifth star of the model is possible for datasets that follow all the aforementioned criteria, while having the ability to link the dataset to other datasets.

★	Available on the web (whatever format) *but with an open licence, to be Open Data*
★★	Available as machine-readable structured data (e.g. excel instead of image scan of a table)
★★★	as (2) plus non-proprietary format (e.g. CSV instead of excel)
★★★★	All the above plus, Use open standards from W3C (RDF and SPARQL) to identify things, so that people can point at your stuff
★★★★★	All the above, plus: Link your data to other people's data to provide context

Figure 7: Five-Star model of Berners-Lee (2009)

Open Knowledge Foundation

According to the Open Knowledge Foundation, "open data is data that can be freely used, re-used and shared by everyone" (Open Knowledge Foundation, n.d.). Data openness is defined in relation to:

- Availability and access. The data needs to be available on the internet in modifiable form, for no more that a reasonable production cost.

- Reuse and redistribution. The data should be provided under licences that are compatible with open licences and the data need to be in a machine readable format.

- Universal participation. Every user should be able to use, reuse and redistribute the data. This means that "commercial" restrictions would prevent "non-commercial" use.

The focus of this framework is to maximize the interoperability of the data, which is in agreement with the importance of linked data in the five star model of Berners-Lee (2009). It is important to note that in the reuse and redistribution of the data, share-alike licenses are also part of it, which could be a barrier for the reuse of open data, but it can also be an option for the private sector to create revenue from specific datasets with "commercial" use.

Multi-dimensional model of Boone and van Loenen

The Multi-dimensional model of Boone and van Loenen (2022) is built upon six dimensions,the type of user, data quality, data regime, findability, usability and in which way data is shared. Three levels of open data were identified: not open, partly open and open.

At the first level data is considered not to be open and only accessible to the internal user, and it is not findable through a general engine. The absence of an open licence makes it impossible to share the data with external users (Welle Donker and van Loenen, 2016; World Wide Web Foundation, 2017). This is on par with the internal regime that focuses on the internal purposes of data, limiting data quality to the purpose of the internal user.

At the second level data openness is improved by making it find-able and accessible through a general search engine or data portal, presented in a machine-readable format (Welle Donker and van Loenen, 2016). However, fees may be charged and the data can only be shared under certain conditions and terms. This data policy generates internal and external value.

At the third level data can be considered most open. This data is findable through a general search engine and data portal, free of charge, comes in a machine-readable format and with an open licence. Meaning that everyone can reuse the data (Diretive (EU) 2019/1024). This can be applied through an informediary business model, creating the space for the private sector to share the data through a third party either by keeping the data within external trusted parties or by sharing the data openly with everyone (Zuiderwijk and Janssen, 2014). The quality of the data and its openness is still relative for each specific case and user (Safarov et al., 2017). Although the last level is preferred from the user's point of view it might lead to issues with the business model of the private sector (Welle Donker and van Loenen, 2016).
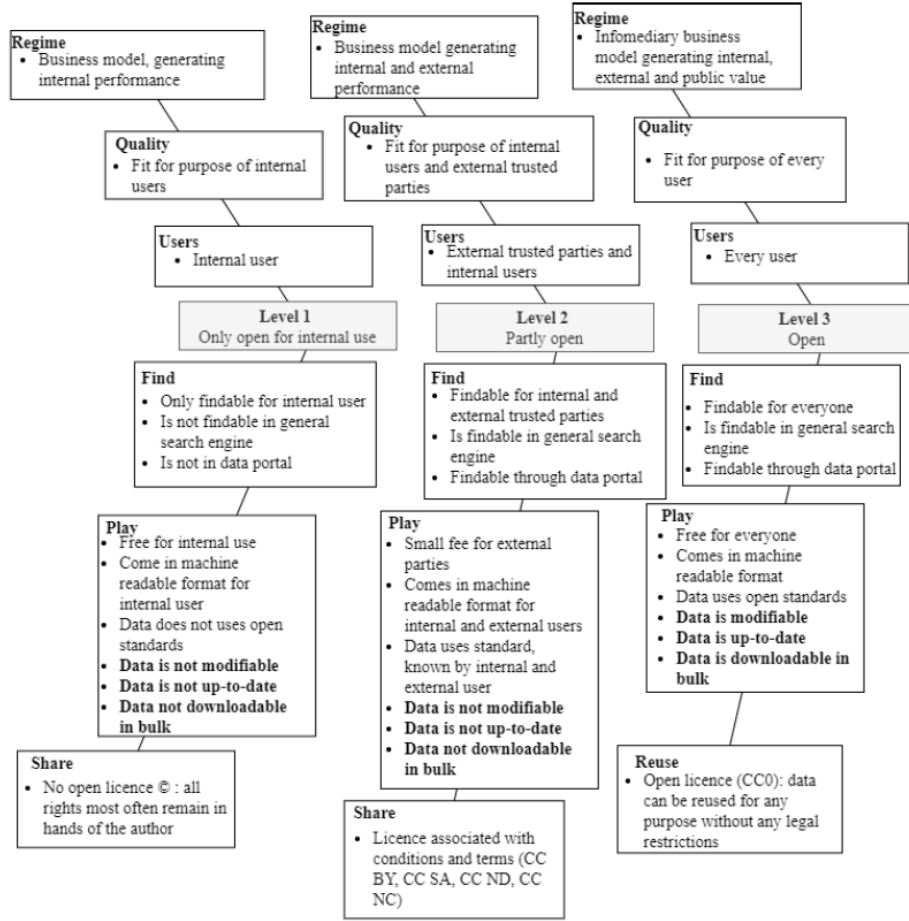
Figure 8: The multi-dimensional model of the three identified levels of open data (Boone and van Loenen, 2022)

2.7 Addressed barriers of open data

Going through the open data assessment frameworks in relation to the data sharing barriers that were identified in Section 2.5, there are three categories that are addressed through them, those are legal, technical, and economic. This will be further described in this sub-section.

Starting from the Data Spectrum of ODI, mainly legal barriers are considered in the process of moving from one level of openness to the next on. The different terms in licences determine also the type of user, from an internal user of the organization, moving to a group-based user, that can be a group of experts in the field, to any user not taking into account the level of skills that may be needed for the reuse of data (Martin et al., 2013). In the fourth level, public access, the characteristics of the user that is limited are not presented, which means there is no indication for the design of the appropriate licence to be used (Welle Donker and van Loenen, 2016).

The framework of Berners-Lee (2009), focuses on the interconnection of the dataset itself, creating the basis of the legal framework, with an open licence and builds upon it (Janssen et al., 2012). In the next level, the focus is on the technical aspects of data standards, starting from a limited propriety format to an open format, such as CSV. While maintaining these criteria it focuses on the importance of metadata as a way to connect data with similar content. At the highest level of five stars the interconnection of the dataset with other datasets is the drive to the creation of value from the dataset. This framework takes into account the legal and technical barriers, while also proposing a solution for the development of business models, connected to services that can be created, through

the added value of linked data.

The Open Knowledge Foundation, defined openness based on technical characteristics of the existence of data standards (format, metadata), data portal and its connection to a data portal through the use of metadata. The reuse and redistribution of open data is connected to the legal aspects of open licences. Part of the licences in the framework, are also share alike licences which could hinder the reuse from everyone, but could be an opportunity for the private sector to maintain their business model through commercial licences.

The multi-dimensional model of Boone and van Loenen (2022), takes into account the holistic framework of Welle Donker and van Loenen (2016), to consider the user perspective in the levels of openness, which is in agreement with three out of five of the levels of users presented in the Data Spectrum (Open Data Institute, nd), internal access - internal use, named access - external trusted parties and internal users, and anyone - every user. Through out the six elements of the framework the legal aspects that are addressed are licences in the share element, the technical aspects are addressed in find and play elements, through the data standards (format, metadata, quality), data portal, and general search engine, and the economic aspect through the development of a regime connected to the characteristics of the user for every level.

The common characteristics of all four frameworks are their focus on the technical, legal and economic barriers, while there is no mention of strategic or cultural barriers and ways to address them. The importance of a regime is highlighted in the multi-dimensional model, without mentioning the cultural differences that may exist on a national and an organisational level for the private sector connected to historic openness or restrictions of sharing, that prevent the private sector from even developing a strategy for open data (Fassnacht et al., 2023; Barry and Bannister, 2013). Establishing an open data culture for the organization is important to enable open data sharing to the other levels of the organization (Janssen et al., 2012; Waterman et al., 2021).

The enabling of data sharing, could lead to management commitment and the creation of a corporate strategy, that involves all levels of employees and departments of the organization, while making data sharing part of the core business, which translates to a long term internal strategic direction, that takes into account technical (data standards,data portals, management systems), legal (licences, liability) and economic barriers (use case identification, development of open data revenue models), by stating clear responsibilities and decision-making processes (van Veenstra and van den Broek, 2013; Fassnacht et al., 2023).

Although, the establishment of an open data culture is important, the lack of trust was identified as a barrier that could prevent it. Lack of trust for data providers was linked to fear of misuse and misinterpretation of data, which comes as a result of the user not being known in the open data system (Sane and Edelstein, 2015; Boone and van Loenen, 2022).

Based on the literature review and the multidimensinaol model of Boone and van Loenen (2022), the updated multi-dimensional model of the four identified levels of open data is presented in Figure 9

2.8   Research Approach

Based on the literature review that was conducted the private sector is not sharing their data with other public or private organizations. Most of the existing literature was focused on public sector, public-undertaking data, where the intention to open their data was clear due to the objectives of the ODD (2019). With the clear intention, the focus moved to how to tackle the barriers to open data, those barriers were technical, legal and economic.

For the private sector data sharing, there is a different starting point, because there is a lack of research regarding the willingness of the private sector to share their data, as they are not bounded by the ODD or other legislation. This different starting point, is the base to identify different categories of barriers that may hinder private sector data sharing. Through the literature review two additional

Open Culture of Organization

Strategic
Use case identification and give responsibilities

Regime
Business model, generating project performance

Regime
Business model, generating internal performance

Regime
Business model, generating internal and external performance

Regime
Infomediary business generating internal, external and public value

Quality
Fit for purpose of specific project

Quality
Fit for purpose of internal users

Quality
Fit for purpose of internal users and external trusted parties

Quality
Fit of purpose of every user

Users
Project user

Users
Internal User

Users
External trusted parties and internal users

Users
Every user

Level 0
Only Open for project use

Level 1
Only Open for internal use

Level 2
Partially open

Level 3
Open

Find
Only findable for internal user
Is not findable in general search engine
Is not in data portal

Find
Only findable for internal user
Is not findable in general search engine
Is not in data portal

Find
Findable for internal and external trusted parties
Is findable in general search engine
Findable through data portal

Find
Findable for everyone
Is findable in general search engine
Findable through data portal

Play
Free of charge for internal user
Come in machine readable format for internal user
Data does not use open standards
Data is not modifiable
Data is not up-to-date
Data not downloadable in bulk

Play
Free of charge for internal user
Come in machine readable format for internal user
Data does not use open standards
Data is not modifiable
Data is not up-to-date
Data not downloadable in bulk

Play
Small fee for external parties
Comes in machine readable format for internal user and external trusted users
Data uses standard know by internal and external user
Data is not modifiable
Data is not up-to-date
Data not downloadable in bulk

Play
Free for everyone
Comes in machine readable format
Data uses open standards
Data is modifiable
Data is up-to-date
Data is downloadable in bulk

Share
No open license ©: all rights most often remain in hands of the author

Share
No open license ©: all rights most often remain in hands of the author

Share
License associated with conditions and terms (CC BY, CC SA, CC ND, CC NC)

Reuse
Open License (CC0): data can be reused for any purpose without any legal restrictions
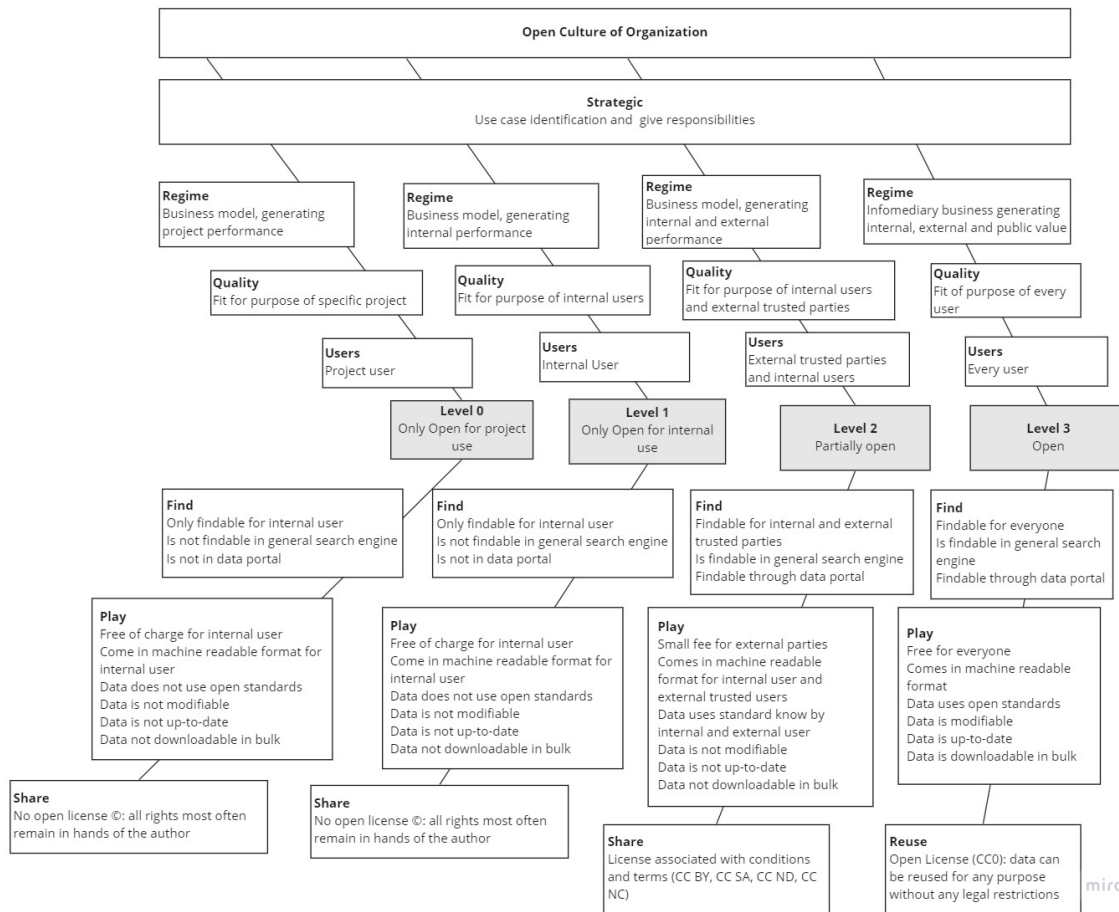
miro

Figure 9: The updated multi-dimensional model of the four identified levels of open data, created from the literature review

categories were identified, those of strategic and cultural barriers. From the cultural barriers, cultural differences on a national and organizational level and the unwillingness to share data due to cultures of risk-aversion that were established for years, can be indications on why there is lack of organizational motivation to enable data sharing on a strategic level. Those are some barriers that indicate that unwillingness of the private sector to share data, is not rooted only on technical, legal and economic barriers.

The intention is to move forward from data sharing to the private sector opening up their data, to achieve that it was important to identify whether different levels of openness have an impact on these barriers. Four open data assessment frameworks, that were identified as relevant to this research, were further researched. The common characteristics of all four was their focus to technical, legal and economic barriers, neglecting the strategic and cultural barriers. The lack of an open culture in the private sector, might be preventing from even developing a strategy for open data, which is why it is important to be researched further. The focus of this research will be "What are the barriers to private sector data sharing of geospatial data in the Netherlands?" and "How can those barriers be addressed in relation to the impact of the level of openness on them?".

Private sector does not share data → Open Data Directive (ODD) (2019) + Data Act (2022) B2B data sharing B2G data sharing → Barriers to data sharing → Level of openness impact data sharing → Overcome barriers to private sector data sharing → Share high value datasets of private sector

miro

Figure 10: The situation explanation with the raised problem in red.

3 Research Questions

3.1 Objectives

The main research question for this thesis is "What are the barriers to private sector data sharing of geospatial data in the Netherlands?" and "How can those barriers be addressed in relation to the impact of the level of openness on them?".: .

In order to answer the main research question the following sub-research questions should be answered:

- What are the different levels of openness for geographical data?

- How does the different levels of openness impact the barriers to private sector data sharing?

- How can those barriers be addressed, with a focus on strategic and cultural barriers?

3.2 Scope of research

Figure 11: The scope set for this research

4 Methodology

This section elaborates on the methodology that will be followed to answer the research questions presented in the previous section. Although, there is existing research that focuses on data sharing for the private sector to private sector (Fassnacht et al., 2023), and research for barriers for the public sector to open up their data (Janssen et al., 2012), this research will investigate the barriers for the private sector to share their data in a more open manner. The topic will be researched through an exploratory research, as the topic is not clearly defined yet, and it will be used to have a better understanding of the problem.

Merkus (2022), describes a general methodology for an exploratory research, which can be divided to primary and secondary research based on the data collection and analysis. In primary research, the data collection is being done through surveys, focus groups or interviews, while in secondary it is being done by using results of a primary research, such as case studies, literature review or published results of surveys. Furthermore, George (2022) gives an overview of the types of interviews, which are structured, unstructured, semi-structured (a combination of both, and focus group interviews. The method for this research will be based on a literature review of the related work that will be used as the theoretical basis, and it will be enriched with the collection of quantitative and qualitative results from surveys and interviews with the private sector. The steps of the methodology will be explained in the following section.
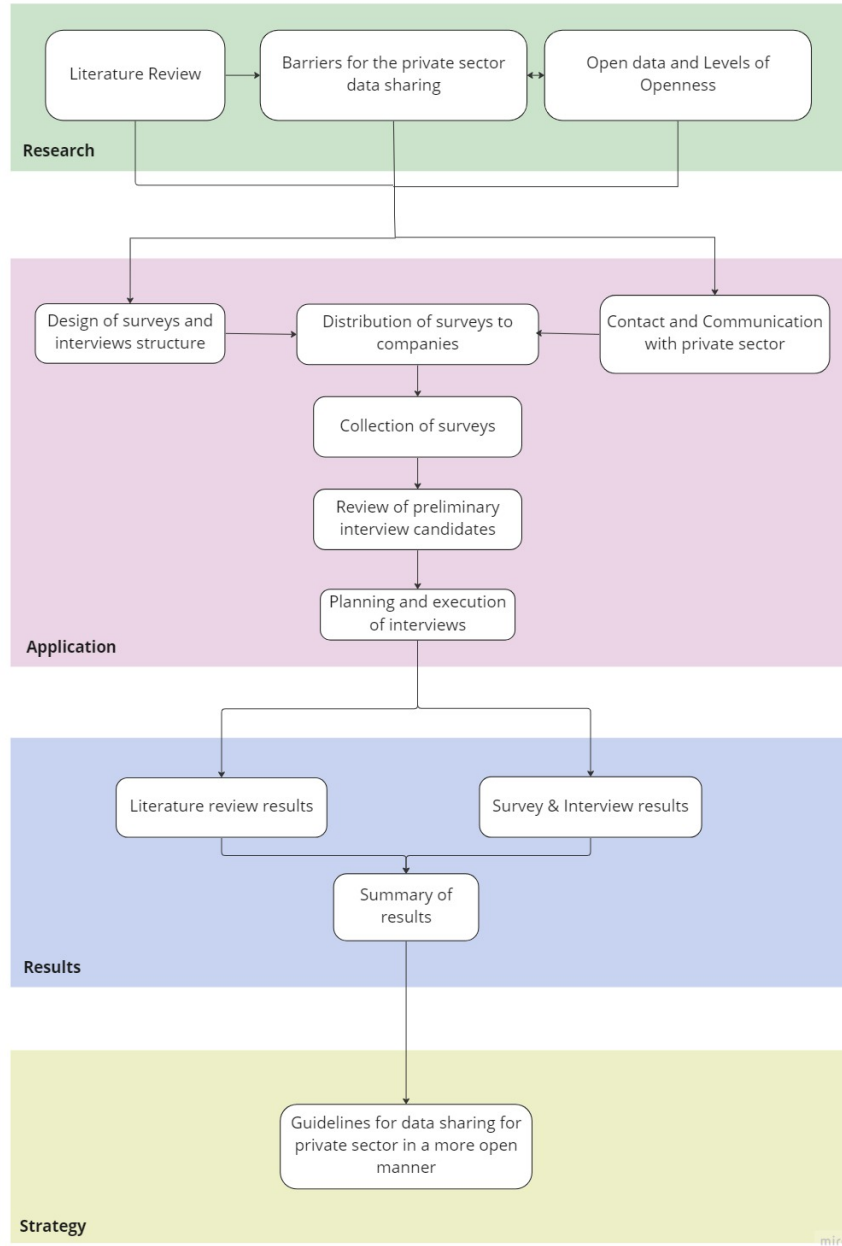
Figure 12: Proposed methodology

4.1 Surveys for private sector

As it is mentioned in Jones et. al. (2013), online surveys are the way to assess a large target in with relative ease and get a quick response and data compilation. Which is what is needed to quickly identify preliminary barriers for the private sector to participate in data sharing. To do that the official portal for the European data (data.europa.eu) will be used to identify geographical datasets, in the transport sector, with high value and their providers, with a focus in private sector from the Netherlands. The survey will be sent to those providers to have an understanding if they are willing to open up their data.

With the obtained knowledge from the literature review, some questions that may be relevant for the creation of the survey are:

- Is the private sector aware of the intend of the European Commission to involve the private

sector in sharing their data in B2B and B2G collaborations?

- How willing is the private sector to share their data in B2B and B2G collaborations?

- If not, what are the reason why they are not willing to participate?

- Does the private sector have a strategy for open data?

- If not, what are the reasons for not developing one?

4.2 Interviews with selected companies

As the next step the research will continue with semi-structured in-depth interviews where the results of the surveys will be used to choose the interviewed companies and the thematic framework of questions. According to Crinson and Leontowitsch (2006) the qualitative interviewing could be used to go into more detail of the results of the surveys. Interviews will be conducted with the private sector as an expert on the field to get more meaningful insights on the barriers that may exist in data sharing. The result of the surveys are too generalized to give that in-depth knowledge, that is why the semi-structured interviews are an important addition.

4.3 Guidelines for private sector to share their data

The results of the literature review will be enriched with the results of both surveys and semi-structured in-depth to have an understanding of the barriers of data sharing for the private sector. Those barriers with the levels of open data that were identified through the literature review some guidelines will be proposed on how the barriers can be addressed in order for the private sector to share their data in a more open manner.

5 Time planning

5.1 Plan of the Ps

The following Gantt Chart was created, based on the activities which are needed to meet the research objectives. The meetings with the both Supervisors, B. van Loenen and S. Calzati, for P1 and P2 were scheduled as in the Gantt Chart. For P3, P4 and P5 the proposed dates for meetings are presented.
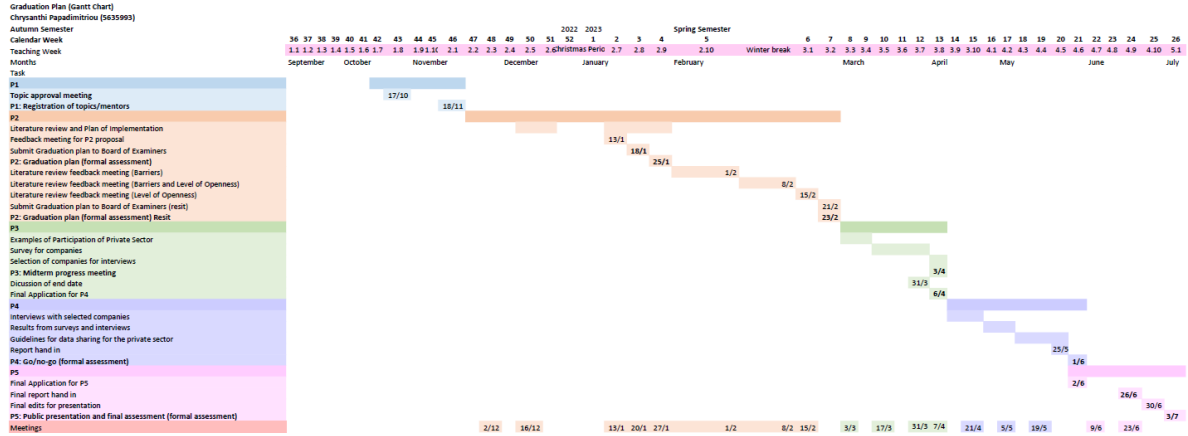

Figure 13: Gantt Chart

6 Tools and Datasets used

The information for the data will be provided by the results from the surveys distributed to the companies and the interviews. Additional information will be provided by the other studies regarding

the data sharing for the private sector, levels of openness. Regarding the tools, Google forms will be used for the distribution of the surveys and interviews, while Microsoft Office tools will be used for the elaboration of documents, presentation, and results for this research. Tools for the analysis of the survey and interview results will be decided at a later stage.

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