Value creation through business data sharing

A case study of the Maritime Industry

by

L. M. Voogt

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Preface

This thesis has been written to obtain the degree of Master of Science at the Delft University of Technology. The thesis expands on the knowledge in the research domain of open data sharing in a business context. It aims to provide a theoretical foundation for evaluating the value creation opportunities through business data sharing in a case study.

After obtaining my Bachelor's degree in 'Mechanical Engineering', I wanted to broaden my horizon with a Master's degree in a different field rather than expand my knowledge about a specific mechanical subject. Next to technology I have always had an interest in entrepreneurship and this had been fueled even more during my Minor in 'Tech-based Entrepreneurship'. I enjoy the thought processes in the business side of technology about how to create value from technology. That is why I chose for the 'Management of Technology' Master program at the Delft University of Technology and I have not regretted it one bit.

When I was given the opportunity to combine my graduation with an internship at a large specialized technical corporate like Boskalis, I was more than excited. Open business data sharing is an important topic in a vastly digitizing world in which even the conservative maritime industry cannot lag behind. Although open business data sharing is not something for tomorrow's agenda, it is something which in my view should be examined for the long run. This thesis is of value to those who have an interest in exploring the value creation opportunities of business data sharing; e.g., researchers and people working in business management. People interested in topics such as (open) data sharing, business data, business models, dredging or the maritime industry may also find this thesis interesting.

Although writing is not one of my biggest hobbies, I did genuinely enjoy writing this thesis overall. Writing this thesis had been a goal I set for myself ever since starting my career at the university. Upon reaching this milestone, there have been moments where I found myself struggling with managing a research of this size, and documenting all steps properly. These were the moments where I have learned that systematic procedures help carrying the research project and that persistence pays off.

Throughout the research there have been people in my surroundings who have supported me at different levels. First I would like to thank Dr. Anneke Zuiderwijk, my first supervisor from TU Delft. She has guided me throughout the entire research and gave intermediate feedback to bring the thesis to a next level. Second I would like to thank Boskalis and in particular Bart Dekker, my company supervisor, for the opportunity to work at the office and conduct the case study. It has been a great environment to work in. Bart provided me with ad hoc feedback and was very cooperative in giving direction to the research. He helped to sustain the relevance of the research to Boskalis and vice versa. Thirdly I would like to thank Dr. Robert Verburg for being both my chair and second supervisor from TU Delft, and making this thesis possible. His feedback greatly improved the quality of the thesis. Other words of thanks go out to all the people who participated in the case study and workshop. Last but not least I would like to thank my parents for their support. Not only during the writing of this thesis, but throughout my entire studies. Getting the opportunity from them to go to university is something I will always be grateful for.

L. M. Voogt
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Executive Summary

This research has been about exploring the value creation opportunities of sharing business data as open as possible. There has been relatively little insight in the value of sharing data or making data public in a business context. This has been in part due to the reluctance of businesses to share and use their data openly in view of their competitive position, legal constraints or the fear of other users misinterpreting and misusing their data sets. There are however advantages described in literature to openly sharing business data as well. For example it may increase shareholders trust, expand collaborations with suppliers and provide new insights essential for their business model. In the research field of open data sharing there is ambiguity about what open data sharing entails. In this research the definition of data sharing has been based upon the Data spectrum which was set up by the Open Data Institute. This spectrum regards open data as 'data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and sharealike' (Open Knowledge Foundation, 2022). Any data that is shared under conditions which restrict the 'openness' of the data is referred to as shared data. One type of industry that is characterized as conservative and relatively slow in the uptake of novel technologies and ways of working is the maritime industry. Potential value is currently left unexploited as business data is little to not shared. The objective of this research is to identify the value creation opportunities in relation to business data sharing in the maritime industry. Therefore the main research question is: *How can business data sharing help to create value in the maritime industry?*

To answer the main research question, a three phase research was set up. First, a literature review delivered a new conceptual framework in which existing models have been combined to provide a more complete understanding of the value creation process of business data sharing. Next, this knowledge was applied in a case study at a fleet management department of a dredging company, Boskalis, to identify the business data sharing value creation opportunities. The data was gathered through nine interviews in which the questions were based on the knowledge from the conceptual framework. At last, the findings from the case study were validated and the framework was refined based on the case study and the validation feedback. The validation was done by means of a workshop with eight employees from Boskalis who are acquainted with data.

The conceptual framework that was constructed in the first phase of the research was a combination of multiple other models that had been found in the literature. These models showed that in order to create value from sharing data in a business context, there are a few things to consider. First it is important to describe the data that is assessed into detail. The metrics or properties of the data must be listed and the relation of the data to the existing business model of the company should be described, such as how related the data is to the core business. The next step is to map the potential values and risks of sharing the data in order to determine the criteria for data being suitable for sharing. Therefore the shared data value proposition should be set up, and risks such data misappropriation and loss of competitiveness should be identified. The decision whether or not to share the data depends on whether or not the data meets the requirements and the trade off between the values and the risks. When the data is to be shared, the requirements for implementation can be set up. The framework describes functional elements of a data sharing infrastructure at the producer level and user level. Both the criteria and implementation requirements are dependent on a company's context and stakeholders. Lastly, the framework summarizes the data sharing value proposition and required infrastructure in the business data sharing value canvas.

The case study at Boskalis showed that the value that can be created from sharing their business data is not explicitly monetary, but rather aimed at improving primary business processes, making the world a better place and inherently improving the company image, and improving customer relations. This is because the business model of Boskalis does not match with a data driven business model in which revenue is generated from selling data. Safety data can be shared openly to make the world a better place and improve the company image. Improving the company image can also be done by openly

sharing non-core business data to showcase how well the business performs and increase trust. Survey data can be openly shared in a collective to improve the quality of sea maps and increase efficiency survey practises industry wide. In the shared domain there are opportunities for sharing data that is closer related to the core business. Primary business processes can be improved by sharing sensor data from engines with suppliers for tailored expert advice. In a collective with all engine users, data can even be shared to further increase the quality of the expert advise but also the quality of the engines and result in better products.

The workshop has shown that the subject of (openly) sharing data and creating value from it currently is a rather abstract topic. A long term vision is required in order to see the potential benefits of sharing business data. The participants did see the potential of the value creation opportunities that followed from the case study, however in the current ways of working, infrastructure and policies there are many challenges. Employees require a more detailed and tailored framework which takes these hurdles into account to make implementation possible. The framework can be made more concrete by conducting a pilot case study on a specific dataset at a specific company. The workshop also showed that there is a strong belief that data sharing will be adopted in the maritime industry for various reasons and to different degrees. This is an incentive to further develop the framework and fuel the discussion for sharing business data in the maritime industry.

This thesis is of value to those who have an interest in exploring the value creation opportunities of business data sharing in dredging fleet management in the maritime industry; e.g., researchers and people working in business management. People interested in topics such as (open) data sharing, business data, business models, dredging or the maritime industry in general may also find this thesis interesting.

1

Research Introduction

A recent development among various industries has been digitalization (Kraus et al., 2021). Through digitalization, processes can be automated and optimized. The most prominent asset of digitalization is data. Data can help organisations and businesses to improve their processes (Ritter & Pedersen, 2020) and decision-making through data analytics to stay innovative and competitive (Lavalle et al., 2011). There are different types of data and it can be challenging to extract value out of them. One way to increase the value extraction opportunities from data is by sharing it, which enables more people to look at and use the data. There are different ways in which data can be shared. Multiple terms are used in the context of data sharing, such as the synonyms 'open data' and 'public data', the synonyms 'closed data' and 'private data', and 'shared data'. The difference between the terms lies in the extent to which the data is made accessible. Public data is data that is freely available on the internet and can be used by anyone at any time (Open Knowledge Foundation, 2022). This type of data is often generated through research and made available by government bodies or research institutes. Private data is data that is kept from the public, and can in principle only be accessed by those who are authorized (McKinsey & Company, 2013). An example is business data that is kept within the company. In between private and public data there is a range of different types and degrees of 'shared data' (Open Data Institute, 2022).

Prior research has been done on sharing data and making it public, but this has mainly been in the governmental and institutional research domain (Attard et al., 2015; Zuiderwijk, 2015; Zuiderwijk & Janssen, 2015). There is relatively little insight in the value of sharing data and making it public in a business context, in addition to the existing value of private data. This is in part due to the reluctance of businesses to share and use their data openly in view of their competitive position, legal constraints or the fear of other users misinterpreting and misusing their datasets (Van Gorp et al., 2020). There are however valuable advantages to openly sharing business data as well. For example it may increase shareholders trust (Bertot et al., 2010), expand collaborations with suppliers (Kassen, 2013) and provide new insights essential for their business model (Ribes & Polk, 2014). In previous research, advantages like these have been shown for open government data and models have been constructed for governmental bodies to help them make the trade-off between opening up or keeping data private (Zuiderwijk & Janssen, 2015). In a business context, similar research has been done into opportunities for public data use (Gao & Janssen, 2022; Zeleti et al., 2016). The business context research however is still rather generic and the findings leave room for refinement. Moreover, current research into business data marketplaces is still in the technical design domain, rather than in the non-technical adoption domain which deals with (Abbas et al., 2021). In order to refine and contribute to the current body of knowledge about business data sharing in the non-technical adoption domain, the presented research is about how value can be created from sharing business data.

One type of industry that is characterized as conservative and relatively slow in the uptake of novel technologies and ways of working is the maritime industry. A common topic throughout the maritime industry is fleet management (FM). Maritime FM involves all activities related to the operations of a fleet of vessels, such as performance and maintenance. The main objective of FM is to achieve op-

timal performance, minimizing costs and maximizing availability. In recent years, digitization of the maritime industry has been upcoming (Bureau Veritas, 2020), with advancements in sensors, predictive maintenance and data use (Lazakis, Raptodimos, et al., 2016). These advancements allow for the generation of plenty data of which the value is yet to be explored. Creating this value through sharing the data is something that is considered in the industry (Lind et al., 2021; Wärtsilä, 2020). This incentivises the exploration of data sharing opportunities in the maritime industry. This can be done through a case study at a company that operates in the maritime industry, because a case study takes the contextual influences of the maritime business environment into account. The case study in this research has been conducted at Boskalis. Boskalis is a dredging company which operates in the maritime industry.

This research is about how value can be created through business data sharing in the maritime industry. In the remainder of this introductory chapter a brief overview is given of relevant research background information, the problem statement, research objective, societal & academic relevance, methodology and report outline.

1.1. Research Background Information

Before diving into the research it is important to have a preliminary understanding of the keys topics related to the research field. First it is important understand what degrees of data sharing fall within the scope of the research. Open and closed data set the two boundaries of the shared data spectrum that is considered in this research, which is also elaborated on later in subsection 2.3.1. The definitions for open, closed and shared data are provided below. Secondly, it is useful to have prior knowledge of some of the data sharing researches and initiatives, which helps to adequately start the research.

Open and closed data definition

Open data, or public data, is a relatively vague and broad term. According to the Open Data Handbook, set up by the Open Knowledge Foundation and supported by Shuttleworth, The World Bank and The OpenData for Development Network, open data is defined as: "data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and share-alike." (Open Knowledge Foundation, 2022) Free use does however not necessarily entail that the use should be free of charge; a reasonable reproduction cost may apply (Open Knowledge Foundation, 2022) and being able to charge any costs has been argued within the limits of open data in a business context (Enders et al., 2020). According to the Open Data Institute, closed data, or private data, can only be accessed by its subject, owner or holder (Open Data Institute, 2022). This is data that is strictly personal and is not to be shared. Any type of data sharing that lies between open and closed data is referred to as shared data (Open Data Institute, 2022). Shared data may be data which is shared under contractual agreements which limit the accessibility and use of the data. More detail about the data spectrum (closed, shared and open data) described by the Open Data Institute is provided later in subsection 2.3.1. For now it is important to understand that in the remainder of this thesis, 'data sharing' refers to sharing data both in a 'shared' and 'open' fashion.

Data sharing research & initiatives

In government and research organizations there have been advancements in facilitating (open) data sharing, through for example creating infrastructures that enable open data use and expose its benefits (Zuiderwijk, 2015). Specifically in fleet management, there have been efforts in science to create frameworks for centralizing data for fleet maintenance optimization purposes (Lazakis, Dikis, et al., 2016), and there are technological developments that may allow for innovations to be implemented in fleets, such as the Internet of Things (Wei et al., 2021) and open data sharing (Wärtsilä, 2020). These efforts, though, seem to focus on the technological feasibility of performance improvements, rather than the details about implementation of data sharing within business models of large organisations or between organisations and their external stakeholders. Therefore, research on what data sharing can do for applications in the maritime industry would be interesting and of great help in accelerating the digitalization of the maritime industry. For government applications, decision models have been created (Zuiderwijk, 2015). For businesses, there has also been research on a decision model, however in this case a more flexible definition for open data was taken, as the private business context

poses extra challenges which are not or less often encountered in the government context, such as competition (Enders et al., 2020). The researches mentioned in this paragraph will be discussed more thoroughly in section 2.3.

1.2. Research Opportunity

As mentioned in the paragraphs above, research has been done on data sharing at different levels of openness, but this has mainly been in the governmental and institutional research domain. There is relatively little insight in the value of sharing data in a business context and this is not without reason. Businesses are reluctant to sharing business data due to risks such as losing their competitive position or misappropriation of the data. Potential benefits of open data sharing that are recognized in a governmental and non-profit context, such as increased trust, expansion of collaborations and new insights, are only explored to a limited extent in a business context. Research that has been done on exploring these benefits require further testing and refinement, according to the authors (Gao & Janssen, 2022). Models have been constructed for governmental bodies to support them in the decision for whether or not to disclose government data (Zuiderwijk & Janssen, 2015). It has been suggested to refine and test the model in other contexts as well. Moreover, current research into business data marketplaces is still in the technical design domain, rather than in the non-technical adoption domain (Abbas et al., 2021). This leaves room for looking into the non-technical aspects of business data sharing. One of those non-technical aspects is exploiting the value that can be created from sharing business data.

The above mentioned findings accommodate an opportunity to conduct a research on value creation through data sharing in a business context. Specifically for this research, a dredging business context in the maritime industry is chosen because this has not been done before. The presented research aims to expose value creation opportunities in the dredging context, which may also be generalisable to the entire maritime industry. Additionally the data sharing insights may be useful for the maritime research domain.

1.3. Research Objective

The objective of this research is to identify the value creation opportunities in relation to business data sharing in the maritime industry through a case study at dredging fleet management department of Boskalis. These opportunities relate to dredging fleet management in the first place, but may apply to the entire maritime industry. 'Data sharing' is considered in the broadest sense possible in the research. The focus area of the current research is depicted in Figure 1.1. The aim is to create value from sharing data (which is currently not being shared) as open as possible, and measures that restrict the openness are implemented when there are contextual factors that demand it. The according research question that is to be answered therefore is:

RQ: 'How can business data sharing help to create value in the maritime industry?'
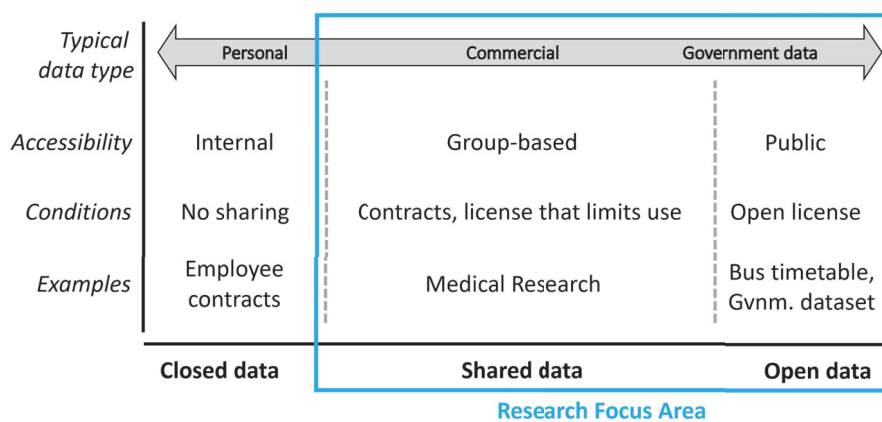

Figure 1.1: Research focus area derived from the data spectrum set up by the Open Data Insutitute (Open Data Institute, 2022)

To reach the objective and come to a well founded answer, a structured research approach is required. First, it is necessary to find ways in literature in which value creation opportunities can be identified. Second, based on these ways, the value creation opportunities can be explored through a case study in the dredging fleet management context in the maritime industry. Third, the results as well as the methods should be validated and refined to increase the soundness of the results and potentially harvest more insights. In order to help structure the research, three sub-research questions have been set up in accordance with the three step research approach:

rq1: *What conceptual framework can be used to identify value creation opportunities through business data sharing in a business context?*

rq2: *What are the data sharing value creation opportunities in dredging fleet management applications in the maritime industry?*

rq3: *To what extent are the proposed framework and value creation opportunities useful in the maritime industry?*

Each sub-research question is answered in a different phase of the research in a separate chapter of the report. An overview of the research flow is given below in Figure 1.2. The methods that have been used to arrive at the answers are discussed below. The deliverable at the end of the research is this thesis report. Next to an overview of the value creation opportunities in dredging fleet management and the maritime industry, a framework is delivered which companies in the maritime industry can use to identify business data sharing value creation opportunities by themselves.
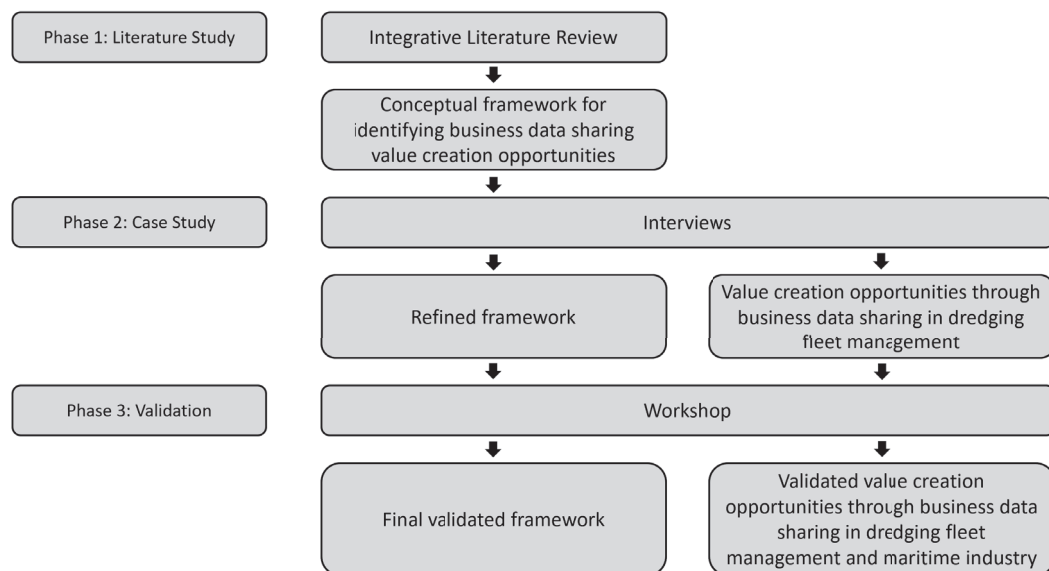
Figure 1.2: Research Flow Diagram

1.4. Methodology Overview
For each of the three phases of the research, an appropriate method is used. As can be seen in Figure 1.2, the three respective methods are an integrative literature review, case study interviews and a validation workshop. A brief description of each of the three methods is given below, as well as the motivation for using these methods in the research.

Integrative Literature Review
First and foremost, it is necessary to get acquainted with literature, to gain a better understanding of the topics relevant to this research and get to know if and how business data sharing can be of value in businesses and in the maritime industry specific. A literature review is suitable for gathering the

information because academic knowledge is most often laid down in articles. Through an integrative literature review (Snyder, 2019), information is harvested about topics such as data sharing definitions, value creation from data sharing, data sharing infrastructures, and benefits and risks of data sharing. From this gathered knowledge, an analysis framework is composed that will help to identify business data sharing value creation opportunities in a case study. The integrative literature review approach is chosen because it is time-wise not possible to do a full, and more rigid, systematic literature review in the time window of this thesis project.

Case Study Interviews

The second part of the research is an exploratory case study, for which the case study protocol from the book 'Case study research and applications' by Robert Yin (2018) has been used to set up the methods. Yin describes a case study as an empirical method that investigates a contemporary phenomenon in depth and within its real-world context. This method is a suitable research method for exploring the value creation opportunities in dredging fleet management because of two things. First, there is a contemporary (ongoing) phenomenon to be investigated, which is the practise of data sharing. Second, it is expected that the value creation opportunities through data sharing are very case specific and the context plays a key role. According to Yin, proper case selection criteria is required for case study research. The major criteria for the current case selection were the accessibility to the company, the business context and the fact that the company was hesitant about data sharing. The case study in this research is done at the fleet management department of the dredging division at Boskalis located in Papendrecht. There was the opportunity to work from within the company during an internship, which allowed for easy access to interview participants and company data. Boskalis has a large variety of data in-house of which little to nothing is currently shared. Boskalis managers do however see potential benefits in dredging fleet management from sharing data, such as the opportunity to improve maintenance practises. Therefore they were willing to cooperate in this research. To structure the case study, a case study protocol has been set up which also increases the rigidity (Yin, 2018). This protocol is elaborated on in section 3.2. The data for the case study is gathered through interviews with employees of Boskalis. In the case study, Boskalis is the unit of analysis and the interview participants are the units of observation.

Validation Workshop

In order to validate the findings from the case study interviews, a validation workshop is used. Having a validation procedure follow the case study is recommended to boost the quality of the study (Yin, 2018). The workshop is a one hour session in which employees from Boskalis were presented with the value creation opportunities in dredging fleet management and the maritime industry. Also, the refined framework was presented for review. At last, the workshop facilitated a discussion on the results and framework between the participants. Some of the participants had also participated in the case study interviews. In this way, the workshop provided a final round of fine-tuning the framework and makes for a more credible result of the research and a more applicable framework for the maritime industry.

1.5. Research Report Outline

As can be seen from the table of contents, the report is split into five chapters. The first chapter, which you are reading now, explains what the research is about and what is to follow in the report. Chapter 2 is about the integrative literature review, chapter 3 is about the case study findings, chapter 4 is about the validation workshop and chapter 5 contains the conclusions of the research. Chapters 2 to 4 correspond with the three phases of the research. These chapters first introduce the research phase, then provide a detailed methodology assessment, discuss the results, and subsequently draw conclusions and answer the related sub-research question in the conclusion. Although the validation workshop is related to (if not part of) the case study, it has been put in a separate chapter because having a separate chapter for each phase of the research makes the thesis report better structured and easier to read. This is in part due to the fact that for each phase a different methodology has been used.

1.6. Academic & Societal Relevance of Research

This research explores how businesses in the maritime industry can create value through sharing their business data. The need for refinement and applying models in real-life scenarios has been expressed in literature (Gao & Janssen, 2022; Zuiderwijk & Janssen, 2015). The current research responds to that need and uses the literature to see the current body of knowledge in relation to value creation opportunities of data sharing, and then applies this knowledge to the specific case of dredging fleet management. The findings from this research can help to refine the existing models in literature. This research takes the knowledge from, for example, a governmental context, to the business context. Additionally, the research links the models from multiple other researches into one model in the current research, which puts the existing models into perspective in the data sharing research field.

Next to being academically relevant, the research has also a societal relevance. Businesses miss out on value creation opportunities when they do not share their data. The interest in and need for sharing data has been recognised in the maritime industry (Bureau Veritas, 2020; Wärtsilä, 2020). This research provides a step in the direction of creating value for sharing business data in the industry, and it contributes to the body of knowledge about data (sharing) in a business context, which is useful for the digitalization of the maritime industry (Kraus et al., 2021). In the first place the research delivers a set of value creation opportunities that businesses involved in dredging fleet management or the maritime industry can exploit. Second, the research delivers a framework which these businesses can use to seek value creation opportunities for themselves based on their own in-house data. This framework may be suitable for other businesses as well, with few alterations. Third, the research highlights the creation of value which does not (directly) translate to monetary value, but rather to moral and social values. Examples these values are making the world more safe and environmentally friendly, which relate to the dredging industry, the maritime industry, the environment, and society as a whole.

1.7. Connection to the 'Management of Technology' Program

This research has been set up as part of the graduation for the Master's degree in 'Management of Technology' (MoT). The aim of this master program has been to learn to explore and understand how firms can use technology to design and develop products and services that contribute to improving business outcomes. Because this is a graduate thesis, it should align with the master program of MoT. To do so, the thesis should align with three criteria: it should report on a scientific study in a technological context; show an understanding of technology as a corporate resource or is done from a corporate perspective; and the research problem should be analysed through scientific methods that have been put forward in the 'Management of Technology' curriculum. The study that is reported in this thesis is about data sharing in the maritime industry, which is a scientific topic in a technological context. Second, this study looks at how business data sharing can be used to create value for a business in a corporate context, i.e. improve business outcomes. This means that the concept of data sharing is used as a corporate resource and that it is assessed from a corporate point of view. Thirdly, the research involved methodologies which have been discussed in the MoT curriculum, such as the literature review and the case study interviews. Having met the three criteria, the research can be considered to be in line with the MoT program.

2

Integrative Literature Review

2.1. Literature Review Introduction

As mentioned before, the research presented in this thesis is split into three main parts, being the literature review, the case study and the validation. In this chapter, chapter 2, the findings of the first part are presented. The sub-research question that is answered is: *What conceptual framework can be used to identify value creation opportunities through business data sharing in a business context?* The first objective of the literature review is to expand on the knowledge that was gathered in preparation to this research, which was discussed in chapter 1, and gain a better understanding of the literature that is already available related to the field of interest about (open) business data sharing. Second, the literature research helps to identify knowledge gaps between found literature in the particular field of interest. Having both the knowledge of what is known and what is not known helps to formulate the framework used for the case study and shows what needs to be paid attention to.

This chapter on the literature review first provides a detailed description of the methodology that was applied in order to conduct the review in the first place. Then, the results of the review are organised and presented, followed by a discussion on the findings. Lastly, from the results and discussion, conclusions that will lead to the design of the conceptual framework described later in subsection 2.4.1. This framework will be used in analysing the (open) business data sharing opportunities in the case study.

2.2. Literature Review Methodology

The method used for the literature review follows an integrative literature review approach (Snyder, 2019). This approach ensures proper selection of the most relevant literature and is suitable for assessing literature on a research topic that enables new theoretical frameworks and perspectives to emerge (Torraco, 2005). In general terms, the method used consists of a literature search, selection and analysis.

2.2.1. Literature Search

In order to find relevant literature, online databases (TU Delft repository, Google Scholar and Scopus) have been consulted. These platforms are databases which have gathered (mostly) academic literature which can be sourced. When searching using adequate keywords, these platforms provide the most relevant literature by means of their database algorithm. The keywords used for searching are matched with the title, abstract and/or list of keywords of the literature in the platform's database. Throughout the entire literature review, this approach of using keywords for finding literature is used.

To make sure that the keywords used are adequate, it is important to define more specifically which topics are relevant for this literature research. 'Maritime business data sharing' was the initial search. Although it is a good search, and it may result in relevant literature, it is too limited. To illustrate, the search term 'business data' does not distinguish public and private data, and therefore may not be a

sufficient search term on its own to get into the depths of how public and private business data sharing may be of value.

In order to grasp all relevant information from the different domains, the main fields of interest that overlap in this research are distinguished and segmented, to find specific information that, when combined, still spans a broad topic. Afterwards, the findings can be combined and overlap in information and limitations will become visible. The fields of interest in this research entail: open data, closed data, (open) business data, (open data) business models, maritime industry digitalization, maritime data and maritime fleet management data. From these fields of interest, and the prior found literature that lies at the base of this research (Gao & Janssen, 2022; Zeleti et al., 2016), the keywords were derived. An overview of the searches and keywords is provided below in Table 2.1.

Search No.	Keyword(s)
1	Open business data
2	Open & closed business data
3	Open data infrastructures
4	Government & corporate data differences
5	Data sharing benefits
6	Data Marketplaces
7	Data sharing risks
8	Maritime open data
9	Open fleet management data
10	Open vessel maintenance data

Table 2.1: Overview of searches and keywords

Not all literature was found through searching for keywords in the databases. Fundamental literature was also provided by supervisors of this thesis research. Dr. A.M.G. Zuiderwijk- van Eijk, first supervisor, is an associate professor and has a sophisticated background in open data research. The literature that she provided proved to be very useful. The last means of searching for literature was through backward snowballing (Wohlin, 2014). This method entails that additional literature is collected from the reference list of prior found literature.

2.2.2. Selection
Although the databases aim to provide literature most relevant to the search keywords, a large part of the results may not be sufficiently relevant to the research topic. Therefore, the literature that was found through the searches using the above mentioned keywords was narrowed down through manual selection, based upon various criteria. An overview of these criteria is given in Table 2.2. In the first place, the found literature had to be either in Dutch or English, in order to be interpreted. Any other language would hinder the literature from being interpreted correctly. The next step in filtering literature consisted of an initial quick-scan of the title, details and abstract. Literature that was not found relevant enough was aborted from the results. In a vastly developing technological context, it is important that information is not outdated. Therefore, the found literature was further filtered based upon a publication date not older than approximately 15 years. Exceptions were made however, when the literature would discuss fundamentals or when it would describe the current state of the art. Lastly, a criterion for the literature was that it either had to be peer reviewed or contain a sufficient amount (>15) of references to other articles. This secures a level of trustworthiness of the article.

In addition to the academic literature that was filtered from the databases, there were also some results that did not necessarily meet the criteria, but were still included in the literature review. These exceptions were made whenever the result regarded a report that was published by a government-, industry- or research institute. These types of results can strictly spoken not be regarded as literature, however they can be fruitful sources for definitions, historic data or findings from large scale researches, experiments or pilots. These types of sources were also specifically sought for outside of the systematic search methodology whenever there was a specific need for filling a gap of knowledge. The considered

sources have been put in the literature review results under 'Supporting industry reports' in Table 2.3.

No.	Selection Method	Criteria
1	Language	Dutch, English
2	Date of publication	<15 years old
3	Credibility	Peer reviewed or >15 references

Table 2.2: Selection Criteria

2.2.3. Analysis

After the literature had been selected for review, the articles were thoroughly read through and key topics were noted down. In total, there were approximately 25 articles that have been assessed, and this number was narrowed down to 13 articles, that have taken up in the results of this review. The remaining literature was sorted and grouped according to the general theme that they discuss. These themes broadly reflect the most important components of the conceptual framework to identify a companies opportunities for data sharing, which is constructed in subsection 2.4.1. The final results of the literature search are presented in Table 2.3 and elaborated on in section 2.3.

2.3. Literature Review Results & Discussion

Through the selection methods of the literature review, around 25 articles and reports were found. Upon reading, only the most relevant articles and reports were included in the final results in Table 2.3. The relevance was based upon whether or not the article or report would be of help in creating the conceptual framework for identifying data sharing opportunities for businesses. Four main themes have been found in multiple articles which are of importance for businesses when considering to share data. These themes are 1) defining data sharing, 2) creating and capturing value through data sharing in business models, 3) deciding whether or not to share data based upon perceived benefits and risks, and 4) facilitating data sharing. In some cases, articles discuss multiple themes. The themes and further content of the results of the literature review are discussed below in this section.

2.3.1. Data sharing definitions

In this section, the literature that relates to the theme 'data sharing definitions' is discussed. In the research field of data sharing, there are a number of degrees of data sharing. These degrees of data sharing are clearly illustrated on the data sharing spectrum which is set up by the Open Data Institute (Open Data Institute, 2022). The spectrum varies from private or closed data, which is not shared at all, to completely open data, which can be accessed by anyone at anytime. Figure 2.1 displays a spectrum of data which is used in this research for defining shared and open data. It is based upon the data spectrum which was set up by the Open Data Institute. (2022). To illustrate the types of data, examples are provided within the figure, such as employee contracts or a bus timetable. The figure also indicates the typical data type that is related to the degree of sharing. As previously mentioned in the introduction chapter, chapter 1, the objective is to find out how data sharing can be used to create value in businesses. For companies, the assumption is made that keeping data private is the conservative, safe and default option, and going as public as possible with the data is what is strived for to unlock the potential positive effects of openly sharing data that were mentioned in chapter 1. When concessions have to be made in terms of openness, due to for example commercial interests, a company can then take a step back on the data spectrum and choose for a data sharing type that limits the access in some way.

Although the data spectrum seems to clearly put the definitions of closed data, shared data and open data into perspective, there still is ambiguity regarding the definitions of 'open data' (Open Knowledge Foundation, 2022) and terms related to 'open data' across the literature (Enders et al., 2020). This has become clear from various sources and was pointed out by Zuiderwijk for terms like 'Open Government Data' (OGD) and 'OGD Infrastructures' in a government context (2015). This has led to researchers establishing their own definitions, based upon findings in their research (Zuiderwijk, 2015). In the Open Data Handbook, as set up by the Open Knowledge Foundation, open data is defined as: *'... data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to*

LITERATURE REVIEW RESULTS		
Title	*Reference*	*Topics*
Data sharing definitions		
Open data infrastructures	(Zuiderwijk, 2015)	Open data, Infrastructures, Coordination
Knowing what to share: selective revealing in open data	(Enders et al., 2020)	Open data, Selective Revealing, Data Sharing
Business data value creation & value capture		
Exploring the economic value of open government data	(Zeleti et al., 2016)	Open data business models, Open data industry, Open data value
Capturing value from data: Exploring factors influencing revenue model design for data-driven services	(Enders et al., 2019)	Big data, Business model
The open data canvas - Analyzing value creation from open data	(Gao & Janssen, 2022)	Open data, Value creation, Business model canvas
Benefits & Risks: Decision models		
Knowing what to share: selective revealing in open data	(Enders et al., 2020)	Open data, Selective Revealing, Data Sharing
Towards decision support for disclosing data: Closed or open data?	(Zuiderwijk & Janssen, 2015)	Open data, Decision support, Trade-offs
Data sharing organization & influencing factors		
A systematic review of open government data initiatives	(Attard et al., 2015)	Open data, Government data, Data portals
Business data sharing through data marketplaces	(Abbas et al., 2021)	Data markets, Business data sharing
The open data canvas - Analyzing value creation from open data	(Gao & Janssen, 2022)	Open data, Value creation, Business model canvas
Open data infrastructures	(Zuiderwijk, 2015)	Open data, Infrastructures, Coordination
Innovation with open data: Essential elements of open data ecosystems	(Zuiderwijk et al., 2014)	Open data ecosystem, Infrastructure
Supporting industry reports		
Study on data sharing between companies in Europe	(European Commission et al., 2018)	Business data sharing, Data re-use, B2B data sharing
Expert paper: B2B data sharing	(ERT, 2021)	B2B data sharing, Value creation, Risks, Organisation
Exploring data sharing obligations in the technology sector	(Ecorys et al., 2020)	Data value, Data sharing, Data sharing Legislation

Table 2.3: Literature Review Results

attribute and sharealike' (Open Knowledge Foundation, 2022). It must be noted that 'freely' does not entail that there is no monetary compensation. This monetary compensation should not be more than the reasonable production costs of the data. In a commercial or corporate context however, organisations sometimes dilute this definition and e.g. limit the usage of their openly published data through licenses, whilst still referring to it as 'open data' sharing (Enders et al., 2020). Strictly taken, this 'openly' shared data should be referred to as shared data according to the data spectrum in Figure 2.1.

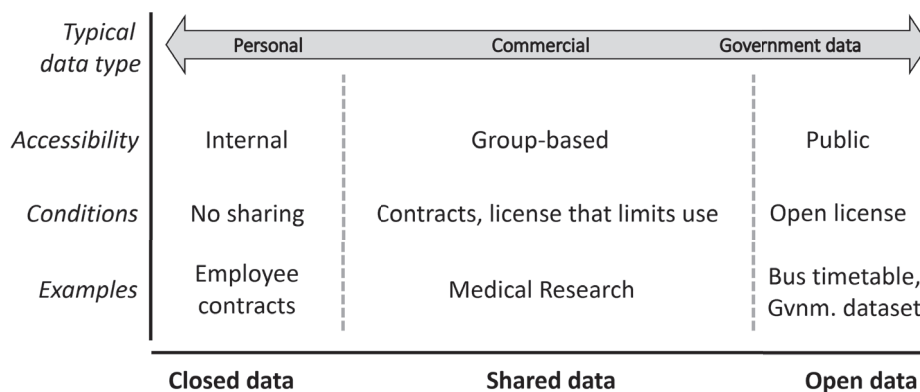| *Typical data type*	Personal	Commercial	Government data
Accessibility	Internal	Group-based	Public
Conditions	No sharing	Contracts, license that limits use	Open license
Examples	Employee contracts	Medical Research	Bus timetable, Gvnm. dataset
	Closed data	**Shared data**	**Open data**

Figure 2.1: Data spectrum used for this research based on the data spectrum set up by the Open Data Institute (2022)

For clarity purposes, in this research, the definition for 'open data' in a business context is taken as stated above by the Open Knowledge Foundation. Other data that is shared with any sort of limitation is referred to as 'shared data'. For the typology of this 'shared data', the Data Spectrum is consulted.

2.3.2. Business data value creation & value capturing
This subsection discusses the theme of value creation from data and how this value can be captured. Data is often a byproduct of primary activities in a business which is collected through e.g. sensors. In the first place, data can be used internally in businesses to optimize processes and improve decision-making (Lavalle et al., 2011). Business models can be shifted to be more data-driven. Real-time data collected from machines could for example be used to shift from periodic and reactive maintenance towards predictive or condition based maintenance, in order to lower downtime (Lazakis, Raptodimos, et al., 2016; Yang et al., 2008).

Next to the value created from internal data usage, additional value can be created through openly sharing such data. Open data sharing increases transparency towards stakeholders (Bertot et al., 2010), which has a positive effect on trust. It also fuels collaborations with other parties (Bertot et al., 2010) and may result in new insights that are provided by these other parties as they have another point of view on the data (Ribes & Polk, 2014). Additionally, the value created from sharing data knowledge does not only have to do good to the data provider itself, but it may also increase social welfare in an entire ecosystem, by e.g. fuelling innovation (Harhoff et al., 2003). Apart from these relatively indirect benefits of sharing data, there is an interest in how to drive business from data sharing, from a business perspective. In the literature, articles have been found that identify the value components of the business models that lie at the heart of various types of data sharing businesses (Zeleti et al., 2016). Additionally, literature has been found on capturing the added value that is created through data sharing (Enders et al., 2019). Lastly, an open data canvas has been found that is helpful for acquiring an overview of value creation from open data (Gao & Janssen, 2022).

A companies business model reflects how value is created and how it is captured, based upon decisions and its consequences (Lambert, 2008). Zeleti et al (2016) considered 15 existing Open Data Business Models (ODBM's) and assessed the value related processes through their 6V (value) model conceptual framework. These open data business models do strictly speaking not all adhere to the 'open data' definition, but are rather considered to be based upon 'shared data' in this research. This

changes the name to Shared Data Business Model (SDBM). With the 6V framework, the components and characteristics related to the 1) value adding process, 2) value in return, 3) value capture, 4) value management, 5) value network and 6) value proposition were identified for each of the SBDM's. Having these components and characteristics known, makes the 6V model a suitable tool to compare a regular businesses business model with those of the SDBM's. In this way, a business can identify business data sharing opportunities that fit their existing business model. Additionally, businesses can see what components or characteristics are required to change or add in their business model to implement an envisioned SDBM.

Apart from enjoying the indirect benefits of (openly) sharing data that were mentioned at the beginning of this section, it would be beneficial for a company to also directly benefit from sharing data in terms of revenue. Although generating a revenue from sharing data (which is higher than the cost of producing the data) is not in line with the definition of 'open data', it is of interest to businesses to explore how revenue can be generated from data sharing. Commercial businesses are there to make a profit after all. Enders et al (2019) have researched what factors influence the revenue model design for data-driven services that complement existing product and service portfolio's of businesses. Such a revenue model is the means of monetizing the value capturing component of the business model. Four main influencing factors on the revenue model design are service characteristics, provider interests, customer interests and market factors. One type of service characteristic, is the usage pattern. If data is provided continuously through a dashboard for example, a pay-per-use mechanism would not make sense and a subscription based pay mechanism would be more suitable. Another characteristic is whether the data sharing service is part of another offering, or whether it is standalone. If it is a supplement to an existing offering, it may be sold as an added feature or be embedded it in the core offering. It is in the interest of a data provider that they generate a stable and continuous revenue, and therefore a subscription mechanism is suitable. In the interest of a customer, a performance-based mechanism would be best as they only pay in case of success. In finding the right revenue mechanism, trust between suppliers and customers is important and a supplier should always keep the customers interest in mind. Lastly, market factors also influence revenue design. For example, when collaborating with other partners in an ecosystem (e.g. one that moves towards an open data ecosystem), it is important to align the revenue mechanism with the partners. There may even already be an industry wide standard which competitors, partners and customers are used to. (Enders et al., 2019)

Figure 2.2: The data sharing value canvas inspired by the open data value canvas by Gao & Janssen (2022, p. 7)

While Zeleti et al (2016) and Enders et al (2019) consider business models based upon any type of data sharing, Gao and Janssen (2022) have created an open data value model canvas. This canvas is based upon the business model canvas, as created by Osterwalder & Pigeuner (2010), and has been modified with open data value creation in mind. The strengths of this open data canvas are to create an overview of various data sources from public and private organisations, combine heterogeneous data and to connect data and needs. It helps to better understand the required resources and the value creation process from a data-user perspective. The canvas shows that the open data utilization process relies on 11 components: the value proposition, data providers (data source), infomediaries, activities, resources, channels, partners, costs (efforts), data users, private benefits and public values. Specifically for open data value creation, the role of infomediaries has proven to be important. These infomediaries extract, aggregate and transform the open data. They make sure the data is of quality and usable. In terms of usability, this open data value canvas has only been used in one case study, and using it in an new case study like in this thesis contributes to the development and rigidity of the canvas. Because the current research considers both shared and open data in a business context, an adjustment has been made to the data canvas of Gao and Janssen. The business context brings about risks for the company which is looking to share their data, and therefore these risks should be assessed and accounted for. The result is the data sharing value canvas which is depicted in Figure 2.2.

2.3.3. Benefits & Risks: Decision models

In this subsection the benefits and risks of (openly) sharing data are discussed. More specifically, ways of deciding whether or not to share data are presented. Can the benefits outweigh the risks and how can these risks be mitigated? While revealing data sparkles new opportunities, companies also run the risk of exposing too much knowledge and hence a careful consideration between revealing a protecting data must be made (Hallberg & Brattström, 2018; Henkel, 2006). From the literature review, two articles have been found which provide support for deciding which data is suitable for sharing. Enders et al (2020) have created a decision model for businesses for selecting which data to share. Zuiderwijk & Janssen (2015) have done the same in a seperate research for government data. The findings from these articles are discussed below.

Selective revealing is described as the voluntary, purposeful and irrevocable disclosure of selected pieces of knowledge, which the business could have chosen to keep proprietary (Enders et al., 2019; Henkel, 2006). Whether or not a dataset is suitable for sharing depends on three main groups of concepts, being dataset metrics, decision criteria and macro-level factors. Dataset metrics refer to the characteristics of the dataset, decision criteria guide the decision-making process and macro-level factors describe influences from outside of the firm. A detailed overview of the dataset metrics and decision criteria is provided below in Table 2.4. The dataset metrics are coreness, currentness, extent, granularity, interoperability and quality. Criteria for deciding whether or not to share a dataset are the impact on competitiveness, chances of data misappropriation, the innovation opportunity, legal risks and privacy risks.

The concepts that are described in Table 2.4 are useful in deciding whether or not to share a given dataset. The concepts, however, have only been found through literature research which only evaluated a subset of the available literature and therefore only form a basis for the decision-making process, which goes as follows: A well defined dataset is the starting point for which the metrics are evaluated. Based upon these metrics, the criteria are assessed. After this assessment, a final decision is made on whether or not to share the data. In case of not publishing the data, it is an option to modify the dataset and re-evaluate. This decision-making process is embedded in an organisation, and the outcome should align with the policy of the organisation. A schematic overview of the decision-making process is given below in Figure 2.3.

A downside of the model in its current form is that is that it lacks detail in the concepts for practical implementation. A way of learning more about the practical details of the concepts is by conducting a case study in which the model is used and where practical implications are imposed. That way, the model can be improved.

Dataset Metrics	Description	Decision Criteria	Description
Coreness	How related is the data to the core business	Competitiveness	Risk of negatively impacting the competitive position
Currentness	How recent is the data	Data Misappropriation	Risk of data being misused or misunderstood
Extent	What fraction of a dataset is shared	Innovation Opportunity	Potential benefits in innovation
Granularity	The amount of detail in a dataset	Legal	The risk of violating legal restrictions
Interoperability	How well the data can be processed and exchanged by software or computer systems	Privacy	Risk of privacy infringement
Quality	Level of completeness and accuracy		

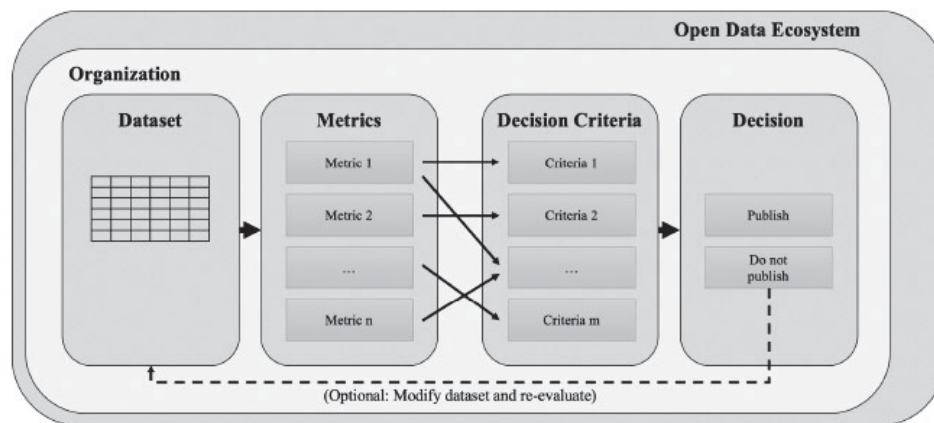Table 2.4: Data sharing decision concepts retrieved from Enders et al. (2020)

Figure 2.3: Data sharing decision-making process model by Enders et al. (2020, p. 6)

Another model which helps to decide whether or not to share a given dataset was constructed by Zuiderwijk & Janssen (2015). Based upon contextual and dataset related variables, they have come up with potential positive effects and potential risks for each variable. There are seven variables in total, which are about the data ownership, the embargo period, the objective to publish data, the data access and licensing, the data sensitivity, the data quality, and the metadata. If datasets are owned by multiple organisations, the positive effect may be that these datasets are interesting because they combine various insights. This may however pose the risk of having no clear responsible and accountable entity, and asking permission for publishing all data can be difficult. With regard to the embargo period, releasing less current datasets has the positive effect that risks of opening data are reduced. The downside is however that the data may be less useful. If a company were to publish data to become more transparent, then this may lead to more insights from external parties on how business processes can be improved. The downside is that the company risks sharing too much data in a wrongful way which leads to bad publicity. With regard to data access and licensing, data access can be restricted to specific groups which gives the benefit of having more control over the data use and mitigate data misuse. This does however also limit the amount of people who can access the data and thus decrease the changes of creative reuse of the data or new insights. With regard to data sensitivity, a restrictive policy could be adopted. This reduces the risk of negative publicity and privacy infringement, and increases the amount of datasets that can be published because the privacy sensitive parts are filtered out. This filtering however also implies bias, because not all data is shared. Additionally it is difficult to determine the sensitivity of datasets. With regard to data quality, it is an option to have no quality

control over the datasets. The public can judge the quality themselves and improve it. This does however greatly depend on the input of the public, and without a quality guarantee, decisions and conclusions may be drawn from low quality datasets. Lastly, with regard to metadata, it is an option to have as little meta data as possible such that data can be shared through relatively simple systems. The downside however, is that data may be misinterpreted and more difficult to use.

Although this decision-making model is aimed at disclosing open government data, it is also useful in a business context. This is because themes such as data sensitivity, and data quality are discussed as well. Moreover, this article has used a more broad (and less strict) definition of open data, since data access and licensing are considered as well. With both the positive and negative effects in mind, a trade-off can be made on whether or not to publish data. This model is suitable for evaluation of the benefits and risks of sharing data in practise, when the contextual variables that have been discussed arise.

2.3.4. Data sharing infrastructure

This subsection discusses the literature found on data sharing infrastructures. In the open data value canvas, key components of such an infrastructure have already been discussed, but more literature has been found which relates to how data sharing can be organized (Abbas et al., 2021; Attard et al., 2015; Zuiderwijk, 2015; Zuiderwijk et al., 2014).

Zuiderwijk (2015) stated that there are three functional elements that enhance the use of open government data: proper metadata, interaction mechanisms and quality indicators have a positive effect on the use of open data. Metadata makes finding the data easier; the interaction mechanisms easen interaction with the data and quality indicators easen the quality analysis of the data. These functional elements are aimed at fulfilling the 28 functional criteria for the open data infrastructure which were set up in the research. Fulfilling these criteria through the functional elements easen searching and finding open data, analysing open data, visualizing open data, interacting about open data and quality analysis of open data. An overview of the 28 functional requirements and use categories can be found on pages 112-113 of the dissertation (Zuiderwijk, 2015). For the business perspective, specific criteria and the related functional elements can be selected from this research to be taken into account when designing an (open) data sharing infrastructure for a company or an entire sector or industry.

Abbas et al (2021) have shown in their article that the current state of the art research into data sharing marketplaces (or data sharing infrastructures) mainly has focused on the technical aspects of setting up such a marketplace. Non-technical aspects have been studied far less. When looking at the lifecycle of a platform, many platform projects are stuck in the first phase with the innovators and the adoption phase does not come about due to (non-technical) practical problems. Examples given are defining data ownership, assessing data quality, lacking legal frameworks, lacking expertise and resources to operate a data sharing infrastructure and an unclear organisational structure. Knowing that these challenges are yet to be tackled is helpful because it shows what the focus should be put on in a framework of analysis for organizing data sharing between businesses.

In order to get a better feeling of what a (open) data sharing infrastructure or ecosystem looks like, a closer look can be taken at the elements of an open government data ecosystem which were identified by Zuiderwijk et al (2014). These elements have been put in an overview in Figure 2.4, accompanied with an example of each element. The elements are grouped into the data producer level, the data user level and the tools & services that are used by the producers & users. The model can be consulted by businesses when assessing how to enable data sharing and what elements are required.

As can be seen from the previously discussed literature, there is a lot of attention for open government data infrastructures, from which businesses can learn as well. Worldwide there are many initiatives scattered around that separately have focused on sharing government data openly. Attard et al (2015) have conducted a literature research on the open government data initiatives that exist around the world. From this research it became apparent that there is not one way to go about setting up such an initiative and that there is also not one agreed upon way of evaluating the performance of the initiative. Attard et al introduced the open government data lifecycle, which describes the path that a particular dataset takes. Additionally, they provided an overview of the most common challenges in open government data intiatives.
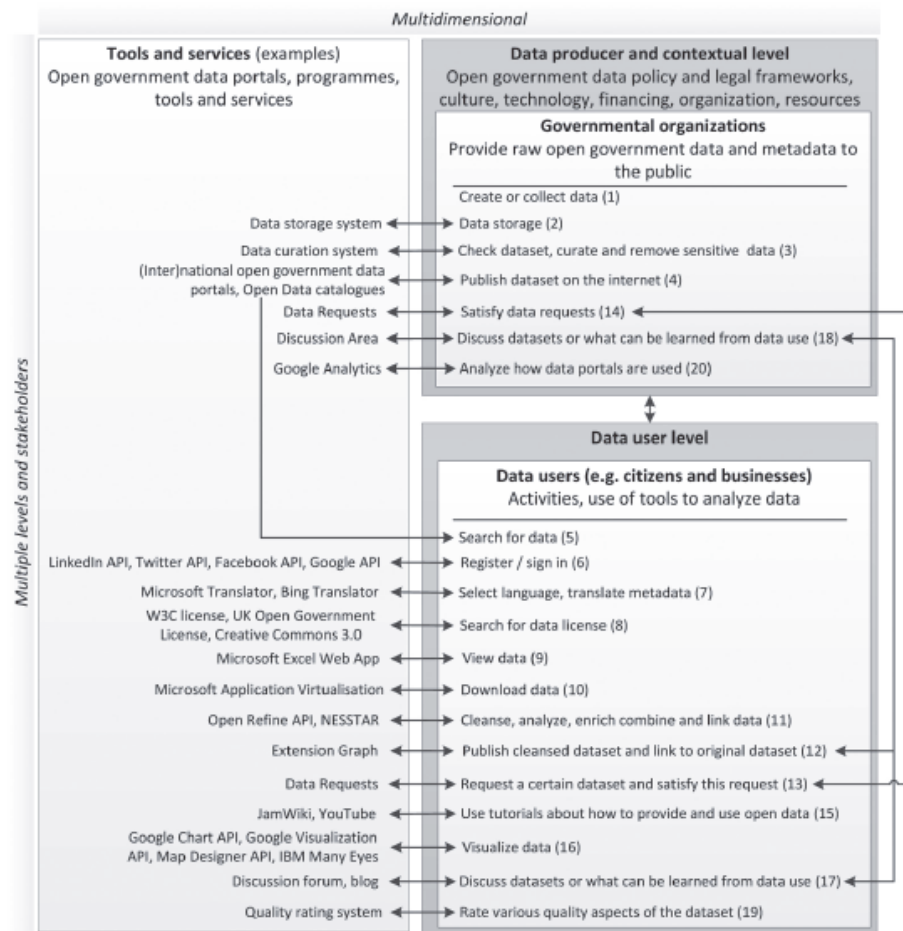
Figure 2.4: Essential elements of an open government data ecosystem by Zuiderwijk et al. (2014, p. 26)

2.4. Literature Review Conclusions

From the reviewed literature it has become apparent that data sharing is still in an infant state in businesses. The models that have been found in the literature are still general and abstract, and have only been tested to a minor degree or in contexts other than a business context. It has been recommended by researchers to further develop and test the constructed frameworks (Gao & Janssen, 2022). Additionally, the frameworks describe decision making, value creation and infrastructure design separately, rather than relating the themes to each other. It can be concluded however, that these themes are indeed related. There are points of contact between the different models where subjects overlap or follow-up on each other. This allows for merging the frameworks together into one conceptual framework which can be used to identify the value creation opportunities through business data sharing. There are four main models from the literature that have been modified and merged together to form the framework . The data sharing decision-making process model by Enders et al (2020, p. 6) forms the basis. The decision criteria for data sharing have been supplemented with the value assessment from Zeleti et al (2016). In the original decision model there was only one benefit considered (an innovation opportunity), whereas now there is the possibility of considering multiple value propositions. After deciding whether or not to share data, the framework used the model from Zuiderwijk et al (2014, p. 26 to identify key elements to facilitate data sharing. At last, the modified data sharing value canvas inspired by Gao & Janssen (2022, p. 7) provides an overview of the key requirements, elements and players for extracting value from sharing a particular dataset. The new conceptual framework is the answer to the sub-research question *What conceptual framework can be used to identify value creation opportunities through business data sharing in a business context?* The framework itself and how to use it is described below in subsection 2.4.1.

2.4.1. Conceptual Framework

This section describes the conceptual framework that has been set up based upon the concepts and models that have been found in the literature review. The framework is depicted below in Figure 2.5. This conceptual framework aims to help businesses identify opportunities to (openly) share their data. Identification of these opportunities is done through assessing the value proposition, benefits, risks and infrastructural needs of sharing business data that is available at the company. In the last step of the framework, the open data value canvas is filled it. This canvas gives an overview of all the elements needed to create value from sharing data.
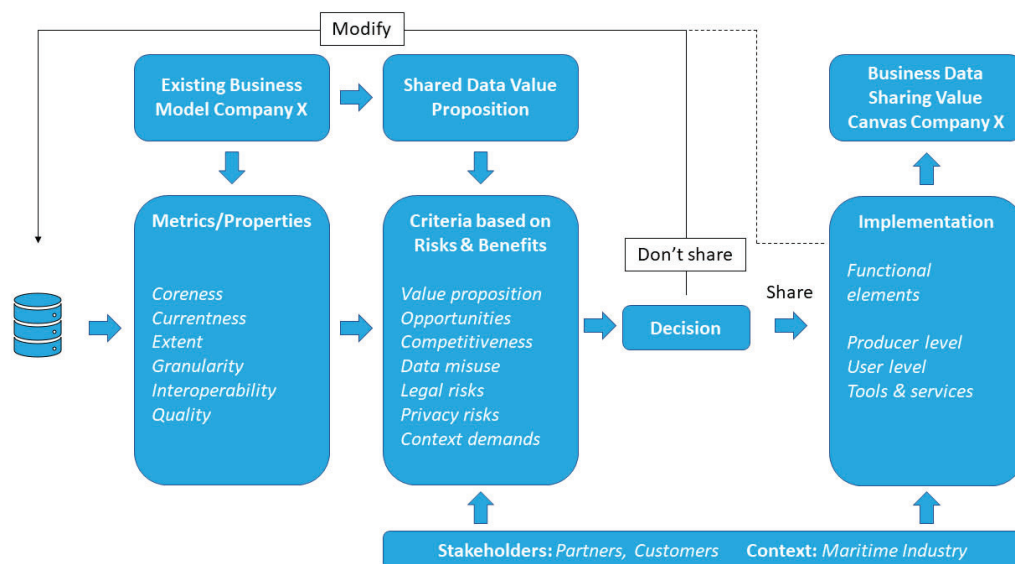

Figure 2.5: Conceptual framework based on literature

The framework works as follows: first, the data from company X is described based on its metrics. This can be done by relating the data to the existing business model of company X. The coreness, currentness, extent, granularity, interoperability and quality can be described. Next, the value proposition of sharing the data is assessed. This value proposition is sought for in shared data business models and corresponding revenue models. When the value proposition is assessed, the criteria for sharing the data can be checked. These criteria have been set up beforehand and are based upon the value proposition (and innovation opportunities) and the risks that go with sharing the data. Examples of risks relate to the competitiveness, data misuse, legal issues, privacy issues and contextual demands. The criteria are also influenced by the stakeholders and context of company X. Therefore, the stakeholders related to company X and the context of company X have to be identified too.

After checking the criteria for sharing the data, a decision can be made on whether or not to share the data. If the decision is made to share the data, the requirements for implementation can be assessed. If the decision is made to not share the data due to a specific property, the data can be modified and re-evaluated. It is also possible that the data is simply not suitable for sharing, and it is therefore not done.

Whenever it is decided that certain data can be shared, practical implications for implementation can be set up. In this step, an infrastructure for sharing the data is set up. This infrastructure contains in principle the functional elements, and can be at both a producer and user level. This step, too, is influenced by stakeholders related to company X and the context of company X. When the contents of all parts of the framework have been assessed, a complete overview of the value proposition and what is required to capture that value can be created by filling in the business data sharing value canvas.

As can be seen from the framework, it is a rather universal set-up. When applying it to a company's data, there are a few things that need to be prepared and tailored beforehand. It is important to have a decent knowledge about the company's existing business model, the data that the company has, the

value proposition of sharing data which fits the existing business model, the criteria which are important to the company and the practical implications for data sharing. In chapter 3, the framework will be tested at a company. The required background knowledge is then harvested to enhance the framework and make it ready for assessing the value creation opportunities through business data sharing at that company.

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Case Study Findings

3.1. Case Study Introduction

This chapter describes the exploratory case study that has been conducted to apply and test the conceptual framework that was set up in subsection 2.4.1. The case study is aimed at answering the second sub-research question: *What are the data sharing value creation opportunities in dredging fleet management applications in the maritime industry?* The information for the case study is collected at a dredging company that operates in the maritime industry, which has limited experience with data sharing. Possibly there are value creation opportunities such as increasing trust from stakeholders or gaining new insights. The chapter starts with the case study protocol, in which the methodology for the case study is described. This includes an overview of the case study, the data collection procedures, protocol questions and a tentative outline for the case study report. After the case study protocol, the results which are derived from the case study are presented and discussed in parallel. Because this is a qualitative research and the results have been acquired through interviews, the results and discussion are combined. Based upon the findings of the case study, both the value creation opportunities for the company and and the points of refinement for the framework are concluded.

3.2. Case Study Protocol

In order to increase the reliability of case studies in general, Yin (2018) advises to use a case study protocol. It is a rigid protocol which prescribes how the case study is executed. This section elaborates on the protocol that has been used in this particular case study. This protocol has been written from a contemplative point of view and can be used as a guide for replicating the research. As mentioned before, the case study protocol includes an overview of the case study, the data collection procedures, the protocol questions and the tentative outline for the case study report.

3.2.1. Case Study Overview

This case study overview gives an impression of the goals of the case study and background information about the company at which the case study is held. The subject of (open) data sharing and the conceptual framework have been extensively discussed in chapter 2, so no further background information about that is needed. The case study approach has been chosen for this research about (open) data sharing because it is a relatively new topic in a business context, while it has been adopted successfully in government and research contexts. Through the case study, answers can be found for why (open) data sharing has not been adopted in businesses the same way as in the other contexts. More specifically, the business context in this case study is that of a dredging company which operates in the maritime industry. Next to learning what is peculiar about this business context, opportunities for (openly) sharing data can be explored in the case study. This can be done by using the conceptual framework which was constructed in subsection 2.4.1. In turn, the conceptual framework can be tested and refined based upon the case study.

Case study company background

As said before, the case study is held at the dredging division of a company that operates in the maritime industry: Royal Boskalis Westminster. Boskalis is a listed Dutch company that specializes in dredging and heavy lifting for offshore and maritime infrastructure. Worldwide, Boskalis operates in over 75 countries and has almost 10,000 employees. Their fleet consist of about 700 vessels in total. (Boskalis, 2022b) Fleets of such size require proper fleet management.

Because Boskalis is so large, the case study could only focus on a part of the company. It has been executed at the fleet management department at the dredging division of Boskalis. Therefore the findings in the case study are mostly focused on, but not limited to, this department. The main objective of fleet management at the dredging division is to achieve optimal performance, in which costs are minimized and availability is maximized. In other words, the fleet management department makes sure that the vessels stay operational. Underlying activities of fleet management therefore include maintenance, compliance and crewing. Maintenance is done on the vessels, compliance is about making sure that certificates and inspections are in order for the vessels, and crewing is about making sure that everything is in order regarding personnel. Because the dredging fleet is so large, these activities have been divided over different teams who are each responsible for a different part of the dredging fleet. Next to these teams, there is an overarching fleet management team, compliance team, human resources team and a maintenance team.

One can imagine that in all activities of a fleet management, a lot of data is generated. This data is safely held private (for the most part) and only used for internal day to day operations. An example of this data is condition data which is collected by sensors on the vessels. A vessel is covered in sensors and therefore capable of generating heaps of data. This data, however, is not always collected and used to its fullest potential. There are limitations of technical and organisational nature. One of the interests of fleet management is to optimize maintenance practises. Chances of failure of a vessel can be minimized through timely maintenance, making the fleet more reliable. A solution to do so is by decreasing the maintenance and inspection interval. Current maintenance practises are based upon prevention, but Condition Based Maintenance (CBM) proves to be useful for more efficient maintenance (Dikis et al., 2015). This can potentially be done by making use of the generated data. Leaving this data unused is a waste of the potential value it holds. This value can be captured by processing the data internally, or even by sharing it externally.

Within Boskalis, there have already been initiatives and projects that explore the potential of sharing data. These efforts, however, were focused on internally sharing data. Because Boskalis is so large, it is split into divisions and business units. Data exchange between these units can be challenging already, as was mentioned during the case study interviews. Projects like these may count as prior experience with 'open' data sharing, however these projects lack the competitive element which external open data sharing has in a business context. Truly external (open) data sharing initiatives hardly exist. The data that Boskalis is truly open about is the data which they are obliged to share due to the fact that they are a listed company. This entails data which is put in the yearly reports that Boskalis has to publish on their website (Boskalis, 2022c). This includes e.g., the annual report, the sustainability report and financial statements.

3.2.2. Data Collection Procedures

This subsection describes how the data was accessed, what resources were used and how the data was handled security-wise.

Resources

To conduct the case study properly at Boskalis, I, the researcher, had access to the main office. This is because the research was combined with an internship at the company. This has been very convenient as there was easy access to resources. To collect information about the case study, multiple resources were consulted. These resources were public Boskalis websites, private Boskalis intranet portals and employees from Boskalis. Boskalis' website was useful for general background information about the company, its practises and statistics. Boskalis' intranet portals were helpful for learning about business processes. The employees were useful for conducting interviews to gather insights about (open) data

sharing from different perspectives within the company.

Physical resources which were used in the case study include a company workstation, company laptop, pen, paper, figures found in the literature (chapter 2), a phone and a private office space. The company was used to access the company network. The phone was used to audio record the interview for later processing. The figures from the literature were used as part of the interview questions. The private office space helped the interviewer and participant to focus on the interview without any auxiliary disturbances.

Data collection activities

The collection of data from the website and intranet has been done over an extended period of time from February 2022 till June 2022. This was done at need and did not need to be planned in advance. At the beginning of this period, I also did a short introductionary training which explained about the company and the dredging activities. This gave a head start on background knowledge about the company.

For collecting data through employees of Boskalis, and more specifically from the dredging division, interviews were set up. These interviews were held over a timespan of two weeks. An interview protocol was first set up for these interviews, which is discussed below in subsection 3.2.3. The participants, all employees at Boskalis, were selected for the interviews based upon their role at the fleet management department within the dredging division and/or whether they are involved with activities related to data sharing. Therefore, the participants were gathered from fleet management, IT and data science. In this research, the participants are the unit of observation and Boskalis as a company is the unit of analysis. In total 9 participants have participated in the interviews. An overview of the participants and their role is provided in Table 3.1. Each of the participants was first approached at the office, via email or via phone in order to give them a short introduction about the research and ask them if they would like to participate in an interview. If they were willing to participate, an appointment was made of approximately 1.5 hours to conduct the interview. The participants were sent the informed consent form in advance, which is elaborated on in Table 3.2.2. Additionally, to save time during the interview, the participants were sent the first questions of the interview protocol to prepare and possibly answer via email. These questions were about the company and background of the participant, which are easy to answer via email and do not require back and forth interaction with the interviewer.

Participant	Role
1	Maintenance Manager
2	Maintenance Manager
3	Fleet Manager
4	Fleet Manager
5	IT Manager
6	Fleet Manager
7	IT Manager
8	Knowledge Manager
9	Data Scientist

Table 3.1: Interview participants

As the participants have very busy business agenda's, it did occur that a participant had to cancel the interview. In those instances, a new appointment was made as quickly as possible. If a participant was not able to get to the office on the day of the interview, the interview was conducted online via Microsoft Teams. When an interview ran out of time, an additional meeting was scheduled to finish the interview.

The interview was conducted as follows: before the interview a private office space was claimed. The interviewer (me) and the participant first got to know each other informally. In combination with the interview being held at the office (most of the time), this puts the participant at ease. Afterwards, the interview was started and conducted according to the interview protocol (subsection 3.2.3). From this point onward, the interview was audio recorded in order to process and analyse it at a later stage. During

the interview, notes were made which were helpful in processing the collected data. After the interview, the audio recording was stopped and uploaded to the TU Delft OneDrive. These audio recordings were then reviewed and, in combination with the notes, used to make summaries of the interviews. These summaries can be found in Appendix B.

Data management & security

Correctly handling the data is important for the privacy and security of participants. For example, it is undesirable that statements from participants are misinterpreted or are used against them. To mitigate risks like this, the TU Delft has set up a Human Research Ethics Committee (HREC) to safeguard the privacy of humans in research done at the TU Delft. For the current case study, a HREC application was addressed to this committee and subsequently approved. The application consists of a checklist which states the possible risks and according mitigation strategies, the informed consent forms and a Data Management Plan (DMP). In short, the raw data (audio recordings) is only stored at the TU Delft OneDrive, and can only be accessed by the researcher (me) and the project supervisors. After the research, this data is destroyed. The interview summaries are anonymized and made available for review by the participants.

3.2.3. Interview Protocol

The actual content of the interviews has been laid down in the interview protocol (Appendix A). This protocol prescribes how the interview is conducted and what questions are asked. The purpose of the case study is to answer the sub-research question *What are the data sharing opportunities in dredging fleet management applications in the maritime industry?* In order to answer this question, the interviews must deliver answers regarding the business context, the business data of the company, the potential value of sharing this business data, the decision criteria for sharing this business data and the tools or instruments that are required to facilitate the sharing of business data.

Based on these topics, the interview protocol has been divided into parts: company & participant background information, business data, business data sharing value, decision criteria based on benefits & risks, and data sharing implementation. These topics form the core of the interview: Hidden between these questions is the overarching concrete question about what value creation opportunities there are by sharing business data. Prior to the questions, an introduction about the research and interview is given. After the questions, the participant is thanked for his/her participation. At this point, the participant can add final remarks and state whether he/she wishes to receive the final thesis report when the research is finished. The detailed interview protocol can be found in Appendix A.

3.2.4. Case Study Report Outline

Planning how the results are presented speeds up the analysis process of the results. Therefore the way in which the results of the case study are presented is prescribed in this case study report outline. Firstly, in the results the documentation that has been gathered in the case study is presented. This sort of information is mostly not discussion worthy, however it may be useful for further research or replication to have it at hands. Secondly, the results from the interviews are presented. The full summaries of the interviews are put in Appendix B and only the key findings are included in the results. Because this is a qualitative research and the interview results have been obtained through interactive discussions with the participants, the results are simultaneously discussed. The interview questions were bundled into five topics beforehand and the results are discussed accordingly. In addition to these results for these topics, an overview of the concrete (open) data sharing opportunities is presented and discussed. In the conclusion, the sub-research question is answered and infrastructural and institutional instruments are identified.

3.3. Case Study Results & Discussion

As mentioned previously, the results include both documentation found on the internet and findings which were harvested from the interviews. In this section, an overview of the found and used documentation is presented. Additionally, an overview of the findings from the interviews is given per topic. The full summaries of each interview can be found in Appendix B.

3.3.1. Documentation Results

The case study has resulted in multiple documents which were found on the company's website or mentioned by participants in the interviews. These documents include annual reports, sustainability reports, fact sheets about equipment and project reports. The annual report contains information about the strategy of the company and the financial statements. The sustainability reports contain information about how the company performs and aims to meet sustainability goals. The equipment fact sheets contain basic non-core metrics and facts about equipment such as vessels. The project reports contain project features, activities, challenges and more related to the project. An overview of the documentation is provided below in Table 3.2.

No.	Document type	Source
1	Annual Reports	(Boskalis, 2021a)
2	Sustainability Reports	(Boskalis, 2021b)
3	Equipment Fact Sheets	(Boskalis, 2022b)
4	Project Sheets	(Boskalis, 2022a)

Table 3.2: Overview of documentation results

3.3.2. Interview Results & Discussion

The interviews have provided insights from various points of view within Boskalis. People from management, IT and data science have shared their insights. Some of the results have contributed to a better understanding of the business context, and have already been adopted in the case description. Other results were directly related to the topic of (open) data sharing.

Company background

The company is originally a dredging company but has expanded its activities with offshore services, towing, heavy transport and salvage. The dredging fleet management department is responsible for vessel maintenance, crewing, vessel performance, compliance and support to other business units within the company. The added value of the company's activities for the client are delivering projects from A-Z. The company operates in the high-end market and delivers quality at a competitive price. Next to that, the company aims to build in harmony with nature as much as possible. The company works with various partners, such as suppliers of equipment, building materials and IT commodities; OEM maintenance companies; docks and shipyards for maintenance; employment agencies; survey and analysis companies; clients such as governments; and lastly friendly competitors for joint ventures.

Business data

There have been three different ways to approach the data that is available within the company. First, there is the distinction between internal and external data. Internal data is data which is generated within the company. External data is data which is harvested outside of the company from others. Second, there is the distinction made from a management perspective between financial, operational, technical and personal data. Financial data includes data for bookkeeping and strategic decision-making. Operational data includes data related to location, dredging production and performance. Technical data regards maintenance, item data and inspection data. Personal data is all employee related. Third, there is the IT point of view which makes a distinction between master data, meta data and specialized data. Master data is about e.g., personal data, fleet data and project data. Meta data gives context to the master data, which is required to understand and find the master data. Specialized relates to the core business of the company and regards production, finance, commerce, nautical and survey data.

Next to the typology of the data, there is a variety in ways the data is collected and what it looks like. There is data in the form of periodic sensor data from e.g. engines. This data is logged in .txt files. Such data can be useful for Condition Based Maintenance (CBM). There also is data in the form of reports, doc's or pdf's. Examples are compliance data and item data. Other data comes in the form of excels, such as Point of Interest's (PoI's) or Areas of Interest's (AoI's). An overview of all the data that was mentioned in the interviews is given below in Table 3.3, with a distinction between internal and external data.

Internal data	Examples	External data	Examples
Vessel sensor data of machinery	RPM, operating hours, temperature, pressures, vibrations, fuel consumption	Analysis data	Fuel & oil analysis reports
Dredging production data	Dredging speed, flowrate, pipeline wear	Survey data	Soil samples, weather, biodiversity
Vessel location data	GPS, speeds	Item data	Part- or machinery specifications
Compliance data	Certificates, safety reports, audit reports, inspection reports	Benchmarks	Salary, port state, inspections
Administrative data	workorders, office processes	Tender data	Project data provided by a client
Financial data	Financial statements, tenders, workorders	Location data	AIS data (vessel location), PoI, AoI
Personal data	Employee contracts	IT trends	Security, threats info
Survey data	Soil samples, H2S gas measurements, weather		

Table 3.3: Overview of business data

Business data sharing value

Sharing data is something that is already sporadically done at the company. Because the company is listed, it has an obligation to openly share data such as the financial statements in the annual report. Other data which is mandatory to share is AIS data, which shows the location of vessels to mitigate the risk of crashing into other vessels and increase safety. Next to these obligations, there have been initiatives between the company and partners to share data. These were, however, group-based access sharing initiatives and the data was rather abstracted knowledge than raw data. An example is the initiative to share knowledge about maintenance in the dredging industry, because there was a shared conception that maintenance does not have to be competed on and that the industry can improve as a whole by sharing knowledge. This initiative is currently a sleeping dog, as the corona pandemic interrupted the agenda.

The stance towards sharing data varied among the participants. Approximately half of the participants looked at the value from a commercial point of view. They explicitly want something in return for the data that they share, regardless of the way in which the data is shared. They seem reluctant to share data because they fear that the value of the data they share is larger than the value they get in return. On the other hand, approximately a third of the participants saw no need for receiving explicit value in return when sharing their data, as long as there is no risk to the core business. These risks are elaborated on later. The motivation for these participants to share data comes from a moral to do good or a sense of social responsibility. The value of sharing the data is to make the world a better place. This requires a change in idea of what value a corporate business should generate. The company acts out of a sense of good world citizenship. In the current *zeitgeist*, when in line with e.g. climate goals, this will have the secondary benefit of improving the company image as well.

Regarding the business models driven by sharing data (SDBM's), the participants were unanimous about the fact that capturing direct monetary value from sharing data does not align with the core business of the company. The company is a technology driven company. The core business is to deliver a service for which they engineer solutions and that is how they make their money. Generating revenue from sharing business data deviates too much. Some participants noted that these types of SDBM's probably fit the companies from which the case study company gathers external data. The types of SDBM's that the participants did think were suitable were those that improved the company image, primary business processes or quality through participation. This is because these SDBM's are of value to the existing business activities. Improving the image can be done by openly sharing data which helps others and does not harm the core business. Improving primary business processes can be done by sharing data with the industry or research institutions, similar to what was done with insights in the

dredging maintenance initiative. Improving quality can be done by sharing user data with manufacturers which helps them to improve their products.

A value which was mentioned by a participant regardless of the SDBM's is improving the customer relationship through data sharing. If data is shared more transparently, this improves the relationship. Additionally, after a data sharing infrastructure is set up, it saves administrative steps. There is no more need to report to another because the data and insights are already communicated. It saves time and is therefore more efficient. This was underlined by another participant as well. A complete overview of the value which can be created is given below in Table 3.7, along with practical examples from the case study. These examples are discussed in Table 3.3.2.

Decision criteria based on benefits and risks

There were plenty responses from the participants with regard to the question what risks are associated with sharing data. First and foremost is the risk of harming the competitiveness of the company (no.1), as was suggested in the conceptual model as well. Other risks that were mentioned in the interviews that correspond with the literature are the risk of misappropriation (no.2) of data due to the lack of context, legal risks when data is used against the company (no.3) and privacy infringement (no.4). The latter two risks were underpinned by multiple participants while one other participant does not regard them as actual risks as they can be mitigated relatively easy in that participants view. It is merely something that needs to be dealt with. Another 'risk' that was mentioned during the interviews was that sharing the data may only benefit others and not the company. It is arguable that this is an actual risk. If a benefit for others (e.g. competitors) results in a *relatively* weaker competitive position for the company, then it is, and comes down to the risk of harming the competitiveness of the company. If it does not, then it forms no risk to the company. This can be the case when data is useless to competitors but useful for researchers. Additionally, a risk of losing data overview (no.5) was mentioned when it is shared. It may be hard to manage and find the data. Also, multiple 'data truths' (no.6) may arise or in other words: there are different versions of the data and it is unclear which is correct.

No.	Risk mentioned in interview	Found in literature	Stated by participants	Mitigation steps
1	Harming competitiveness	x	1, 2, 3, 4, 5, 6, 7, 8, 9	Only share non-core business related data
				Limit data access & use
				Create a level playing field
2	Data misappropriation	x	5, 6, 7, 8, 9	Add metadata to the data
				Limit data access & use
3	Legal problems: Data (sharing) used against you	x	2, 9	Consult expert legal advise
				Limit data access & use
4	Privacy infringement	x	5	Don't share personal data
5	Lack of data overview		4	Add metadata to the data
6	Multiple 'data truths'		5, 6, 7	Have one responsible data owner

Table 3.4: Risks mentioned in interviews & related mitigation steps

The benefits or value of sharing data have already been described in Table 3.3.2. This value creation is the driver for sharing data and should outweigh the risks. In order to mitigate the risks, several criteria and mitigation strategies have been mentioned in the interviews. These steps of mitigation both to data sets and institutional/infrastructural arrangements. First, it should be a harsh criterion for the data to be not related to the core business or harm the competitiveness of the company. Second, the data should be supplied with proper meta data which describes the metrics and context of the data. Third, one of the participants noted that the data should in principle be accessible by anyone within the company already. If this is not the case, then sharing the data outside of the company is not an option. With regard to 'just dealing with' legal and privacy risks, not sharing personal data and consulting legal expert advice should help. Another way of mitigating the risk of data getting in the wrong hands or being misused is by limiting the extent to which the data is openly shared; or in other words limit the data access & use. By choosing for data sharing in the shared domain rather than the open domain, these

risks get mitigated. Group-based access with contracts, non-disclosure agreements and licenses can narrow down the group of people who are able to access and the way they use the data. To further mitigate the risk of harming the competitiveness of the company, a level playing field can be created. This entails that all parties in e.g. an industry share a certain data set. If everybody is transparent and shares their data set, then all parties run the same risks and have the same benefits. An example of such a level playing field regards AIS data. This is data about the location of vessels. It is obliged by law to share this data. Therefore all parties do it and thus run the same risks and have the same benefits. The level playing field was mentioned as an institutional condition, and is further elaborated on in Table 3.3.2.

Another way of controlling the use of the data, is by not sharing the data itself but rather the fact that you *have* the data in store. This was mentioned by a participant who made a distinction between having access to data and knowing that data exists. They are two different concepts. It is in line with the statement from participant 5 to work in an output driven fashion where only is used what is needed. If a company opens up about having certain data available, then other parties can approach that company when they feel the need to access the data. At that point, the company can make up the decision whether or not to share the data and under what conditions. A complete overview of the risks and according mitigation steps are provided above in Table 3.4. The criteria are listed in Table 3.5.

No.	Data-related criteria for sharing
1	The data is not related to the core business
2	The data is supplied with metadata to describe the data and provide context
3	The data is already available company-wide
4	The data does not contain personal data

Table 3.5: Data sharing criteria mentioned in interviews

Data sharing implementation

Once the decision is made to share particular data, there are infrastructural and institutional arrangements that have to be made to enable data sharing. The participants were asked which tools they consider necessary to share data. The responses varied and all responses are listed below with the corresponding participants in Table 3.6. The table also lists whether the responses aligned with the literature that was discussed in chapter 2, along with an example reference. The infrastructural need for some sort of portal or dashboard (no.2) where the data can be accessed was mentioned most. On such a dashboard or portal, the data is visualized (no.7). Before the data is presented on the dashboard, it should first be processed (no.13) as was suggested by participant 9. An important part of this processing is checking the quality of the data (no.2) and supplying it with proper metadata (no.5) such that the data can be easier found and understood. Processing the data, and making it interoperable (no.3), would be more easy if there is one data standard (no.1). Three participants thought that this preprocessing should also involve turning the raw data into e.g. KPI's (no.11), so that decisions can be based on the data immediately. The pitfall of extensive metadata, and especially turning the raw data into KPI's, is that the data is then biased (Zuiderwijk & Janssen, 2015). An overarching requirement of the data sharing infrastructure was provided by participant 9, who said the infrastructure should enable the data to be FAIR: Findable, Accessible, Interoperable and Reusable (no.14). This requirement is in line with the definition of what open data is about.

The portal or dashboard that was discussed in this subsection first can be managed in multiple ways. In case there is only one party sharing its data, they can be the data and data platform owner. In case of a collective in which multiple parties share their data (either open or group-based), there are two options. One way is to create a data platform where the data and data platform owner is one of the contributors (no.7). This contributor then has the benefit of being able to access the data first because it is provided to them and they process it first to then share it on the platform. This gives them a competitive advantage for approximately a year over the others according to participant 7. This may however make other parties reluctant to contribute to the platform. The other way is to create an independent

No.	Infrastructural & institutional conditions for data sharing	Stated by participants	Found in literature review Yes/No + example ref.
1	One data standard	2, 7, 9	Y (Attard et al., 2015)
2	Portal/Dashboard	1, 2, 3, 5, 7, 8	Y (Gao & Janssen, 2022)
3	Data quality check	1, 7, 8, 9	Y (Zuiderwijk et al., 2014)
4	Interoperable with other data & existing systems	2, 3	Y (Zuiderwijk et al., 2014)
5	Meta data for categorization, findability, context	3, 7, 8, 9	Y (Zuiderwijk, 2015)
6	Legal framework (e.g., contracts, N.D.A's)	3, 4, 7	N
7	Visualisation of data	5, 9	Y (Attard et al., 2015)
8	One contributing party is data (platform) owner	7	N
9	Independent data (platform) owner	6, 7	N
10	Level playing field	1, 3, 4, 5, 6	N
11	Pre-process data into e.g. KPI's	3, 4, 7	N
12	External platform host service	7, 9	Y (Zuiderwijk et al., 2014)
13	Processing of the data: e.g. Ingestion system, raw data storage, data cleansing, cleansed data storage, data exposure interface, visualization	9	Y (Zuiderwijk et al., 2014)
14	FAIR: Findable, Accessible, Interoperable, Reusable	9	N

Table 3.6: Infrastructural & institutional conditions for data sharing

legal entity that becomes data and data platform owner (no.9). Parties are then less reluctant to share their data because there is a sense of equal ownership among all contributors.

With regard to institutional arrangements, there was a strong need for the creation of a level playing field (no.10) in order to mitigate the risk of losing the company's competitiveness. It has been said by 5 participants that if everybody shares a data set, that there is no problem. This does however require a shared spirit before everybody is willing to simultaneously share their data and overcome the fear of being taken advantage of. Participant 6 stated this is difficult and that there is a need for a party to start sharing their data, accept the risks and convince others to share their data too. Lastly, for setting up a data sharing infrastructure it may be wise to find a specialized party who can be the platform host (not owner). This platform host can be an IT service provider that delivers commodities. This idea was brought up by participants 7 and 9 because it saves unnecessary work for the platform owner (re-inventing the wheel) and decreases the risk of damaging the company image when the IT service fails because another party is responsible for that.

Value creation opportunities
With the gathered knowledge about the company, available business data, potential value of sharing business data, decision criteria and infrastructural needs in mind, we can discuss the concrete examples of data sharing opportunities in the case study. During the interviews there have been a couple of suggestions that were made by the participants regarding specific examples of data that can possibly be shared to create value. As already discussed, this value can be express itself in different forms. An overview is provided in Table 3.7.

The first example is openly sharing safety data with other marine or industry companies in order to make the world a better place. Data is gathered about H2S gas, which is a toxic gas and can come up to the surface while dredging. Having knowledge about the presence of H2S gas makes that one can account for it and take the appropriate measures to ensure the safety of personnel. Measures include the provision of Personal Protective Equipment (PPE), which drive up the costs of a project. It can be argued that having this data makes a company more knowledgeable and therefore more credible towards a potential client. Therefore it could be seen as core-business information which influences the competitive position. On the other hand it can be argued that safety is a topic on which should not be competed. From a moral perspective the data can be shared to make the world a better place and

reduce hazards for other parties who have business there. This could include industry competitors, surveyors and researchers. On the same note, data about the location of old WOII sea mines or unexploded bombs can be shared to improve safety in maritime practises.

Data such as this type of safety data can be shared on a portal similar to Google Maps. On this map, the data points (points of interest) can be easily seen and when clicked on, they show the contents of the dataset at that location. This works similar to an internal data portal at the case study company. An additional value which can be extracted from sharing the data in this manner, is improving the company image. This can be done by communicating the message to the public that they do not want to compete on safety matters and therefore share safety related data. Additionally it can improve the relationship with competitors, because their safety is considered.

Sharing type	Data type	Value	Example	Stated by participants
Open	Safety data	Make the world a better place	H2S location data Mine location data	2, 5, 6, 8
Open	Safety data	Improve company image	H2S location data Mine location data	2, 5, 6, 8
Open	Administrative data	Improve company image	Food catering data	3
Open	Survey data	Collectively improve quality through participation	Bathymetric data	6, 9
Shared	Sensor data	Improve primary business	Engine data	
Shared	Sensor data	Collectively improve quality through participation	Engine data	
Shared	Project data	Improved client relationship	Project data	1, 9
Shared	Project data	Reduced administrative pressure	Project data	2, 3, 6

Table 3.7: Case study value creation opportunities

Another type of data which can potentially be openly shared is administrative data about e.g. food catering. This is the type of data which is absolutely not related to the core business of the company. It is data about commodities with which the company does not (primarily) differentiate itself from the competition. It can however be used to improve the company image and make the company more attractive to work at. If the company can share data, such as statistics, which reflect how well and healthy the employees are eating, people may be more attracted to work at the company. Additionally the data may be of use to food researchers.

The last open data sharing initiative that was mentioned during the interviews was the open sharing of bathymetric data. This is data about the sea floor which is acquired through surveys. Data like this is gathered by all types of maritime companies and it is used to improve sea maps. If this data is openly shared by all parties that conduct the surveys, this saves a lot of efforts and resources. Through this the maritime industry becomes more efficient. It must be noted however that the bathymetric data should in the case of Boskalis not be related to the core business. This means that data regarding the sea floor composition should not be shared, but e.g. sea floor depths can be shared.

While creating a better world and profiting from a potentially improved company image, there are also ways to profit from business data sharing with a more direct impact on the business. Because this data sharing impacts the business more directly, this also means that the data is more related to the core business and hence risks are higher. Therefore there is a strong need to regulate the data sharing which leaves us in the shared domain rather than the open domain.

One shared data example that has been mentioned multiple times during the case study at the fleet management department was the sharing of sensor data from engines which are installed on the vessels with the supplier. Engines are produced by external parties and therefore do not contain engineering from Boskalis with which they differentiate themselves from the competition. Therefore it can

be argued that the user data from the engine is non-core business data. The engines are covered in sensors of which the measurements can be used for condition based maintenance. While this can be done within the company, it may be of more value to share the data with the supplier. The supplier can have a look at the data and provide expert advice on the condition of the engine and possible maintenance practises tailored to the specific use of the engines. This will improve primary business of Boskalis. In return, the supplier can use the user data to improve their engines, which will also benefit Boskalis because they receive a better product. Because the value is only extracted from the expert advise from the supplier, the data is exclusively shared with them under contracts, such that they do not share the gathered knowledge with other users of their engines.

The sensor data can however be shared with other engine users as well, but under different conditions. If there is a collective in which all engine users share their engine user data, then the engine supplier has a larger data set on which they can base their expert advise. When the user data is supported by adequate meta data which provides context, the supplier can provide even better tailored advise based upon context. This collectively improves quality through participation. Because all engine users share their data in this collective, there is a level playing field and all users have the same benefits and equal risks. An additional value, which was not explicitly mentioned during the interviews, is to again make the world a better place. If improvements to the engine (use) lead to fewer emissions, this helps to decrease the carbon footprint of the industry.

Another concrete way to benefit from business data sharing in the shared domain is to improve the client relationship and reduce administrative pressure. If project data is shared via dashboards with clients this increases transparency and makes communication more efficient. There is less need for reporting between individuals and this reduced reporting translates to a reduction in administrative pressure.

3.4. Case Study Conclusions

The aim of the case study at Boskalis was to answer the sub-research question: *What are the data sharing opportunities in dredging fleet management applications in the maritime industry?* Interviews were held to gather the data needed for answering the question. The interviews showed that there are large amounts of data available at the company, which vary from raw sensor data to abstracted reports. Boskalis works with a lot of external parties with whom data can potentially be shared in order to create value. Boskalis is an engineering company and has a business model which does not align with a data driven business model. Therefore it is not considered relevant to generate revenue directly from sharing data. The value that was mentioned most was not monetary but rather aimed at improving primary business processes, making the world a better place and inherently improving the company image, and improving customer relations. Making the world a better place does require a philosophy where is acted from a moral point of view rather than a commercial point of view. In a commercial environment this proved to be challenging, especially in combination with the fears for the risks of sharing business data.

The risks which were described in the literature have been confirmed during the case study. The biggest fears are the loss of competitiveness, data misappropriation and having multiple data truths. To mitigate these risks, there are criteria that the data must meet before sharing. The data should not be related to the core business; it should be supplied with metadata to describe the data and provide context; and the data should not contain personal data. Another way to mitigate risks is to limit the extent to which the data is shared openly. While the goal is to share data as openly as possible, limitations with regard to who can access the data and how the data may be used can eliminate the before mentioned risks. This results in business data sharing opportunities in the shared domain rather than the open domain (see domains in Figure 2.1).

In order to share the data, there are infrastructural and institutional requirements that were brought about during the interviews. Participants highlighted the need for a portal or dashboard on which the data can be found, accessed and visualized. The data should be findable, accessible, interopereable and reusable. To achieve this, a data standard can be created and meta data should be included. The case study has also shown that participants are more willing to share data if a level playing field is created where an independent data (platform) owner manages the data. This level playing field can

also arise when it is laid down in law to share certain data, such as AIS location data. This shows that contextual influences, such as industry standards or laws, greatly influence the willingness to share data.

With the values, risks, infrastructural needs and institutional needs in mind, there have been found multiple value creation opportunities through business data sharing at Boskalis. These opportunities lie in the open and shared domain. Safety data can be shared openly to make the world a better place and improve the company image. Improving the company image can also be done by openly sharing non-core business data to showcase how well the business performs and increase trust. Survey data (e.g. bathymetric data) can be openly shared in a collective to improve the quality of sea maps and increase efficiency survey practises industry wide. In the shared domain there are opportunities for sharing data that is closer related to the core business. Primary business processes can be improved by sharing sensor data from engines with suppliers for tailored expert advice. In a collective with all engine users, data can even be shared to further increase the quality of the expert advise but also the quality of the engines and result in better products. Project data can be shared with clients to improve the relationship and reduce the administrative pressure of reporting.

3.4.1. Refined Framework
The findings from the case study have resulted also in a refinement of the framework. In the journey to find data sharing opportunities there have been findings which reflected on the conceptual framework. These finding have resulted in refinements of the framework. The refinements have been mostly in the value that is created from sharing business data and in the implementation needs for data sharing. The value that was discussed in the case study is rather implicit instead of explicit for the company. Additionally the implementation needs which are most important to the employees at Boskalis have been identified. This has shown what infrastructural and institutional instruments should be put focus on in a business context. The refined framework is displayed below in Figure 3.1.
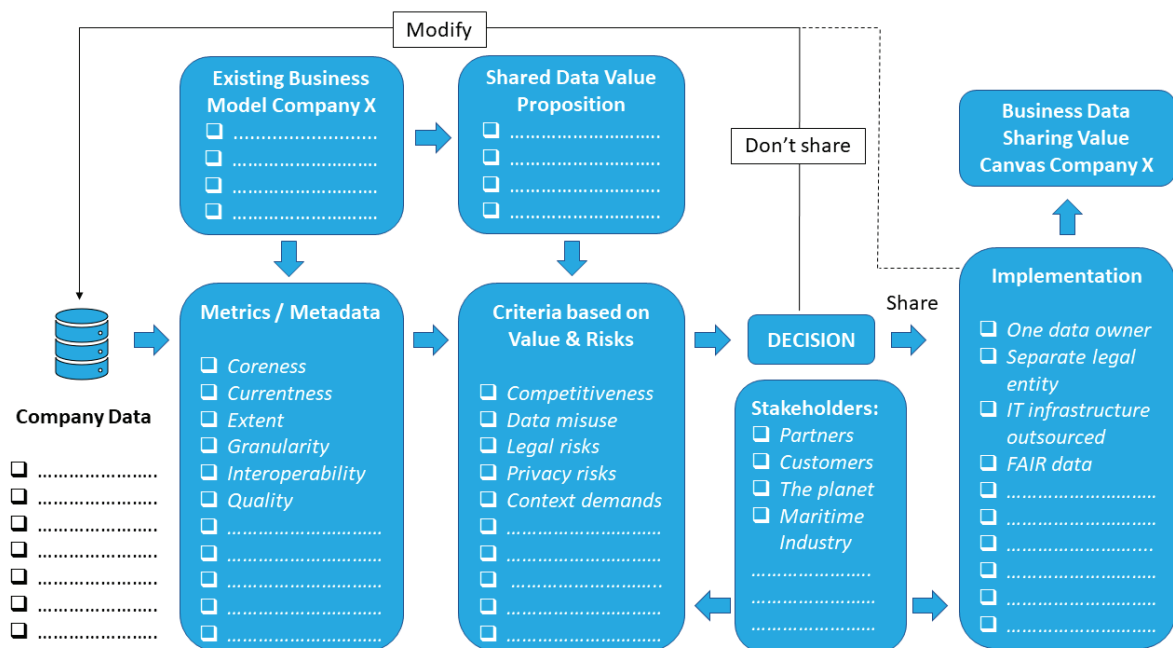

Figure 3.1: The Refined Framework

4

Validation Workshop

4.1. Workshop Introduction

This chapter is about the validation workshop that was organized in this research at Boskalis. The workshop is the third and last phase, and it aims to validate both the theoretical framework and findings of the case study. Although the workshop is closely related to the case study at Boskalis, it has been put in this separate chapter because it makes the thesis report better structured and easier to read. The workshop began with a presentation of the results, followed by a discussion on some of the specific business data sharing value creation opportunities at Boskalis and the industry that the company operates in. The workshop was concluded with a feedback round in which the participants could rate the case study results and theoretical framework through survey questions that they were given. This chapter describes the methodology that was used, discusses the results and finally answers the third sub-research question in the conclusion: *To what extent are the proposed framework and found value creation opportunities useful in the maritime industry?*

4.2. Workshop Methodology

The methods of the workshop are described in this section similar to how the case study protocol was described in section 3.2. The workshop was held at the same company as the case study, which is Boskalis. Details about Boskalis can be found in subsection 3.2.1 and no further explanation about the company is needed. This section describes how the data from the workshop is collected, what the contents of the workshop are and how the data is reported.

4.2.1. Data Collection Procedures

This subsection describes how the data from the workshop was accessed, what resources were used and how the data was handled security-wise.

Resources

The workshop was held at the office of Boskalis in a meeting room suitable for 12 persons. The meeting room was equipped with a screen on which the presentation sheets were displayed during the workshop. The room was further equipped with a large table and chairs which made the room suitable for having a discussion. Next to the digital presentation, a worksheet was handed to the participants with a copy of the refined framework and the business data sharing value canvas. The value canvas includes an example of a data sharing value creation opportunity at Boskalis. The worksheet can be found in Appendix C. The worksheet presented the refined framework in the first place, but it also served as a guide for the participants during the discussion. Additionally, the worksheet was designed such that notes and input from the participants could be added.

In the last part of the discussion, during the feedback round, a Mentimeter (Mentimeter, 2022) was used. This is an online tool which allows you to have participants answer questions via their smartphone in private. The entries to the questions are collected from all participants and then put into an

overview that suits the question. This tool enabled to ask conclusive questions that help verify the first and second sub-research questions, and answer the third sub-research question.

For later data analysis purposes, the workshop was audio and video recorded. For this an integrated camera in the meeting room was used to record video via a teams meeting. Additionally, a secondary camera was set up at the other side of the room to capture video footage as well. There were two recordings because if one of the two failed, there was a back-up.

Data collection activities

As said, the workshop serves two purposes: validating the findings from the case study and validating the theoretical framework that was used. In order to do so, input is required from employees at the case study company. In total, there were 8 participants who provided their feedback. These participants were all from the fleet management department and were all acquainted with data. Two of the participants had already participated in the interviews; the others had not. An overview of the participants and their role are given below in Table 4.1. The complete workshop lasted for an hour, of which the first 20 minutes were spent on explaining what the research is about, what the conceptual framework looks like, and what the case study results were. During these 20 minutes there was room for any questions that the participants had. Next, the worksheet was introduced to the participants which they could use to make notes and assess the refined framework and case study results.

The remainder of the workshop was reserved for a discussion. The discussion began with an overview of the four most common identified business data sharing value creation opportunities, which were subsequently discussed one by one. The participants were asked whether or not they agreed with the opportunity, and why or why not. This was done in an open manner where the participants could discuss with each other. After the four examples had been discussed, the participants were asked to answer three questions via the Mentimeter tool, and elaborate on their answer. Because there was limited time for the participants to elaborate, an additional email was sent out to all participants. This email contained the same set of questions and the worksheet. This way, the participants could send their elaborate answer after the workshop.

Participant	Role	Case study participant
1	Fleet Management Program Manager	
2	Fleet Manager	X
3	Fleet Management Engineer	
4	Information Manager	X
5	Fleet Management Engineer	
6	Fleet Management Intern	
7	Fleet Management Engineer	
8	Fleet Management Engineer	

Table 4.1: Interview participants

Data management & security

The data management procedures that were applied in the case study do also apply to the workshop. The details can be found in subsection 3.2.2. The only difference is that the participants were video recorded this time during the workshop, which required a separate slightly adjusted consent form. Additionally, the raw data also included responses that were sent via email. This raw data is also destroyed immediately after the research ends.

4.2.2. Workshop Protocol

As said before, the workshop started of with an introduction of the research and an overview op the results. For the discussion that followed there was a small protocol. This protocol helped to guide the discussion, but left enough space for the input from and interaction between the participants. First, there were four examples of value creation through business data sharing to which the participants could respond. These examples were:

1. *Improving company image and making the world a better (safer) place by openly sharing safety related survey data.*

2. *Improving primary business processes by sharing non-core business related sensor data from installations with their supplier for expert advice.*

3. *Improving quality through participation by collectively sharing non-core business related sensor data from installations with the supplier. If this is done by all users, this creates better benchmarks.*

4. *Cutting costs by improving free sea maps by providing non-core related sea surface survey data collectively with the entire marine industry.*

After this part of the discussion, the participant were asked to take out their phones and go to Mentimeter.com . Here they could access a set of questions to which they could give a response on a Likert scale ranging from one to five. The answers to these questions help to verify the answers to the last two sub-research questions in this research. The questions were:

1. *I now know how the company can create value through business data sharing.*

2. *To what extent do you think the framework is useful for identifying business data sharing value creation opportunities and why?*

At last, there was an open question to which the participants could respond on the spot.

3. *What do you think business data sharing will look like in the maritime industry in 10 years from now?*

This question did not relate specifically to one of the sub-research questions but the answers do reflect the stance of the participants towards business data sharing in the maritime industry. After this question the participants were thanked for their participation and there was room for general feedback on the workshop from the participants.

4.2.3. Workshop Report Outline
Like in the case study protocol (section 3.2), planning how the results are presented speeds up the analysis process of the results. This workshop report outline prescribes how the results are presented. Because the workshop was relatively short, a full summary of the workshop is included in the results section. This also includes the Mentimeter result graphs and the responses which were received via email. Again, because the qualitative findings from the workshop are a result of an interactive discussion, they are simultaneously discussed. At the end, conclusions are drawn from the discussion, and the third sub-research question is answered.

4.3. Workshop Results & Discussion
Among the participants of the workshop were Boskalis employees from Fleet Management who are involved with data and business process efficiency improvements or who were generally interested in the research. One participant left halfway the session, due to an urgent matter. Because not all workshop participants were fully aware of the contents of the research, a brief overview of what the research entails was provided first. This overview touched upon the relevance of conducting the research, the definitions of business data and (open) data sharing, the research approach and the conceptual framework.

4.3.1. Workshop Presentation Summary: Case Study Results
Regarding the company background results, the participants had no remarks. I, the researcher, highlighted that the core business of the company is dredging, supplemented with other offshore services. The value that the company brings to the customer is that they take on and deliver projects from A to Z, deliver quality at a competitive price and build in harmony with nature. Additionally, I provided an overview of often mentioned partners/stakeholders outside of the company.

Regarding the types of business data available within the company, the participants had no remarks. I provided an overview of the data that was mentioned in the interviews. These types of data were categorized in multiple ways. The first was my own categorization, being internal and external data. Second, there was the management point of view which distinguished financial, operational, technical and personal data. Third, there was the IT point of view who segmented master data, meta data and specialized data.

Regarding the business data sharing value, the participants had no remarks. I showed the types of value that were discussed during the interviews. This includes the value of making the world a better place. This requires a change in idea of what value a corporate business should generate. The company acts out of a sense of good world citizenship and a moral to do good. In the current zeitgeist, when in line with e.g., climate goals or current morals, this will benefit the company image as well. Other values are improving primary business processes by sharing data under contracts or N.D.A.'s, improving the quality of e.g. products industry-wide through participation by sharing puzzle pieces of a dataset, and sharing data between clients and the company for increased transparency and a better client relationship and less administrative work. The interviews also made clear that capturing monetary value does not align with the core-business of the company and is therefore not interesting. One of the participants made a comment about another value (and the importance) of sharing data. The participant stated that sharing data benefits the continuity of the company. This mostly referred to sharing data internally within the company and reflects the interest of employees at the company to share data within the company more transparently. It can however be scoped to the industry level, where in order to know as an industry, sharing knowledge increases the continuity of the industry.

Regarding the data sharing criteria, the participants initially had no remarks. The risks of sharing data entail harming the competitiveness of the company, losing the commercial potential of data, not being able to capture the value of sharing data, misappropriation, lack of data overview, data being used against the company, having multiple 'data truths' and a faulty data sharing infrastructure which harms the image of the company. Related criteria are therefore that the data to be shared should not be related to the core business or harm the competitiveness of the company (e.g., production data), the data should have proper meta data and the data should already be classified as 'internal' in the company. Other ways of mitigating risks are to have one clear data owner to establish the 'one data truth', to have a proper data sharing decision method and to have a data sharing infrastructure hosted by a commodity service provider. One of the participant pointed out that there may be a risk of data being wrongfully registered, due to e.g. a malfunctioning sensor. Despite this not having specifically to do with sharing the data, it should be accounted for when sharing anyways. Through proper meta data, the data can be described, including the probability of a sensor registering a wrong value.

Regarding the data sharing implementation results, the participants had no remarks. For setting up a data sharing infrastructure there are various ways to go about. A separate legal entity can be set up who is data owner (infomediary), so other stakeholders are less reluctant to sharing their data in collective data sharing initiatives, because there is a sense of equal data ownership. If the company can manage to be the platform owner, they have approximately a one year competitive advantage because its data scientists process the data first before making it public. Interview participants saw no technical hurdles in setting up a data sharing infrastructure. When sharing data, it should be FAIR: findable, accessible, interoperable and reusable. Lastly, it was pointed out during an interview that one should simple take a bit of risk and start sharing data, because there must be a first mover in order to convince others to do the same and create a collective.

The conceptual framework was refined based upon the findings in the case study. This refined framework was presented to the workshop participants. Each participant received a copy of the refined framework in the form of a worksheet. On this worksheet they could indicate which parts of the framework were (un)useful (tick boxes) and they could add to components of the framework. Additionally, the worksheet could be used as a reference in the discussion that followed.

4.3.2. Workshop Discussion: Value Creation Opportunities

After the general findings from the case study interviews, the workshop participants were presented four examples of value creation opportunities through data sharing from the company. These examples were directly deducted from the case study interviews. To help the participants in their thinking, one of the examples (Improving quality through participation by collectively sharing non-core business related sensor data from installations with the supplier) was already filled into the business data sharing value canvas. The examples were discussed one by one and the key takeaways from the discussion are provided below.

1. **Improving company image and making the world a better (safer) place by openly sharing safety related survey data**

The idea behind this value is that the company can contribute to a better world and subsequently improve their image, because they do not compete on safety related matters. Two of the participants immediately commented that in order for this to work, the benefit of improving the company image should only be considered a by-catch and not the driver. Making the world a better place should be the driver. To this, I responded that I tried to make the created value as relevant to the company as possible, therefore first indicating the benefit of improving the company image.

A third participant commented that sharing such data would not be possible due to legal limitations. The participant argued that such data from a project belongs to a client and not the company. Next to uncertainty about whether this is true, participant 4 responded that for this case, (practical) legal limitations should not hinder the discussion about the potential value of sharing the data. A fifth participant added that legal limitations like these can be avoided by making clear agreements with clients.

Participant 2 added that this example shows that the created value does not have to directly benefit the company (e.g., a monetary value). A sixth participant stated that improving the safety outside of the company through data sharing aligns perfectly with the internal safety maximization initiatives (No Injury, No Accidents program). Sharing safety data outside of the company is a way of propagating company culture externally as well (such as to subcontractors or clients – participant 7). Upon the question whether the participants saw the created value in the example, they responded positive.

Participant 1 also made an addition about an example in which safety data was shared by another company. There had been an unforeseen incident from which this company learned a lot. Because they felt that an incident like that should never happen again, they decided to share the information, during a presentation, about the incident and the measures to make sure it does not happen again. The information included what exactly went wrong. They shared it to the dredging industry, but according to the participant it could possibly be shared openly with the same philosophy. The participant admired how open and transparent this company was about the incident. It showed the intrinsic motivation of the company to share the information because they really did not want to have something happen like that to their competitors (participant two). Comments on this example from other participants were about the risk of customers or outsiders taking the data out of context and thinking that the company has bad working conditions, which works against you. To this, participant 5 responded that the measures (or lessons learned) can be shared safely without running the before-mentioned risk. There should however still be detail about the incident in the lessons learned, because otherwise valuable context is missing and the lessons learned can be misinterpreted or be unusable.

Participant one added another example of a company which shares what goes well, and what does not go well: Tony Chocolonely. They have recently shared data about the things that they have not yet achieved and struggle with in their company. This is an example of a company operating from an ideal or mission that lies outside of running their business. Participant 2 adds that if someone (or a company) wants something to change, then someone has to make the first move and then intentionally take the (calculated) risks that go with it.

2. **Improving primary business processes by sharing non-core business related sensor data from installations with their supplier for expert advice**

This value proposition entails that primary business processes can be optimized. More specifically, maintenance practices can be optimized by sharing sensor data from engines with the suppliers. Participant two thinks that the value does not only apply to the company who shares their user data, but it also applies to the supplier in the form of being able to improve their engines. Participant seven states that it should be a win-win situation. When I elaborated on the commercial point of view, where it is considered to be important to receive equal value as the supplier, the participants state that receiving a better engine in return is already valuable enough. Participant six suggested to reverse the question. Why would you not share user data? If it is valuable to others, that would be a sufficient motivation.

Some of the participants stated that engine data is already being shared with suppliers. There did not seem to be an unambiguous agreement about this data sharing, but there are rather separate instances where data sharing occurred, such as when a supplier engineer comes over to service an engine or when an engine is already equipped with remote access hardware. One of the participants points out that when these instances are spoken about, there is the assumption that sharing that data only leads to negative consequences for the company. Therefore, another participant questions whether the company (and its employees) is/are mentally ready to share data. This negativity follows from the fear that the data is misused, and that e.g. suppliers only use the data to their benefit. A participant names the example of a train of thought where employees may fear that a supplier will use the data to solely maximize its profits, by e.g. reducing the quality of a pump to earn more on parts and maintenance.

Participant one stated that at the level of technology that we are at now, sharing data is a key practice to further improve. Things have become so complex that one cannot do it alone anymore. The mindset regarding data of companies (at least in the maritime industry) is still protective, and therefore a change in mindset is required for the long run in order to make data sharing happen. Because data sharing is new, there may be a lot of hurdles in the short run, but keeping in mind the benefits in the long run should help to persist.

3. **Improving quality through participation by collectively sharing non-core business related sensor data from installations with the supplier. If this is done by all users, this creates better benchmarks.**

This value proposition suggests that if e.g. all engine users share their user data, better advice and benchmarks can be set up, which are tailor made for specific use cases. Participant one replied that sharing the data with suppliers without having other users share their data can be valuable as well. The user data from your company can be used by the supplier to improve the advice towards other users. The participant compared it to a sports example. If you share your data with suppliers and the competition, it forces you to keep innovating and stay ahead of the competition. This also comes from a sense that the competition will find out about your innovations anyway. The participant did state that this train of thought is an out-of-the-box one.

The idea mentioned above is the opposite of what I initially thought of when arranging the data sharing for this value proposition. I proposed that engine users can only benefit from improved advice and benchmarks if they contribute to the shared data pool. If they do not, then they cannot reap the rewards. This was nodded to and agreed to by the other participants.

4. **Cutting costs by improving free sea maps by providing non-core related sea surface survey data collectively with the entire marine industry (e.g. GEBCO)**

This value proposition is about creating a free alternative for relatively costly sea maps. The sharing aspect of the value proposition has been discussed previously. One of the participants asked what costs currently go with the sea maps that are currently bought. The costs of these sea maps were not quantified. In order to weigh off whether or not it is necessary to put effort into such an initiative, it helps to know what the current costs are. If these turn out to be marginal compared to the efforts for the initiative, then it is unattractive to participate in order to cut costs.

4.3.3. Workshop Discussion: Validation Questions
The last part of the discussion was a moment where feedback could be given on the research. The (at this point seven) participants were given three questions, to which they could reply. The first two

questions were combined with an Agree/Disagree type of Likert scale via the mentimeter. Because there was limited time to elaborate on the scores that the participants gave, the participants have been given the opportunity to provide their reasoning for the scores via email.

1. I now know how the company can create value through business data sharing

All participants have filled in the mentimeter, and the question scored a weighted average of 3.3 on a scale from 0 to 5; with 1 being 'I don't agree' and 5 being 'I strongly agree'. In hindsight, adding 'strongly' in 'I strongly agree' was a mistake because it caused an unbalance in the Likert scale. The score however still leans towards the participants seeing the value creation opportunities, but with remarks. This shows from the elaborations that the participants shared.
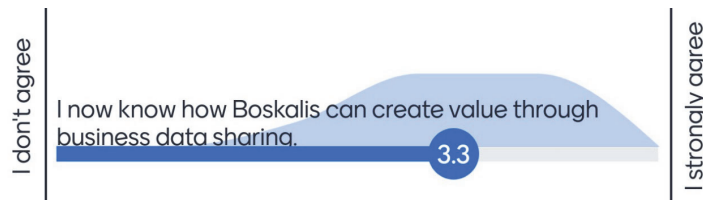

Figure 4.1: Mentimeter Response Question 1

Participant 2 stated that opening up the world of value creation opportunities through business data sharing requires to first better define the goals of data capturing and data usage within the company. The ways to manage and control data should be further developed within the company too. Currently a lot of data is gathered internally on a daily basis and this is only partially used at most. The participant sees a lack of data ownership in all departments, which leaves data capturing, validation and usage in the middle as well. The internal data sharing infrastructure is already challenging on its own and has priority. Creating value from sharing the business data externally can only be done when this is sorted first. It can be argued, in response to participant 2, the theoretical framework for data sharing can be used for internal data sharing in Boskalis as well. Because of its divisional nature, the divisions and departments can be seen as separate entities or parties. Although risks related to competitiveness are not as relevant, topics such as data misappropriation and data ownership are. The response of participant 2 confirms that it is already challenging enough to internally implement data driven solutions in a company that is relatively conservative.

Participant 3 commented that the results from the case study did show value creation opportunities, but in an abstract manner. The participant felt that the results were not concrete or detailed enough such that the results could immediately be implemented. In response to this I argued that this research was of an exploratory nature and that further research into specific cases results in more concrete answers. The need for concrete insights may come from the fact that participant 3 is a Fleet Management Engineer who is occupied with practical day-to-day business and needs information to be concrete to be able to process or apply it.

In line with the exploratory nature of this research, participant 4 stated that the results of the research provided insights into the different values which can be created by data sharing. Especially the insight that the value may not be monetary or explicit to the company, but also a 'social' value. The level of detail in the specified opportunities did not seem to bother the participant. Possibly this is due to the fact that participant 4 is one of the managers and therefore is used to a more abstract way of thinking in the top-level day-to-day business.

2. To what extent do you think the framework is useful for identifying business data sharing value creation opportunities and why?

All participants have filled in the mentimeter and the question scored a weighted average of 3 on a scale from 0 to 5; with 1 being 'completely useless' and 5 being 'perfectly useful'. This score suggests that the participants think the theoretical framework is moderately useful. The participants elaborated on their answers and provided suggestions for the framework.
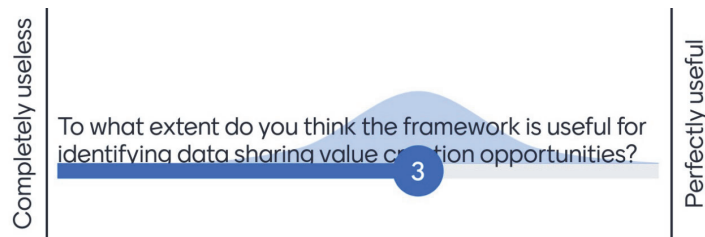
Figure 4.2: Mentimeter Response Question 2

Participant 2 states that the framework can help companies to define which business data they are willing to share and what to keep in mind when sharing that business data. The framework can also help companies in smaller internal projects (like the Fuel Dashboard at Boskalis) to define the value creaiton possibilities of sharing business data with business partners. One suggestion that the participant made is to include a 'company vision' component to the theoretical framework. If in this vision, the company sees data as a value asset, then handling data will be part of the agenda and there will be a strategy in which data sharing can play a role. In response to the suggestion for adding a 'company vision' component to the theoretical framework, it can be argued that the company's vision is already part of the existing business model. The vision, ideal or point of view from which the company acts did however prove to be important for how the value of business data sharing is defined. Therefore, special attention for the company's vision is sensible.

Participant 5 stated that the theoretical framework can be useful as an exploratory tool at the beginning of the business data selection process for sharing data. It is a fruitful tool that can add value to the discussion about value creation through business data sharing. The framework is however very dependent on the context of a particular dataset, business and its environment. Therefore the framework may not be generally applicable and needs customization for every other case. One other detail that participant 5 noted was that the framework did not have an option to not share the business data which was being assessed. There was only the option to share or modify ,and eventually share the data. In response to the statements of participants 5 it can be concluded that the theoretical framework indeed lacked the option to not share the business data based on the assessment, and therefore it should be added. The notion of the framework being dependent of the context of a particular dataset, business and its environment is something that has been concluded in the discussed literature as well (Gao & Janssen, 2022). This is ground for conducting further research into more specific business data sharing cases. One of those cases could be an in depth assessment of one of the value creation opportunities that has been suggested during the workshop.

The need for conducting further research on a specific case study has been expressed by participant 4 as well. The participant believes the framework is useful since all relevant elements are included. However, the participant also thinks that the framework must be tested in depth in a specific case study to proof that it is sufficient.

Participant 3, again from a practical point of view, suggested that the trade-off between the values and the risks of business data sharing should be done through a 'Cost-Benefit Analysis' (CBA). This analysis assigns a monetary value to all costs and benefits (or values and risks) and enables the trade-off to be calculated in monetary terms. In response to this suggestion it can be argued that there currently is indeed no tool in the theoretical framework to make the trade-off. Using a CBA to make the trade-off may serve a solution to make the trade-off. This does however require all values and risks to be monetized which can be challenging. To illustrate: How can one express or measure 'making the world a better place' in monetary value? An alternative analysis can be a 'Multi Criteria Analysis' (MCA). In this type of analysis, it is easier to take non-monetary factors into account.

3. **What do you think business data sharing will look like in the maritime industry in 10 years from now?**

This question was an open one and therefore the questions was not part of the mentimeter. Participant 4 replied that he believes it will not be a choice anymore to not share data, because you simply have

to in order to stay relevant and compete. This relates to the trends that are ongoing in the maritime industry. Participant 8 added that currently there are efforts for creating autonomous vessels. The use of these vessels will most likely be implemented in the next 10 years. One of the issues there is deciding who is responsible for these vessels when they crash. The participant believes that data must be shared (or at least will be helpful) between parties in order to map such issues.

Participant 5 thinks that the maritime industry will still be reluctant towards sharing data in 10 years, in view of competitive risks. The participant thinks, in case of the autonomous vessel example, that companies will keep information regarding that technology to themselves since its so novel and therefore a technology with which a company can differentiate itself. The only data which may be available for sharing is data for which the sharing is regulated by governments. Contrary, participant 2 believes that in 10 years' time (maritime) data is stored, sold and bought in data warehouses. Data sharing will become a commodity where data collection, selling and buying is a part of a state-of-the-art business proposition. With regard to the data collection and access, participant 3 thinks that machinery will be equipped with data collection systems which can be accessed remotely by the supplier and the user when requested. The supplier will have a portal through which the user can access the data. Participant 4 expects that open data sharing (as part of a company's transparency) will become much more important when the societal benefits are recognised. However, since maritime industry is a rather conservative industry, it will take quite some time before companies see an added value.

The above mentioned responses from the participants to question three show that, despite the lack of implementational detail and the framework being mostly useful as a foundation for discussions, there is still a strong belief that data sharing (in both the open and shared domain) will be adopted in the industry for various reasons and to different degrees. This is an incentive to further develop the framework and fuel the discussion for sharing business data in a business context in order to meet the expectations in 10 years and exploit the value of business data sharing.

4.3.4. Wrap-up & General Feedback on Research

I thanked the participants for their participation. The participants thought the presentation of the results and the workshop were very much in line with the long term vision that the company tries to establish. This workshop is a trigger for employees to zoom out of the day to day business, and think about the future of the company and what activities the company can undertake which pay off in the long term.

4.4. Workshop Conclusions & Final Framework

The goal of chapter 4 has been to validate the findings from the case study and answer the third sub-research question: *To what extent are the proposed framework and value creation opportunities useful in the maritime industry?* Through a workshop at Boskalis, a set of 8 participants were presented with the case study results and the refined theoretical framework. The sub-research question could be answered through the discussion of four examples of business data sharing value creation and three questions regarding the research results. Generally speaking, the case study results were validated for dredging fleet management during the workshop. The opportunities that are not specific for dredging fleet management, such as improving quality through sharing sensor data from engines, can apply to the entire maritime industry. Another example that applies to the entire maritime industry is sharing bathymetric data, because it can be used by all sorts of maritime parties such as seafloor researchers.

The workshop has shown that the vision or ideal of the employees and the company indeed is of great influence on how 'value' is defined. The generated value may not be monetary or explicit to the company, but it can rather be something that benefits society. Therefore, in order to define what value is to be achieved through business data sharing, this vision should be well established first. One extra remark was that the actual costs of setting up a data sharing initiative should be outweighed by the value that it will generate, like in value creation opportunity example no. 4.

The subject of (openly) sharing data and creating value from it currently is a rather abstract topic. The subject matter is something which is not on the agenda of tomorrow, but rather something for which a long term vision is required in order to see the potential benefits of it. In the day to day operations,

employees find the subject relatively abstract and require a more concrete framework to make implementation possible. The abstractness and lack of detail is caused by the fact that these details different from company to company. One company may have other criteria for sharing data than the other. With the current level of detail or abstractness, the framework is rather general which makes it suitable as a basis for all sorts of companies. Currently, it is specific for the maritime industry insofar that the maritime industry is considered a contextual factor and stakeholder. The framework can serve as a foundation for getting a discussion started about how business data sharing can bring value. The framework can be made more concrete by conducting a pilot case study on a specific data set at a specific company.

The workshop has also addressed the importance for companies, or at least Boskalis, to first have the internal data sharing infrastructure in order. If the data is not used to the fullest potential first, then making optimization efforts there has priority.

Lastly, the workshop has shown that, despite the lack of implementational detail and the framework being mostly useful as a foundation for discussions, there is still a strong belief that data sharing (in both the open and shared domain) will be adopted in the industry for various reasons and to different degrees. This is an incentive to further develop the framework and fuel the discussion for sharing business data in a business context in order to meet the expectations in 10 years and exploit the value of business data sharing.

With regard to the refined theoretical framework, the validation workshop has resulted in various suggestions which improve the usefulness of the framework. First, explicit attention should be paid to the overarching vision of a company. This correlates with the existing business model, but it has shown to also influence the business data sharing value proposition. Second, the framework can be improved by implementing a tool of analysis to make the trade-off between the values and the risks, such as a cost-benefit analysis or a multi-criteria analysis. Lastly, the refined framework did not show an option to decide to not share a particular data set. Because the risks of sharing business data can outweigh the potential value, this option should be included. With these adjustments to the refined theoretical framework we have arrived at the final theoretical framework. The final framework is displayed below in Figure 4.3. This framework can be used as a foundation for discussions about how value can be created from business data sharing.
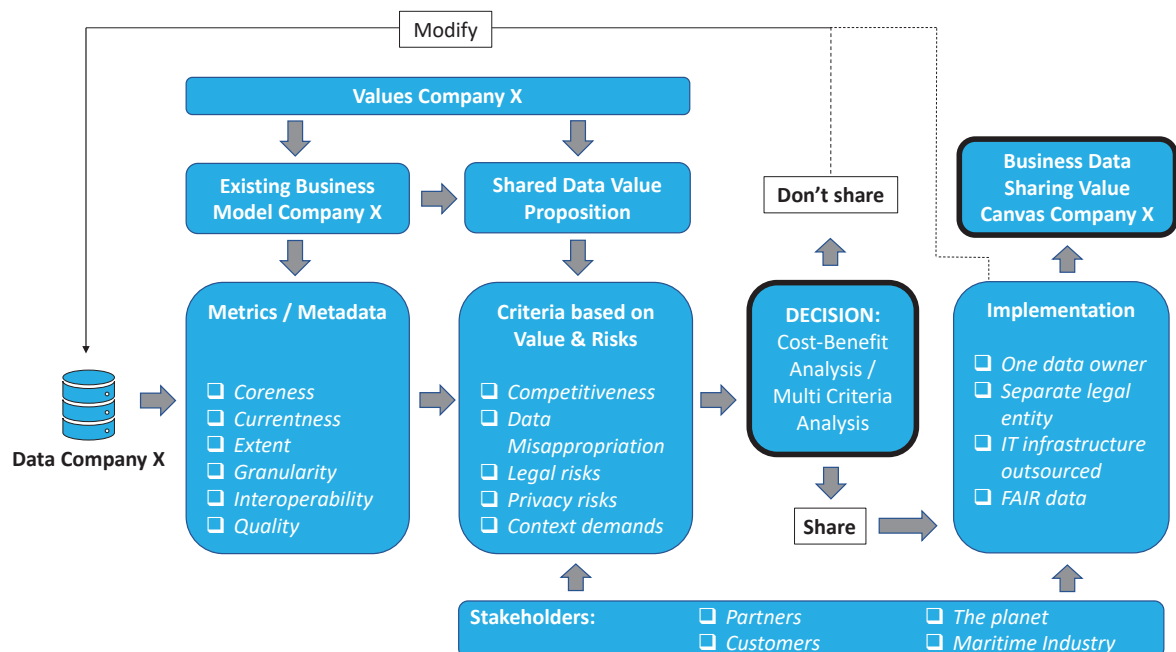

Figure 4.3: Final Theoretical Framework

5

Conclusions

The aim of this research has been to identify the value creation opportunities in relation to business data sharing in the maritime industry through a case study at the dredging fleet management department of Boskalis. Businesses are often reluctant to share their business data (openly), in fear of e.g. losing their competitive position or misappropriation of the data. There are however opportunities for creating value through business data sharing, such as increasing trust or improving business processes. One type of industry that is characterized as conservative and relatively slow in the uptake of novel technologies and ways of working is the maritime industry. There was the opportunity to conduct a case study during an internship at the dredging fleet management department of Boskalis. Boskalis has a large variety of data in-house of which little to nothing is currently shared, but Boskalis managers do see potential benefits from sharing data, such as the opportunity to improve maintenance practises. The main research question that is answered is: *'How can business data sharing help to create value in the maritime industry?'* To answer the main research question, three sub-research questions were answered in three phases of the research. Prior to the case study, an integrative literature review was conducted to find out what conceptual framework can be used to identify value creation opportunities through business data sharing in a business context. Based on the framework, interviews with employees were conducted as part of the case study to find out what the value creation opportunities are in dredging fleet management in the maritime industry are. These opportunities, as well as the framework, were validated for their usefulness through a workshop in which employees discussed the results.

The integrative literature review showed that the research on value creation through business data sharing is still in an infant stage. The literature that was found indicated that the models in relation to (open) data sharing are still relatively generic and leave room for further research to refine the models. Additionally, the frameworks describe decision making, value creation and infrastructure design separately, rather than relating the themes to each other. It can be concluded however, that these themes are indeed related. There are points of contact between the different models where subjects overlap or follow-up on each other. By combining these models into one, a conceptual framework has been created which can be used to identify the value creation opportunities through business data sharing.

The dredging fleet management case study showed that value can be created from sharing their business data to improving primary business processes, making the world a better place and inherently improving the company image, and improving customer relations. Because the business model of dredging companies does not match with a data driven business model in which revenue is generated from selling data, there is no explicit monetary value from sharing data. This monetary value is only implicit when processes are optimized and costs are saved. To be specific, in dredging fleet management safety data can be shared openly to make the world a safer place and improve the company image. Improving the company image can also be done by openly sharing non-core business data to showcase how well the business performs and increase trust. Survey data can be openly shared in a collective to improve the quality of sea maps and increase the efficiency of survey practises industry wide. In the shared domain there are opportunities for sharing data that is closer related to the core business, when contractual agreements and access limitations are set up. Primary business processes, such as

maintenance, can be improved by sharing sensor data from engines with suppliers for tailored expert advice. In a collective with all engine users, data can even be shared to further increase the quality of the expert advise but also the quality of the engines and result in better products. The improved products and efficiency contribute in their turn to a reduced impact on the environment. In a collective effort, a level playing field is created where benefits and risks are equal for all participants. Having this level playing field increases the willingness of companies to participate and share their data. The value creation opportunities for dredging fleet management also apply to the maritime industry, as most opportunities are not specific for dredging activities.

The workshop has shown that the subject of (openly) sharing data and creating value from it currently is a rather abstract topic. The subject matter is something which is not on the agenda of tomorrow, but rather something for which a fresh long-term vision is required in order to see the potential benefits of it. It can be concluded that the ability to have this fresh long-term vision depend on the experience and function of the individual. Higher tier managers are less likely to be bound in their thoughts by current policies while lower tier managers often adhere their thoughts to these current policies. Also, more experienced employees tend to stick with their common practises, rather than opening up for new ideas because they impose new risks. In the day to day operations, employees find the subject of business data sharing relatively abstract and require a more concrete framework to make implementation possible. This can be done by adding a Cost-Benefit Analysis or a Multi-Criteria Analysis to the decision-making process. Despite the lack of implementational detail in the results and the framework being mostly useful as a foundation for discussions, the workshop also showed that there is still a strong belief that data sharing will be adopted in the maritime industry for various reasons and to different degrees. This is an incentive to further develop the framework and fuel the discussion for sharing business data in a business context.

To conclude and answer the main research question, business data sharing can help create value in the maritime industry by sharing business data in such a way that it does not harm the competitive position of companies that share their data. Through a careful decision-making process, both business data and the conditions under which the data is shared (degree of openness, etc.) can be selected. The value that can be created from sharing the business data in the maritime industry is not explicitly monetary, but rather aimed at improving primary business processes, reducing climate impact, making the world a better and safer place and inherently improving the image of the companies and overall industry.

5.1. Contributions & implications

The contributions and implications of this research are twofold: First the research provides specific business data sharing value creation opportunities for dredging fleet management and the maritime industry, which can be further explored through dataset specific case studies. The research has provided a step in the direction of creating value for sharing business data in the maritime industry, and it contributes to the body of knowledge about data sharing in a business context, which is useful for the digitalization of the maritime industry. The research highlights the creation of value which does not (directly) translate to monetary value, but rather to moral and social values, like making the world a safer and better place. For society this implies that when these values are created, they benefit from it as well.

Second, the research has integrated multiple models from existing literature into one framework, which can be, depending on the context, be used in businesses to identify value creation opportunities through business data sharing. In its current state, it can most likely be used as a guide in the discussions regarding value creation through business data sharing in the maritime industry. The framework can however also be tailored for other industries by taking their stakeholders and contexts into account. This means that the framework can be used beyond the maritime industry and help other industries as well.

5.2. Limitations

Despite careful research design, there have been limitations in the research. First, the literature review is only based upon a subset of the publications on this topic. This was due to the fact that there was only one researcher with a limited time window for the literature review. To ensure the validity of the framework, the literature that was used was filtered through strict selection criteria.

Second, as stated before in the literature (Enders et al., 2020), a decision framework for sharing business data heavily relies of the peculiarities of specific use cases. What is valid for dredging fleet management may not be valid for other companies in the maritime industry or other businesses in general. To make sure that this is not misunderstood, the importance of context is highlighted throughout the report. To find valid value creation opportunities in other contexts, further research is suggested on use cases in different industries.

Third, the amount of interviewees participants that were consulted is limited. A larger population of participants would make the findings in the case study and validation workshop more sound. This, again, is due to the tight time window in which the research was conducted. Additionally, the participants were all employees with busy schedules, so scheduling appointments was challenging at times. To ensure valid results, the interview case study results were validated in the workshop.

Fourth, although the interview protocol was in English, the interviews were held in Dutch as all participants we native Dutch speakers. In the translation from English to Dutch and vice versa, despite careful review, words may have been misinterpreted and therefore nuances/meaning may be lost. To mitigate this risk, the summaries of the interviews with the participants were checked for mistakes by the participants themselves.

Lastly, the current research mostly took existing stakeholders of the company into account, rather than looking at potential new stakeholders such as researchers. Hence the value creation opportunities were mostly based on the current network, rather than on possible new ties outside of this network.

5.3. Recommendations for Further Research

First, because the current theoretical framework has only been used as an exploratory tool to identify possible data sharing value creation opportunities, it is recommended to take one of the value creation opportunities and actually try to implement it in detail at the case study company. When going into more detail, it is also recommended to investigate why prior data sharing projects or initiatives, which were mentioned during the interviews, have stranded. What went well and what went wrong? To gain a better view of the incentives of other parties to participate in data sharing, it is recommended to also interview stakeholders outside of the case study company.

Second, because Boskalis did not seem to fit a business model in which a direct revenue stream is generated from sharing the data, the opportunities regarding the revenue model design that was discussed in the literature review remain unexplored. For further research, another case study can be chosen with a more suitable business model in which this can be tested.

Third, because the motive for sharing data has shown to be very important and requires a vision that is value focused (in the broadest sense) instead of merely profit focused, a case study could be set up where a questionnaire is set out company wide to map the willingness to share data based on this motive.

Fourth, a more comprehensive and extended literature review would result in a more refined and sophisticated framework. For example, a systematic literature review (SLR) would provide a better representation of the current body of literature about business data sharing, which would provide a stronger foundation for creating the framework.

Lastly, it is recommended to look deeper into sharing data with parties outside of the existing network of the company, such as with researchers. Collaborations can be set up with research institutions to

boost innovation. This has only been slightly done in the current research.

List of Figures

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Bibliography

Abbas, A. E., Agahari, W., van de Ven, M., Zuiderwijk, A., & de Reuver, M. (2021). Business data sharing through data marketplaces: A systematic literature review. https://doi.org/10.18690/978-961-286-485-9

Attard, J., Orlandi, F., Scerri, S., & Auer, S. (2015). A systematic review of open government data initiatives. *Government Information Quarterly*, *32*(4), 399–418. https://doi.org/https://doi.org/10.1016/j.giq.2015.07.006

Bertot, J. C., Jaeger, P. T., & Grimes, J. M. (2010). Using icts to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies. *Government Information Quarterly*, *27*(3), 264–271. https://doi.org/https://doi.org/10.1016/j.giq.2010.03.001

Boskalis. (2021a). Boskalis annual report archive. https://boskalis.com/reports.html

Boskalis. (2021b). Boskalis sustainability report archive. https://boskalis.com/reports.html

Boskalis. (2022a). Boskalis project reports. https://boskalis.com/about-us/projects.html#view/map

Boskalis. (2022b). Fleet and equipment. https://boskalis.com/about-us/fleet-and-equipment.html#view/grid

Boskalis. (2022c). Interview about condition based monitoring solutions in marine applications. *Boskalis*.

Bureau Veritas. (2020). How digitization is winning over the maritime industry. https://www.bvsolutions-m-o.com/magazine/how-digitalization-winning-over-maritime-industry

Dikis, K., Lazakis, I., Taheri, A., & Theotokatos, G. (2015). Risk and reliability analysis tool development for ship machinery maintenance.

Ecorys, Economics, & Radicand Economics. (2020). *Exploring data sharing oblications in the technology sector*. Government of the Netherlands. https://www.government.nl/documents/reports/2020/11/30/exploring-data-sharing-obligations-in-the-technology-sector

Enders, T., Schüritz, R., & Frey, W. (2019). Capturing value from data: Exploring factors influencing revenue model design for data-driven services.

Enders, T., Wolff, C., & Satzger, G. (2020). Knowing what to share: Selective revealing in open data. *ECIS*.

ERT. (2021). *Expert paper - b2b data sharing*. European Round Table for Industry. https://ert.eu/documents/ert-expert-paper-b2b-data-sharing/

European Commission, Directorate-General for Communications Networks, C., Technology, Scaria, E., Berghmans, A., Pont, M., Arnaut, C., & Leconte, S. (2018). *Study on data sharing between companies in europe : Final report*. Publications Office. https://doi.org/doi/10.2759/354943

Gao, Y., & Janssen, M. (2022). The open data canvas–analyzing value creation from open data. *Digit. Gov.: Res. Pract.*, *3*(1). https://doi.org/10.1145/3511102

Hallberg, N., & Brattström, A. (2018). Concealing or revealing? alternative paths to profiting from innovation. *European Management Journal*, *37*. https://doi.org/10.1016/j.emj.2018.04.003

Harhoff, D., Henkel, J., & von Hippel, E. (2003). Profiting from voluntary information spillovers: How users benefit by freely revealing their innovations. *Research Policy*, *32*(10), 1753–1769. https://doi.org/https://doi.org/10.1016/S0048-7333(03)00061-1

Henkel, J. (2006). Selective revealing in open innovation processes: The case of embedded linux. *Research Policy*, *35*, 953–969. https://doi.org/10.1016/j.respol.2006.04.010

Kassen, M. (2013). A promising phenomenon of open data: A case study of the chicago open data project. *Government Information Quarterly*, *30*(4), 508–513. https://doi.org/https://doi.org/10.1016/j.giq.2013.05.012

Kraus, S., Jones, P., Kailer, N., Weinmann, A., Chaparro-Banegas, N., & Roig-Tierno, N. (2021). Digital transformation: An overview of the current state of the art of research. *SAGE Open*, *11*(3), 21582440211047576. https://doi.org/10.1177/21582440211047576

Lambert, S. (2008). A conceptual framework for business model research.

Lavalle, S., Lesser, E., Shockley, R., Hopkins, M., & Kruschwitz, N. (2011). Big data, analytics and the path from insights to value. *MIT Sloan Management Review*, *52*, 21–32.

Lazakis, I., Dikis, K., Michala, A. L., & Theotokatos, G. (2016). Advanced ship systems condition monitoring for enhanced inspection, maintenance and decision making in ship operations [Transport Research Arena TRA2016]. *Transportation Research Procedia*, *14*, 1679–1688. https://doi.org/https://doi.org/10.1016/j.trpro.2016.05.133

Lazakis, I., Raptodimos, Y., Theotokatos, G., Varelas, T., & Drikos, L. (2016). Ship sensors data collection & analysis for condition monitoring of ship structures & machinery systems. https://doi.org/10.3940/rina.sst.2016.13

Lind, M., Ward, R., Jensen, H. H., Chua, C. P., Simha, A., Karlsson, J., Göthberg, L., Penttinen, T., & Theodosiou, D. P. (2021). The future of shipping: Collaboration through digital data sharing. In M. Lind, M. Michaelides, R. Ward, & R. T. Watson (Eds.), *Maritime informatics* (pp. 137–149). Springer International Publishing. https://doi.org/10.1007/978-3-030-50892-0_9

McKinsey & Company. (2013). Open data: Unlocking innovation and performace with liquid information. https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/open%20data%20unlocking%20innovation%20and%20performance%20with%20liquid%20information/mgi_open_data_executive_summary_oct_2013.pdf

Mentimeter. (2022). Mentimeter homepage. https://www.mentimeter.com/

Open Data Institute. (2022). The data spectrum. https://theodi.org/about-the-odi/the-data-spectrum/

Open Knowledge Foundation. (2022). What is open data? https://opendatahandbook.org/guide/en/what-is-open-data

Osterwalder, A., & Pigneur, Y. (2010). *Business model generation*. John Wiley & Sons.

Ribes, D., & Polk, J. (2014). Flexibility relative to what? change to research infrastructure. *Journal of the Association of Information Systems*, *15*, 287–305. https://doi.org/10.17705/1jais.00360

Ritter, T., & Pedersen, C. L. (2020). Digitization capability and the digitalization of business models in business-to-business firms: Past, present, and future. *Industrial Marketing Management*, *86*, 180–190. https://doi.org/https://doi.org/10.1016/j.indmarman.2019.11.019

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/https://doi.org/10.1016/j.jbusres.2019.07.039

Torraco, R. J. (2005). Writing integrative literature reviews: Guidelines and examples. *Human Resource Development Review*, *4*(3), 356–367. https://doi.org/10.1177/1534484305278283

Van Gorp, N., De Bijl, P., D e Graef, I., Molnar, G., Regeczi, D., & Peeters, R. (2020). https://www.government.nl/documents/reports/2020/11/30/exploring-data-sharing-obligations-in-the-technology-sector

Wärtsilä. (2020). Will the shipping industry finally start sharing data? https://www.wartsila.com/insights/article/will-the-shipping-industry-finally-start-sharing-data

Wei, T., Feng, W., Chen, Y., Wang, C.-X., Ge, N., & Lu, J. (2021). Hybrid satellite-terrestrial communication networks for the maritime internet of things: Key technologies, opportunities, and challenges. *IEEE Internet of Things Journal*, *8*(11), 8910–8934. https://doi.org/10.1109/JIOT.2021.3056091

Wohlin, C. (2014). Guidelines for snowballing in systematic literature studies and a replication in software engineering. *Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering*. https://doi.org/10.1145/2601248.2601268

Yang, Z., Djurdjanovic, D., & Ni, J. (2008). Maintenance scheduling in manufacturing systems based on predicted machine degradation. *Journal of Intelligent Manufacturing*, *19*, 87–98. https://doi.org/10.1007/s10845-007-0047-3

Yin, R. K. (2018). *Case study research and applications: Design and methods* (Sixth Edition.). Sage Publications.

Zeleti, F., Ojo, A., & Curry, E. (2016). Exploring the economic value of open government data. *Government Information Quarterly*, *33*. https://doi.org/10.1016/j.giq.2016.01.008

Zuiderwijk, A. (2015). *Open data infrastructures* (Doctoral dissertation). Delft University of Technology. https://doi.org/10.4233/UUID:9B9E60BC-1EDD-449A-84C6-7485D9BDE012

Zuiderwijk, A., & Janssen, M. (2015). Towards decision support for disclosing data: Closed or open data? (J. Zhang, G. Puron-Cid, & J. R. Gil-Garcia, Eds.). *Information Polity*, *20*(2, 3), 103–117. https://doi.org/10.3233/ip-150358

Zuiderwijk, A., Janssen, M., & Davis, C. (2014). Innovation with open data: Essential elements of open data ecosystems. *Inf. Polity*, *19*, 17–33.

A
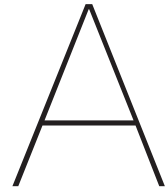
Interview Protocol

Interview Protocol in the case study
'Value creation through business data sharing'

1. Research & data sharing concept Introduction (±5 minutes)
(Goal: study background, research goals, recap informed consent)

First of all, I would like to thank you for participating in this interview. This interview is part of my final research project for obtaining a master's degree at the University of Technology Delft. The project is about how additional value can be created for firms by openly sharing their business data. Sharing business data openly may improve transparency, facilitate new collaborations and bring new insights to the firm. The concept of openly sharing data is relatively new to businesses and in order to find out if and how value can be created from sharing business data, I have created a conceptual framework based upon prior research. The aim of this interview is to gather information about Boskalis in order to test the conceptual framework and identify opportunities for value creation through business data sharing.

Prior to this interview, I have given you an 'informed consent' form to sign, which explains the goal of this research, the purpose of the interview, the potential risks of participating and the steps I take to mitigate these risks.

To collect, organize and process the findings from this interview I will be collecting personal data (such as your name and contact details) and I will be audio recording the interview. A potential risk of participating is that these personal data will unintentionally end up in the research report, exposing your identity. In order to mitigate this risk, the raw interview data (audio) will be stored securely at TU Delft, transcripts will not be made and the summaries of the interviews will be anonymized. An additional risk is that you unintentionally mention the names people involved in the examined case. If this happens, I will anonymize these names. The raw interview data can only be accessed by me (Rens Voogt) and my supervisor (dr. Anneke Zuiderwijk- van Eijk). When the research project is completed, I will immediately destroy the raw interview data.

If any questions arise during the interview or when something is unclear, feel free to interrupt me. The interview is planned to take about 60 minutes, so I may have to interrupt you when time is running short in order to finish all interview questions in time. If needed I welcome you to provide elaborations on answers via email.

I bundled my interview questions into sections about the company background, business data, the value of data sharing, decision criteria and implementation needs for data sharing. *In order to save time during the interview, I would like to ask you to answer questions Q1-Q5 under section two in advance via email along with the signed consent form.*

2. Participant & Company Background (± 10 minutes)
(Goal: get to know the company & participant's position)

I would like to start off by getting to know more about the company you are employed at and what your position at this company entails.

Q1: Can you tell me about the background of the company you are employed at and your department in particular?

Q2: Can you tell me about your position at the company? (job description, years of experience)

I have read that Boskalis' main clients are governments, port- & terminal operators, oil, gas and wind energy companies, mining companies and related contractors, shipping companies, insurance companies and international project developers. Is that right?

Q3: What value does your company deliver to the customer of Boskalis?

Q4: What are your company's underlying activities to bring this value to the customer of Boskalis?

Q5: Who are your company's main collaborating parties/suppliers?

3. Business Data (± 10 minutes)
(Goal: get to know what data is available and used at the company)

Now that you have introduced the company and I have a clear view of what the company is about, I would like to dive deeper into the fundament of what this research is all about: business data. Business Data means recorded information, regardless of the form or method of the recording, including specific business data contained in a computer database, of a financial, administrative, cost or pricing, or management nature. With this definition for business data in mind:

Q6: What kinds of business data are generated and available for employees at your company?

Q7: What kinds of this business data do you process as part of your work?

Q8: What kinds of data outside of your company do you collect/process as part of your work?

Q9: What kinds of data does your company not collect at the moment but might be useful or valuable for your work?

4. Data Sharing (±15 minutes)
(Goal: learn about the participant's view towards open business data sharing and link shared data business model [SDBM] to the company)

In my view of data sharing there are different degrees of sharing, depicted in the data spectrum (figure 1). The most transparent way of sharing data is as 'open data', which is defined as: *"… data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and sharealike." – Opendatahandbook.org.* Other ways of data sharing should be referred to as shared data, but they are often (strictly spoken incorrectly) referred to as open data as well. You can think of data sharing between partners with license agreements. Data that is kept within a company is referred to as closed data.

As mentioned in the introduction, open data sharing can bring value to a company in different ways. Before we dive further into how this value can be created, I would like to know:

Q10: What prior experience do you have with business data sharing at your company?

There are different ways in which value can be created by sharing business data. In figure 2 that I have handed over, there are fifteen shared data-driven business models (SDBM's), of which the value proposition and value capture mechanism are presented.

Q11: Which type of SDBM do you think would fit your company best, with the available data and partners in mind? And why?

5. Decision criteria based upon benefits & risks (± 15 minutes)

(Goal: identify benefits and risks of openly sharing data from the company and learn what concessions/mitigations should be undertaken to enable open data sharing or less open forms of data sharing)

Q12: What types of risks would you consider when openly sharing business data from your company?

Q13: Taking into account the value proposition of the SDBM that you chose in Q13, what benefits do you see from openly sharing your company's business data?

Q14: What measures or concessions with regard to 'openly' share data can be undertaken to mitigate the risks and exploit the benefits (through less open forms of data sharing), such as licensing or contract agreements on how the data is used?

Q15: What business data do you think then can be shared (either open and available to the public or shared with specific parties with license agreements)?

6. Implementation (± 15 minutes)

(Goal: Lean what practical implications the participant sees for facilitating data sharing)

In order to facilitate the business data sharing, there is the need for a business data-sharing infrastructure. This infrastructure requires particular functional elements and tools at a data producer (company) level and a user level.

Q16: What tools for facilitating data sharing do you think are needed at the data producer (company) level?

Q17: What tools for facilitating data sharing do you think are needed at the data user level?

7. Wrap-up (± 5 minutes)

(Goal: end interview, check if there is anything the participant would like to add, thank the interviewee)

The interview has come to an end. Thank you for your participation! The answers and insights you have provided in the interview will be used to further develop the knowledge on exploiting opportunities for (open) business data sharing. Your input will be helpful in further developing tools for identifying these opportunities and implementing (open) data sharing in practice.

Q18: Do you have any last questions or remarks?

Q19: Would you like to receive the final thesis report in which the results of this interview are used?

Thank you once again for participating in this interview!

B

Interview Summaries

Interviews were held as part of the case study discussed in chapter 3. The detailed summaries of these interviews are provided here in Appendix B. Nine participants have been interviewed in total, who all have given informed consent. For each participant, the general role within the company is given. The summaries are segmented into the five general topics that were discussed: Company background, business data, business data sharing, decision criteria based on benefits and risk, and the implementation of data sharing.

B.1. Interview 1

Participant no.	1
Role	Maintenance Manager

B.1.1. Company & participant background

The participant is part of the maintenance cell in the fleet management department of dredging of the company. In his function he manages large scheduled maintenance for vessels, such as the maintenance activities during docking. Next to that he supports other staff in smaller (unscheduled) maintenance activities. In his work, the participant has no direct contact with the end client of dredging activities, but rather reports to and supports other departments (business units) within Boskalis that do report to end clients. The task of fleet management is to support dredging activities of Boskalis by managing the equipment and (human) resources used. The external parties (a.k.a. parties outside Boskalis) that the participant has contact with are suppliers of equipment such as engines (Wärtsila, Caterpillar), but also docks and shipyards all over the world (e.g. in Singapore, Dubai, Netherlands, Curacao) that execute or facilitate maintenance. Contacts like these happen under contractual- and framework- agreements.

B.1.2. Business data

The data that is generated and used in the fleet management department (and by the participant in particular) is related to the maintenance of vessels. Examples of this data are workorders, maintenance data, machinery sensor data, operating hours, inventory management data, safety records, transportation data and budgeting. The data is stored and managed in different third-party software systems that are somewhat integrated with each other, but not fully. Data that is collected from outside the company includes independent analysis results of fluids like oils and fuels (from e.g. Veritas) and (real time) information of installed machinery which can be accessed through the supplier's portal (from e.g. Caterpillar). This data helps to check the status of machinery and plan maintenance.

B.1.3. Business data sharing

The participant has experience with sharing user data of machinery, such as engines, with their suppliers. A supplier can remotely access the user data and is also aware of prior defects as they have been reported to them in order to get fixed. Also, there has been an initiative called 'Maintenance in Dredging' (MiD) where problems and insights regarding common maintenance topics were shared at events among Dutch dredging companies. The goal of this knowledge sharing initiative is to increase efficiency and effectiveness of maintenance and thus enforce the dredging industry (https://mid-nl.org/).

The participant believes that data that enables competitors to provide a better product or service should not be shared. An example of such data would be the drawings of vessels that have been designed by the company itself, or data about parts that have been specifically engineered for practices that are related to the core business of the company. This type of data is what the company competes with. The participant thinks that data related to maintenance on basic installations (such as diesel engines that have been engineered by external suppliers) or prior defects would not bring any harm to the company or benefit to the competition, because that data does not relate to the core business of the company, and it is not something the company competes with.

About creating value through sharing data for improving the company's image, the participant seems hesitant between acting from an ethical perspective and a commercial perspective. For example, openly sharing safety data would indeed increase the image of the company, because it highlights the importance of safety to the company. However in the participants view it would also impact the competitive position, because the company does not stand out anymore with their exclusive safety knowledge towards their clients, because competitors can also provide that safety information now.

B.1.4. Decision criteria based on benefits & risks

The risks that the participant sees for sharing data is that competitors in the industry can use the data to adopt the same ways of working as the company. Therefore, only data that does not relate to the core business and does not influence the strategic position can be shared. Giving away data poses the risk of losing the company's strategic advantage, because receiving nothing in return for the data gives the competition an advantage. Therefore, the participant only sees a benefit from sharing data when agreements are made with competitors in the industry to all exchange their data, such that they all benefit from each other's data. This benefit translates to learning from each other's mistakes and insights. In order to mitigate the risks of data sharing, the participant believes that a thorough screening is necessary of what the impact is of sharing data. Themes that are important in the screening are e.g. the coreness and impact on the competitive position. Additionally, very close attention must be paid to the impact on the company's image, because it is listed (beursgenoteerd). The company has a responsibility to their stakeholders and impacts on their image has financial consequences.

B.1.5. Implementation of data sharing

To share the data, the participant thinks that some sort of portal is needed to make the data accessible. This can be part of the company's website and will bring value to the company because it shows that the company is willing to share data and hence positively impacts the company's image.

B.2. Interview 2

Participant no.	2
Role	Maintenance Manager

B.2.1. Company & participant background

The company is historically a dredging company specialized in creating coastal defense, land reclamation and maintenance on ports and rivers. The company increased its activities in the last two decades with offshore services, towing, heavy transport and salvage. The fleet consists of over 600 vessels. The company brings a full package of services to fulfill a project. To do so, the company bundles her resources and makes them work together to support the client from A to Z in a project. The participant works at the Dredging Fleet Management department. This department is responsible for the maintenance, crewing and performance of the vessels that are used at the dredging projects. The participant is involved in insurance claims, ship recycling and various projects aimed at facilitating data use in the maritime industry (e.g. OMDS and MARCONI). The dredging department has contact with external parties for their activities. There are contacts with other dredging companies for joint ventures, governments for projects, class societies for ships, ship builders for building the best dredging vessels in the world, shipyards for maintaining the vessels, logistics partners and suppliers for spare parts.

B.2.2. Business data

The company has various data. There is ships technical data, such as data about the machinery that is collected through sensors (e.g. rpm, temperature, pressures, vibrations and fuel consumption). Data about the production process is also collected (e.g. dredging speed and flow rate). Other data includes ship location data (GPS, speed, AIS), item data (external item information from suppliers/manufacturers), work order data, certificates, financial data and LTI (Learning Tools Interoperability) data. Having these data properly organized is important. For example, when using a lifting strap, the item data and certificates must be in order for safe working, insurance and transits. One of the types of data that the participant currently works with is Inventory Hazardous Materials (IHM) data, which includes item data of materials and work orders. This data is shared with a third-party organization that processes this data for certificates. According to the participant, the use of sensor data can be further exploited. Previous research has shown that sensor data can be used for condition based maintenance (CBM), but it is still in an infant stage. Multiple sensor data could for example be aligned and combined to optimize CBM, and the interpretation of sensor data could be improved through e.g. dashboarding to give meaning to the data.

B.2.3. Business data sharing

The participant referred to the MARCONI project when talking about the value of data sharing. He stated that in a competitive context like in a business, a company is only willing to share data when it is mandatory. And when it is mandatory, it often is not a problem to set up an infrastructure to share the data through e.g. dashboards. The participant compared it to the formula 1, where everything is kept secret apart from the e.g. the tires because it is mandatory. Other than that, the participant states that the company is very careful with sharing data. Sharing data may jeopardize a strategic advantage. For example, openly sharing data about the wear and tear of dredging components may tell something about the production process, costs and revenue. It is basically giving away the recipe for the core business of the company.

When it comes to only sharing data with specific partners, such as suppliers, the participant sees difficulty as well. When sharing user data with machinery suppliers, they may improve their machines. This benefits the participants company, but also benefits other users and enables the supplier to market improved machines. It is difficult to capture the full value of sharing the user data. The participant, however, also stated that in his experience user data is already remotely collected to some extent by a supplier of their engines.

When considering what data can be shared and how, the participant thinks that data which is not related to the core business of the company can be shared. One example is the OMDS initiative, where a 'one maritime data standard' is initiated. This initiative suggests a standard for item data, such that communication between maritime parties is more fluent and reduces administrative waste. When this standard is established, it also enables for a data pool about items, such as already established by 2BA (https://www.2ba.nl).

The participant does not see data sharing as a standalone business model that is suitable for the company, but rather thinks that sharing data should provide support for primary business practices. Initially, the participant did not consider improvements of the company's image as a possible value of data sharing.

B.2.4. Decision criteria based on benefits & risks
The participant thinks that data can only be shared when it is not related to the core business of the company. It should not jeopardize the strategic position of the company. Considering this criterium, the participant thinks that it may be beneficial to share user sensor data on basic machinery from suppliers that is installed on the vessels, such as engines. Sharing this data allows for better planning of maintenance and improvements on the machinery. This should however be done under contractual- and/or confidentiality agreements in order to mitigate the risks for the company.

The participant was presented with the possible value improving the company's image through openly sharing data related to safety. The participant however thought that it would also impact the competitive advantage of the company as competitors could now also access this information and hence provide their service more efficiently. Also, the participant considered that openly sharing data related to safety could harm the company's image as it would also expose the sometimes dangerous circumstances under which the company operates. A possible solution would be to then also emphasize the innovative measures that the company takes to mitigate the risks under these circumstances.

B.2.5. Implementation of data sharing
The participant states that there are already various tools available within the company which are used to process data and share the data within the company (e.g. Boskalis World, DredgeView). These are dashboards which can be accessed by those who need the data. For data sharing externally, similar types of tools can be used.

B.3. Interview 3

Participant no.	3
Role	Fleet Manager

B.3.1. Company & participant background

The company originally is a dredging company but has expanded its operations to multiple maritime services, such as building wind parks and laying cables on the seafloor. The Dredging Fleet Management department originally was the technical department which serviced the fleets vessels. Currently, the activities have expanded to crewing and providing support to other business units as well. These activities also entail inspections, nautical matters and compliance. The participant is one of the managers of fleet management. The company's activities are aimed at serving the high-end maritime market, delivering projects from A-Z and working together seamlessly with different business units and partners. External partners that the Dredging Fleet Management works with are suppliers of machinery (e.g. Pon, Wärtsila, Kongsberg, ABB) and shipsyards (e.g. IHC) for maintenance practises. Large maintenance on basic machinery such as engines is executed by the original end manufacturer (OEM). Another remarkable partner is one that is related to the crew, which is a supplier of food (IFS).

B.3.2. Business data

The participant states that there is a lot of data within the company and specifically at the Dredging Fleet Management department. This entails financial data, logistics data, maintenance data (e.g. lube analysis, vibration analysis, sensor data), location data (AIS) and data about office processes. Data like these are stored in data management systems (e.g. Maximo). The participant also uses data regarding safety, inspections and audits. Externally, data about the weather, voyage planning and item data are collected.

B.3.3. Business data sharing

In the participants experience, there is a remote equipment support project in which mechanical user data is shared with suppliers of e.g. engines. In the past, there has also been a big data project called 'SMASH' in which data about the wear on dredge pumps was shared with external parties in order to model the wear process and improve performance. This project however has stranded. Similar projects for improving engine performance stranded as well due to legal issues. Other occasions where data is shared is between the company and fuel suppliers (e.g. BBK) and between the company and e.g. Bureau Veritas, who analyze lubricants in order to detect maintenance needs. In response to the notion of machinery suppliers being able to remotely access user data, the participant stated these suppliers do not have full access to all information due to restrictions that have been due to security. The participant also stated that he too thinks that sharing technical user data about basic machinery, such as engines, with suppliers is a possibility and would not jeopardize the core business of the company.

Regarding the value creation through business data sharing, the participant thinks that sharing data can improve the image of the company. In view of the climate change and the according energy transition that we are in, the participant thinks that sharing data related to the environment and emissions can increase transparency and improve the image. Also, the participant stated that sharing data regarding safety is worth looking into. He believes that a company should not compete based upon an advantage in safety knowledge. In his suggestion, the participant mentioned geo-safety data. The participant brought up this idea prior to my (the interviewer/researcher) own suggestion for sharing geo-safety related data. Openly sharing data related to safety does however depend on the type of data. For example, when the company has developed safe ways of working and engineered special equipment for the task, a lot of resources have been invested in the solution and therefore the company would need more than recognition in return when sharing data about it.

B.3.4. Decision criteria based on benefits & risks

The participant stated that a risk for sharing data is that the company loses its strategic advantage and competitors will copy ways of working and equipment. The participant also noted that when certain data is shared by all parties in an industry, a level playing field is created. This means that all parties have the same benefits and risks because they all share the same type of data. An example of such a level playing field regards AIS data. All vessels are obliged by law to share their location data. This data can be accessed by anyone and therefore provides no competitive advantage.

The participant thought that the decision criteria for sharing data that were suggested during the interview were all relevant to the company. The participant also stated that the company probably will not initiate data sharing, because they are not in that type of business. However, when they are approached by an external party who wants to deliver a service for which data from the company is required, they are more likely to cooperate. In order to mitigate the risks of sharing data with a partner or the industry, the participant thinks that contractual agreements on how the data is used may be a solution.

Considering the criteria, the participants sees a couple of opportunities for sharing data. Safety related geo-data can be shared openly, to support safe working in the industry and boost the image of the company. Additionally, data regarding the food consumption within the company could be shared to boost the image. The company takes good care of their employees, and this is reflected in the food statistics. A last opportunity for sharing data is between the company and its client. Data about the dredging practices can be presented in a dashboard to the customer. Not only is this an additional service, but it also saves time on reporting to and communication with the client.

B.3.5. Implementation of data sharing

For the implementation of data sharing, the participant thinks the data should be presented in an attractive and user friendly manner (e.g. through a dashboard). Also, the data and dashboard should be interoperable, so that different datasets can be combined. After showing an overview of possible tools required for setting up a data sharing infrastructure, the participant pointed out that being able to categorize data, correctly name the data, visualize the data and pre-process the data for interpretation (into e.g. KPI's for decision-making) are important as well.

B.4. Interview 4

Participant no.	4
Role	Fleet Manager

B.4.1. Company & participant background

The company is originally a dredging company. Next to dredging, the company is active in the off-shore energy market, i.e. building offshore wind parks. The participant is part of the management of the dredging fleet management department. The activities of the company are building new land, helping its customers protect land against the sea and build new sea infrastructure. In their activities, the company considers a competitive price and harmony with nature. The company's main partners regarding production are suppliers of bulk materials (e.g. stone, fuel, steel, rubber). For fleet management, partners are shipyards, suppliers of machinery (e.g. Pon, Wärtsila, MAN diesel) and suppliers of workforces (e.g. Anglo-Eastern).

B.4.2. Business data

The participant segmented four types of data within the company, being financial data, operational data, technical data and personal data. Financial data is used in hindsight for bookkeeping, but also for strategic decision-making for the future. Operational data includes location data, dredging production data and performance data. Technical data entails maintenance data, item data and inspection data. Personal data is about employees. The participant uses all types of data in his work for management purposes and decision-making. From outside of the company, the participant gathers data for benchmarks (e.g. for salary indicators) and location data (AIS data) from competitors (e.g. for pricing strategy in tender processes). The company is also looking at gathering information from engine suppliers in order to create benchmarks for how the engines perform compared to other users. To establish this, the company is willing to share their user data. Commercially, it would be interesting for the company to also gather information about what projects are upcoming and which competitor dredgers have signed up for these projects. To access this information, the company has to also share their prospect knowledge in return. This way, the company runs the risk of sharing information which they exclusively had access to, and hence lose a competitive advantage.

B.4.3. Business data sharing

The participant states that he has little experience with data sharing initiatives at the company. Regarding the business models that are driven by data, the participant thinks that the business models 'improving primary process' and 'increasing quality through participation' are the most viable models. These models align with what the particpant previously said about sharing user data with engine suppliers. The participant stated: 'Sharing is the new stealing' (translated from Dutch: delen is het nieuwe stelen). Sharing user data with a supplier and receiving data and insights about 80 other engines is valuable. It allows for access to expertise and benchmarking, which helps to improve the performance of the company's machinery, which saves money. This does require a cooperative mindset of other users to also share their user data.

B.4.4. Decision criteria based on benefits and risks

The most important criterion for sharing data is that the data should not be linked to the cost price as it determines the competitive position. When keeping this in mind, the participant believes that the benefits of sharing data are the possibility to have experts look at the data and compare (i.e. benchmark) performance. This is possible, because the company extract no significant competitive advantage from their maintenance practices and engine performance.

A new insight that the participant gave is that he questions whether having access to information only has benefits. From experience, the participant believes that data access comes with a responsibility and when things go wrong, people may say 'you could have known because you had access'. Therefore, the participant thinks that one should be protected and only have access to the data that they need

for their work. In other words, the sharing of data should be regulated. The participant also highlighted the importance of filtering and reporting data to others. This would help to interpret the data better. It does however require excellent teamwork between the parties involved where communication is highly efficient.

Regarding the suggestion to openly share safety related geo-data, which is incentivized from an ethical perspective to improve the company's image, the participant is not too enthusiastic. The participant has a commercial stance and believes that the efforts the company put into collecting the data should at least be compensated financially or with a data contribution to the data pool. 'When everybody contributes and shares their data, there is no problem.' When everybody shares their data, a level playing field is created and all parties in the industry are equally competitive regarding that data. The participant does still note a bit of reluctance towards sharing the safety related geo-data, because exclusively having that data at hands serves a competitive advantage as it enables for a better estimate of a project.

B.4.5. Implementation of data sharing

For sharing data, the participant thinks that a proper legal framework is required for both the supplier of the data and the user of the data.

B.5. Interview 5

Participant no.	5
Role	IT Manager

B.5.1. Company & participant background

The company is organized into divisions. The IT department facilitates the IT infrastructure for all divisions, including dredging. The IT department is engaged in the digital workplace, information services, specialized software for primary business and data analytics. Additionally, IT has a transformation office that delivers new or adjusted services. The participant is responsible within IT for realizing IT solutions for new or adjusted services for divisions within the company. A priority for these solutions is to align with the business strategy and maximize the value of the solution. Parties that IT works with are mostly parties to which IT activities have been outsourced (e.g. Lenovo, Microsoft). These types of activities are commodities and they do not play a differentiating role in the company's business.

B.5.2. Business data

The participant distinguishes three types of data: master data, meta data and specialized data. Master data is data about employees (personal data), equipment (fleet data) and project data (e.g. dredging projects). Meta data is the data that is required to understand, find and use the master data. Specialized data includes data related to production, finance, tender calculations, commerce, nautical (e.g. AIS) and surveys (e.g. geo, wave, soil, weather and flow data). Examples of data which is collected from outside are AIS data and weather data. Also, divisions operating in the Netherlands make use of public ground data (so called 'Klic-meldingen') and the salvage division makes use of a database in which incidents are reported. According to the participant, IT services become more and more data driven, where conclusions and decisions are drawn from data.

The participant states that, regardless of the context, there should be only 'one data truth'. This means that there should be one source and one owner of data, from which the data is extracted. Otherwise, multiple versions of data can exist which is confusing and may result in the use of untruthful data.

B.5.3. Business data sharing

The participant states that the company has experience with open data sharing. Because the company is a listed company, they have the obligation to share an annual business report. Additionally, they publish various other reports, such as a Corporate Sustainability Report. Other open information can be found on the company's website, such as whitepapers about equipment in the fleet. In the IT domain, other data that is shared under licenses is user data of the software systems that are used in the company. This data can be used to optimize the software systems.

From the presented SDBM's, the participant concluded that most of these business models do not align with the core business of the company and will not add significant value to the business. 'Improving primary business', however, is something that is interesting to the company. The company is engaged in projects about optimizing processes in order to be more efficient and cut costs (fuel efficiency project). For such projects, the participant thinks that the IT solutions should be output driven. This means that first the envisioned output must be considered before consulting the IT and data resources. This way, there is better overview of the data and there is only access to the data that is required for the solution. There have been ideas in the past for collecting all sensor data from vessels, in order to then make soup from this huge pile of data (read: big data). However, facilitating this big data transfer from the vessels to shore required tremendous resources and it was unclear what the goal was of transferring all this data; the output had not been set yet. Often, the output of an IT solution is some sort of dashboard from which a user can draw conclusions and act accordingly. For this dashboard, the IT solution has gathered the required data and interpreted it so it can be used immediately, in the form of KPI's for example. IT solutions like these help to steer the behavior of users in order to optimize performance.

The participant appeared positive about sharing user data of basic engines on the vessel, as part of a community of more users who share their user data, in order to improve the performance of the engines and maintenance. In doing so, the participant noted that it should be well defined who the data owner is.

B.5.4. Decision criteria based on benefits & risks

The participant indentified a couple of risks related to data sharing. First, the company runs the risk of (implicitly) sharing data that impacts the commercial position of the company and provides benefits for competitors. Second, there is the risk of privacy infringement where personal data is accidentally shared. Third, there is a risk of sharing data without a proper explanation of the context (metadata). Fourth, there is the risk that the strategic advantage (through which the company differentiates itself from its competitors) is lost when business data related to the core business (models, ways of working and own engineering) is shared. Lastly, the participant sees a legal risk: data may be used against you when you share it.

One of the criteria for sharing business data that the participant highlighted was the currentness of the data. When the company is making an offer for dredging to a client (the tender process), that information is confidential. However, when the tender is completed and the project has been assigned to the company, most of the information regarding the tender is published. Additionally, sharing certain data like these is mandatory because the company is listed; i.e. a level of transparency is required. A criterion that the participant sees regarding a benefit of sharing data is the innovation opportunity.

In addition to the before-mentioned criteria, the participant also considered the fact that storing data and facilitating data sharing costs money. This should also be taken into account when assessing the value of data sharing.

With regard to the questions about which data can be shared with external parties, the participant agreed on the potential of sharing user data from basic machinery on the vessels (e.g. engines) to optimize the performance and maintenance. The participant responded positively when presented with the example of sharing safety related geo-data. The participant even added another type of geo-data (location of WOII bombs & mines) which is related to safety, which potentially can be shared. Possibly, this data is already shared because it is mandatory. This brought the interview to the recurring theme of data being mostly shared when it is mandatory. This is because competitors also need to share this data and then there is no strategic advantage to be gained from the data (level playing field, 'If everybody shares, there is no problem'). This was confirmed by the participant. Another occasion on which data is shared, is when it is obliged by the customer.

B.5.5. Implementation of data sharing

The participant stated that data is not the same as information, but you can turn it into information when you interpret it. It is only information if you can do something with it. Then you can gain value from it. An important way to do so is to visualize it through e.g. a dashboard. The participant referred back to the output-driven approach, where data should be used in such a way that the envisioned output (e.g. KPI's) is achieved. How to organize the data sharing infrastructure therefore highly depends on the envisioned output and its user (e.g. fuel efficiency or maximum production, manager or captain). Another thing the participant highlighted was the importance of having one data owner, is order to establish the 'one data truth' principle. This also means that there should be one data storage system.

B.6. Interview 6

Participant no.	6
Role	Fleet Manager

B.6.1. Company & participant background

This part of the interview was shortened as there was already an elaborate understanding of the background of the company and its partners. The participant is a manager at the dredging fleet management department who is responsible for the crewing and compliance in the dredging fleet management department. Activities of the participant include checking compliance of vessels, training of crew and previously covid management.

B.6.2. Business data

The participant uses different data streams in the company, which are managed in different data management systems. These systems somewhat overlap in terms of data contents, but they are not integrated into each other and require manual transfer of data. This is a burden in the intended 'one version of the truth' (read: one data truth) and hence leaves room for improvement. The types of data are related to crew, certificates and quality. These data are in compliance with the GPRS (global) and AVG (NL). Other data are related to the registration of incidents (which are linked internally to worked hours), finance and audits. The participant collects external data on benchmarks regarding port state, salaries and inspections (flags, class, machinery & hull). Data that the participant would like to have access to (which currently is not the case) regards a better real time overview of which workers are available at what cost in what part of the world (some sort of marketplace for crewing). Another valuable use of external data would be the integration of travel data into worked hour registration systems. This would make the manual hour registration process obsolete for travel hours. This could be set up in conjunction with the partner travel agency, who are highly automated.

B.6.3. Business data sharing

In the experience of the participant, there have been data sharing initiatives between the company and a shipyard (IHC). Other data sharing initiatives were between the company and Dutch competitors in the dredging industry (Maintenance in Dredging). This initiative was brought up as the companies saw no incentive to compete based upon maintenance practices in dredging at the time. However, this initiative is on the back burner and should be revived to bring value. According to the participant, companies are very reluctant to share their data. And when they share data, the data is of such low quality, too general, or too specific that it is of no value. For example, when sharing user data about engines and comparing that with the user data of other users, the circumstances under which those data are gathered can vary. This results in insights that are based upon an average. The context is not considered, and (a part of) the meaning of the data is lost. The participant also noted the fear for sharing user data with external parties, because it may reveal ways of working that the external party does not agree with or conflicts with previous advises. Fears like these keep companies from sharing their data.

With regard to the SDBM's, the participant deviated from the idea that money should be made from sharing data. The participant rather acts from the ideal that the world should benefit from sharing data and that the world should be preserved/sustained. For example, if sharing data can contribute to the reduction of emissions, that is sufficiently valuable. The company also aims to preserve the world in their dredging activities, such as collecting sand from a remote location in order to preserve the reefs at a more nearby location. The participant also states that revenue and profits are needed in order to run a healthy business, but this profit should be made from adding value to the world rather than doing things at low costs. Because most of the time when doing things at low cost, this is at the expense of the world's resources. The profits from adding value to the world flow from an improved image of the company. The transition from a profit making ideal towards a world preserving ideal takes time. However, in the current zeitgeist with the energy transition and climate agreements for the near future,

this transition in ideal is gaining momentum. Profit maximization at the expense of the world is 'not done' anymore.

Another point that the participant mentioned, based on internal experience, was that sharing data as open as possible maximizes the potential of people that have access. Keeping something from people will slow them down. This is in contrast with what has been said earlier by another manager (participant 4). The participant does however agree that it should be very well defined how the data is used when it is used. Currently, conclusions are drawn from fractions of datasets while those conclusions do not hold when looking at the full data set. This can be prevented by openly sharing the data.

Concisely, the participant things that data can be shared to serve value to the preservation of the world. In the current zeitgeist, this implicitly brings value to the company as it has a positive impact on the image. Secondly, efficiency improvements that reduce e.g. emissions may also serve a financial benefit to the company in the long run.

B.6.4. Decision criteria based on benefits & risks

The presented criteria appear usable to the participant and span wider than the criteria that the participant could think of. The largest risk of sharing business data is the losing a competitive advantage over competitors. It should therefore be clear whom you share the data with.

A premise of the participant for sharing data is that it should bring something in return. This can either be monetary value, new insights, a better world or an improved image. Criteria like extent, granularity, currentness and quality are criteria for which the participant thinks that they are important insofar that parties involved in the data sharing should align closely what type of data they are dealing with.

With regard to privacy and legal related criteria, the participant thinks that these are burdens rather than risks. It is often used as an excuse to not do something, while the participant thinks it is something one should simply deal with and move on.

Concisely speaking, the participant thinks that certain survey data can be shared openly. The composition of the soil influences the dredging process and therefore is closely related to the core business. Knowledge about the depth of the seabed has no strategic value to the company and can therefore be shared to e.g. create better sea maps. Even if the company were the only party to share their data, the participant sees no risk in doing so or loss of potential value for the company. Contrary, the participant believes that the value is creating a better world, because data that is already known does not have to be recreated and hence saves resources.

Upon the suggestion for sharing safety related geo-data, the participant responded positively because this data too does not bring a significant competitive advantage to the company and sharing it makes the world a better place.

B.6.5. Implementation of data sharing

The participant shared a text of wisdom in which the need for someone to stand up and do something when they want change is emphasized. Within the company there is also a companywide initiative to transform the leadership in which employees and managers work together. The value of each other's input is emphasized. So for the implementation of data sharing, the participant believes that having someone to stand up and set up such a project is required. Just start! The proposed tools can probably be set up and the most important take away is to just start and explore. Additionally, more people who act based upon the ideal to make the world a better place are needed, rather than those who only aim at making larger profits. From a more practical point of view, there should be an external party that controls the shared data pool. This party maintains the shared data and it is the only place where the data can be found in order to uphold the 'one data truth'.

A final remark from the participant is that it would be a major breakthrough and 'cool' if the company were to make the decision to openly share data, such as the safety related geo-data.

B.7. Interview 7

Participant no.	7
Role	IT Manager

B.7.1. Company & participant background

The participant has a career in IT management at the company and the according activities are translating business strategy to the IT infrastructure, with a specialization in security. The participant thinks about how technology and information can be used. The IT management department does not worry about commodity services, but only works on IT cases through which the company differentiates itself. Commodity services are outsourced to other companies, under a non-disclosure agreement regarding the data that is shared. Examples of commodities are software and hardware systems. These are mostly cloud based. The company has multiple commodity suppliers to not be too dependent on one supplier.

B.7.2. Business data

The participant mentions data that the company has inhouse includes tender data, production data, HR data and financial data. The examples of the data that the company has inhouse are immediately followed up by a couple of important topics to consider when dealing with data. For example, the quality of data must be assessed and up to a standard. Additionally, the characteristics of the data must be well defined in order to make it accessible and usable. Lastly, there must be a clear owner of the data. Personal data such as HR information must be well protected.

The company gathers market information from external sources. Additionally, the IT department gathers information about trends and threats in the IT industry. Furthermore, the company has a paid subscription for an independent IT analyst database (Gartner), from which knowledge can be gathered about the IT market and industry.

Not all data within the company is shared among all employees. There are degrees to which the data is shared internally. There are security classifications which vary from secret to confidential to restricted to internal to public.

B.7.3. Business data sharing

From experience, the participant knows that the company shares data openly on their website. Everything that can be found there is public. Other business data sharing happens at projects, where a client (such as the government) provides the company with data which is relevant for the project. After the project, the client requires the adjusted data back from the company. There are occasions where the company works together in joint ventures with competitors. Joint ventures can occur to spread the risk of a project of when the client wishes for it. In these joint ventures, data related to the specific project is exchanged as working together demands it. In these joint ventures, the company aims to work on their software systems to keep control of the data.

When presented with the overview of SDBM's, the participant states that they are very IT oriented and that the business models do not align with the core business of the company. The SDBM's rather fit the services of IT companies that oversee the commodities for the case study company. The participant considers the option to share geo-survey data that has been gathered by the company. What would be beneficial for the company is to create a data platform in which the company puts their data, and where industry competitors and other stakeholders can provide their data. Stakeholders include any other parties that collect survey data, such as researchers or fishing companies. We provide the public basis for a data sharing platform (like Boskalis World 2.0, but public). This can either be set up by the company alone, or in collaboration with friendly competitors from the industry or stakeholders. Parties have access to the platform when they contribute to the platform, which also increases the value of the platform. As the platform owner, the company has a competitive advantage of approximately a

year because we have access first to the raw data. Our data scientists then process the data for public use. These scientists are the best in the market because they want to work for the best platform in the market. The participant compares it to becoming a type of Google for survey data. The service the company delivers is free, but the product (input) is provided by the customers. This also eliminates the incentive for other stakeholders to create their own platform, because access to the platform is at no or a very low cost. Such a platform will therefore not be a milk cow, but the company will benefit from the spin-off of the platform because it is on top of the latest developments in the survey data market and it provides good PR value.

B.7.4. Decision criteria based on benefits & risks
One of the major risks that the participant identified was the misappropriation of raw data. Raw data can be interpreted in diverse ways and lead to different conclusions. To mitigate this risk, proper pre-processing must be done. The data should then be accompanied by proper meta data which explains the characteristics of the data and makes it better interpretable. There must be a standard for how the processing is done and how data is presented. In terms of value, the weigh off should be about what provides the largest value: the value of the potential competitive advantage of keeping data private, or the value of sharing the data? Therefore, core business data should not be shared. Sharing non-core business related data can improve the image of the company. One should keep in mind though, in case of setting up a platform for sharing the data, that the data sharing infrastructure should work flawlessly. If it does not, this would backfire the added value and instead damage the image of the company (or data provider). Setting up such a platform and upholding requires investments.

The participant thought the given criteria in the interview were relevant. The participant explicitly added 'value' and 'completeness' to the list. One other (new) criterion that the participant added, was related to similar data that other parties have, but from different locations or different contexts. If you have data about location A, and another company has data for location B, then there is a greater incentive to share your data because you know what the other company has in store for you and both parties benefit from a more complete dataset. The participant thinks that sharing data for nothing explicit in return is does not fit the company, as it is commercially oriented.

B.7.5. Implementation of data sharing
The quality of data must be closely assessed. Additionally, there must be a standard for how a type of data is presented. As previously mentioned, the data must also be accompanied by metadata which explains how the data can be used. The data should also be preprocessed by a specialist to mitigate misappropriation.

When setting up a data platform, it should not be seen as an extension of existing business, but it is rather an added service. In that way, the service is not in competition with others. It would be even better to set up the platform neutrally and independently from the company, by setting up another legal entity that owns and manages the platform. This gives the sense to parties that all collaborators have equal ownership of the data.

The participant states that the biggest hurdle in setting up such a platform is who will be the first one to share their data. Most data owners think their data is the best and other data does not meet up to their standard and therefore they should not share the data. But when it happens, and more people join the platform, the value of the platform increases. Within the Benelux, the participant thinks you need the four biggest dredging companies to be aboard. This requires a different mindset from people in the industry: collectively contribute to the development of the entire industry rather than protecting their data. A similar collective started a database about asphalt composition (PIM). This project was set up because the government demanded a system in which asphalt data was stored. Because all stakeholders in the asphalt industry shared the same challenge, they started a collective to cut costs. This collective proves that it is possible to create an independent legal entity, a platform, and a standard software system which is used by all parties. Sharing the data between the parties is still something that is worked on, because stakeholders are afraid that not all parties will contribute and share equally; when you share something, you want something in return of at least an equal value. Parties are hesitant about the latter because there still is a sense that their own data is superior. This reflects a level

of distrust. According to the participant, solving the trust issue is a matter of time; it takes time to build trust. Additionally, the independent entity that manages the data platform can enforce an equal contribution among contributors and communicate (e.g. publish information) about the contributions. This touches the image of contributors and creates an incentive to contribute to the best of their ability.

B.8. Interview 8

Participant no.	8
Role	Information Manager

B.8.1. Company & participant background
The company background has become clear from other interviews. What can be added is that there is a transition ongoing in the company culture where emphasis is put on working together more effectively to maximize performance, rather than executing what the management team decides to do. The participant has a background in merchant shipping, SHEQ and nautical business. Currently the participant works at the Dredging Fleet Management. Activities include optimization practices in fleet maintenance by making better use of available resources.

B.8.2. Business data
The participant noted that there is ambiguity about what is addressed by the term 'data'. Most people think that data only is sensor data. The participant agrees with the definition for data that I have provided in the interview. Data that is generated within the company includes sensor data from vessels, maintenance data from maintenance management systems and technical data, such as drawings of vessels or components. The participant states that data regarding maintenance includes damages and incidents. The company aims to learn from these data to prevent similar damage/incidents and optimize maintenance practices in the future. External data that the participant mentioned which is collected from other parties (outside the company) includes reports of subcontractors about maintenance on the company's vessels (such as maintenance on engines), fuel prices (BunkerWorld) which are visualized in an internal knowledge management system, and analysis results of fuel and oil samples. Lastly, the participant mentioned the collection of weather forecast data. To the question of what external data is missing and would be valuable for the company, the participant replied that one does not know what they miss when they do not know it is there.

B.8.3. Business data sharing
In the experience of the participant, the company does not have a lot of experience with (openly) sharing data. The only experience that the participant has is sharing data about vessels on a compliance basis. Data about fuel and travelled distances must be shared and this is mandatory by law for all vessels. For the company itself there is no other reason for sharing this data other than compliance. This data is shared with a auditory party (Veritas), anonymized and stored in a database from the IMO. Based on this information, benchmarks are set for the status quo and climate goals are set. In this example, the participant notes that the context for the data is lacking because the dredging vessels use fuel when they are dredging as well as while travelling. Relating fuel consumption and travel distance therefore causes a distorted picture; especially when it is compared to e.g. merchant vessels.

Another example of data sharing, in which the participant was involved, was about the impact of sucking up WOII bombs while dredging. This research was commissioned by the government. Information about e.g. vessels was shared with research institutes, but this was done under strict non-disclosure agreements. The reason for the company to cooperate was because it would contribute to the safety of the entire dredging industry. It was a moral decision.

Upon the notion of data being shared about basic machinery (such as engines) with suppliers, the participant replied that he is not sure if this happens. The participant is aware that it is certainly possible and that engine suppliers already can provide services in which they remotely can access user data from the engines to monitor the performance and service the engine if needed.

Regarding the value of sharing business data, the participant thinks that directly generating revenue from sharing data does not fit the business model of the company. It is not the core business. The participant does see a value in sharing data with clients (e.g. governments), because these clients

often want access to the information. Currently, this involves manually reporting the data to the client. It would save a lot of administrative steps if data could directly be shared with the client in the form of e.g. a dashboard. Another value, which is implicit, is a growth in recognition of the company. By sharing data, the company can fulfil a social responsibility by sharing data from which more people can benefit (without hurting the commercial interests of the company). According to the participant, it is part of world citizenship. Lastly, the participant can also imagine that data can be shared with research institutes to make the world (or industry) a better place. This would however require proper anonymization or a non-disclosure agreement and can only be done with data that does not impact the competitive position of the company. Making the world a better place in itself is valuable, but the value in return for the company is, again, recognition and an improved image. Seeing this value in sharing data requires a transition in the stance that a company takes. Originally, a company has a commercial point of view but with regard to seeing the value of sharing data, a moral point of view may be more suitable.

B.8.4. Decision criteria based on benefits & risks

Risks that the participant sees are related to losing the competitive position. Data related to the core business of the company should not be shared; just like a chef does not share the recipe for his best dish. Another risk is the misappropriation of the raw data. Therefore, the raw data should be presented such that the context is clear, and that the data can be interpreted easily. 'The numbers should be relative rather than absolute'.

In response to the possible benefit 'Innovation Opportunity', the particpant again mentions the opportunity to make the world/industry a better place. If there is the possibility to contribute to the safety of the dredging industry, then the participant sees value in sharing safety related data. 'We should not compete on safety matters'. The flipside of the coin however, is that safety data can be related to the core business. The company tries to differentiate itself (or stand out) in her practices; that includes dredging but also the in-house knowledge. This contributes to being a partner for clients which delivers dredging projects from A to Z. Additionally, the safety data directly impacts the ways of working which requires engineering in the dredging process.

B.8.5. Implementation of data sharing

The participant sees the infrastructure for data sharing as a sort of data shop or data marketplace. This data shop is meant for internal use in the company in the first place, but it does have a portal for external parties, who can access a part of the data shop. In this shop, the external party can see which data is available for them, and if they are interested, they can make arrangements with the company to share the data. These arrangements can vary from data sharing on an open basis, to data sharing under non-disclosure agreements.

On a final note, the participant stated that it is important for the company to be aware of the added value or impact that a company can have on immaterial things, such as social responsibility and world citizenship. Even a company with a commercial interest can have a moral incentive to make the world a better place when it does not harm their business model.

B.9. Interview 9

Participant no.	9
Role	Data Scientist

B.9.1. Company & participant background

The participant is a data scientist and manages a team that is involved in all activities related to the use of data at the dredging department. These activities lie in the data science and technical domain as both data science and engineering are done. This is also why the team is interdisciplinary. Examples of activities are software development, automation and developing data analysis tools. External parties that the participant works with are external data consultants. Additionally, the company is connected to DigiShape.nl, which is a partnership where companies work together on different projects. The water industry entails both the maritime (sea) industry and the inland water industry. In this project, the company receives datasets which are ready for machine learning tools. Currently, no data from the company is shared to DigiShape.nl; data is only extracted. This will possibly change in the near future; the company is looking into sharing small datasets. Lastly, external data suppliers and external software developers are contacted for work.

B.9.2. Business data

The data from within the company that the participant mainly deals with is sensor data which are installed on the vessels in the fleet. This is a tremendous amount of data. Other types of data that the participant works with is referred to as contextual data. This includes geo-referenced data related to e.g. safety. This data is collected through surveys and is displayed on a map in a data management system. The contextual datasets are very small compared to the sensor data.

Externally, AIS data, weather forecasts and nautical maps are bought on a contractual basis. These nautical maps contain points of interest (PoI) and Areas of Interest (AoI) such as harbors or warzones. All this data is also displayed on the map in the data management system. Also, data which is openly shared by research institutions (e.g. NASA and universities) is used by the data scientist. Other external data includes data which is shared by a client when a tender project is aired. This is a batch of data that sets the working conditions and boundaries for the project (e.g. environmental data, local survey data such as buoy data, biodiveristy). Lots of this data that is shared by the client is not standardized. Manual preprocessing is required in order to make the data ready for use. And even after the preprocessing, data can be hard to timely analyze when they have been provided in an inconvenient way (e.g. on paper). According to the participant this preprocessing is a burden for all dredging companies in the industry and how well this processing is done is not a point of competition. Additionally, the participant thinks the preprocessing is only a temporary burden as digitization in the industry will resolve the issue in the next five to ten years. This entails that a standard must and will be created in the view of the participant. The participant also notes that having a standard increases the accessibility of data, which helps in openly sharing data. Increasing the accessibility of the data also makes the data more interesting for use for parties outside of the industry (e.g. water related data may also be interesting for the local water authorities).

B.9.3. Business data sharing

Regarding the experience with business data sharing, the participant mainly mentions data sharing where data is harvested from outside of the company. These were additional examples that answered question 8 and these have already been discussed in the section above.

In response to the presented SDBM's, the participant replied, just like participant 7, that these SDBM's do not match the core business of the company. The company is a contractor in the dredging industry; not a seller of data. It is simply not the role of the company. More probable is that the company will gather data from other companies who have SDBM's like these. The participant also states that the company is an end-station in terms of data; the data that the company generates is not interesting to

other parties other than the competitors, because it is closely related to the core business. For purposes other than dredging, the data is of no use. To this statement, I replied that there must be data that is generated in the company which is not related to the core business, such as survey data. In response to this, the participant said that survey data related to weather is always measured at projects, which can potentially be shared with universities for research purposes. This is possible because the data is not related to the core business and does not provide a competitive advantage. Other survey data, related to e.g. safety (H2S measurements) can also be shared according to the participant.

Another way in which value can be created from data is sharing survey data regarding the sea and the seabed. Currently, expensive sea maps are used at the office with an unnecessarily high resolution. If all vessels would share their sea and seabed data, an open sea map like google maps could be made. There already is an initiative for this, but it is not flawless (openseamap.org). Another data sharing initiative regards openly sharing bathymetric data (GEBCO). The aim of this initiative is to make a map of the ocean floor available to all by 2030. The company (and other parties) can contribute to this initiative by sharing their survey data after they have finished a project, to update the ocean floor map and increase its resolution.

What the participant did mention was that the relationship between the client and the contractor can be improved through (improved) business data sharing. This aligns with the aforementioned notion of creating a standard for sharing tender data from clients with contractors. Improving the relationship between the company and the client is associated by the participant with creating more transparency, which is a proven value of (openly) sharing data.

B.9.4. Decision criteria based on benefits & risks

The participant was presented with an overview of decision criteria for sharing data. The participant underlined the importance of taking coreness and the impact on competitiveness. This forms the highest risk because it directly impacts the business results. Regarding the data that was previously discussed, the participant sees no direct risks regarding privacy. Additionally, legal risks of do not form a serious hazard in data sharing according to the participant, because the company already spends resources on compliance. Regarding the data metrics (such as quality and extent), the participant said that proper metadata should be included to the data. Adding metadata minimizes the risk of misappropriation and increases the opportunity for innovation. Also, it makes the datasets easier to find and reduces the risk of legal issues (if any) because the metadata can describe the data and its context in detail, which makes the user more aware of what they deal with.
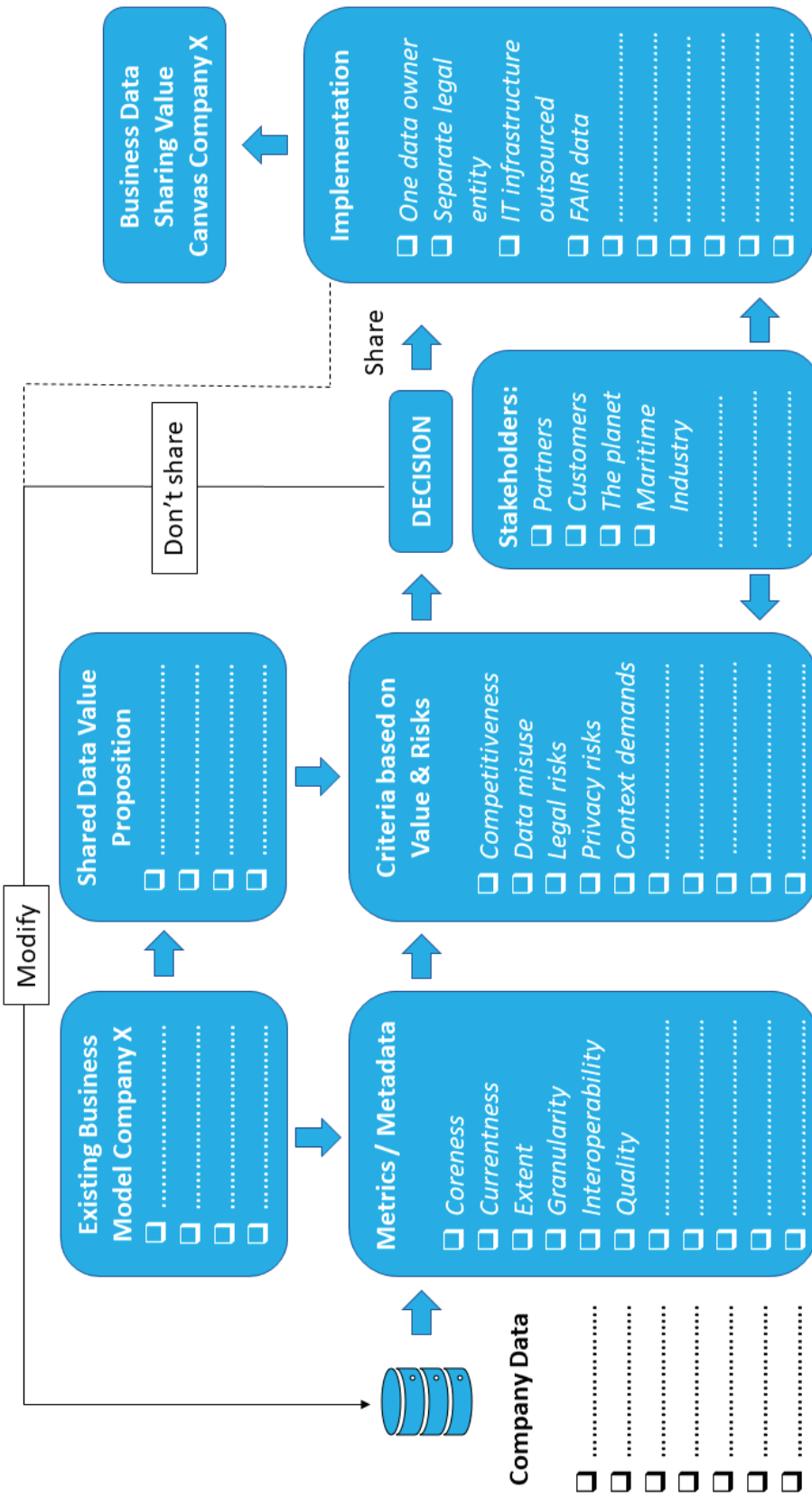
B.9.5. Implementation of data sharing

The participant referred to, regarding openly sharing data, the concept of 'FAIR' data. This is an abbreviation that stands for Findable, Accessible, interoperable and Reusable. These are pillars which are required for openly sharing data.

For all data sharing, an IT infrastructure is needed for digitally sharing data. The participant described a flow of IT building blocks which are needed for processing data. This flow of building blocks is common in the company and works as follows: First the raw data is gathered through an ingestion system. This raw data must be stored. After that, the raw data is 'cleansed', which means that it is processed such that it is usable and of a level of quality. Next this 'clean' data is stored in a separate place. After that, a data exposure layer (e.g. and API) or interface is needed for an external party to access the data. Part of this exposure layer is the security of the data. After this layer, there is a visualization layer, such as a dashboard. Systems (IT infrastructures) like these are also offered by companies like Microsoft.

C

Workshop Worksheet

Business Data Sharing Value Creation Framework

Business Data Sharing Value Canvas Company X

Implementation
- ☐ One data owner
- ☐ Separate legal entity
- ☐ IT infrastructure outsourced
- ☐ FAIR data
- ☐ ☐ ☐ ☐ ☐ ☐ ☐

Share

DECISION

Don't share

Modify

Stakeholders:
- ☐ Partners
- ☐ Customers
- ☐ The planet
- ☐ Maritime Industry
...

Shared Data Value Proposition
- ☐ ☐ ☐ ☐

Criteria based on Value & Risks
- ☐ Competitiveness
- ☐ Data misuse
- ☐ Legal risks
- ☐ Privacy risks
- ☐ Context demands
- ☐ ☐ ☐ ☐ ☐ ☐ ☐

Existing Business Model Company X
- ☐ ☐ ☐ ☐

Metrics / Metadata
- ☐ Coreness
- ☐ Currentness
- ☐ Extent
- ☐ Granularity
- ☐ Interoperability
- ☐ Quality
- ☐ ☐ ☐ ☐ ☐ ☐ ☐

Company Data
...
☐ ☐ ☐ ☐ ☐ ☐ ☐

Additional notes:

Business Data Sharing Value Canvas

Data source; where in the company is the data collected?	What is done with the data?	Value Proposition	Via what channels is the data shared?	Partners/Collaborators/ Contributors
Non-core business related engine sensor user data	Collected, cleaned, analyzed, compared	Improving quality through participation	Login portal	Engine users from the industry

Infomediary; Who extract, aggregate & transform data	Resources	Risks	Efforts & requirements	Data Users
Engine manufacturer	IT infrastructure	User data is used against the company by manufacturer	-Proper meta data -One data truth	-Engine users from the industry -Engine manufacturer

Company Benefits	Public Benefits
-Better quality engines -Better benchmarks -Access to external advise → better maintenance	-Better quality engines -Better benchmarks -

Additional notes: