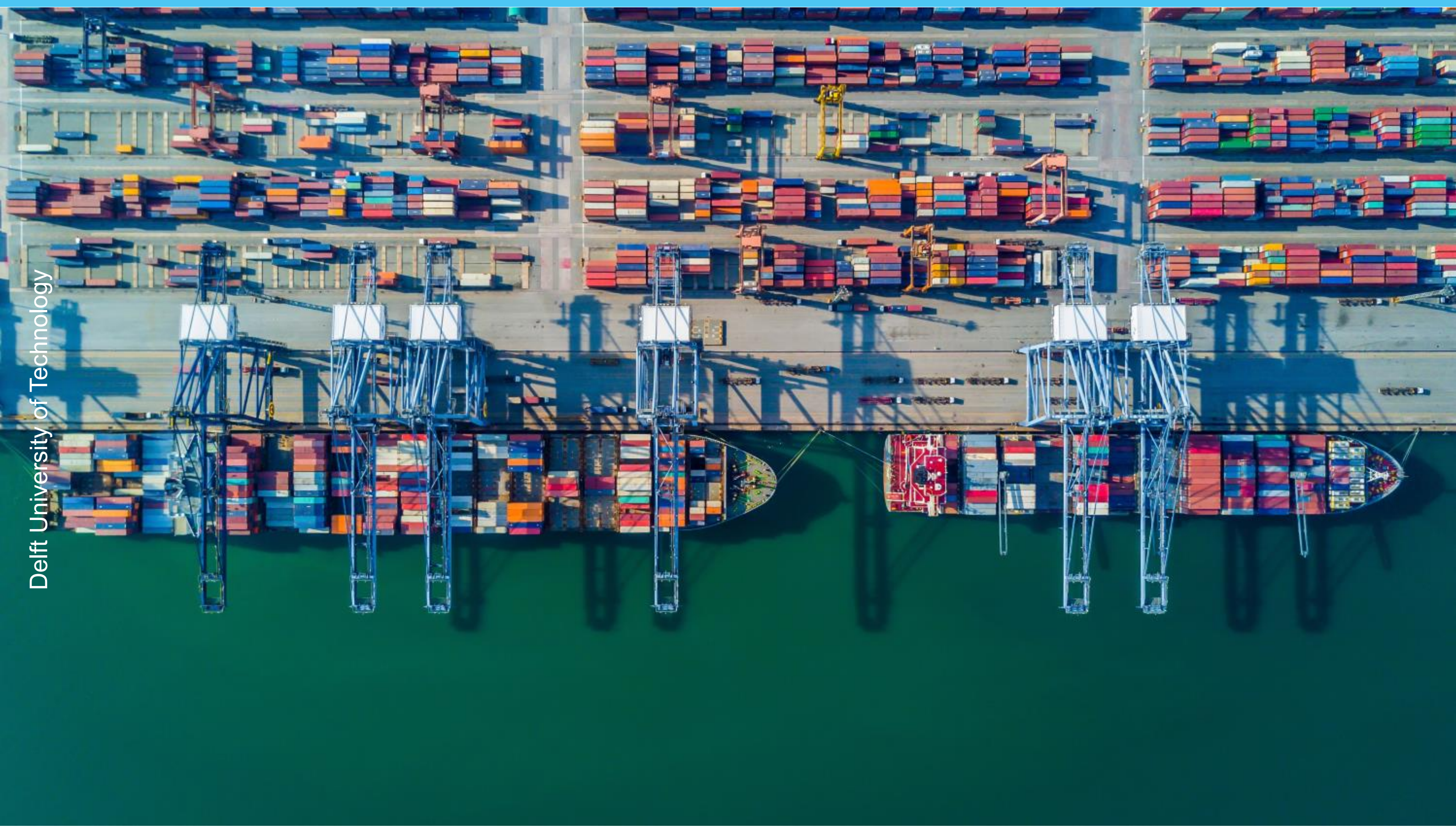
Mapping inter-organizational data governance mechanisms in the container supply chain

Case study for the Port of Rotterdam

TIL Thesis

M.P.H. van Adrichem



Delft University of Technology

TU Delft

Port of Rotterdam

Mapping inter-organizational data governance mechanisms in the container supply chain

Case study for the Port of Rotterdam

by

M.P.H. van Adrichem

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Dedication

This Master thesis is dedicated to my grandfather.

”That you may become a good engineer.”

Aad van Winden

Preface

This Master thesis is written for the TIL5060 TIL Thesis course which is part of the Master Transport, Infrastructure & Logistics at the TU Delft. This research has been conducted in collaboration with the Port of Rotterdam (PoR) and is the final step towards obtaining the degree of Master of Science.

The process of writing a Master thesis is one of trial and error. Starting with a first acquaintance at the Port of Rotterdam brainstorming about a research topic. After that refining this thesis idea in order to form a commission, followed by a next iteration of the research proposal. Still I was uncertain about the methods to apply. However, finally after many interesting conversations about the port community, data-sharing and many other topics this thesis took shape. To me the port environment was always a point of interest initiated by a tour on the ”Spido” through the port, but also because of my affection for Rotterdam. I already gained some experience in the field of the maritime sector by writing my Bachelor thesis about synchromodal transport. However, the topic of data governance was completely new to me. This research provides me with useful insights regarding ecosystems, adoption of innovations, collaboration and sharing information, but also warmed my feelings for the maritime sector even more. You could say, it is also reflected in my name as Marinus means *of the sea*.

This Master thesis would not be possible without the help of many people. First of all I would like to thank my supervisor of the Port of Rotterdam Pieter de Waard for his dedication and support during my project. You gave me a warm welcome at PoR and stimulated me by discussing various topics and provided me with some relaxation with laughter from time to time. I also want to express my gratitude to Arjan van Binsbergen, first supervisor of TU Delft, for his positive feedback and critical view on my thesis. I also would like to thank Anneke Zuiderwijk-van Eijk for her knowledge in the field of data governance and her always constructive feedback. I also want to express my appreciation to Lori Tavasszy for being chair of my commission and helping me out with the methodology and structuring my research.

On a personal note I want to thank Martijn, my fellow student, for having discussions about our researches and the dynamics in the maritime sector, mental support and the coffee life-hack at the TPM-faculty. Foremost I want to thank my girlfriend Ellen for supporting and encouraging me in this process and for having a critical look at my research. She also cheered me up when I was in a mental breakdown (again) and brought me some relief. I love you.

Last but not least I want to thank my family, in particular my parents Peter & Ellen, my brother Milan & his girlfriend Nika and my grandmother for giving me the opportunity to study and providing me with the safe environment in which I could learn and develop myself.

By finalizing this Master thesis my study years come to an end and therefore I can call myself ”engineer”. However, it is also a beginning of new opportunities and encounters in which I can apply my acquired knowledge and experiences. Therefore, I will always carry with me the promise to my grandfather to be ”a good engineer”.

I hope that this research will give you as a reader stimulating insights in the field of data-collaboration in the context of the container supply chain. If you are further interested in this research, feel free to reach out!

Marijn van Adrichem
Delft, September 2022

Summary

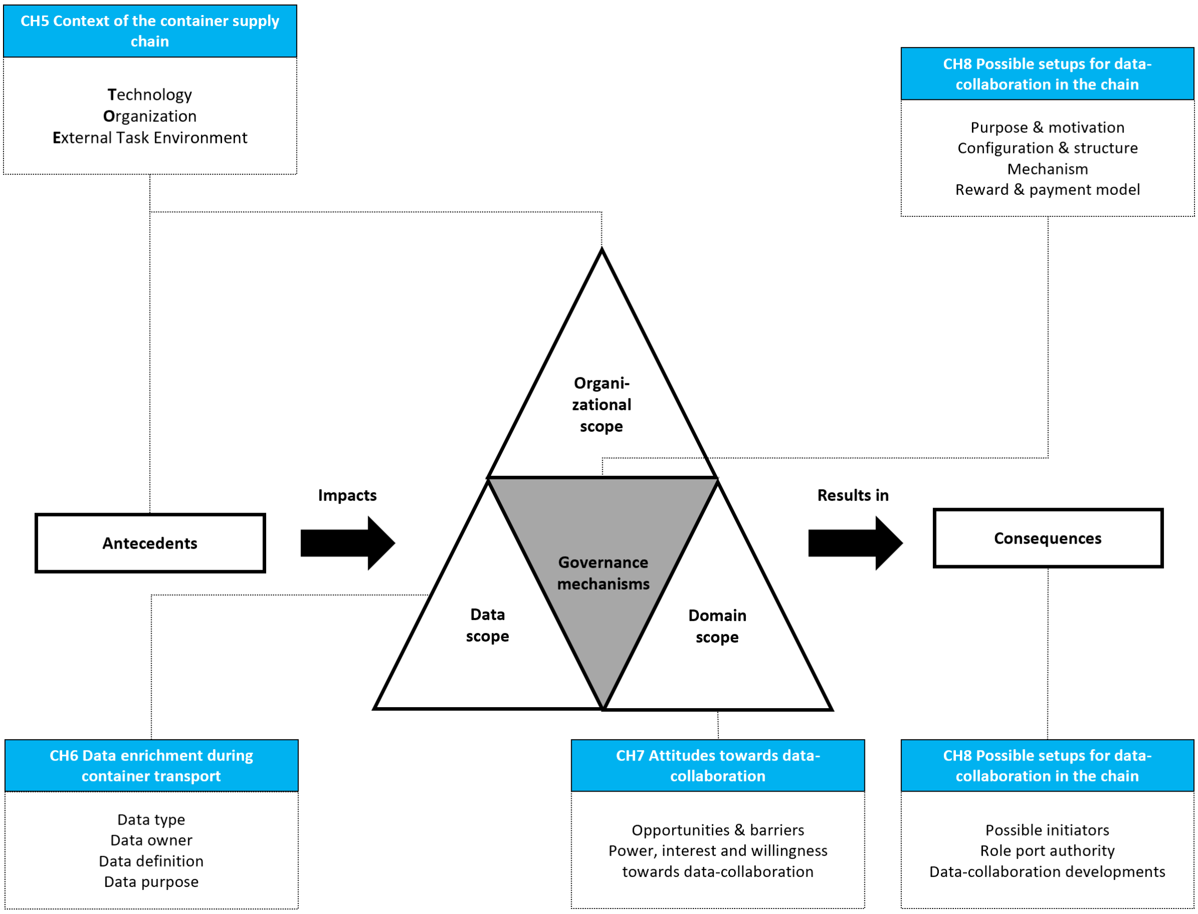
Data-collaboration is a promising concept for improving overall performance of the logistics system. Potential benefits are related to: efficiency gains, reduction of errors, faster flow of containers, improved customer service and safer logistics. However, not all involved parties are willing to collaborate unconditionally and data-sharing initiatives run into a number of barriers: trust, competition, privacy, but also information and power asymmetries have an impact on the willingness to collaborate. The right mix of inter-organizational governance mechanisms could be helpful to setup new data-collaborations within a port ecosystem. Inter-organizational data governance is defined as the formal and informal rules by which data-sharing is made possible between different parties. Little researched has focused on combining both inter-organizational and data governance. Especially not in the context of the container supply chain. Therefore, the aim of this research is to map which data governance mechanisms are suitable for improving data-collaboration in the context of the container supply chain. Leading to the following research question:

Which inter-organizational data governance mechanisms could improve data-collaboration among stakeholders participating in the container supply chain?

The overall research follows the design of a case study. By systematically describing the case of data-collaboration in the container supply chain, questions about why data-collaboration takes place (and why not) and how this data-collaboration can be improved should be investigated. In order to do so, different sources has to be consulted to get a balanced description of the case. This research applies three methods: multi-actor analysis, developing an inter-organizational data governance framework and expert interviews. First the involved actors were analyzed resulting in the following set of actors: carrier, customs, freight forwarder, inland shipping, knowledge hub, data-platforms, Port Community System, inland transport operators, shipper and terminal. Then an overall inter-organizational data governance framework was developed which structured this research (Figure 1). This framework is based on previous research about data governance. The case study is described using different aspects of that framework. Input is generated by interviewing 13 interviewees which are all part of a different actor group following the multi-actor analysis. Those interviews consisted of open questions and were used throughout the research to describe the case study. Also an internal evaluation session was conducted with the Port of Rotterdam to validate the outcomes of the interviews. Also three validation interviews were conducted to validate the overall outcomes of this research.

The governance framework is developed by reviewing previous data governance research and followed the design of Abraham, Schneider, and Vom Brocke (2019). The case study is described using the aspects of this governance framework. First the antecedents, or the description of the container supply chain, of the framework in Figure 1 are analyzed. Due to the traditional nature of the maritime sector, adoption of innovations requires time and effort. The commercial incentive, for logistics parties, is as important as the logistics perspective itself. The container supply chain is a competitive environment with many different parties providing the same services where it is difficult to differentiate. The profit margins for the involved actor groups is also unevenly distributed varying from negative profit margins to higher positive margins. This makes that parties are sometimes skeptical towards data-collaboration or collaboration in general. All companies have their specific scope, tasks and objectives which makes it complicated to align incentives and collaborate. The purpose, definition and characteristics of the data can be unclear for the involved stakeholders. Therefore it is important to describe in detail what the definition of a particular data-set is, who the owner is, with whom the data is shared and for what purpose. By doing so, goals and incentives of data-collaboration can be more aligned.

Figure 1: Overall data governance framework based on Abraham et al. (2019), Tornatzky et al. (1990), Van den Broek and van Veenstra (2015), Lis and Otto (2021) and Gelhaar et al. (2021)



The interviewees identified five categories of data-requirements related to: ownership, data quality, standardization, trust and security. Without taking the requirements into account, data-sharing will not take place. The consideration regarding data-sharing of companies is dependent of the experienced opportunities and barriers. Four categories of opportunities could be deduced from the interviews: future proof supply chain, effective logistics, efficient asset utilization. Those categories consist of: a more effective and efficient supply chain, reduction of greenhouse gas emissions and improve adaptiveness to disruptions are major advantages of data-sharing. Also four categories of barriers were identified by the interviewees: competitive position, business model, attitude and data-sharing standards. Those categories consist of: risk for their individual competitive position, the monetization of data, confidentiality of data and lack of trust are major disadvantages of data-sharing. When a stakeholder considers to share data, a weighted decision against opportunities and barriers will be made.

The willingness towards data-collaboration is dependent on the stakeholder himself, the involved other stakeholders and the data which will be shared. Based on the findings of this case study, the position of the freight forwarder will be mainly at stake, due to the fact that they do not own the real transportation assets. Data-platforms could take over their role in the chain. The port authority, Port Community System and customs are positive towards data-sharing because this can improve logistics and administrative processes and overall performance. However, those parties do not own valuable for the supply chain themselves. Terminals and carriers are powerful parties in the supply chain and do not see the urge to collaborate due to their high profit margins. Besides, the terminals and carriers are skeptical towards providing insights about their internal performance, because of commercial reasons. Lastly, inland transport operators will most likely benefit the most from data-collaboration because data-sharing could lead to less waiting times at the terminal. However, they do not have the power to force parties to share the required data with them.

After describing the case study, a new data governance framework is developed based on previous data governance research (Figure 2). A selection of data governance dimensions and characteristics, mainly based on two papers by Gelhaar et al. (2021); Lis and Otto (2021), is made by evaluating the case study. This resulted in a framework consisting of seven dimensions: purpose, motivation, configuration, structure, mechanism, reward and payment model. The foundation of a data-collaboration consists of the purpose and motivation dimension. The governance structure is selected based on this foundation and consists of the configuration, structure and mechanism foundations.The further implementation of a data-collaboration focuses on what will be given in return for sharing data. This layer consists of the dimensions reward and payment model. Based on this framework three most obvious archetypes regarding data-collaborations were developed. These most obvious archetypes were based on the description of the antecedents and the findings of the interviews and resulted in the following archetypes: regulate data, buy & sell data and data-for-data. Regulate data could be done via regulations or agreements. Buy & sell data is a market form of data-sharing, which will be mostly applied by data-platforms. Lastly, exchange data could be done in cases where both parties have valuable data for each other. Those three archetypes could be applied by different kind of actors. Regulation of data can only be done by parties which have the power to force parties to share data. This could be regulatory bodies like the Interorganizational Maritime Organization (IMO), European Union (EU) or in some cases the port authority. Shippers could also enforce total visibility of their shipments via booking agreements. As stated before, platforms would mainly apply buying & selling data in order to retrieve data and provide data-services to their clients. Data exchange will only happen if both parties have something valuable in return. However, also in this case it is important to know what the value is of the data-sets which will be shared. The Port of Rotterdam port authority also reflected on the developed archetypes and mentioned that it could help to define their role regarding the development of data-collaborations. Port of Rotterdam also stated that it could very well be that all archetypes could be valuable to different data-collaboration cases.

Concluding, there is no *one fits all* solution for data-collaborations. Therefore, each specific case asks for other conditions and agreements. These archetypes could be used by the port authority and Port Community System to open-up discussions and develop new data-collaborations with partners. Data-providers and -users, for example inland transport operators, could use the framework to discuss how to setup new data-collaborations and what should be taken into account. Platforms could adjust their data-services and make these more fit to their users by addressing the notions of the framework. From a scientific point of view, this research first combined both inter-organizational and data governance and second applied this on a practical case, the container supply chain. Future research could focus on further describing and validating the developed archetypes, evaluating the value of data-sets by applying a game theoretical approach and investigating the legal basis of data ownership.

Based on this research the following key takeaways should be noted:

- Commercial incentives are as important as logistics incentives to stakeholders in the competitive supply chain of containers.
- There is no *one fits all* solution regarding data-collaborations. The willingness towards data-collaboration of a stakeholder is dependent on the stakeholder in question, the other stakeholders involved and the data which will be shared.
- Based on previous data governance research combined with the context of the container supply chain, three data governance archetypes are developed: regulate data, buy & sell data and data-for-data.
- The data-governance archetypes help to open up discussions and develop new data-collaborations. Besides it can help stakeholders to define their role in the container supply chain regarding data-collaborations.
- Future research could further describe and evaluate the developed archetypes, evaluate via an game theoretical model what the distribution of costs and benefits of a data-collaboration could be and finally investigate what the legal basis of data-ownership entails.

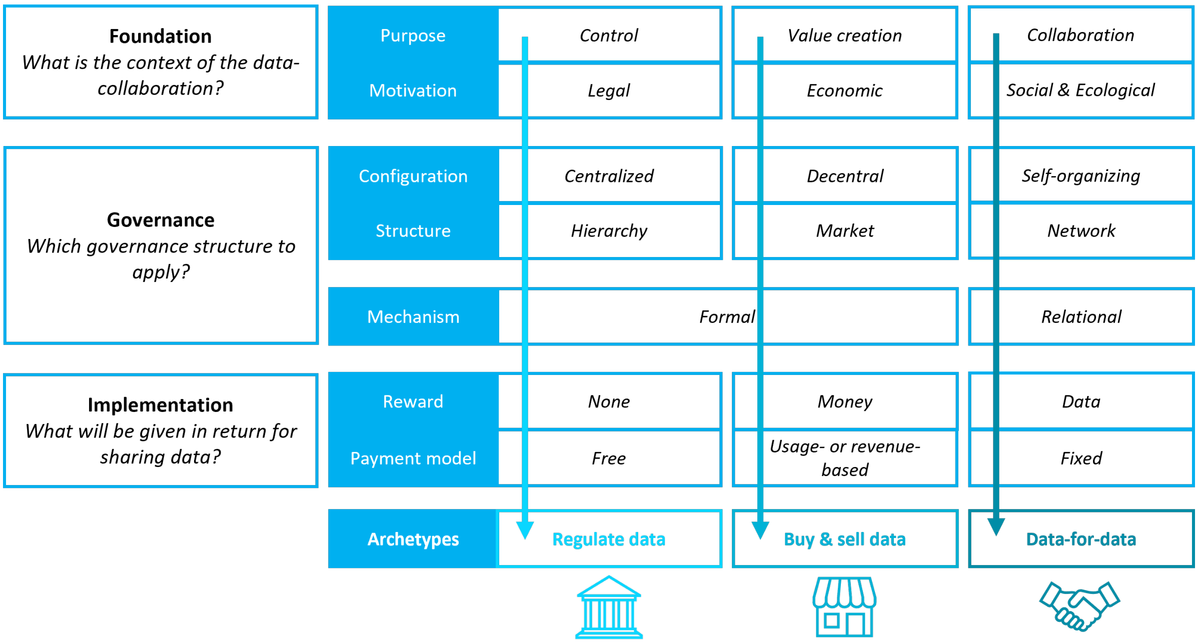


Figure 2: Data governance archetypes applicable to the container supply chain

Contents

1
Introduction

Decision making in supply chains is becoming more and more driven by data (Baştuğ, Arabelen, Vural, & Deveci, 2020). The reason behind this is to further improve the supply chain and make this chain less sensitive to uncertainties. Besides, planning of equipment, vehicles and infrastructure could be improved through this digital transformation. As stated by Huttunen, Seppala, Lahteenmaki, and Mattila (2019), data-related benefits can be categorized into two dimensions: operational efficiencies and strategic opportunities which can be both internal or external. Different benefits are mentioned in internal reports of the Port of Rotterdam by PWC (2013), KPMG (2021) and Portbase (2022) and by PBI Research Institute (2015), McKinsey (2016) and Huttunen et al. (2019). A selection is listed below and is also validated further on in this research by the conducted interviews in Chapter 7.

- *Efficiency gains* consisting of less waiting times, mostly at the terminal and due to this efficiency gains a reduction of transport and storage costs and a reduction of greenhouse gas emissions.
- *Reduction of errors* and repeating tasks due to digitized (customs) forms and procedures and due to this error reduction a reduction of administrative costs.
- *Faster flow of containers* and therefore capacity gain for infrastructure and modalities.
- *Improved customer service* and prevention of lost sales.
- *Safer logistics* process due to increased visibility.

The total added value of a single year of transparency in and around the port of Rotterdam is estimated to be between 20 and 60 billion euro by KPMG (2021), in a internal Port of Rotterdam report. This estimation was based on previous research of PBI Research Institute (2015); McKinsey (2016); KPMG (2018). Those potential benefits of data-collaboration make that by developing new data-collaborations it is an opportunity to further improve the performance of the supply chain of containers. Heilig, Lalla-Ruiz, and Voß (2017) also argued that data-sharing is not an end but a means to an end. Therefore, a lack of data-collaboration in the supply chain is not a problem on itself. However, data-collaboration is an opportunity. Besides, if a company chooses to neglect this opportunity, other companies could take advantage of this which damages the competitiveness of the company (Baştuğ et al., 2020). Especially in this competitive ecosystem of the container supply chain.

However, despite many data-sharing initiatives, not all stakeholders are willing to be part of such a data ecosystem. Trust, competition and privacy plays a major role in the willingness to collaborate (Heilig et al., 2017). Besides, information and power asymmetries between the different actors, make it difficult to adequately govern such developments (Roehrich, Selviaridis, Kalra, Van der Valk, & Fang, 2020). Different actors, with different sizes and objectives, could have conflicting strategies regarding collaboration, data-sharing and operations in the supply chain. Therefore, it could be that data-sharing does not fit their strategy. Another aspect is the role of the port authority. Classically, the port authority is seen as the party who acts as landlord and has some regulatory and operational power (Verhoeven, 2010; Kringelum, 2019). Nowadays, port authorities have become more of a facilitator or community manager.

According to the ITF Transport Outlook 2021, freight transport will increase 2.6 fold by 2050 compared to 2015 (ITF, 2021). The emissions will also increase by 16% despite the current commitments to decarbonize transport. Current sustainability innovations will not be enough to compensate the expected growth. More transport also means increase of congestion and nuisance. In order to cope with this expected increase of transportation, disruptive changes in the transportation market have to be made. Disruptions in the supply chain and capacity planning are commonalities in container transport. Also the complexity of having multiple shippers and different modalities, multi-modal transportation, make it difficult to implement such a collaborative system. Therefore, the focus of this research lies on container transportation.

Figure 1.1 shows the physical and digital flow in the container supply chain. The physical flow is the transportation of the container and focuses on the logistics processes. The digital flows are about sharing information in order to orchestrate transportation. The dashed arrows show a grasp of data-sharing possibilities. A lot more possibilities could be added to this overview.

Container transport starts at the production site of goods at the other side of the ocean. After four to six weeks, the container arrives at the sea port. The container is transshipped by cranes and temporarily stored at the stack of the container terminal. At a specific moment the container is picked up by the inland transport operator. Hinterland transportation in the port of Rotterdam can be by truck, barge and train. After the container reaches the inland terminal where it can be transshipped again, mostly in the case of barge or train, or transported directly to the consignee or shipper. The port authority is mainly responsible for the efficient and safe handling of ship transport in that specific port, in this case study the Port of Rotterdam (PoR). Customs is responsible for the declaration of shipments in the port, which is mandatory for all import and export shipments. Some of the shippers transport their goods by themselves, others outsource this to freight forwarders. These freight forwarders could be responsible for the whole chain, or just a part of it. Lastly, platforms are there to give logistics parties the right information at the right time. Some of this platforms are for internal use only, others are developed for multiple different logistics parties. A specific data-sharing platform is the Port Community System (PCS) which is mostly developed for a port environment, for example Portbase for the port of Rotterdam.

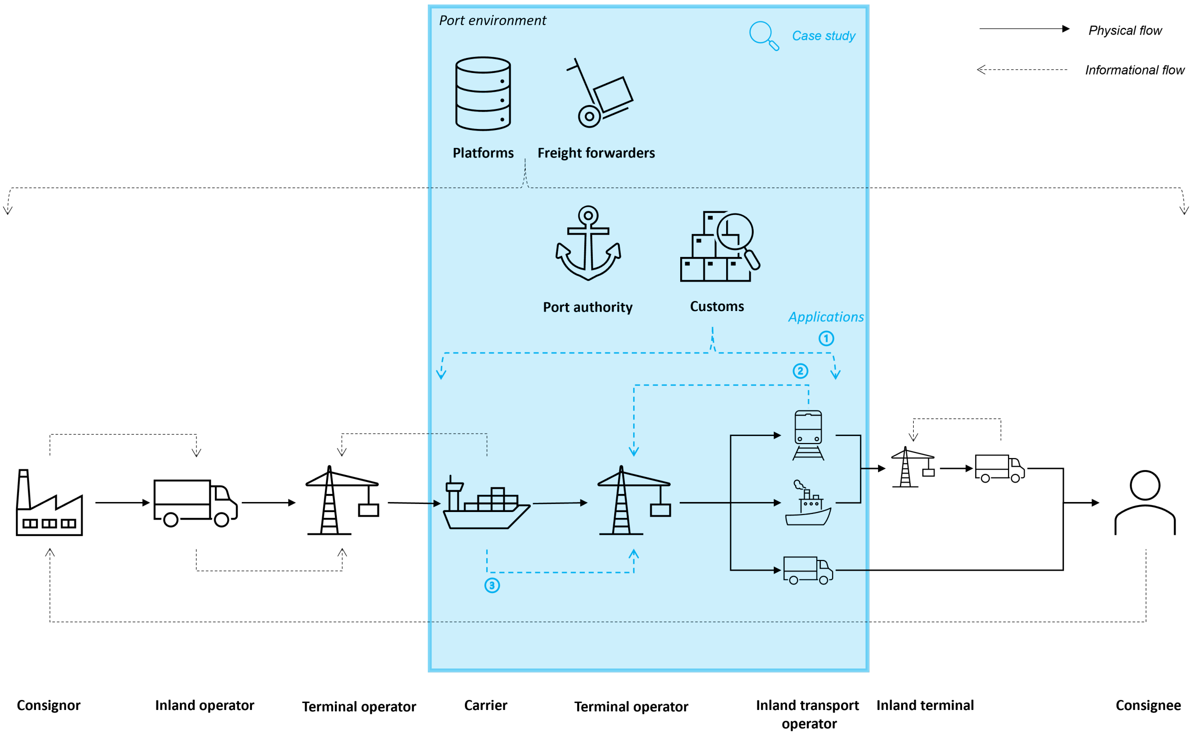


Figure 1.1: Conceptualization of physical and digital flows in the container supply chain

This research will follow the setup of a case study proposed by Yin (2018) and will focus on the port environment of the port of Rotterdam in a container supply chain context. Within this environment different logistics processes take place which require information about, mostly, time and location data. Data-sharing can be complex due to the fact that data can be present at different stakeholders in the supply chain and that multiple other stakeholders can be interested in this data. Therefore data-collaboration can take place in countless arrangements of data type, data owner and data consumer, under different conditions and circumstances. These data-collaborations will be described in this case study and will be combined with inter-organizational data governance mechanisms, which gives a basis of the agreements which have to be made in such a collaboration. Further explanation of these mechanisms can be found in the literature review (Chapter 4). Based on the overall data governance framework the following aspects will described respectively: the antecedents and organizational scope (Chapter 5), the data scope (Chapter 6, domain scope (Chapter 7) and finally data governance by itself (Chapter 8). Three practical application will be described in Chapter 6): customs declaration (1), inland transportation (2) and arrival of deepsea vessels (3). Also the possible initiators for the data governance archetypes, developed in Chapter 8, will be discussed in this chapter. The overall research goal is to investigate how to improve data-collaboration in the container supply chain by applying the right combination of inter-organizational data governance mechanisms.

2 Research questions

This chapter describes the research questions following the introduction of Chapter 1. By fostering data-collaboration, the overall performance and the competitiveness of the port can be improved (Heilig et al., 2017). However, stakeholders will not automatically participate in data-collaborations and therefore proper agreements have to be made about data-sharing and inter-organizational collaboration. In this research these agreements are referred to as inter-organizational data governance, see also Chapter 4 for a more detailed definition. Further on inter-organizational data governance will be referred to as data governance in short. The scope of this research remains data-sharing between different companies.

Previous conducted research has little touched upon this combination of two fields of governance and especially not in the context of the container supply chain and ports. The theoretical framework shows the interconnection between the propositions (Figure 2.1). This research focused especially on the container supply chain which assumes the container as the focal point in the context of a supply chain in which different stakeholders with different stakes are connected to each other.

The main objective of this research is investigating how to improve data-collaboration in the container supply chain by applying the right combination of data governance mechanisms. This leads to the following main research question:

> *Which inter-organizational data governance mechanisms could improve data-collaboration among stakeholders participating in the container supply chain?*

Diving deeper into this question results in five sub-questions. As the main focus lies on data-collaborations, the current situation and potential opportunities and barriers are described (RQ1). Then the actors involved, their characteristics and corresponding attitude towards data-collaboration in the container supply chain are analyzed, because the willingness to share data can be different per company (RQ2). Different inter-organizational data governance mechanisms could be applied in order to improve data-collaboration. However, which mechanisms can be distinguished (RQ3)? And which archetypes of data governance mechanisms is best suited for data-collaboration in the container supply chain (RQ4)? It could be possible that per use case, a different archetype consisting of data governance mechanisms is required. Finally it is required to know which actors should take the initiative to improve data-collaboration within the container supply chain with respect to the different attitudes among stakeholders (RQ5).

(1) What are the potential benefits of data-collaboration in the container supply chain and what are the opportunities and barriers involved?
(2) What is the willingness towards data-collaboration of the different actors within the container supply chain?
(3) Which inter-organizational data governance mechanisms could be distinguished?
(4) Which inter-organizational data governance archetypes are best suited to improve data-collaboration?
(5) Which actors should take the initiative to encourage and enhance data-collaboration while considering the different attitudes of the involved stakeholders?

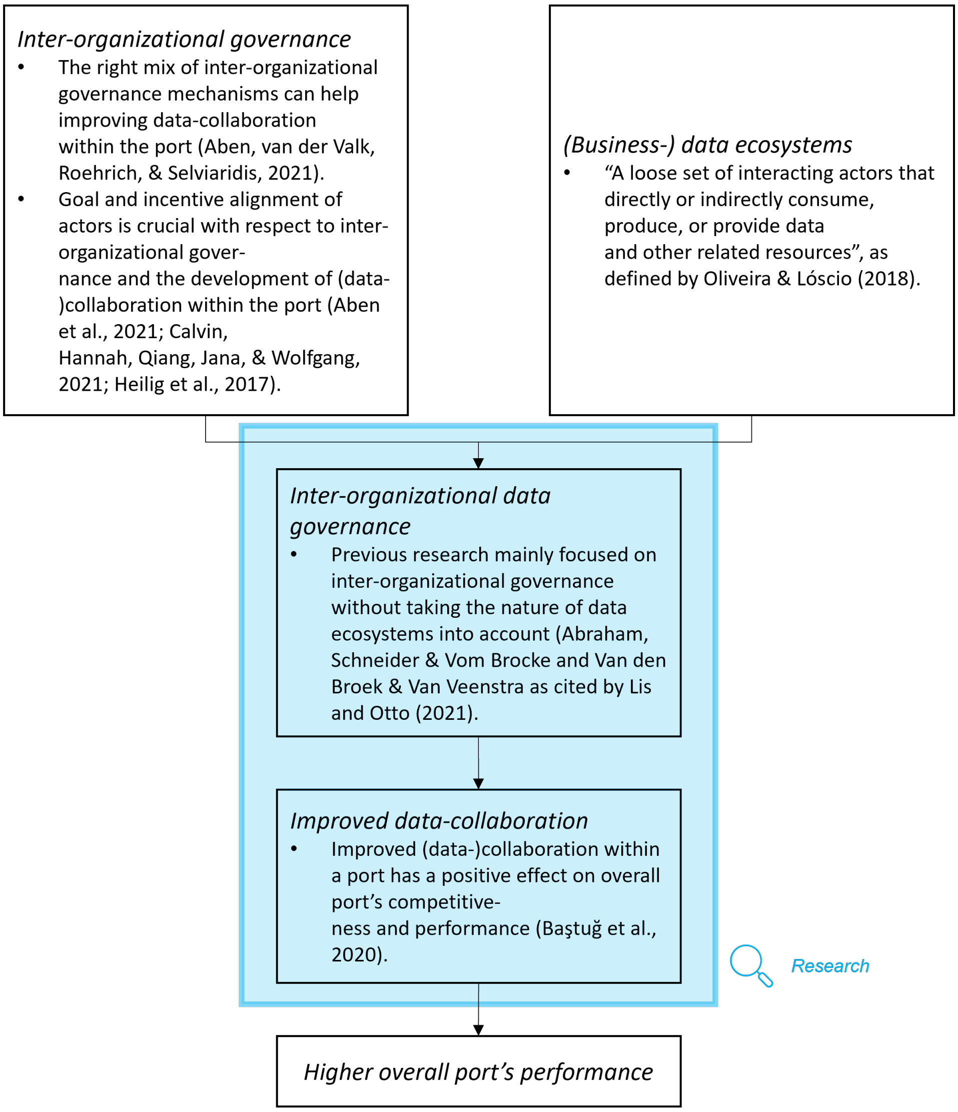


Figure 2.1: Theoretical framework

3 Methodology

This chapter discusses the methods that are applied in this research to answer the research questions mentioned in Chapter 2. Figure 3.1 gives an overview of the layered methodology of this research. The bold faced words refer to the different parts of the inter-organizational data governance framework introduced in the literature review (Section 4.5). The overall research design follows the case study setup of Yin (2018). Within this case study, multiple sources are used to describe and analyze the case. This analysis part consists of a multi-actor analysis based on (grey) literature, a inter-organizational data governance model based on scientific literature and expert interviews with involved stakeholders in the container supply chain. The outcomes of the expert interviews are evaluated during an internal Port of Rotterdam evaluation session. After this evaluation, the governance arrangements are applied, given the input of the multi-actor analysis and the expert interviews, on the use cases. Then the applied arrangements are validated by external stakeholders. The next sections will describe the methods into more detail.

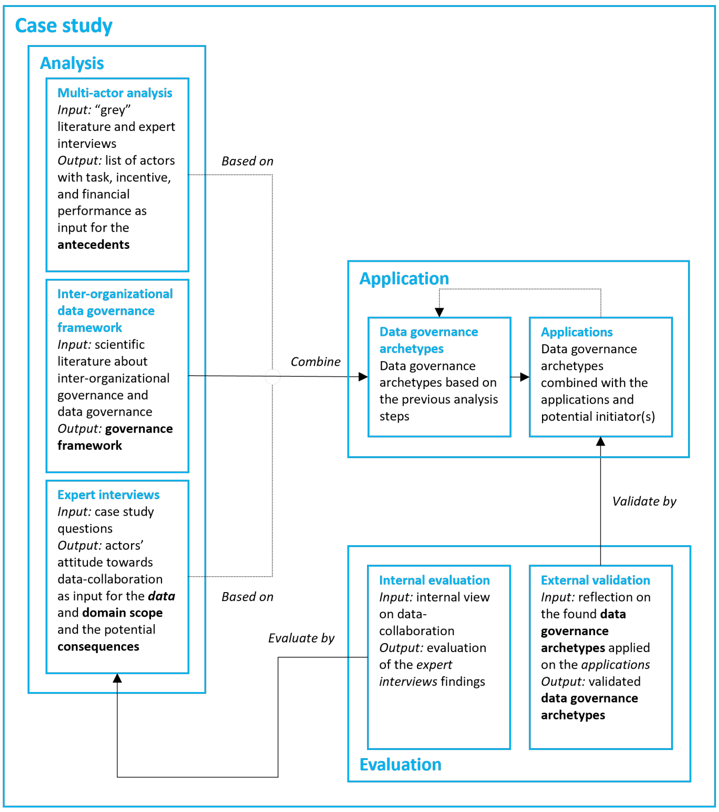


Figure 3.1: Research setup

3.1. Case study

The research design follows the case study setup proposed by Yin (2018). As he argues, case studies mainly answer *why* and *how* research questions given a contemporary phenomenon or case. This means that the interest of this research is about answering the questions why data-collaboration (should) happen(s) and how this is or should be formalized. The port of Rotterdam is chosen as the main case due to the collaboration with the Port of Rotterdam port authority during this research. However, within this main case, several practical applications are described. In order to describe this case study, several methods are used to collect information. These methods are explained further on in this chapter. As to be discussed in the literature review (Chapter 4), data-collaboration is seen as a game changer for the performance for ports and supply chains (Baştuğ et al., 2020). However, not all parties are unconditionally willing to share data with other partners or competitors (Heilig et al., 2017; Roehrich et al., 2020). Therefore, it is useful to systematically describe this real-world contemporary case, to the definition of Yin (2018), and answer the question why and how data-collaboration takes place in the context of the container supply chain with a focus on the port of Rotterdam. It is important to note, according to Yin, that the conclusions of this research cannot automatically be generalized to the population of data-collaboration cases within the port of Rotterdam or outside. This is due to the fact that this cases study focuses on a single case and a limited set of use cases.

The case study design of Yin consists of multiple steps: design, prepare, collect, analyze and share. These steps are described briefly in this section. First the setup of the research should be **design**ed by formulating research questions and addressing theoretical propositions, see also Chapter 2. Then the case should be described and in this research the overall case is described as: *data-collaboration in the container supply chain within the port of Rotterdam environment*. Within this overall case, applications are described in order to say something about the usefulness of inter-organizational data governance archetypes. These applications are described further on in this research. Secondly, the research should be **prepare**d by gaining the right skills and formulating the case study protocol. Also the sources of information, the methods applied in this research and described in this chapter, are part of the preparation phase.The next phase is **collect**, planning how the information retrieved, or evidence, from different sources are collected and stored. This is also addressed further on in this chapter when explaining the methods. After that the collected information should be analyzed in the **analyze** phase. Information can be shown in multiple ways and therefore an analytic strategy should be applied. In this research the *overall inter-organizational governance framework* (Figure 4.10) are the core of the analysis of this research. Finally, the case study should be **share**d, however in this research the format is given by writing a thesis report and a defense presentation. Information and conclusion should be shared in a comprehensive and clear manner by the use of figures. These overview figures are used through this whole research.

3.1.1. Analysis

The core of the case study is the analysis phase in which three different methods are applied: multi-actor analysis, an inter-organizational data governance framework and expert interviews. Those three methods are based on different sources in order to verify all the findings. This is also referred to as triangulation. By a combination of different methods and sources, the credibility and validity of a research can be increased (Noble & Heale, 2019). It also helps to get a more balanced explanation of this case study.

Multi-actor analysis

At first a multi-actor analysis are conducted to map all involved stakeholders, or actors, and their corresponding tasks, incentives, scope and financial performance. This method will answer RQ1, mentioned in Chapter 2, and are used as the further description of the case study. This also connects to RQ2 and later RQ4 the outcome of the applied data governance archetypes.

Inter-organizational data governance framework

As stated in Chapter 2, this research will connect two fields: inter-organizational governance and data governance. This section will also be used as a starting point for further research and are extended in order to develop a combined framework. Besides the scientific literature, strategic documents, so called *grey literature*, of the involved actors have to be analyzed too. The literature study will therefore (partly) answer RQ1 and RQ3.

Expert interviews

An important part of a case study is retrieving information which gives a detailed insight in the case itself. Therefore focused interviews are conducted with the key players described in the multi-actor analysis. These focused interviews used a standard set of open questions which is used for all interviewees. This set of questions can be found in Appendix B. Interviewees were asked to participate via email and the interviews took a maximum of 60 minutes. After the interview, the interview was summarized in a conversation impression. Due to the sensitivity, the conversation impressions are not part of this report. The list of interviewees is shown below with a short description and the duration of the interview Table 3.1. Throughout the report, these conclusions are used to give insight in the case study and are referred to by mentioning the interview in squared brackets.

Table 3.1: List of interviewees

Interviewee	*Position*	*Description*	*Duration*
Carrier	Manager	Maritime container shipping company active in the port of Rotterdam	60
Customs	Consultant	Customs of The Netherlands	60
Freight forwarder	(ex-) Director	Globally operating freight forwarder	40
Inland shipping[1]	Director	Inland barge and terminal operator	40, 40
Knowledge hub[1]	Strategist	Knowledge hub for the port of Rotterdam	45
Platform 1	CEO	European data-platform focusing on road transport	30
Platform 2	Director	International data-platform focusing on visibility	50
Port authority	Evaluation session (20 attendees)	Port authority in the port of Rotterdam	60
Port Community System	Consultant	Port Community System of Rotterdam	60
Road transport	Secretary	Interest group road transport	60
Shipper	Manager	Globally operating manufacturer	30
Terminal[1]	Manager	Transshipment and temporary storage in the port of Rotterdam	40, 30

3.1.2. Evaluation

Internal evaluation

The expert interviews are evaluated in the internal evaluation session and are used to apply the governance arrangements. Main goal is getting a realistic view on the relationships and actions of the actors within the container supply chain. This evaluation session with employees of the Port of Rotterdam is conducted to evaluate the findings of the expert interviews. 20 people of different departments, both the harbor master and commercial part of the company, have attended the session. Afterwards the conclusions were shared and reviewed. Also these statements are used throughout the report. The setup of this evaluation session followed the setup of the interviews and can also be found in Appendix B.

[1] (Also) interviewed for validation.

External validation

After developing the data governance archetypes and combining those with the applications, the outcomes were validated by a second round of expert interviews. Three validation interviews were conducted with the Terminal, Inland Shipping and Knowledge body. The Knowledge body was not interviewed before in order to get an external view on the whole research. The archetypes and applications were shared and the interviewees were asked to reflect on those outcomes. The reflection is used to improve the arrangements and is used as input for the overall research discussion. The outcomes of the validation interviews are included in the research itself.

4
Literature review

The literature review, discussed in this chapter, has multiple purposes. First of all it gives a brief overview of the container supply chain which results in the research gap focusing on inter-organizational data governance. Second, the research gap will be further described into more detail and an overall data governance framework will be described. Those two purposes also used their own keywords. The literature describing the context and research gap are found with keywords “data sharing” AND ”port”, “port authority” and “port community system”. As a start, the most recent paper is taken which focused on data sharing in a supply chain of containers in a port context. Then backwards and forwards snowballing is used to find the other literature. The overall governance framework is based on literature which is found by the following keywords: “inter-organizational governance”, “inter-organizational relationships” and “inter-organizational collaboration”. Those papers are then filtered on data-sharing. Also here backwards and forwards snowballing are applied. All literature is found by using Scopus and Google Scholar as databases.

4.1. Motivation

In order to improve port competitiveness, most ports strive for increasing productivity and extending economies of scale (Baştuğ et al., 2020). By doing so underutilized capacity of modes and infrastructure, which is a common port problem, can be reduced. Improving data-sharing among the stakeholders is a promising solution which could lead to the further development of planning, controlling, and management of operations within and between organizations (Heilig et al., 2017). It is also stated that ports cannot ignore this digital transformation, because otherwise other ports or port stakeholders will adapt and thereby gain greater competitive advantage and outplay the port authority (Baştuğ et al., 2020). Baştuğ et al. mention two port competitiveness improving strategies: cost reduction by adopting new (data) technologies and differentiation by offering efficient facilities or new (data) services. Ports already developed Port Community Systems (PCS), in order to make data-sharing safer and faster. However, PCSs are at the moment mostly limited to the digitization of ship and cargo paper processes, and less on improving current processes and transparency, adding new services, automation and decision-making (Caldeirinha, Felício, Salvador, Nabais, & Pinho, 2020). Port authorities therefore extended their traditional role, as both Verhoeven (2010) and Kringelum (2019) argued. The classical role of a port authority has shifted from landlord, regulator and operator towards being more of a facilitator and community manager. Lastly, Kringelum (2019) stresses out that the port’s performance is dependent on the inter-firm coordination. However, this coordination is difficult to achieve due to lack of trust and the risk of opportunistic behavior of stakeholders.

4.2. Context

Van der Lugt and De Langen (2007) mention two goals related to two levels of a port authority: sustainable performance at port level and efficient organization that generates sufficient revenue at port authority level. Port authorities already extended their traditional landlord role within and outside the port relating both operational and supporting activities which can be own port but also non-own port related (Van der Lugt & De Langen, 2007). As major reason for the extending role of port authorities mention Van der Lugt and De Langen that port authorities are capable of developing coordination mechanisms and establishing hierarchical control in order to enable collective action, but also improve the overall performance of the port. This could be, for example: the creation of platforms and independent organizations or the introduction of incentive-structures towards the hinterland. According to Baştuğ et al. (2020) Industry 4.0 is essential for port operations and maintaining the port competitiveness. Information collection, exchange, analysis and dissemination should therefore be enabled for all different stakeholders. This information or data can be of different forms, for example: internal, sensitive data or publicly available data. Distinguishing different types of data form the basis of a data ecosystem and the services build upon that Gelhaar and Otto (2020). Port authorities are mostly responsible for the overall competitiveness of the port (Tijan, Jović, Panjako, & Žgaljić, 2021). Besides, these port authorities have strong powers regarding the implementation of policies, laws and regulations. By producing and exchanging data, ports can develop towards (transport) information hubs (Brunila, Kunnaala-Hyrkki, & Inkinen, 2021). However, these services should align the strategic vision of the supply chain industry and the port's stakeholders.

To improve the transmission of information between stakeholders, port authorities started developing PCSs (Tijan et al., 2021). However, there is no ideal PCS model, because different stakeholders have different preferences. Caldeirinha et al. (2020) found a strong relation between PCS and port's performance, The PCS characteristics – for example: advanced services, partner network, service level, etc. – all have different weights. Caldeirinha et al. (2020) recommend port managers to focus on extending the current PCS by creating a network of partners, collaborating for common goals and adding additional cargo and ship information. Digitalization is seen as main factor for improving competitiveness. Brunila et al. (2021), however, argue that digitalization in the long term will be less important for maintaining competitiveness because of prevalence and cost reduction of digitalization solutions.

4.3. Data ecosystems

Besides the physical context of transporting containers, there is also a digital context of exchanging data and information. This interplay of different actors takes place in a so called data ecosystem. Different definitions of a data ecosystem exist. Gelhaar and Otto (2020), Calvin, Hannah, Qiang, Jana, and Wolfgang (2021) and (Lis & Otto, 2021) follow the definition of a data ecosystem from M. Oliveira and Lóscio (2018): "a loose set of interacting actors that directly or indirectly consume, produce, or provide data and other related resources." Geisler et al. (2021) also follow the data ecosystem definition of M. Oliveira and Lóscio (2018) and add to this: "data ecosystems are distributed, open, and adaptive information systems with the characteristics of being self-organizing, scalable, and sustainable". Calvin et al. (2021) extended the definition of M. Oliveira and Lóscio (2018) of a data ecosystem: "a set of networks composed of autonomous actors that directly or indirectly consume, produce, or provide data and other related resources (e.g., software, services, and infrastructure). Each stakeholder assumes one or more roles and is connected through relationships with other stakeholders, such that collaboration and competition among stakeholders promotes self-regulation of the data ecosystem". This can be visualised by the following figure (Figure 4.1):

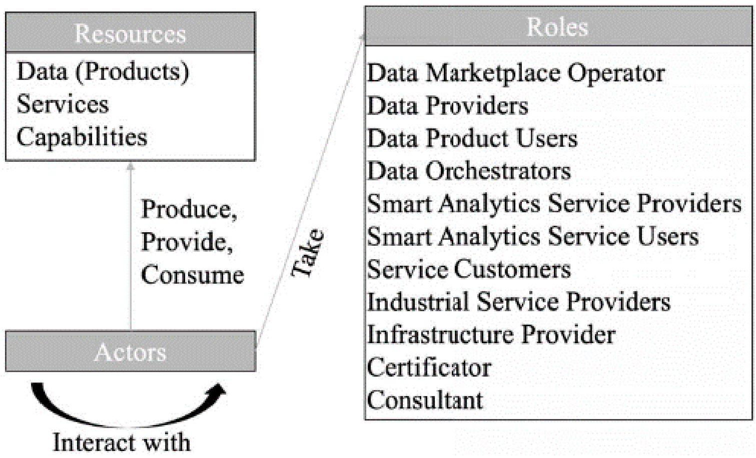


Figure 4.1: Actors, roles and resources in data ecosystems (Calvin et al., 2021)

The latter definition will be used in this research, because this definition is the most broad one and the most practical when conducting an extensive multi-actor analysis (see also the explanation in Chapter 3). To bring both inter-organizational governance and ecosystems together, the definition of ecosystem data governance of Lis and Otto (2021) is used. They define ecosystem data governance as "arranged institutions and structures to ensure that individuals behave in line with the collective goals, conflicts between individuals are prevented and resolved, and the effective and fair use of collective resources within the inter-organizational collaboration".

As mentioned before, incentive alignment is of major importance in inter-organizational governance. Calvin et al. (2021) applied a framework where different actors with corresponding roles, expectation, capabilities and resources in a data ecosystem could be analyzed. This example is shown in Figure 4.2.

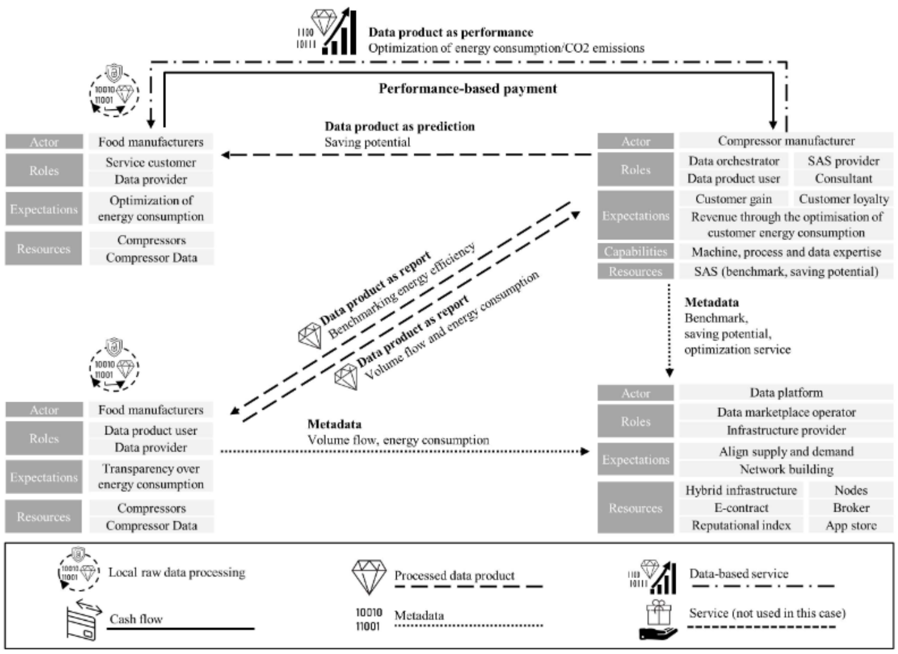


Figure 4.2: Examplary presentation of a data ecosystem (Calvin et al., 2021)

Geisler et al. (2021) conducted a research about the requirements for a transparent data ecosystem and divided these requirements into three categories: data management, organizational-centric, and legal & ethical. They focused particularly on data quality and transparency challenges. They used the model for a network data ecosystem proposed by Cappiello, Gal, Jarke, and Rehof (2020), which consists of four parts: data sets, data operators, meta-data, and mappings (Figure 4.3).

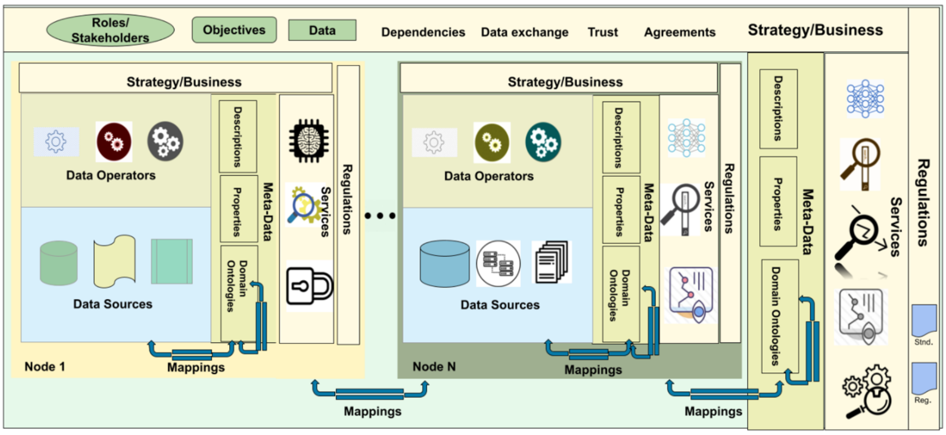


Figure 4.3: A network of data ecosystems empowered with strategy and business models and regulations (Cappiello et al., 2020)

At the birth stage of development of the business ecosystem, some cooperative and competitive challenge might occur (Moore, cited by Gelhaar and Otto (2020)). Cooperative challenges entail challenges around demand and supply parties that must work together in such an ecosystem. Competitive challenges entail challenges that has to do with protecting ideas from similar parties or customers. Gelhaar and Otto also state that developing a data ecosystem cannot be done by too many actors, because this could lead to conflicts regarding strategic and technical decisions.

4.4. Research gap

The main challenges of port digitalization, mentioned by Brunila et al. (2021), are: incompatible systems, lack of resources, security threats, and resistance towards digitalization. Especially the last challenge will be the focal point of this research. Heilig et al. (2017) underpin this challenge and state that the success of the digital transformation not only depends on technology, but even more on the willingness of actors to cooperate and collaborate. This follows the reasoning of “digital technology is a means, not an end”. The alignment of port and digital strategies, but also cooperation between actors with different interests are key to the success of digital transformation.

Diving deeper into digital transformation and collaboration between different stakeholders, leads to multiple researches focusing on the further development of inter-organizational governance in the context of a data ecosystem. Moros-Daza, Amaya-Mier, and Paternina-Arboleda (2020) conducted a literature review on PCSs and concluded that future research should focus, due to lack of research, on IT governance and the barriers and benefits of the further development of PCSs. Brunila et al. (2021) acknowledge that future research should focus on the challenges of digitalization regarding organizational culture, open data systems and information transparency. Also Barbieri, Ellram, Formentini, and Ries (2021) state that a more holistic and empirical look at the digital supply chain and the governance of such systems remains scarce. Lastly, Lis and Otto (2021) argue that there is limited research conducted on data governance in the context of inter-organizational collaboration involving the multiple actor aspect in a broad perspective.

Previous research predominantly focused on business-to-consumer (B2C) data-sharing, however, this can only be generalized to a limited extend for business-to-business (B2B) data-collaborations (Lis & Otto, 2020). Data-sharing can take place between different entities. Business-to-consumer (B2C) is widely known by examples such as Facebook and Google, this is also why this way of data-sharing is mostly researched upon (Lis & Otto, 2020). In this research business-to-business (B2B) and business-to-government (B2G) data-sharing takes place. As for example Praditya, Janssen, and Sulastri (2017) studied the major determinants for information sharing arrangements in B2G context.

This research will focus on two major topics: inter-organizational governance and data governance in a data ecosystem. Limited research has focused on the governance of data ecosystems, which involves many different stakeholders, and especially not in maritime transport context. Therefore, this research aims to map which data governance mechanisms are suitable for improving data-collaborations in the container supply chain. The next two sections will explain this research gap into more detail.

4.4.1. Inter-organizational governance

First it is important to describe the definition of inter-organizational governance. Roehrich et al. (2020) defines inter-organizational governance mechanisms as “the formal and informal rules of exchange between partners”. This entails two forms of governance: contractual governance, which stands for “explicit, formal, and usually written contracts”, and relational governance, which stands for the more informal and socially derived ‘arrangements’ (Vandaele et al., as cited in Roehrich et al. (2020).

To get the scope of this research, and especially of governance, clear, the overview of Williamson (2000) is used (Figure 4.4). The figure shows the social embeddedness of the different layers of social analysis. Higher levels show the institutions which change over a longer period of time, such as cultural factors and laws. Level 4 shows the operational level of resource allocation and employment which changes continuously. Governance is the third level and is focused on the play of the game, as Williamson calls it. Those contracts mostly change on a yearly basis when contracts or equipment are renewed. Williamson states that ”governance is an effort to craft *order*, thereby to mitigate *conflict* and realize *mutual gains*”. It is also mentioned that the unit of governance is a transaction, in this case it would be a transaction of data between different parties.

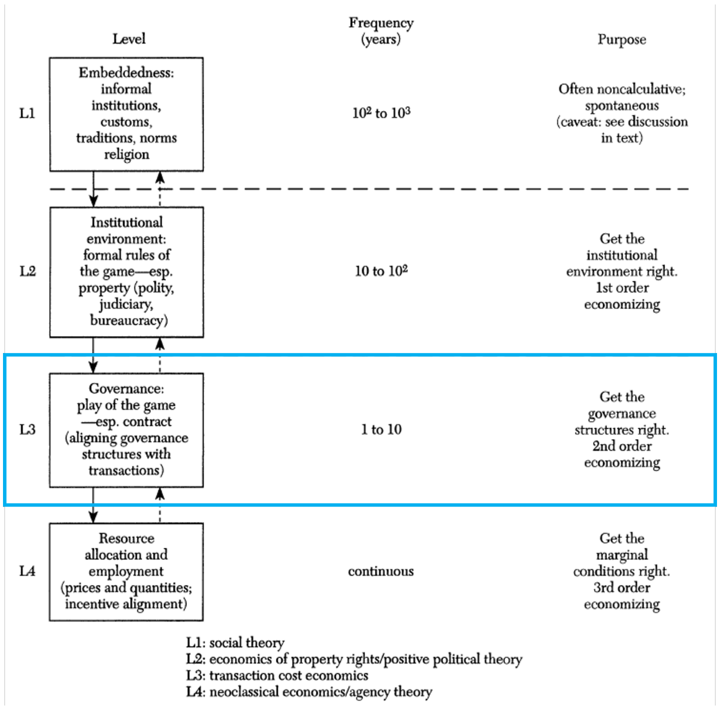


Figure 4.4: Economics of institutions (Williamson, 2000)

Aben, van der Valk, Roehrich, and Selviaridis (2021) and Keller, Lumineau, Mellewigt, and Ariño (2021) investigated what kind of contractual and relational governance mechanisms could be applied in public-private relationships to manage information asymmetry. Keller et al. stated that “contractual governance is not necessarily formal and relational governance not necessarily informal”. They investigated the trade-offs between those two forms of governance and its impact on the inter-organizational relationships over time. A simplification of the typology of the different alliance governance mechanisms is shown below (Table 4.1).

Table 4.1: Typology alliance governance mechanisms (Keller et al., 2021)

	Contractual	*Relational*
Formal	Codified and enforceable promises (e.g. lawsuit provisions)	Uncodified enforceable promises (e.g. information exchange)
Informal	Codified patterns of behavior, expected to conform (e.g. decision-making rules)	Uncodified patterns of behavior, expected to conform (e.g. interpersonal relationships)

Informal mechanisms could be less costly and less time-consuming due to the fact that these mechanisms do not have to be codified and therefore do not have to be articulated in a precise manner, according to Keller et al. (2021). The authors also argue that if agreements are predominantly made on a contractual formal basis, this can encourage arguments between parties and could eventually lead to more opportunistic behavior instead of less. Self-enforceable mechanisms do not have this negative signal and therefore breaching the agreement will be less attractive. However, the ability to enforce made promises and agreements remains as a critical factor (Keller et al., 2021).

The definition of inter-organizational governance according to (Provan & Kenis, 2008), however, is: "[...] the arranged institutions and structures to ensure that individuals behave in line with the collective goals, conflicts between individuals are prevented or resolved, and the effective and fair use of collective resources within the inter-organisational collaboration". Praditya et al. (2017) argue that the architecture of data-collaboration and the inter-organizational governance structure are closely related.

Further research regarding inter-organizational governance could focus on expanding the theoretical framework by for example agency theory or a capability perspective, but also on the influence of asymmetries and relational capabilities on firm an relationship performance (Roehrich et al., 2020). This future research should improve our understanding about the determinants and drivers of governance mechanism decisions on strategic behaviour.

4.4.2. Data governance

Abraham et al. (2019) define data governance as follows: "Data governance specifies a cross-functional framework for managing data as a strategic enterprise asset. In doing so, data governance specifies decision rights and accountabilities for an organization's decision-making about its data. Furthermore, data governance formalizes data policies, standards, and procedures and monitors compliance". In short this entails "who holds the decision rights and is held accountable for an organisation's decision-making about its data assets", according to Khatri and Brown (2010).

According to Aben et al. (2021) governance mechanisms play a key role, governing relationship-guidelines for the collection, sharing and transformation of data. This could be helpful to further explicating, for example, format and levels of detail of the provided data.

It is also stated by Aben et al. (2021) that it is difficult to organize collaborative data-sharing solutions if parties have different incentives, goals, institutional backgrounds, values, practices and decision-making processes. Incentive and goal alignment between stakeholders will help to get a clear perspective on the required data and the purpose of the data. It can also lead to further data-sharing, beyond the contractually stipulated information required. It is stated that information asymmetry and bargaining power asymmetries lead to detailed contracts complemented by trust mechanisms (Roehrich et al., 2020). Trust plays a major role in inter-organizational relationships and this mostly consists of two parts: "positive expectations regarding the actions and/or intentions of partners and voluntary vulnerability towards a partner" (Rousseau et al., as cited in Roehrich et al. (2020)). Regarding information asymmetry two types can be distinguished, according to Aben et al. (2021): uncertainty, also referred to as a lack of information, and equivocality, which entails ambiguity of information. Finally, Aben et al. (2021) argue that data acquisition needs to be properly organized before further transformation activities are applied. This starts by mapping the information requirements for each stakeholder, considering the different contractual decision-making processes.

Data-sharing between different entities is far more complex and therefore barriers arise, such as the risks around commercial sensitive data or the competitive position of the company, but also data-ownership and controllability (Van den Broek & van Veenstra, 2015). However, by using the right governance mechanisms, these barriers may be overcome. Earlier conducted research has focused on data governance within a organization. However, data governance between organizations, inter-organizational data governance, is more complicated and diverse in a ecosystem context (Lis & Otto, 2020). Especially defining data-ownership and decision rights in an inter-organizational context is more complicated. Van den Broek and van Veenstra also state that before data-sharing is undertaken, the how-questions about data-collaboration and -governance should be determined, but also what kind of data will be shared under which regulatory conditions.

Abraham et al. (2019) argue that the definition of data-ownership and accountability is unclear, this could be the data steward or producer, but also the owner of the application or storage facility. It is also unclear under which conditions a specific definition of data-ownership is beneficial. Organizations should first know what kind of data they store and what the value of this data is (Lis & Otto, 2020). Second, they should understand the "playing field" and determine which role they take in a data ecosystem. The platform owner has the advantage of being capable to change data governance mechanisms and via this control the dynamics and interactions between actors within the data ecosystem (Lis & Otto, 2020). This gives the platform owner a powerful role.

Lis and Otto (2020) found some technological, organizational and environmental challenges regarding data governance. First of all data definitions and purposes should be clear within a data ecosystem. Also the quality of data, accuracy and reliability, has to be maintained. Standardization could help to improve interoperability and lastly a trustful way of sharing data is required. On organizational level, data processes of the involved companies should be aligned. This starts by determining what the demand is for data which is relevant and profitable, but also by determining pricing models. Data ownership and controllability, decision making authority and providing a trustful an neutral platform are important challenges on a environmental level.
As mentioned by Lis and Otto (2021) previous research about data governance is primarily focused on inter-organizational governance, without taking the nature of data ecosystems into account (Abraham et al., 2019; Van den Broek & van Veenstra, 2015). Therefore, this research will focus on the combination of these two fields: inter-organizational governance ánd data governance.

Multiple data governance frameworks has been developed to give an overarching view on the different data governance mechanisms and how to apply them. Some of these frameworks will be used in this research as story line and as theoretical underpinning of the described case study. As main framework, the *conceptual framework for data governance* of Abraham et al. (2019) is used. They developed this framework by conducting a literature review of 145 research papers and practitioners publications regarding data governance resulting in the framework below (Figure 4.5). At the end of this paragraph, all the relevant frameworks and aspects will be combined and prepared for further use in this research.

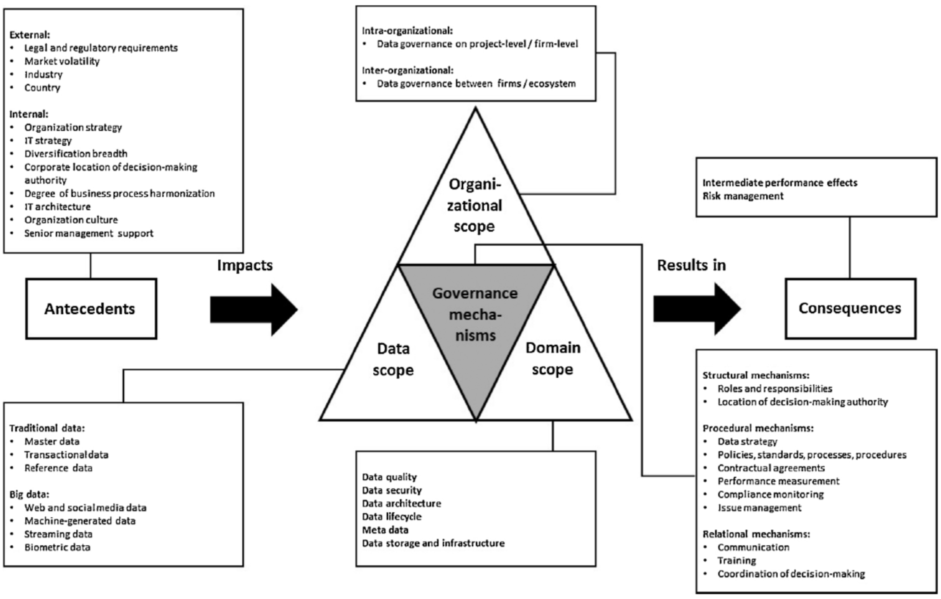


Figure 4.5: Conceptual framework data governance (Abraham et al., 2019)

The Technological, Organizational and Environmental (TOE) framework is widely used for describing technology adaption in organizations in general (T. Oliveira & Martins, 2011). Baker (2012) further explained the basis and applications of the TOE framework (Figure 4.6). The technological part of the framework entails all technologies which are used internally in a organization but also the technologies on the market which potentially can be used. The structures and characteristics of the involved organizations and the way of communication is part of the organizational aspects of the framework. Lastly, the environmental part focuses on the industry of the organization. The TOE framework is mostly applied on intra-organizational cases or inter-organizational cases from a single organization's point of view (Baker, 2012). Therefore, this framework could be extended in order to analyse inter-organizational cases from a system's point of view.

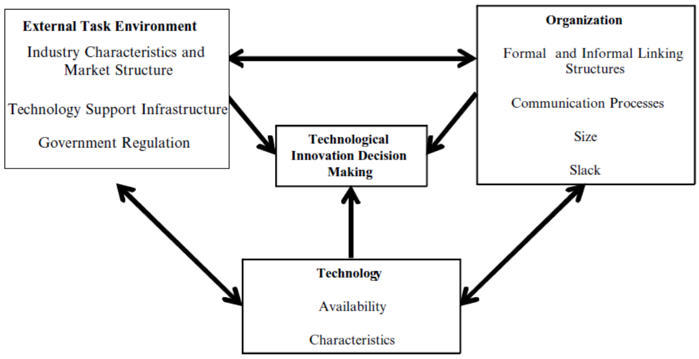


Figure 4.6: Technological, Organizational and Environmental framework (Baker (2012) adapted from Tornatzky et al. (1990))

Based on the TOE framework of Tornatzky et al. (1990), Praditya et al. (2017) found 27 determinants of information sharing arrangements. Their research resulted in five main determinants: trust, power, involvement of major public organizations, compatibility and interoperability. They also concluded that the importance of each of these determinants can change over time during the adoption of data sharing arrangements. The TOE framework will be applied in order to systematically describe the antecedents mentioned in the framework of Abraham et al. (2019).

Van den Broek and van Veenstra (2015) described four archetypical modes of data governance: market, hierarchy, bazaar and network. At first, the archetypes are described in a general inter-organizational context, later on the modes are further applied on inter-organizational data governance. These modes are described by the following characteristics: type and characteristics of data-sharing, coordination mechanisms, control over data and example of data collaboration (Figure 4.7). Which of these modes is most suitable in a specific case is dependent on the kind of data which will be shared, the industry structure and the attitude of the involved actors. Data can be commercial sensitive and parties want to remain in control over 'their' data. These archetypes will be applied on the described case and aligns with the governance mechanisms applied in the overarching framework (Figure 4.5).

	Market	**Bazaar**	**Hierarchy**	**Network**
Type of data sharing	Pooled	Complex	Sequential	Reciprocal
Characteristics of data sharing	Buy and sell data based on (dyadic) transactions	Open up and reuse of data	Data exchange orchestrated by dominant member(s)	Lateral data exchange between individual members
Coordination mechanisms	Contracts	Data quality	Power exerted by the dominant member(s) over the others	Trust
Control over data	Remains at individual organisations	Open licence means that everyone has access to the data	Determined by the dominant member(s)	Remains at individual organisations
Example of data collaboration	Central marketplace for big data	Open data community	Supply chain network	Networked exchange of data

Figure 4.7: Characteristics of four modes of inter-organizational data governance (Van den Broek & van Veenstra, 2015)

Diving deeper into data governance, the *taxonomy for ecosystem data governance* Lis and Otto (2021) gives an overview of the multiple possible characteristics of a data ecosystem. The framework can be used to describe and compare data ecosystems and the applied data governance, and consists of eight dimensions with a total of 24 characteristics divided into three main layers: interaction, governance and data (Figure 4.8). Power structures and the more dominant central actors can influence ecosystem governance implementation (Lis & Otto, 2021). Where the interaction layer is more applicable to the organizational scope of the data governance framework, the governance and data layer can be used to describe the data governance mechanisms.

Layer	**Dimension**	**Characteristics**			
Interaction	Purpose	Control	Collaboration	Value Creation	Conflict Resolution
	Scope	Intra-organizational		Inter-organizational	
	Phase	Pre-partnership collaboration	Partnership creation	Partnership program delivery	Partnership termination/succession
Governance	Configuration	Centralized	Decentral	Self-organizing	
	Structure	Market	Hierarchy	Network	Bazaar
	Mechanism	Formal		Relational	
Data	Data Ownership	Individual	Organizational	Shared	
	Decision Rights	Monocentric		Polycentric	

Figure 4.8: Taxonomy for ecosystem data governance (Lis & Otto, 2021)

The incentive of the involved actors is of major importance and has to be aligned in order to develop data-collaborations, as discussed earlier. Incentives can be of different forms according to another framework developed by Gelhaar et al. (2021). The taxonomy showed below, Figure 4.9, illustrates the different characteristics of incentive mechanisms for data-sharing in data ecosystems. The data layer is most suitable for the data scope of the conceptual data governance framework, the foundation can be used to describe the antecedents and lastly the implementation layer can be added to the description of the data governance mechanisms.

Layer	Dimension	Characteristics						EX
Data	Data type	Scientific data	Government data	Industry data	Personal data			ME
	Data control	Transferred	Sovereign	Shared				ME
Foundation	Motivation	Economic	Social & ecological	Legal	Cultural			NE
	Underlying theory	Economics	Social & behavioural science	Others	None			ME
Implementation	Infrastructure	Centralized	Distributed	Hybrid				ME
	Reward	Money	Virtual assets	Data	Service	Reputation	None	NE
	Payment model	Free	Fixed	Subscription	Usage-based	Revenue-based	Hybrid	ME

Figure 4.9: Taxonomy for incentive mechanisms of data-sharing in data ecosystems (Gelhaar et al., 2021)

4.5. Data governance framework

If all the frameworks discussed are combined into a single framework capable of describing this case study, this results in the framework shown below (Figure 4.10). This framework is also used to structure this research.

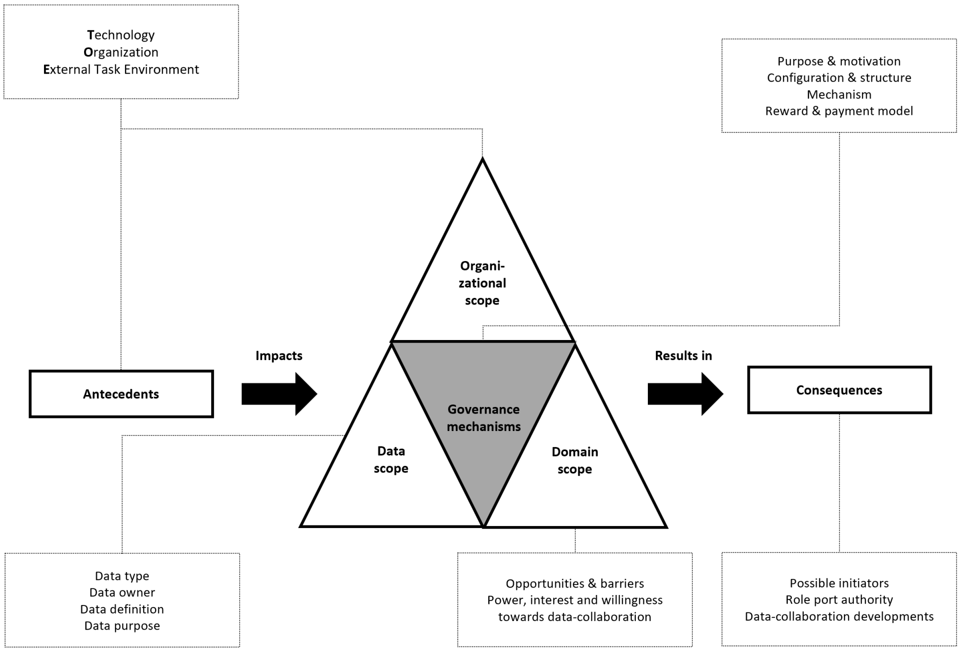


Figure 4.10: Overall data governance framework based on Abraham et al. (2019), Tornatzky et al. (1990), Van den Broek and van Veenstra (2015), Lis and Otto (2021) and Gelhaar et al. (2021)

The overall framework is based on the framework developed by Abraham et al. (2019). This framework mostly suited the setup of this case study, because it systematically describes the different parts of a data-sharing case and the influence of this on the right governance mechanisms. The first part of the framework entails the context, or the antecedents mentioned by Abraham et al., which is described using the TOE framework, consists of the involved actors, the described industry where data collaboration take place and lastly the technological capabilities. This is based on the paper of Baker (2012). Then the overall case study, container transport in the port of Rotterdam, and inter-organizational collaboration will be introduced. After that, the data scope can be explained by giving insight in the available data types and corresponding owner, definitions and case specific purpose. This is based on the data which is relevant for the container supply chain and the conducted expert interviews. Abraham et al. (2019) described the domain scope as data decision domains and focused on the requirements for data-sharing. This case study, however, focused on the opportunities and barriers of data-collaboration and the power, interest and willingness towards data-collaboration. This is also in line with Abraham et al., but more focused on the collaboration requirements instead of the data requirements. After describing the three scopes, the governance mechanisms can be worked out given the description of the antecedents and scopes. The governance mechanisms will focus on purpose, motivation, configuration, structure, mechanism, reward and payment model based on three papers (Gelhaar et al., 2021; Lis & Otto, 2021; Van den Broek & van Veenstra, 2015). The chosen characteristics of a data-collaboration will be further explained in Chapter 8. At last, the consequences of such data-collaborations and the future and developments of data-collaborations will be described. This part is tailored to this case study and focuses on the possible initiators of data-collaborations and the role of the port authority.

4.6. Conclusion

The literature review described the developments regarding data-sharing in the maritime sector. Data-sharing cannot be ignored because otherwise this will affect the competitiveness of companies and ports in general. Besides, data-sharing has the potential to further improve planning, control and management of activities in the port. Despite the introduction of PCSs, stakeholders are not always willing to collaborate and extend the functionalities of the PCS. Bringing different parties, with different incentives, goals and decision-making processes, together is difficult to achieve. Information and power asymmetry, strategic behavior and trust have an impact on the successful development of data-collaborations. Therefore, proper agreements regarding data-sharing have to be made.

Previous research has limited focus on inter-organizational data governance and especially research in the context of data-sharing in the container supply chain is lacking. This research combines these two fields and aims to map data governance mechanisms that are capable of enabling data collaborations in the container supply chain. In order to do so, a data governance framework is developed based on previous data governance research. This framework will be used to systematically describe this case study and to map the applicable data governance mechanisms based on the context of the container supply chain.

5

Antecedents: context of the container supply chain

In this chapter, the antecedents and organizational scope, mentioned in the overall inter-organizational data governance framework, of this case study will be described by using the Technological, Organizational and Environmental (TOE) framework. This description uses the outcomes of the conducted expert interviews and the internal evaluation session. First the involved stakeholders or actors will be introduced as part of the organizational context. Then the industry or market of container transport will be described in the environmental context by mapping all formal tasks, objectives scope and profit margin of the involved stakeholders. Lastly, the technological context will focus on data facilitators, in this case: the Port Community System (PCS) and (data-)platforms. This last context is less important for this research, following the hypothesis that setting up data-collaborations is not a technology problem, but rather a social problem of parties who cannot or do not want to share data.

5.1. Organizational context: involved actors

Multiple actors are involved in the container transportation sector, for example: freight forwarders, shipping lines, port authorities, customs, terminals, inland transport operators, inland terminals and shippers. The list of actors mentioned are directly involved in container transport and will be further described throughout this research. Other stakeholders in container transport - such as: container leasing, insurance or towage companies - are beyond the scope of this research. All of these actors can have multiple internal (or external) functions which are more focused on logistical or commercial services. Therefore, both actors itself as the roles that an actor can play, can have multiple views on data-collaboration. This makes it complex to analyze such an ecosystem. This section describes the players involved in the container supply chain in and around the deepsea port.

Freight forwarder

A freight forwarder is responsible for the end-to-end transportation of freight and works as an agent for a shipper (*Saloodo logistics dictionary*, 2022). Most of these freight forwarders do not have the real assets to transport goods and therefore outsource transportation. Others, have physical transportation assets such as trucks and barges. Most of the freight transport is outsourced by buying capacity at other carriers and inland transportation operators. Freight forwarders are also known as forwarders or Logistics Service Providers (LSPs).

Carrier

Shipping lines are companies who are responsible for the maritime part of the transportation. The deepsea vessels can be owned by the carrier itself or a non-vessel operation common carrier (NVOCC), for example, buys capacity on a deepsea vessel owned by another carrier. From a contractual perspective two kind of carriers can be distinguished: a common carrier where the carrier is not bound by contracts with shippers and a contract carrier where transportation is bound by a contract (*Saloodo logistics dictionary*, 2022). The shipper or freight forwarder, authorized by a shipper, or a NVOCC is the contractor and buys capacity on a deapsea vessel owned by the carrier. Often capacity is exchanged between carriers, mostly within the alliances. In this case the relation between carrier and other carrier is the same as for example between carrier and shipper. Due to the fact that 85% of the containers is transported by a limited set of carriers brought together in alliances, carriers are powerful in the supply chain of containers (ITF, 2022).

Port authorities
The definition of a port authority, according to Verhoeven (2010), is: "the entity, which whether or not in conjunction with other activities, has as its objective under national law or regulation, the administration and management of the port infrastructure, and the coordination and control of the activities of the different operators present in the port". The main focus of port authorities is to facilitate a safe and smooth flow of vessels. This position of harbor master is legally established to the port authority in the Netherlands. Besides, port authorities focus on the competitiveness of the port in the international context, attracting freight and clients and finally offer additional services.

Customs
Customs has the legally mandated task of regulating flow of goods coming into and out of the country (*Saloodo logistics dictionary*, 2022). Another task is collecting duties over the imported goods. Before goods can enter the port, a customs declaration form has to be handed in to the authorities. This form contains all detailed information about the goods and has to be shared with customs 48 hours before the vessel enters the port. For import it is essential to know if those goods could harm human health or the environment. Most of the time, the shipping company is responsible for the declaration forms. However, these shipping companies can outsource the responsibilities to an agent. When goods are entering the country, customs has to check these goods and give customs clearance before the goods can be transported further. This customs clearance, or release message, can only be shared with the declarant.

Terminal operator
Terminals are mainly focused on "gateway activities" which is handling import and export containers between larger container vessels and inland transportation modes (Jiang, Chew, & Lee, 2015). Other activities are focused on transshipment between vessels in order to bundle container streams. This follows the hub-and-spoke strategy of container shipping, because not all terminals are final destinations. The terminals located in a deepsea port are responsible for unloading deepsea vessels, temporary storage of containers and loading of inland transport modes such as trucks, barges and trains. The most advanced terminals are almost fully automated: cranes are controlled via a control room, Automated Guided Vehicles (AGVs) transport containers to and from the stack and straddle carriers are capable of stacking containers automatically.

Inland transport operators
After the maritime part of transport, the container has to be transported to the hinterland. This can be done by using different modes: truck, barge and rail. However, this is dependent on the port of call and the destination of the container. Also multiple modes of transport can be used in combination, which is referred to as multi-modal transportation. Due to increasing pressure on the hinterland transportation system in combination with sustainability goals, focus of transport lies on larger carriers such as rail and barge (Bouchery, Fazi, & Fransoo, 2015). In order to improve the coordination between inland transport operators, information exchange is a requirement. Most of the containers are transported by truck. Those road transport operators can be a single truck driver or a whole company consisting of hundreds of trucks. Most of the trucks are capable of transporting 2 TEU at the time. What holds for trucks, is also true for barges. There are some single barge operating companies and companies who own multiple barges, trucks and inland terminals. However, barges are more costly compared to trucks. Barges can transport between 16 and 250 TEUs. There are far less rail operators as compared to truck operators. Rail transportation is also dependent on a timetable and is therefore less flexible. It is also dependent on rail infrastructure, which is comparable to barges which are dependent on waterways. The average train can transport up to 80 TEU of containers.

Shippers
Shippers mostly are the manufacturers or sellers of the product that is being transported via containers. Transportation starts at the shippers side at the origin of the transported freight. Some shippers control transportation by themselves, other smaller companies outsource transportation to freight forwarders or carriers. Shippers make agreements with the consignee, end-user of the product, about who is responsible for which part of transportation and how transportation costs are distributed. This is also known as Incoterms. Transport performance indicators are not always part of the agreements made with the stakeholders responsible for transportation. Therefore, it is hard for shippers to address those indicators on a shipment level. Due to the fact that the container supply chain has witnessed multiple major disruptions, those performance indicators are becoming more important.

5.2. Environmental context: market analysis

All the actions or activities of the involved stakeholders together show specific market behavior. The characteristics which explain this market behavior, are shown in Figure 5.1. The actors are the same as described under Section 5.1 and can be described on a more general basis. However, those actor groups consist of multiple stakeholders with different characteristics. The approximate number of players in the port of Rotterdam is based on internal Port of Rotterdam statistics. The formal tasks, objectives and scope are based on the actor descriptions discussed earlier in this chapter and the judgment of the author based on the conducted interviews. The profit margins are based on financial sources, discussed further on.

The number of active stakeholders within an actor group gives a basis for the diversity. In a specific port there is just a single port authority and customs office and a few container terminals. There are a lot more inland transport operators and shippers. The carriers are also limited to a set of alliances. Besides the formal (logistics) tasks, companies also have their own objectives. Some of those objectives are directly related to logistics as is a main driver for the port authority and customs, whereas other objectives are more focused on profit and market share, which is more applicable to carriers and terminals. Some of the actors are footloose and can therefore move to another location if necessary, such as carriers choosing another port call. Other parties operate just locally and can therefore not move to another location. Global operating companies also have different requirements with respect to data-sharing, for example international applicable standards. Terminal operators can be both local players or international players. ECT is for example a global player which owns multiple terminals across the globe. As discussed before, freight forwarders, but also data platforms do not own (many) transportation assets. Carriers, terminals and inland transport operators do own transportation assets which makes the financial incentives a lot different.

The profit margin, or operating margin, shows the ratio between operating earnings and total revenue. The profit margins shown are based on the statistics of the companies mentioned under examples (shown in Figure 5.1) and were retrieved from online sources (Crunchbase, 2022a; Yahoo Finance, 2022; DBSchenker, 2022; DHL, 2022; Hapag-Lloyd, 2022; Port of Rotterdam, 2022; APM Terminals, 2022; Hutchison Port Hldg Trust, 2022; IKEA, 2022; Inditex, 2022). Companies indicated by 1 are found on Crunchbase and companies indicated by 2 are found on Yahoo Finance. For the inland transport operators it was more difficult to find an average profit margin, therefore an article from 2018 is used for an indication (Logistiek, 2018).

As shown, profit ratio's are lowest for the inland transport operators, also due to increasing fuel prices. Carriers had low profit margins but these are increasing because of high demand for container transport and a limited supply of container transport. During the COVID-19 pandemic, maritime container transportation fares between Shanghai and Rotterdam have increased from 2,000 dollars in January 2020 to approximately 10,000 dollars in June 2022 (ITF, 2022). This because of increasing demand for products and an decrease in supply due to closing factories in China during quarantines. It can also be seen that the margins of freight forwarders are smaller as compared to carriers. Also terminals benefit from the high demand for container transport and therefore have high profit margins. Shippers have different margins, dependent on the products they sell.

	Platform	Freight forwarder	Carrier	Port authority	Customs	Terminal operator	Inland transport operator	Shipper
Approximate number of players in Port of Rotterdam	> 100	> 100	≈20	1	1	5	≈20,000	>10,000
Examples	FourKites[1], Project44[1]	DBSchenker, Kuehne Nagel[2], DHL	Maersk[2], Hapag-Lloyd, Evergreen[2]	Port of Rotterdam	Dutch Customs	APM, ECT	Evofenedex, TLN, EGS	IKEA, Heineken[2], Inditex
Formal tasks	Providing logistics information	Forwarding the shipment	Providing transport overseas	Safe and efficient shipping	Checking the shipment	Handling and storing containers	Providing transport to the hinterland	Owner of the shipment
Objectives	Private Maximize market share	Private Maintain market postion	Private Maximize market share	Semi-public Improve competitiveness	Public Improve safety and efficiency	Private Improve efficiency and maximize throughput	Private Improve profit margin	Private Maximize revenue
Scope	Global/International	Global	Global	International	National	Global/Local	International	Global
Profit margin	200M – 1B* **funding*	5-7%	32-53%	42%	-	41-55%	-8-8%	13-62%

Figure 5.1: Market analysis

As mentioned earlier, many different parties are involved in transporting a container. Parties are therefore trying to differentiate their services in order to attract more clients to them. Due to the fact that there are a lot of parties involved, it is hard to align the whole supply chain to the wishes of a single client. Also differences in capacities, a deepsea vessel is capable of carrying thousands of containers and a truck just a few, results in congestion. It is the terminal where those modes come together and it is therefore that this is the major bottleneck of the container supply chain [Inland shipping, Carrier]. This is because of the capacity of (automated) cranes, but also the limited quay space available for both sea going vessels and barges. This results especially in the current overheated container market, in further increasing dwell times. In order to handle these disruptions and optimize the usage of the terminal stack, data-collaboration is required.

Two more perspectives are worth mentioning regarding the market behavior: the internal perspective focusing on logistical versus commercial incentives of companies and the external perspective focusing on the influence of trust in the container supply chain. Data-sharing in a maritime context is often related to further improvement of the logistics system, as discussed before. However, the involved actors also have their own commercial incentives focusing on improving their profit margins and market share [Terminal]. Those commercial incentives are focused on short-term performance and influences the current role and the continuity of the company. Therefore, the commercial perspective can be as important as the logistics perspective for companies whose main activity is the transport of containers. Of course, those two perspectives can be interrelated, but this is not always the case. In addition, it is sometimes unclear when and how costs and benefits are distributed among stakeholders when entering into a data-collaboration [Platform 1, Port Community System, Road transport].

Another perspective is trust within the container supply chain. Due to the competitive nature of the industry, companies can be skeptical towards collaboration [Platform 1, Port authority, Inland shipping, Shipper]. Therefore, actors could behave opportunistically in collaborations because this can be beneficial for their own activities (Kringelum, 2019). Focusing on data-sharing, multiple aspects are associated with trust (Lis & Otto, 2020). Data-security and -availability should be as agreed upon. Data also cannot be used for other purposes as intended or shared with third parties who have no right to, referred to as data-sovereignty and -integrity by Lis and Otto. In the end, all parties choose for their own businesses focused on their own objectives. Therefore, the right data governance mechanisms can be helpful in order to develop data-collaborations (Aben et al., 2021).

5.3. Technological context: Facilitators of data-sharing

In this section the technological context with respect to data-collaboration will be explained. Baker (2012) states that the technological context includes all technologies relevant for the firm. This section discusses data-sharing in the container supply chain context in more detail. There are, however, many different technologies present regarding data acquisition and analysis in the field of artificial intelligence for example. Those technologies are outside of the scope of this research.

Looking at data-sharing within the market of container transport, only a small portion of the available data or information nowadays is shared across parties in the supply chain. Mostly this is data required for customs processes. Another portion is static planning data shared, for example, between shipping lines and terminals. Data-collaboration is currently based on bilateral agreements in cases where there is a lot of volume, high shipment value or trust between parties. Some of these parties mention that data is the new gold or oil [Platform 1, Platform 2, Port Community System][1]. However, the more traditional parties in the supply chain do not agree upon that or are suspicious towards other companies who make this claim [Terminal, Carrier]. Because of the traditional nature of maritime transportation, data-developments are lagging behind as compared to other industries such as the retail industry. However, the supply chain of containers produces a lot of data, for example: container status data, timestamps, vessel locations, capacity usage on barges, shipment information, terminal rush, and much more. It is expected that with the introduction of Internet of Things (IoT) this will increase even further.

Standards for data-sharing and the interpretation of information are still missing [Carrier]. This leads to miscommunication and lacking inter-connectivity. For some parties, data-sharing is seen as a black box where it is impossible to check if information is received in the right manner and if the information is of the right quality [Port Community System]. It is also important to investigate which data is required for the further improvement of the supply chain and what the corresponding source is for that data. Two more actors are relevant concerning the facilitation of data-sharing: the Port Community System (PCS) and Platforms.

Port Community System
A Port Community System (PCS) by Baştuğ et al. (2020) is referred to as: "a key functionality of easy, fast and efficient information exchange and management, customs clearance, dangerous goods declaration, and tracking and tracing of all types of cargo, as well as the processing of maritime and other statistics". The International Port Community Systems Association (IPCSA) defines a Port Community System as follows: "a neutral and open electronic platform enabling intelligent and secure exchange of information between public and private stakeholders in order to improve the efficiency and competitive position of the sea communities" (IPCSA, 2015). In this research the definition of the IPCSA is leading, because this definition is more precise on the characteristics of such a system. PCSs are important platforms for maritime transportation and are mostly initiated by the port authority. Some of the PCSs are now separated from the port authority itself. Most of them focus on sharing data between vessels and the harbor master and sharing required data for customs processes. Currently PCSs are developing additional services in order to improve supply chain performance.

Platforms
In order to share data and give insights, multiple companies are developing data-services or platforms. These platforms can have multiple shapes, but it is mainly capable of transmitting data or information. Some platforms are focused on specific parts of the supply chain or a particular application. Others strive for full end-to-end visibility of the supply chain. These platforms can be developed by a single company or by a consortium of chain partners and it can be both initiated by private or (semi-)public parties. In this case platforms refer to data-transmission services between companies in vertical, between for example collaborative sellers and buyers, and sometimes horizontal, between competing terminals, direction. Internal business intelligence is out of the scope of this research. Project44, FourKites and Tradelens are examples of global operating data-platforms. More local data-platforms in the port of Rotterdam are for example port call optimization platform PortXchange and barge planning platform Nextlogic.

5.4. Conclusion

This chapter mapped the different actor groups involved in container transportation. Those actors differ in size, scope, tasks and objectives which result in competitive market behavior. The commercial incentives of stakeholders can be as important as the logistics perspective. Also a lack of trust within the chain partly explains why companies could be skeptical towards collaboration. Another important aspect is the unevenly distributed profit margins across the chain. Looking at data-sharing specifically, data is mostly shared in cases where data must be shared. For example when data is required by authorities, such as the port authority or customs. The maritime sector by itself is in someway traditional and based on long-term investments, therefore adopting innovations takes time. Data-standards are missing, but are also difficult to define due to the fact that the maritime sector is a globally operation system with thousands of different parties involved. Lastly, two more facilitating parties are added

[1]Refers to a interviewee of the expert interviews.

in the last decades for data-sharing reasons: (data-)platforms and Port Community Systems. Which data is relevant for the container supply chain will be discussed in the next chapter (Chapter 6). The willingness to data-collaboration is part of Chapter 7 and follows the actor descriptions and market behavior described in this chapter.

6

Data-scope: enrichment of data during container transport

As mentioned earlier on, the data required and corresponding format and source should be clearly defined. This chapter connects to the data scope mentioned in the overall data governance framework. In order to do so, different data categories can be distinguished. The categories are based on the conducted interviews. An explanation of those categories can be found in Appendix D. First, the different categories will be shown in practice by looking at the container supply chain. Then some data-applications will be described to show what the opportunities of data-collaborations could be. Lastly, the requirements for data-sharing are discussed, based on the interviews.

6.1. Data across the chain

The different data categories, mentioned in Appendix D, are combined with the container supply chain in Figure 6.1. This conceptualization follows the idea of the enrichment of data during the transport of a container. Per transportation step, data will be added to the string of data belonging to a shipment or container. The amount of available data is infinite and therefore a grasp of data is shown based on the data mentioned in the interviews [Customs, Port Community System, Road transport, Terminal]. The data-layer on top is about logistics data which entails all relevant data about the logistics process. This could be on long term, for example forecasts of shipments, or on short term, about the commercial window of a container. The second layer is about mode data which could be a vessel, truck, train or other modality. This data describes itself as dynamic data and most of the data produced by those modes are real-time location data. It has been decided to also include the terminal data in this category, this entails the internal movements on the terminal. The last layer is about the container, or shipment, and these data are mostly static. These data are about the physical characteristics of the container and other container related data such as location of empty return and inland destination.

Container Supply Chain Data layers	Consignor (shipper)	Inland transport operator	Terminal operator	Carrier	Terminal operator	Inland transport operator	Consignee
Logistics	Forecast shipments				Cargo opening/closing Commercial window Discharge confirmation Loading confirmation		
Mode		*Same as import inland transport operator*	*Same as import maritime terminal*	ETA vessel ETD vessel	Gate-out Gate-in Moves	ETA terminal ETD Terminal Dynamic ETA truck	
Container	Booking Bill of lading details ADR (dangerous goods) Export documents				Demurrage Detention Block group Location empty return	Pickup modality Inland destination	Import documents

Figure 6.1: Enrichment of data in the container supply chain

Table 6.1 shows per data-set the type of data, the owner of the data and a short definition of the data. As discussed before, data can be static or dynamic. Static data does not change during transport and dynamic data changes during transport. Real-time data is also dynamic, but is specifically mentioned because this data is mode related. The real-time ETA and ETD-data can be shared in different time-units. However, real-time gives more opportunities for the inland transport operator to adopt to changing situations. The owner of the data is most of the time the producer of that data-set. For example the carrier owns the vessel which produces ETA-data and can provide other stakeholder with that data. Sometimes copies are stored by other stakeholders who are not the source of that data. In that case, data can be less accurate and trustworthy. This is also stated by the [Terminal] and [Carrier] during the interviews. The table also shows the potential user and application. To get an idea of data-collaborative applications, a few will be discussed into more detail under this section.

First, the application of sharing data between shipper and customs about declaration of goods. The International Maritime Organization (IMO) mandated a standardized way of customs declaration (IMO, 2022). This process entails all different forms which have to be handed-in to the authorities before a container can be imported or exported to or from a specific country. Shippers, and sometimes carriers, are responsible for declaration on container level. Carriers, however, also have to communicate their estimated time of arrival to the authorities. Also information about (potential) dangerous goods has to be shared via an ADR-form. All those documents has to be handed in to the right authorities and this standardized single window is developed in order to streamline international container transport. This application is an example of mandated data-sharing.

The second exemplar application is about sharing data between hinterland transport operators and a terminal. For example a trucking company transports multiple containers from a deepsea terminal to the hinterland. If it would be possible to communicate to the terminal which containers have to be picked-up for that day, the terminal could pick the most obvious container first. This could result in less waiting times at the terminals and also less movements of cranes and straddle carriers on the terminals. On the other hand, terminals could also aggregate the data of all hinterland transport operators and share this with them to give insight in terminal congestion. In that way hinterland operators could adjust their planning to reduce waiting times at the terminal.

As third example carriers share updates of an Estimated Time of Arrival (ETA) of their ships to the terminal and nautical service providers. This is required for orchestrating the whole port call of a deepsea vessel. The involved parties in a port has to be coordinated in order to effectively handle vessels. This means that there is no single planning, but multiple plannings which have to be aligned. Real-time ETA updates could help to make planning more flexible and adaptive.

Table 6.1: Data type, owner, characteristics, description, potential user and application in the container supply chain

Data	Owner	Characteristics	Description	Potential user	Potential application
Forecast shipments	Shipper	Dynamic	Forecast of expected shipments of a shipper	Carrier	Carrier could optimize their vessel schedule
Booking	Shipper	Static	Booking of transport at a transport provider	Freight forwarder	Already being shared, basis of a transport order
Bill of lading details	Shipper	Static	Details about the shipment mostly used by shipper and carrier(s)	Customs	Already being shared, mandatory
ADR (dangerous goods)	Shipper	Static	Notion of dangerous good if that is the case	Customs	Already being shared, mandatory
Export documents	Shipper	Static	Export declaration required by customs to export goods from a country	Customs	Already being shared, mandatory
ETA vessel	Carrier	Real-time	Estimated Time of Arrival deepsea vessel	Inland transport operator	Barges could optimize their planning
ETD vessel	Carrier	Real-time	Estimated Time of Departure deepsea vessel	Freight forwarder	Important for delivering the container on time for export
Cargo opening/closing	Shipper/Carrier	Event	Time window of terminal where the container for export can be dropped off, based on the deepsea vessel's ETA	Inland transport operator	Only being shared with the declarant, based on this data the ITO could optimize their planning
Commercial window	Shipper/Carrier	Event	Clearance of container by customs after which the container can be picked up by the ITO	Inland transport operator	Only being shared with the declarant, based on this data the ITO could optimize their planning
Discharge confirmation	Shipper/Carrier	Event	Signal of customs after which further declaration steps by carrier or shipper can be undertaken	Inland transport operator	Only being shared with the declarant, based on this data the ITO could optimize their planning
Loading confirmation	Carrier	Event	Confirmation by terminal if container is loaded on vessel	Freight forwarder	Already being shared
Gate-in	Terminal	Event	Gate-in container at the container terminal	Inland transport operator	Based on this data barges could adjust their time -schedule
Gate-out	Terminal	Event	Gate-out container at the container terminal	Shipper	Valuable for the track and trace of a container
Moves	Terminal	Static	Number of moves per container on a container terminal	Shipper	Gives insight in the internal efficiency of a terminal which could be valuable for rate negotiations
Demurrage	Carrier	Static	Fee which will be charged, after free time, by the carrier if the container is not picked up at the terminal on time	Shipper	Gives insight in the performance of the ITO if this will be given directly to the shipper
Detention	Carrier	Static	Fee which will be charged, after free time, by the carrier if the container is not on time at the location empty return	Shipper	Gives insight in the performance of the ITO if this will be given directly to the shipper
Block group	Shipper	Static	Location on the terminal where the container can be picked-up	Inland transport operator	Already being shared, relevant for trucks and trains
Location empty return	Carrier	Static	Final destination of the container after delivering the shipment	Inland transport operator	Currently not widely available, but relevant for planning
ETA terminal	ITO	Real-time	Estimated Time of Arrival inland transport modality at the container terminal	Inland transport operator	Based on this data the ITO could optimize their planning
ETD Terminal	ITO	Real-time	Estimated Time of Departure inland transport modality at the container terminal	Freight forwarder	Important for delivering the container on time for export
Dynamic ETA truck	ITO	Real-time	Dynamic Estimated Time of Arrival truck at inland destination	Shipper	Valuable for the track and trace of a container
Pickup modality	ITO	Dynamic	Type of inland transport modality	Terminal	Relevant to know which container will be picked-up by which modality therefore important for terminal planning
Inland destination	Shipper	Static	Inland destination of the container	Inland transport operator	Already being shared
Import documents	Consignee	Static	Import declaration required by customs to import goods to another country	Customs	Already being shared, mandatory

6.2. Data-requirements

This last section discusses the data-sharing requirements based on the conducted interviews and literature. Five categories of requirements were discussed in the interviews: ownership, data quality, standardization, trust and security (shown in Table 6.2).

First, the ownership or sovereignty of data is discussed. [Carrier], [Terminal] and [Freight forwarder] argue that the data-owner should always have the control over the data. Therefore, data-sharing should be done with respect for the data itself and the source of that data [Carrier]. Gelhaar and Otto (2020); Van den Broek and van Veenstra (2015) mention the fear of exposure of commercial sensitive data experienced by companies and stated that in these case sovereignty should be maintained. Geisler et al. (2021) add to this that this sovereignty should be traceable and that the involved actors should also be involved in quality assessment, which also connects to the requirement category of data quality. It should also be known by data-users, as stated by [Carrier], that in case of missing or indirect data, how this data is filled up.

Data-quality consists of multiple different requirements and Geisler et al. (2021) points out that data should be by all means transparent, fit for sharing, trustful and reliable. Van Baalen, Zuidwijk, Van Nunen, et al. (2009) fits this definition and stresses that quality information should be accurate, timely and secure. More advanced forecasts are dependent of the available amount of historical data and the coverage of the global supply chain in the data-system, as mentioned by both platforms interviewed [Platform 1, Platform 2]. Static data-sharing will go to dynamic ways of real-time data-sharing and then to more advanced data techniques such as Artificial Intelligence and Big Data which will give insights in disruption and capacities. All those advanced data techniques require reliable and trustful data.

[Platform 1] points out that parties first have to be technical capable to share data. International operating parties, such as [Carrier], ask for international standards in order to streamline communication. In data-collaborations, data will be transmitted between different systems. This requires data-standards and interoperability of systems. Gelhaar and Otto (2020) state that interoperability of systems between companies is crucial, therefore standardization initiatives are of key importance in the development phase of data-ecosystems. By doing so costs and time delays regarding administrative complications can be reduced (Van Baalen et al., 2009). Both Brunila et al. (2021) and Praditya et al. (2017) point out that systems nowadays are heterogeneous and fragmented and therefore are incompatible. In order to enhance data-collaborations, compatibility and interoperability of systems are a must.

Data by itself should be trustworthy, but trust is also required in a data ecosystem. Therefore, the transmission of data should be done in a confidential and trustworthy manner. This condition is first applicable for the used technology to share data with, but it is foremost important for the party who is responsible for sharing the data, for example a platform or Port Community System [Terminal]. In addition, there must be support for data-collaboration in the supply chain of containers [Carrier]. For example, companies already have their business relations based on earlier experiences and therefore data related collaborations will follow these earlier relationships (Gelhaar & Otto, 2020; Praditya et al., 2017). Geisler et al. (2021) also state that data on itself should be trustful and data should be shared without bias.

The last category of requirements of data-sharing is about a secure and safe data-ecosystem. [Terminal] mentions that data-sharing is only possible if is known with whom data is shared and if this party is verified and authorized to receive this data. Also Brunila et al. (2021) mention that cybersecurity is one of the main hindrances of technology adaption. Data about the shipment and the real-time location can be sensitive data and therefore security should be safeguarded (Geisler et al., 2021). Lastly, data-sharing must also be compliant to data protection legislation (Van den Broek & van Veenstra, 2015).

The requirements for data-sharing mentioned in the interviews can be summarized as follows: sharing reliable and real-time data following international accepted standards based on a secure, safe, independent and trustworthy data-sharing environment which has a global coverage and is cost-effective. The information required for each step of the supply chain should come from the physical flow and processes involved in container transportation [Carrier].

Table 6.2: Data-requirements based on expert interviews and literature

Requirements	**Interviewees**	**Literature**
Ownership	[Carrier, Terminal, Freight forwarder]	Van den Broek and van Veenstra (2015); Gelhaar and Otto (2020); Geisler et al. (2021)
Data quality	[Carrier, Platform 1, Platform 2]	Van Baalen et al. (2009); Geisler et al. (2021)
Standardization	[Carrier, Inland shipping, Road transport]	Van Baalen et al. (2009); Praditya et al. (2017); Gelhaar and Otto (2020); Brunila et al. (2021)
Trust	[Carrier, Terminal]	Praditya et al. (2017); Gelhaar and Otto (2020); Geisler et al. (2021)
Security	[Terminal]	Van den Broek and van Veenstra (2015); Brunila et al. (2021); Geisler et al. (2021)

6.3. Conclusion

This chapter analyzed the different types of data in the container supply chain. The addressed data is just a grasp of available data, however, it gives an practical view on the possibilities of data-collaborations. Three applications were mentioned focusing on different stakeholders: customs & shippers, inland transport operators & terminals and carriers & terminals. Also five categories of data-sharing requirements are discussed based on the conducted interviews. Those categories consist of: ownership, data quality, standardization, trust and security. The next chapter will discuss the willingness to data-collaboration of stakeholders, which is also dependent on the type of data which will be shared.

7

Domain scope: attitudes towards data-collaboration

This chapter gives an answer on the question why companies are willing to share-data in the supply chain of containers and why not. The possibilities and barriers mainly come from the conducted interviews and are verified afterwards with (scientific) literature and the evaluation session. The domain scope mentioned in the overall inter-organizational data governance framework is explained in this chapter. The opportunities and barriers show the consideration of a company to take part in a data-collaboration. After explaining those, the willingness to data-collaboration is explained on actor level. This is done by looking at the consideration of opportunities and barriers, but also the analysis of previous chapters 5 and 6.

7.1. Opportunities & barriers of data-collaboration

This section discusses the opportunities and barriers identified by the interviewees. Those opportunities and barriers are composed, by analyzing the interview summaries which can be found in C. For communicative reasons, the opportunities and barriers are clustered according to their common denominator. A blue box, in both overviews, indicates that the interviewee mentioned that particular advantage. It could very well be that the interviewee does not experience the opportunity by themselves, but that the interviewee only identified the opportunity in the context of the container supply chain. In that case the opportunity is experienced in an indirect way, instead of a direct way.

Figure 7.1 shows the identified opportunities which are clustered in four categories: future proof supply chain, effective logistics, efficient asset utilization and safety. A future proof supply chain is all about ongoing processes regarding supply chain optimization, effective logistics is about providing effective transportation services to customers and efficient asset utilization is about internal efficiency. Safety in this case is about reducing container related crime. The advantage most often mentioned by interviewees is improving logistics performance in general (O1) and a more efficient container supply chain (O2). This is strongly related to the competitiveness of the corridor or port, in this case the port of Rotterdam, with respect to other corridors and ports (O3). From a overall port point of view, improved audittrails are crucial for the whole supply chain (O4). Effective logistics entail a reduction of Greenhouse Gas (GHG) emissions (05), a more adaptive logistics system to disruptions (O6) and satisfied customers by improving the customer experience (O8). Useful insights (O8) based on data can be helpful to make logistics more effective. Effective asset utilization means that waiting times, for example at the terminal, have to be reduced (O9) and capacity utilization of modes and infrastructure need to be improved (O10). This could eventually lead to transport costs reductions (011). The last opportunity identified is about reducing transport related (drug-)crime (O12). By improving visibility of containers and shipments, customs and authorities could be more effective in intercepting crime.

When looking at the different stakeholders and the number of opportunities mentioned, the platforms, port authority and customs mentioned the most opportunities. This can be explained by the fact that those stakeholders have a more distanced role with respect to the transportation itself and are providing services to that supply chain of containers. Also truck operators mentioned many different opportunities focusing on the supply chain and logistics processes in general, but they are also mentioned in relation to performance measures concerning waiting times and capacity utilization. This is also expected, because truck drivers have to wait at the terminals and via an improved (digital-) coordination waiting times could possibly be reduced. Carrier and platforms also mentioned an improved adaptiveness to disruptions in the supply chain. Shipper and barge also referred to an improved system of GHG emissions measurements and the reduction of those emissions.

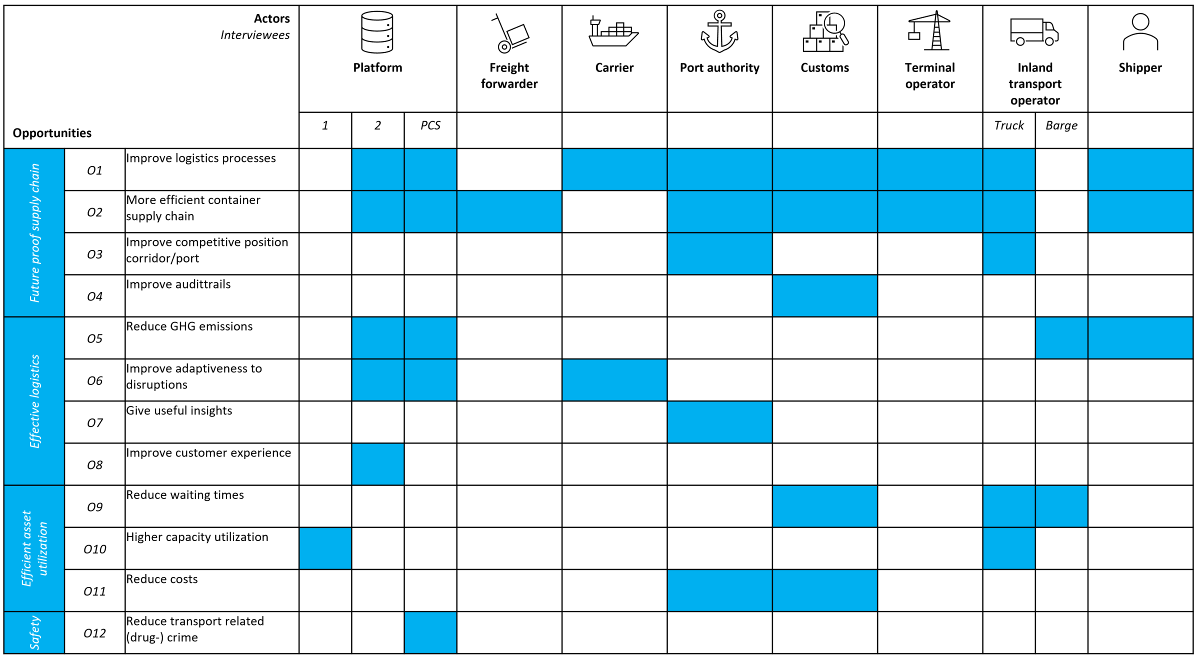


Figure 7.1: Opportunities of data-collaboration identified by interviewees

Besides those opportunities the interviewed parties experience, there are also barriers (Figure 7.2). The barriers are divided into four categories: competitive position, business model, attitude and data-sharing standards. Bringing the competitive position of the company at risk is the most often mentioned disadvantage (B1). Via data-sharing, (internal) processes get more transparent and therefore other parties could use this to their advantage. This also aligns with the confidentiality of data (B2). Stakeholders want to maintain control over their own data (B3). Competitiveness of the container supply chain and the risk of other parties which can threat their position or activities is an important factor. Parties are therefore suspicious about dominant players who want to provide services built on data of others (B4). This also means that the original data-owner has limited control over their own data, which can also encourage misuse of data (B5).

Companies will ask themselves what the potential benefits are of a data-collaboration and at what cost. If the business case for data-sharing is missing, companies will not consider data-sharing. A barrier mentioned is that interviewees are skeptical against companies who are monetizing data, which means that those parties sell data to third parties (B6). However, some of these companies also consider to build such data-services on their own to gain revenue. Adding transparency to the market could also result in an uncertain distribution of the investment costs and the accompanying benefits among the players in the container supply chain (B7). If the benefits and the costs are out of balance, companies will not share data. It is also important in what frame the costs and benefits will occur. In general, companies prefer securing short-term gains over insecure long-term gains. When profit margins are high, companies are less likely to share data if the risk exists of endangering their business. Interviewees also mentioned that the revenue model or success stories are missing (B8).

The attitude towards data-sharing can be a deal-breaker if companies do not want to share data based on their earlier experiences or as it is in the nature of the company. Current collaborations between logistics parties are based on trust and if trust between potential partners or towards the system is missing data will not be shared (B9). This trust is mostly based on years of experience with their partners and is therefore difficult to build. Other parties do not feel the urge to take part in data-collaborations (B10). Overall, parties do not want to risk their activities or their role in the supply chain and are therefore skeptical against unconditional data-collaboration (B11).

The last category focuses on data-sharing standards which are required to make data-sharing possible. Those barriers are strongly connected with the data-sharing requirements discussed in Chapter 6. Some stakeholders mentioned that it is unclear what the possible impact of data-collaboration could be. Besides, it is not clear which data is required to make the supply chain more efficient (B14). The purpose and definition of data has to be clear among all involved parties, *what is meant by specific data?* And then the information has to be transmitted in a standardized way, *how do we communicate this data?* It is difficult to achieve consensus about international holding standards, due to the fact that there are many parties involved whom all have their own preferences (B13). Another aspect why parties are not willing to share data, is low accuracy and reliability of the provided data (B12). If parties have to build their operational processes on this data, this is a major requirement. The same holds for privacy and security problems (B15). Lastly, it can be possible that parties may not share data because this is in conflict with competition law, as stated by the port authority (B16).

The overview shows that the port authority mentioned the most barriers, this is because the evaluated session was attended by a diverse set of departments. Platforms have in some way the same position or connections as the port authority and also mention several barriers followed by the terminal. [Terminal] stated that if their clients would know how efficient the terminal operates, they could use this to enforce lower rates. Therefore data-collaboration could be a threat to their business. This is all the more true for freight forwarders, because those companies provide logistics services based on an opaque transport system. If transport were more obvious, shippers would arrange the transport themselves and forwarders would lose their role.

Barriers		Actors / *Interviewees*	Platform			Freight forwarder	Carrier	Port authority	Customs	Terminal operator	Inland transport operator		Shipper
			1	*2*	*PCS*						*Truck*	*Barge*	
Competitive position	*B1*	*Risk for individual competitive position*	■	■	■	■		■	■	■			■
	B2	*Confidentiality of data*	■					■		■		■	
	B3	*Loss of control*						■		■			
	B4	*Dominance of parties over data*						■					
	B5	*Risk for misuse data*										■	
Business model	*B6*	*Monetization of data*		■			■	■	■	■	■		
	B7	*Unclear costs and benefits*	■		■						■		
	B8	*Missing revenue model and success stories*	■					■					
Attitude	*B9*	*Lack of trust*	■					■				■	■
	B10	*Missing urge*		■	■			■					■
	B11	*Willingness to share data is lacking*	■		■								
Data-sharing standards	*B12*	*Accuracy and reliability of data*				■	■	■					
	B13	*Conflicting data-sharing requirements*						■		■			
	B14	*Missing data-purpose, definition and standards*									■	■	
	B15	*Privacy and security problems*						■		■			
	B16	*Competition law problems*						■					

Figure 7.2: Barriers of data-collaboration identified by interviewees

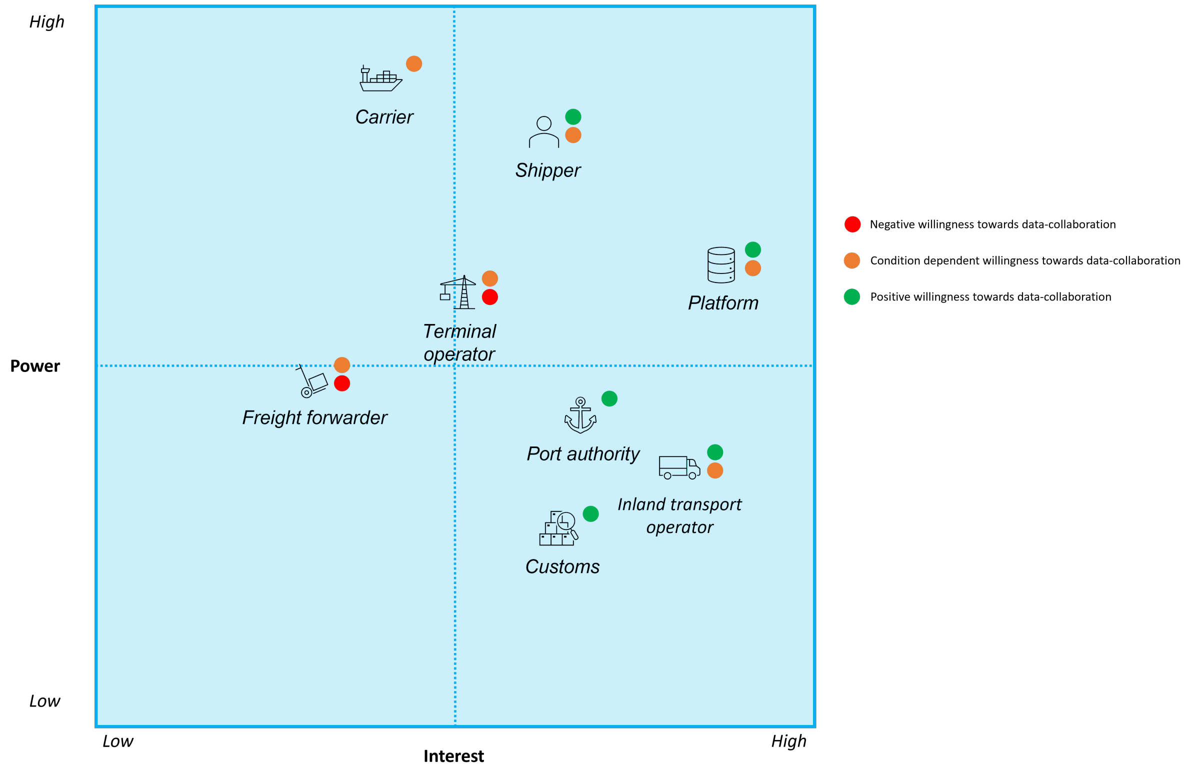


Figure 7.3: Power, interest and willingness towards data-collaboration in the chain

7.2. Power, interest and willingness towards data-collaboration

After describing the identified opportunities and barriers of data-collaboration, the overall willingness of stakeholders to be part of such a data-collaboration are described in this section. This section also builds upon the previous chapters describing the context and behavior (Chapter 5) and the available data (Chapter 6) regarding the industry of the container supply chain. The willingness to data-collaboration is described for: platform, freight forwarder, carrier, port authority, customs, terminal operator, inland transport operator and shipper. The willingness to data-collaboration is dependent on the company itself (Section 5.1), the data-set which will be shared (Chapter 6) and the other companies with whom the data will be shared (Section 5.2). The company whose perspective is taken, takes all opportunities and barriers in consideration (Section 7.1) and makes a decision whether or not to take part in a data-collaboration. This decision normally takes place in a more implicit way instead of an explicit consideration. It could be still the case that a stakeholder is not willing to share data based on implicit and sometimes seemingly irrational preferences.

The power-interest grid gives an total overview of the position which the stakeholders take with respect to data-collaborations. Power, in this overview, stands for the position in the physical container supply chain but also the possibility to enforce data-sharing and develop own data-services. Interest stands for the potential benefits for that particular stakeholder with respect to data-collaborations. Lastly, the willingness to data-collaboration is shown by a traffic light indication. Green means totally willing to collaborate, orange means that the willingness is dependent on the conditions of a data-collaboration and red means that a stakeholder is not willing to share data. Due to the diversity of data-collaboration cases, the willingness could be different for a particular case. Therefore some of the stakeholders have multiple colors. All those factor will be explained on stakeholder level further on in this section.

Freight forwarder

Freight forwarders become less powerful, because shippers are becoming more and more independent. They also have the smallest profit margin and the highest risk for loosing their position in the container supply chain (Section 5.2). Due to the fact that most freight forwarders do not have the physical assets to transport containers and the services are dependent on the in-transparency of container transport, data-sharing could be a threat to these companies. Data-sharing, especially with shippers, makes transport more transparent and gives the opportunity for smaller shippers to also coordinate transport themselves. This makes that freight forwarders are skeptical towards data-collaboration across the chain and especially by stakeholders who are clients of them. Therefore, freight forwarders have little interest in data-collaborations. However, also freight forwarders are developing new data-services which gives their clients useful insights in container statuses. For example freight forwarder FedEx is the lead investor of the data-platform FourKites (Crunchbase, 2022b). This could possibly mean that the freight forwarders of the future will be more like data-platforms. It can also be stated that non-traditional logistics parties, such as platforms will be new competitors for stakeholders such as freight forwarders. Therefore, it is not a choice to change, but a must. [Customs, Freight forwarder] underpin this statement on the decreasing position of freight forwarders. Looking at the willingness to data-collaboration, freight forwarders are skeptical regarding sharing information about their performance. However, if it is about performance of other stakeholders, such as capacity utilization or punctuality of carriers the willingness can be positive, but this is dependent on the data-sharing conditions.

Carrier

The carrier has a powerful role in the container supply chain. Profit margin has increased from negative to positive in the last decade (Section 5.2). Therefore there is more room for carriers to expand their services across the chain but also in a broader sense towards digital services, for example Tradelands which is developed by Maersk [Customs]. Another aspect is that carriers are part of alliances which are responsible for 80% of all transported containers across the sea (ITF, 2022). By increasing call sizes, the pressure on terminals and hinterland transport increases. Due to increasing profit margins and carriers' prominent role in the chain, the urge is missing to share data [Shipper, Road transport]. Therefore, the willingness of carriers to be part of data-collaborations by themselves is slightly negative. By taking part in data-collaborations it could be that their competitive position will be affected. Carriers will therefore only share data under their conditions.

Port authority & Port Community System

The port authority is more positive towards data-collaborations, because this party strives for an optimal corridor of well coordinated corridor partners. The Port Community System is initiated by the port authority and therefore the position of the Port Community System is the same as the port authority. This is different for other private owned platforms. Data-collaboration, in this particular case study, also fits in the Port of Rotterdam strategy to be the smartest port of the world. If it is possible by data-collaboration to increase overall throughput and decrease waiting times, the port authority is willing to encourage stakeholders in the port to get involved. This shows that the interest of the port authority is high. However, power is limited because they do not own data by themselves and they are less involved in the transport of containers. It is possible to force parties to share data through port regulation, but this could make the port less attractive as compared to other ports. Both PCS and the port authority have the position and financial resources to facilitate those data-collaborations, which is shown in Figure 7.3. Further in this research, the possible role of a port authority regarding data-collaboration is discussed into more detail.

Customs

The attitude of customs is in some way similar to the port authority. As discussed in the interview, customs strives for more efficient clearance processes and mentions that end-to-end visibility of shipments could help to improve this [Customs]. Therefore, customs has interest in data-collaboration to improve their own processes. However, customs cannot force stakeholders to give insight in this data, it can only be enforced by a legal entity such as the European Union, the national Government or the International Maritime Organization (IMO). The newly developed Maritime Single Window by the IMO is an example of that (IMO, 2022). Also data-transmission by itself can not be developed by customs because this entity is, in the Netherlands, part of the Ministry of Finance. Another aspect is that customs has no financial interest in data-collaboration, because of this public ownership. Customs data itself can only be shared, by law, with the declarant, as stated in the interview. Therefore customs is really bound to legislation and other imposed mandatory procedures. Concluding, the willingness to share data of customs is positive, but the development of data-collaboration is dependent on other parties.

Terminal operator
Data-collaboration could be beneficial for the terminal when looking at the Estimated Time of Arrival (ETA) of deepsea vessels, also hinterland transportation could be streamlined by sharing the right information. However, internal efficiencies of the terminal are identified as commercial confidential information. Therefore, the terminal can have a positive or negative interest towards data-collaboration dependent on the case. As stated before, some stakeholders in the port experience that the terminal is the major bottleneck of the container supply chain [Road transport]. Therefore terminal efficiency and maximizing throughput are important for both carriers as well as for inland transport operators. However, some revenue of the terminal is based on the time a container is stored at the terminal. Also communicating internal efficiency could give clients a stronger negotiation position. The terminal is a powerful stakeholder in the port, due to the fact that there are a limited number of terminals available. However, as compared to carriers they have limited power. Profit margins of terminals are also low and terminals are much dependent on carriers. This all makes that terminals are not directly willing to collaborate and share data with other parties. Terminals are also looking at providing data-services themselves about container statuses in which they maintain control over their data. Concluding, terminals can be willing to collaborate but it is dependent on the data-sharing conditions.

Inland transport operator
Also the inland transport operator actor group is diverse: different modalities, differences in scale and services and companies can have other working areas. [Inland shipping, Road transport] argue that the major bottleneck is the container terminal. Especially for barges it is difficult to schedule services due to the dependency of the deepsea vessel's Estimated Time of Arrival (ETA) and the planning of the container terminal. In order to optimize capacity usage and reduce waiting times, real-time data-sharing between carrier, terminal and inland transport operator is required. Therefore, interest is high for inland transport operators, however, those parties are dependent on other data-providers. Inland transport operators are positive towards data-collaborations, however, they do not have the power to enforce data sharing. Besides, the same as for terminal operators holds for inland transport operators: internal performance indicators are confidential for clients and competitors.

Shipper
As stated by [Shipper], shippers are willing to share data if this results in better performing transport chains. However, the actor group of shippers is diverse in transport and company scale. As discussed in Section 5.1, shippers can have their own forwarders department or can outsource this to a freight forwarder. The [Freight forwarder] also mentioned that shippers do not fully evaluate transportation performance on shipment level at the moment. However, it can be expected that shippers will choose their logistics partners on level of visibility and transparency of their processes, but also on their day to day performance. This is due to an increase in disruptions, such as lock downs in China and blockage of the Suez Canal, in the chain of containers the past few years. The willingness to collaborate, or willingness to invest in such collaborations, can be different per shipper. Due to the fact that shippers are the clients of logistics providers, shippers can enforce data-sharing regarding their shipments via transport agreements. Overall, shippers have a positive attitude towards data-collaboration which is expected to grow in the future. However, commercial sensitive data will not be shared unconditionally and therefore in that cases shippers will be cautious. If shippers enforce data of their shipments will be shared in order to evaluate transport performance, data-collaboration can be a possible solution. Therefore shippers can have both the interest to share data and the power to enforce this from their logistics providers.

Platform
The major role of platforms is setting up those data-collaborations between stakeholders and therefore their attitude towards data-collaboration is rather positive. However, in order to do so, these parties are dependent on the willingness towards data-collaboration of their potential clients. The willingness of stakeholders to be part of such a platform is also dependent on the attitude of the platform. For example, Tradelens is a joint venture of Maersk and IBM. Therefore it could be stated that this platform is less dependent as for example Portbase, the Port Community System (PCS) of Rotterdam. Such a platforms has to be trusted in order to get parties involved. Overall can be stated that these platforms are willing to provide data-collaboration in order to generate revenue. On the other side, platforms

are not always willing to share meta-data of the requested data. This data could be interesting for data-providers to see which clients demand such data.

7.3. Conclusion

The opportunities and barriers identified by the interviews strongly influence the willingness to data-collaboration. The opportunities can be summarized into four categories: future proof supply chain, effective logistics, efficient asset utilization and safety. The barriers are categorized in the following four categories: competitive position, business model, attitude and data-standards. Besides those opportunities and barriers, the willingness to data-collaboration is dependent on the stakeholder which perspective is taken, the particular data-set which will be shared and the stakeholders who will receive that data-set. The opportunities and barriers are implicitly connected to those three factors. Based on the balance between opportunities and barriers, a stakeholder will decide whether or not to take part in a data-collaboration. Based on the overall analysis in this chapter and previous chapters the willingness per actor is analyzed. The freight forwarder will be the most affected actor when sharing date and therefore this stakeholder is the least interested in collaborating in this area. After the freight forwarder the terminal and carrier follow, because the urge to collaborate is missing and internal efficiency information is sensitive to share. On the other side the port authority, Port Community System and customs are most willing to collaborate. However, those parties do not produce the most valuable data for the container supply chain. Hinterland transport operators could benefit from data-collaborations, however these parties are less powerful as compared to terminals and carriers. The next chapter will dive into possible data governance archetypes which can be applied to different data-collaboration cases. The perspectives found in the previous chapters will be the basis for those archetypes.

8

Governance archetypes: possible setups for data-collaboration in the supply chain

Given the described case study of the container supply chain in the port of Rotterdam, this chapter sheds a light on applicable data governance mechanisms capable of improving data-collaboration. In order to do so, data governance archetypes based on different characteristics are developed by analyzing two taxonomies: the taxonomy of ecosystem data governance by Lis and Otto (2021) and the taxonomy of incentive mechanisms for data sharing in data ecosystems by Gelhaar et al. (2021). To systematically describe useful combinations of data governance mechanisms, taxonomies are helpful to give an overall overview of all the possibilities. However, in order to ensure that all factors are taken into account, an extensive literature review is required. Lis and Otto and Gelhaar et al. did this by analyzing respectively 57 and 141 papers. Those two papers also connect well to the other data governance literature reviewed in Chapter 4 and therefore the overall governance framework of this research.

Gelhaar et al. recommended to first develop governance archetypes based on the found characteristics and then evaluate which of those archetypes could be more successful. Currently there is no, to the author's knowledge, research present focusing on inter-organizational data governance in a container supply. An overarching framework of the possible combinations of data governance mechanism, except for the two taxonomies found, applicable to this particular case is missing. This research aims to map the possible data governance mechanisms, based on both taxonomies and the case study description, and after that develops an overall framework consisting of data governance archetypes. After developing this framework, the developed archetypes are described and some applications are given. Lastly, the Port of Rotterdam port authority reflects on those archetypes focusing on the possible application of the developed framework.

8.1. Data governance characteristics selection

As mentioned earlier, the selection of characteristics will be based on the description of this case study in Chapter 5, Chapter 6 and Chapter 7. Therefore, all dimensions and characteristics in both taxonomies will be discussed with an eye on applicability on this particular case study: the container supply chain in the port of Rotterdam. Figure 8.1 shows the adjusted framework of Lis and Otto (2021) where the dark blue dimensions and somewhat lighter blue characteristics will be added to the overall framework (see also Appendix E for a rough version of the framework). The lightest blue characteristics in gray will be assumed and therefore this characteristic is not a choice but a fixed assumption.

With respect to the **purpose** of data-collaboration, *control*, *collaboration* and *value creation* are most applicable characteristics in this case study. This is because stakeholders in the chain are focused on improving coordination via collaboration when there is trust, creating value by developing new (data-)services and gaining control in order to manage the system. Lis and Otto (2021) define purpose as "the need for establishing some form of structure to balance collective goals and different interests”. Control is for example the case when data is shared for customs purposes as stated by [Customs] and (IMO, 2022). Collaboration will only take place if both parties have valuable information, for example between terminal and inland shipping [Inland shipping]. Value is created in cases where actors are developing own data-services in order to gain revenue by for example platforms such a Project44 or logistics parties such as carriers and terminals [Customs, Terminal]. The **scope** in this research is clear, *inter-organizational*, therefore there is no variety in this dimension which means that this dimension will not be part of the archetype development and the characteristic of inter-organizational scope is assumed. Intra-organizational data governance, such as internal business intelligence, is outside of the scope of this research. The next dimension is the **phase** of data-collaboration. Most companies within the port already work with each other, as discussed before, but do not share (all) data unconditionally. *Partnership creation* and further development of data-collaboration in the *partnership program delivery* phase are also more in line with the main research question, which is in short: how to improve data-collaboration. In case of pre-partnership collaboration, there is no previous connection between the stakeholders. In the container supply chain, stakeholders are already connected in some (physical) way. Partnership termination/succession is about the ending phase of a data-collaboration, however the focus of this research is on developing such collaborations.

The data ecosystem **configuration** is about the position of the dominant body, if this is more *centralized*, *decentral* or *self-organizing*. In this case study this can be different from use case to use case. For example, customs data in the port of Rotterdam at the moment is distributed in a centralized manner via the Port Community System (PCS) Portbase [Customs, Port Community System]. Other data is shared on a bilateral basis between companies, for example shipment forecasts between shipper and freight forwarder. The **structure** of data-collaborations is the core of the case study: under which conditions data will be shared. Van den Broek and van Veenstra (2015) described four modes of inter-organizational data-governance: market, bazaar, hierarchy and network. *Market* is based on bilateral contracts in which data can be sold or bought. In a *hierarchy*, data exchange will be coordinated by a dominant player in the network. Data exchange based on trust takes place in a *network*. Control over data still lies at the individual stakeholders. A bazaar is less in line with expectations, because this means that all parties have access to all data. According to the interviewees, stakeholders want to maintain control over their own data, looking at the discussed data-requirements in Chapter 6. Data governance can use different **mechanisms** to give shape to data-collaborations. It is also stated by (Keller et al., 2021) that governance can consist of *formal* contracts or *informal* agreements. Both can be applicable based on the involved stakeholders and required data.

Lastly, **data ownership** and **decision rights** are key to develop data-collaborations in the container supply chain. As many interviewees argued, companies want to be in control over their data which means that data ownership should be on a *individual* level [Carrier, Freight forwarder, Terminal]. Therefore, the decision what can be done with the obtained data should also be on a *monocentric* level. This follows the line of reasoning discussed by (Gelhaar & Otto, 2020; Geisler et al., 2021; Van den Broek & van Veenstra, 2015) in Chapter 6, especially in cases where data is commercial sensitive.

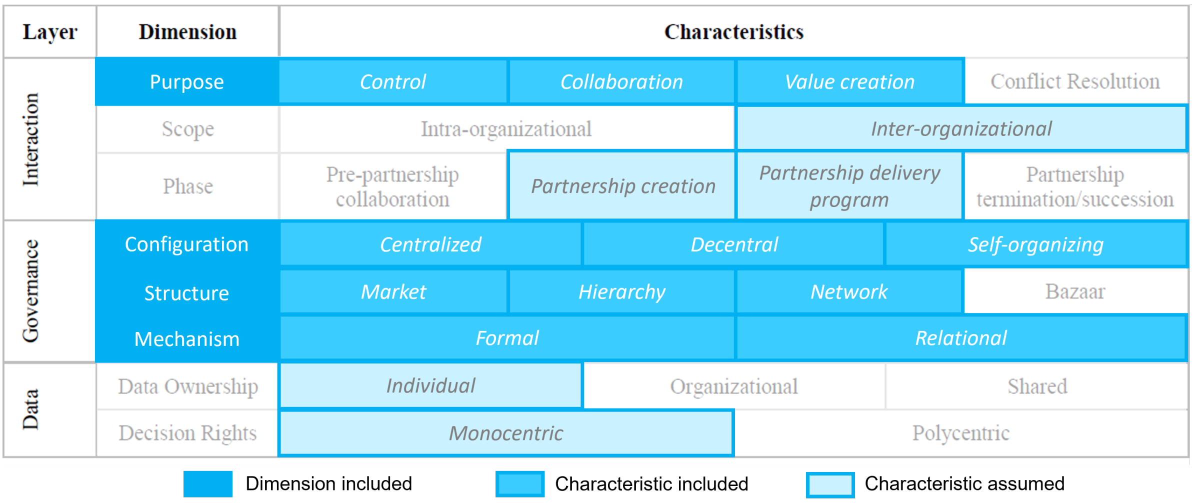


Figure 8.1: Adjusted taxonomy for ecosystem data governance based on Lis and Otto (2021)

The second taxonomy focuses on incentive mechanisms for data-sharing and is developed by Gelhaar et al. (2021) (Figure 8.2). First **data type** and **data control** are discussed. This case study is about *industry data* shared between (mostly) private companies, as discussed in Chapter 6. However, customs data can be seen as government data, the declarant is always a industry stakeholder. Scientific data and personal data are not applicable to this case study and are therefore out of the scope of this research. Data control, as discussed before, is important tot maintain for involved stakeholders. Therefore, data control can only be *sovereign* in this particular case study. If data control would be transferred, a keystone actor will have control over the shared data. Shared control means that there are no restrictions on ownership, which does not suit this case study, as discussed under this section. Stakeholders in this case study want to stay in control over their own data.

Next is the **motivation** of stakeholders to participate in data-collaboration. Most prominent is the *economic* motivation, to improve company performance. Also looking at the discussed opportunities in Chapter 7 (O10, O8). Also the system overview of improving overall competitiveness and performance of the port can be the motivation of stakeholders to collaborate, which can be concluded from Chapter 7 (O1, O2, O3). This is referred to as *social & ecological* motivation in this taxonomy. Lastly, data can be shared on a *legal* basis, for example customs data, which suits the maritime single window case (IMO, 2022). *Cultural* is about the organizational appetite towards data-collaboration, however, this is outside of the scope of this research due to the inter-organizational focus. The next dimension is the **underlying theory** in which data-collaboration is investigated. The taxonomy of Gelhaar and Otto is based on the setup of previously conducted research instead of a specific case study. However, this research itself is based on inter-organizational governance and a case study. Therefore this research focuses on *other* theory.

The technology used to share data with or the required **infrastructure** is outside of the scope of this research. However, all three proposed infrastructure setups can be used in this case study. These also fit the configurations proposed in the taxonomy of Lis and Otto (2021). Portbase as a Port Community System (PCS), for example, is a form of more centralized infrastructure and the blockchain technology in Tradelens can be seen as form of distributed infrastructure. Choosing the right infrastructure strongly depends on the preferences of the involved stakeholders and follows the data ownership and decision rights discussion. **Reward** and **payment model** are both important to convince stakeholders to get involved in data-collaboration. *Money* is the most obvious reward in this case study, because most of the stakeholders in the chain have a small profit margin (see also Section 5.2). Virtual assets, such as cryptocurrencies, services or reputation are less obvious because these rewards are less viable in this case study. Because most parties are interrelated to each other, *data* exchange could also be a viable solution in cases where both parties have valuable data (see also Chapter 6 for the applications). Lastly, in some cases data is mandated to be shared, such as customs data, in that case data is shared for *free* which means that the reward is *none*. The payment model can also be dependent on the used infrastructure. Platforms could for example base payment on subscriptions. However, in bilateral situations a *fixed* payment method is most obvious. However, some parties are developing data services by themselves and would consider payment based on *usage* or *revenue*. For simplicity, a combination of those payment models will not be included in the development of archetypes.

The chosen characteristics from both taxonomies will be combined in a new framework in the next section. After that, data governance archetypes applicable to this case study will be developed.

Layer	Dimension	Characteristics					
Data	Data type	Scientific data	Government data	Industry data	Personal data		
Data	Data control	Transferred	Sovereign	Shared			
Foundation	Motivation	Economic	Social & ecological	Legal	Cultural		
Foundation	Underlying theory	Economics	Social & behavioural science	Others	None		
Implementation	Infrastructure	Centralized	Distributed	Hybrid			
Implementation	Reward	Money	Virtual assets	Data	Service	Reputation	None
Implementation	Payment model	Free	Fixed	Subscription	Usage-based	Revenue-based	Hybrid

Dimension included · Characteristic included · Characteristic assumed

Figure 8.2: Adjusted taxonomy for incentive mechanisms for data-sharing in data ecosystems based on (Gelhaar et al., 2021)

8.2. Data governance archetypes

The chosen dimension and characteristics of the last section are combined in a new framework (Figure 8.3). Appendix E shows a rough version of the framework, based on the discussed dimensions and characteristics in this chapter.

It must be noted that three pathways were already noted from conducting the interviews. First, monetization or buying and selling of data. Most of the data-platforms use this to acquire data for their platforms. Another way of retrieving data is by regulation. This could be done by regulations or agreements. Lastly, data could be shared for other data in return, data-for-data. With those three pathways in mind, the framework is developed. This framework is based on the two taxonomies and validated by both literature and experts in the field, therefore it can be assumed that this framework is collectively exhaustive. Another aspect is the mutual exclusiveness of the found characteristics as both is based on the taxonomies but also on the found pathways. A framework is often a simplification of reality and has the purpose of structuring a complex system or problem. The archetypes are based on the findings of this case study and previous research. The set of characteristics of an archetype are most connected to each other and follow the ideas of (Lis & Otto, 2021; Gelhaar et al., 2021; Van den Broek & van Veenstra, 2015). As a result, the archetypes are the most contrasting, which promotes the discussion about data collaborations. In order to validate the found archetypes, validation interviews were conducted with [Inland shipping, Knowledge hub, Terminal] to refine the framework. Those interviews are referred to in the further explanation of the archetypes.

The foundation of data-collaboration can be explained by two dimensions: **purpose** and **motivation**. This foundation explains why data-collaboration will take place in a specific manner and in which context based on the attitudes of the involved stakeholders and the data type that will be shared. Those two dimensions answer the question: *What is the context of the data-collaboration?* Purpose and motivation can be linked to each other in logical pairs of characteristics. Control can be reached by legal agreements, value creation is mostly based on a economic motivation and collaboration mainly focuses on the social & ecological performance of the whole system. Of course, control could also be achieved via buying and selling of data. However, stakeholders who mainly focus on value creation will have an economic motivation for data-sharing and stakeholders who focus on control and have the opportunity to regulate data-sharing via regulations have a legal motivation. This also follows the applications mentioned in Chapter 6 about public bodies such as customs who try to control the flow of freight (control on a legal basis) and logistics parties such as carriers and terminals who are trying to develop data-services (value creation on a economical basis). Collaboration in a social & ecological basis is mostly based on trust, as stated by (Gelhaar et al., 2021), and in those cases parties mostly strive for mutual benefits, for example in the case of terminals and inland shipping sharing data.

The next layer consists of the governance dimensions. This focuses on the governance structure that will be applied in order to setup the data-collaboration and answers the question *Which governance structure to apply?* First of all the **configuration** of data-collaboration: based on a single dominant player in a centralized setup, decentral by the stakeholders involved or self-organizing when seeking coalitions. The **structure** follows this configuration because a centralized configuration is closely connected to a hierarchy structure. Bilateral buying and selling of data in a market structure follows from a decentral configuration. Networks are self-organizing and based on trust between involved stakeholders. In general, hierarchies and markets follow a formal set of **mechanisms** and networks mainly, based on trust, on relational mechanisms.

Lastly, the implementation consisting of a **reward** and **payment model**. This layer is about what will be given in return to the data-provider for sharing data and answers the question *What will be given in return for sharing data?* Given the other layers, the path based on control and a legal basis is more obvious to have no reward and data will be shared for free. This will be the case when data-collaboration is regulated, in this model referred to as **regulate data**. If value creation is more important and data will be sold and bought on a market, money as reward is most viable. This can be fixed or on a usage or revenue basis. This path is referred to as **buying & selling data**. Lastly, data can also be shared in exchange for other valuable data. This is mostly based on trust between involved stakeholders. This means that the reward is other data and the payment is done on a fixed basis. This last path is referred to as **data-for-data**.

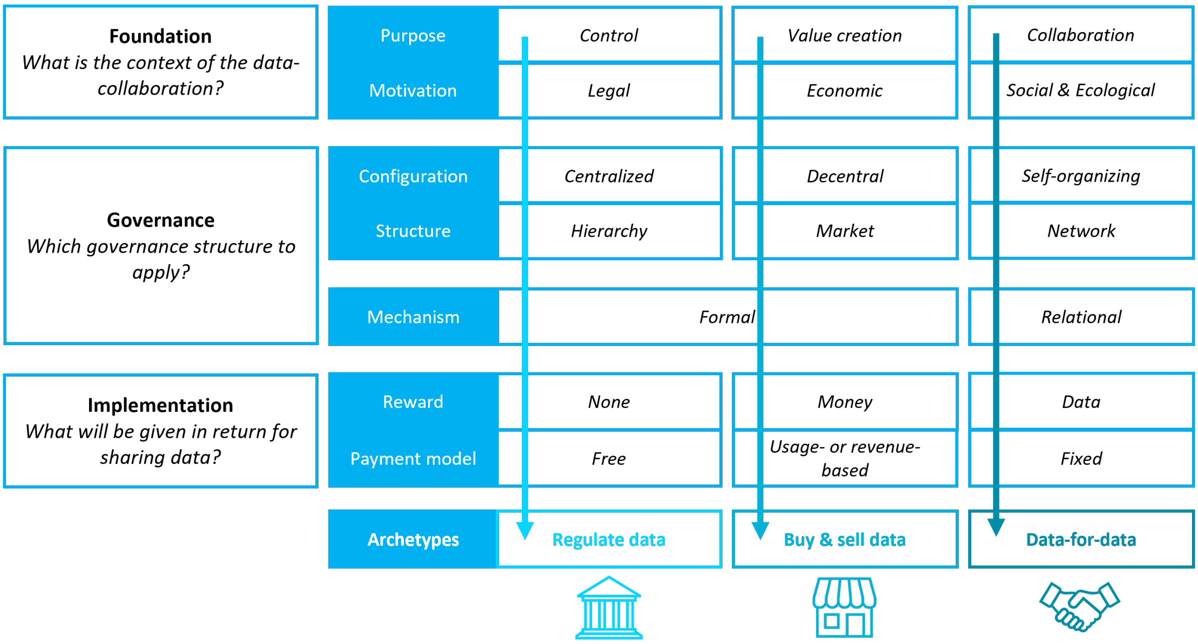


Figure 8.3: Data governance archetypes applicable to the container supply chain

Before the archetypes will be explained into more detail some remarks have to be made. First of all, the presented archetypes could suggest that there are just three pathways of data-sharing. In practice also hybrids will occur, because each data-collaboration requires other conditions or agreements. This is also stated in a validation interview with [Road transport]. For example, a control purpose and economic motivation can be combined in case of a dominant party in the chain. However, in this design is chosen for the most contrasting one of a governing body striving for control capable to regulate this data to be shared. Another example could be that a market can be combined with a centralized configuration, for example via a Port Community System, or with a self-organizing structure where there is no single market but many different data-markets based on local initiatives in the ecosystem. Also in this case is chosen for the most obvious combination of a decentral market in which different bilateral or multilateral contracts are made.

The second remark is regarding the formulation of the framework. It is chosen to directly take over the described dimensions and characteristics from the taxonomies of Gelhaar et al. (2021) and Lis and Otto (2021) in order to connect the newly developed framework and the taxonomies to previous research.

Lastly, it is important to note that these data governance archetypes assume that there is an imbalance between data-producer and data-consumer with respect to costs and benefits of data-sharing. The discussed opportunities and barriers in Chapter 7 could partly explain this imbalance. Mostly, the data-producer has less benefit as compared to the data-consumer. Especially in a competitive environment, as the container supply chain is, stakeholders will ask themselves *what's in it for me?* when the get involved in a data-collaboration. If there is such an imbalance of opportunities and barriers at the data-producer's side (Chapter 7), this stakeholder wants to be compensated for sharing data with other stakeholders. This compensation can be money, but also data if the other stakeholder has valuable data. Regulation of data-sharing will only take place if a data-consumer has the power to regulate this or the government will introduce regulations if there are societal interests at stake.

8.2.1. Regulate data

As discussed earlier in this section, regulate data is most likely in cases where the purpose of data-collaboration is to be in control of the supply chain with a legal motivation to regulate this data-collaboration. In that case it is arguable if there is actual data-collaboration or just data-sharing regulated by regulations or agreements. This regulation takes place in a centralized and hierarchical way in which a dominant stakeholder forces other stakeholders to share data. Those other stakeholders do not get something as reward and therefore there is no payment model required. In general this archetype is most suitable in cases where data-owners are not willing to share data and other stakeholders' processes are dependent of this data. If there are multiple parties experiencing loss in performance and this also has a societal impact, authorities could consider regulation of data-sharing by regulation and law. Another case could be between shipper and transport operator(s) in which a shipper regulates the transport operator(s) to be transparent and provide end-to-end visibility of their shipments. In that case the regulation of data would be part of the (long-term) transportation agreement between shippers and transport operators. However, this is only likely when the shipper has a significant amount of freight to transport, for example: IKEA and Heineken.

As discussed before regulated data-sharing is possible only if the stakeholders are capable to regulate this via regulations or agreements. This requires in some way power over the system or over another stakeholder. Two perspectives will be given: a private and a public one. First of all data sharing could be enforced by regulations. This can only be done by regulatory bodies such as the national government or a supranational body such as the International Maritime Organization (IMO) or the European Union (EU). The port authority, for the case of Rotterdam, could also incorporate data-sharing in their port regulations. The IMO is currently working on a Maritime Single Window, which will be the global standard for administrative procedures around a port call (IMO, 2022). By streamlining those procedures it becomes more straightforward for shippers and carriers to comply to the authorities needs. Besides, the procedures will be the same for all global ports. There are also some developments on European level which entails data-sharing, as the following regulations are in development: data governance act, data services act and data act, as discussed by Port Community System. The reasoning behind this could be that if crucial information is not shared, the societal environment is affected negatively by transportation issues. For example, coordination between terminals and trucks are not effectively attuned to each other, which leads to congestion to the hinterland. This could also influence the inland transportation of goods or passenger flows, but also increases emissions.

Lastly, dominant parties could enforce data-sharing via booking agreements. For example large shippers could demand total visibility of their shipments during transportation, as discussed by Freight forwarder. However, this way only shippers will benefit from that data. By this visibility shippers could improve their internal logistics and stocks.

8.2.2. Buy & sell data

If there is a certain imbalance of opportunities and barriers regarding data-collaborations between stakeholders, this imbalance can be compensated by buying or selling data. Buying data in this case means that a data-consumer, with a specific demand for data, initiates a data-collaboration. Selling data is the opposite way where a data-producer has valuable data that can be transformed to own services or sold to other parties in the chain or data-platforms. However, the value of data cannot simply be determined. As shown in Figure 8.3, the reward can be in a usage-based or revenue-based form. Usage-based means that each time data is retrieved a fixed fee will be charged. Looking for example at data-platforms, data is retrieved from data-producers who get a fixed reward on annual basis and after that data is transformed to services which are billed on usage-basis. Lastly, the reward can also be based on the revenue gained by retrieving the data. However, it can be difficult to determine which part of the revenue has increased due to data-sharing. Data-valorization is outside of the scope of this research and is therefore part of the recommendations.

This archetype could be used if stakeholders in the chain develop their own data-services such as a container terminal giving real-time information about terminal congestion or delays or Estimated Time of Arrival of vessels provided by the carrier to hinterland operators. However, this way of sharing data is less likely in cases where the data-consumer has more power, for example in the shipper and freight forwarder case. In these kind of relations it could be possible that shippers demand transparency. Another example could be data of hinterland transport operators which could be valuable for container terminals, in that case the container terminal has more power over the process of container handling. Therefore it is more difficult for hinterland transport operators to provide this data via paid services to the container terminal.

This archetype will mostly be applied by data-platforms. Those parties will buy data at data providers and then sell this data, or insights, to their customers. Such platforms can be seen as a data-hub between data-providers and data-users. It is important to note that if platforms, or other parties, are able to aggregate data-sets by retrieving data from different sources, the value of that information will increase, as discussed in the validation session with Inland shipping. Therefore the value of a single data-set is also dependent on the value of the total data-set and the purpose of the data-service. This follows the idea of the terminal and inland transport operator example mentioned in Section 8.2. Ownership, decision rights and purpose should be clearly defined before sharing data. Sharing data with third parties and knowing under which conditions this may or may not happen is crucial [Inland shipping].

8.2.3. Data-for-data

The last archetype is focused on bilateral agreements in which data is exchanged for data. This could be the case if both stakeholders have valuable data for each other. Also in this data-for-data concept, the value of data is important to have an agreement on equally valuable data-sharing. However, this could also be dependent on the stakeholders involved and the (previous) relationship between those two parties. As discussed earlier, this archetype is mostly based on trust between the involved stakeholders. Such collaborations can also be based on agreements which specify exactly which data will be shared and what the purpose of the data will be. Also data quality standards and Service Level Agreements (SLA's) can be part of those agreements.

Data-for-data could for example be applied on the data-collaboration case in which a container terminal and inland transport operator work together. The terminal is interested in the modality and the number of containers which will be transported by that inland transport operator. Inland transport operators are interested in time windows and terminal congestion. If those data-sets could be exchanged with each other, the process of container handling could be more efficient. Another practical example could be, through better coordination via data-sharing, that a truck driver could take any container part of that transport booking which allows the terminal to load the most logical container which requires the least moves. In this particular case both parties require valuable data from each other. When exchanging data it is also important to evaluate the data-sets' value. Both data-sets should be equally valuable or both parties are willing to collaborate regardless of the equality of value of their data-sets. In this particular case could the port authority or the Port Community System (PCS), Portbase in Rotterdam, stimulate parties to collaborate by getting those parties together and talk about the possibilities. This research could help to kick-start those discussions and provide "food for thought". A more specific recommendation for the role of a port authority is given in the next section.

8.3. Role port authority

From the interviews and analyzed literature, the question arises what the role of a port authority should be regarding the development of data-collaboration. As this research is conducted in collaboration with the Port of Rotterdam, the discussion focuses on this specific port authority. Most of the interviewees mention that the port authority should be a facilitator and catalyst [Carrier, Platform 1, Road transport, Terminal, Shipper]. The interviews imply that the port authority encourages new data-initiatives, connects parties with each other and communicates what the key possibilities and opportunities are. Central to this statement is the neutrality and independence of such an authority. Also other roles of the port authority were discussed in the conducted interviews. For example, different departments in the port of Rotterdam argued that the port authority should set a good example in order to pursue other companies to follow. Therefore another role could be the one of exemplar [Platform 1]. The major aim of a port authority is to maintain a safe and efficient flow of goods through the port. Therefore, some voices in the port of Rotterdam argued that another role could be that of a problem owner [Port Community System]. The latter also fits the archetype of regulate data. In this case the port authority could implement regulations which enforces parties to share data. In this case the port authority is a regulator [Road transport].

However, a port authority can also have multiple roles in a port ecosystem. As mentioned under Section 5.1, the port authority undertakes different activities in the area of nautical services and business developments. The development of businesses also gives a commercial incentive to develop data-services by itself. The developed archetypes were also validated by the Port of Rotterdam. This reflection had the purpose to discuss what the potential practical value could be of the developed archetypes. Two years ago the data strategy of the Port of Rotterdam focused on developing own services. Experience from the previous years showed, that this profit driven strategy did not match the expectations of the other parties in the port. The major reason for this is the conflict of interest between the facilitating neutral role of the port authority and the direct business model aspect of that strategy. This data strategy was focusing on short term direct revenue based on individual products instead of optimizing the overall position of the port in line with the statutory long-term focus. Currently, the Port of Rotterdam is reassessing which role to play regarding the development of data-collaborations. The port authority realizes that a well-functioning data-ecosystem is of key importance to maintain the port's competitiveness in the (near) future. The archetypes, regulate data, buy & sell data and data-for-data, could help the Port of Rotterdam in structuring the discussion about their future role in the data-ecosystem. Because of the diverse nature of the port authority, consisting of both public and private activities, it could be that all those three archetypes are valuable for the different parts of the company.

The challenges for port authorities regarding business model innovation, as discussed by Kringelum (2019), is consistent with the process described by the Port of Rotterdam. Kringelum also stated that port authorities are expected to be managing business models as multi-sided platforms, which consists of many different users with their own expectations and requirements. Therefore such platforms or communities should be handled with care, according to the discussion with the Port of Rotterdam. Tijan et al. (2021) also state that, regarding the implementation of a Port Community System in which the port authority has a prominent role to play, different stakeholders have different preferences. Therefore, various business models have to be developed. This is also in line with the statement of the Port of Rotterdam that all developed archetypes could be valuable in different situations.

8.4. Conclusion

This chapter offers thee archetypes which could be used to describe and setup data-collaborations. Those archetypes are based on two taxonomies which were developed by analyzing data governance literature. First both taxonomies are been made applicable to this particular case. After that, the taxonomies were combined into an overarching framework. This framework consists of three layers: the foundation of the proposed data-collaboration, the proposed governance structure and the implementation in which the reward for data-sharing is chosen. Three pathways could be made up from the framework: regulate data, buy & sell data and data-for-data. The initiators per archetype could be different. Regulation of data can be done by regulatory bodies such as the EU and IMO, but also the port authority. Buy & sell data is mostly in line with the activities of data-platforms. Terminals and inland transport operators, for example, could apply data-for-data in order to improve their collaboration.

Overall the data governance framework could help to open-up discussions between stakeholders and could also structure discussions about the future role of the port authority.

9 Conclusion

This conclusion is structured as follows. First, the research questions are answered based on the findings of this research. This answers the main research question. Then the societal and academic impact will be addressed in two different sections. Lastly, the limitations of this research and the recommendations for future research will be discussed.

The first research question is: *What are the potential benefits of data-collaboration in the container supply chain and what are the opportunities and barriers involved? (RQ1)* Data-sharing could be a promising solution for a more efficient and effective container supply chain. However, the competitive environment makes it complicated to develop data-collaborations. First of all, the role within the chain makes that a stakeholder could demand data-sharing or oppose against data-sharing. Another important aspect is the profit margins of the different stakeholders. If margins are high, the urge is missing to collaborate. However, if margins are small and the position of the stakeholder comes at risk, parties might also oppose against data-collaboration. It is also important to note that from a logistics perspective it would be obvious to strive for efficiency. However, from a business or commercial perspective, inefficiency or intransparency might be more beneficial in order to gain revenue or improving the competitive position. The opportunities and barriers regarding data-sharing identified by the interviewees give insight in the consideration for each stakeholder if they are willing to share data. The opportunities could be summarized in four categories: future proof supply chain, effective logistics, efficient asset utilization and safety. Barriers, on the other hand, could also be summarized in four categories: competitive position, business model, attitude and data-sharing standards.

This leads to the next research question: *What is the willingness towards data-collaboration of the different actors within the container supply chain? (RQ2)* The willingness towards data-collaboration is dependent of the actor in question, the other involved actors and the data which will be shared. Therefore, the willingness could differ from case to case. The experienced opportunities and barriers are closely connected to the willingness towards data-collaboration. Based on this case study parties who have an overall port point-of-view, such as port authority and customs, are positive towards data-sharing. Others are less willing to share data because their competitive position could become at risk by sharing data. This applies most to parties that do not provide physical transport themselves, such as freight forwarders. Companies with higher margins are less likely to take part in data-collaboration because this could jeopardize their current margins, for example carriers and terminals. Platforms build their services around data-sharing, however those parties are less likely to share their meta-data themselves. Lastly, data-sharing could be for inland transport operators most beneficial. Their profit margins nowadays are low and by sharing data, asset utilization could be improved and waiting times reduced. However, those parties are less powerful and could therefore not enforce other parties, such as carriers and terminals, to share valuable data.

After describing the antecedents, data-types and -requirements, the opportunities and barriers and finally the willingness to collaborate, the possible data governance mechanisms could be mapped based on the described case study. Earlier data governance research gave insight in the different dimension and characteristics of data governance, therefore the research question for this part is as follows: *Which inter-organizational data governance mechanisms could be distinguished? (RQ3)*

After selecting the applicable dimensions and characteristics, using two taxonomies of Gelhaar et al. (2021) and Lis and Otto (2021), a new framework is developed consisting of seven dimensions: purpose, motivation, configuration, structure, mechanism, reward and payment model. This selection is based on the case study analysis and literature following two main arguments. First, the scope and description of this research: intra-organizational data-collaboration in the container supply chain. Second, data ownership and decision rights should by any means lay at the data-providing party. This means that parties always have to maintain to be in control.

After selecting the applicable dimensions and characteristics regarding data governance a new framework is developed suitable for the container supply chain context. This section is focused on answering research question 4: *Which inter-organizational data governance arrangements are best suited to improve data-collaboration? (RQ4)* This eventually resulted in three archetypes: regulate data, buy & sell data and data-for-data. The archetypes assume that there is a certain imbalance between data-producer and data-consumer based on the found opportunities and barriers and the willingness towards data-collaborations of the involved stakeholders. The developed archetypes could be implemented on many cases and therefore it is difficult to answer which archetypes suits a case the best. However, some recommendations are provided by this research. Data-collaboration might be possible, if this imbalance is compensated for. The archetypes buy & sell data and exchange data require both something in return, money or data as reward. Enforcing data will be the case if the data is required from a societal perspective, in that case a public authority will regulate, or a shipper adds those terms to an transport agreement. Besides those archetypes, the terms of data-collaboration should be clear. In any case, data-definition, -purpose and -ownership should be specifically described. Another important aspect is under which conditions data can be shared with third parties. It could be the case that the original owner requires compensation, but it also might be possible that the data-owner will not allow data-sharing with third parties at all.

The last research question focused on who should take the initiative to develop data-collaborations: *Which actors should take the initiative to encourage and enhance data-collaboration while considering the different attitudes of the involved stakeholders? (RQ5)* This is done by analyzing the collected archetypes and the possible corresponding actors. Public bodies, such as the European Union, but also semi-public bodies, such as the Port Authority, could regulate data-sharing by implementing new regulations. Also shippers could add end-to-end visibility of container statuses to their terms of transport. Platforms, developed by original container supply chain parties or new tech-businesses such as Project44, will jump into buying and selling of data. Data exchange might be fruitful in cases of where both parties have valuable data, for example between inland transport operators and terminals. Terminals might then aggregate this data and transform this to insights which can be then shared with hinterland parties. The framework and corresponding archetypes are also evaluated by the Port of Rotterdam port authority. The archetypes could help structuring the discussion about the future role of the port authority. Due to the fact that the port authority has both a public and private function, choosing their own position regarding data-collaborations is perceived as difficult. The port authority also stated that it could very well be that all archetypes could be valuable in different cases of data-collaboration.

The main research question was: *Which inter-organizational data governance mechanisms could improve data-collaboration among stakeholders participating in the container supply chain?*

It can be concluded that there is no one fits all solution for data-collaboration in the container supply chain. Therefore developing such collaborations requires craftsmanship, but foremost awareness about what to discuss given the data-collaboration case lying on the table. The proposed archetypes, based on an extensive description of the container supply chain, could help opening this discussion and getting the involved actors on the same page.

9.1. Societal relevance

There are multiple potential benefits of sharing data in the container supply chain: efficiency gains, reduction of errors, faster flow of containers, improvement of customer service and safer logistics based on multiple internal sources of the Port of Rotterdam and PBI Research Institute (2015), McKinsey (2016) and Huttunen et al. (2019). Companies can neglect this opportunity of sharing data, but this could lead to a threat for their competitive positions while other companies use this opportunity to improve their activities (Baştuğ et al., 2020). The right data governance mechanisms could help to enhance data-collaboration in the supply chain (Van den Broek & van Veenstra, 2015; Aben et al., 2021). The developed data governance framework and corresponding archetypes of this research can have multiple valuable applications depending on the type of actor. Based on the recommendation of Gelhaar et al. (2021), this research discusses the potential pathways in the form of archetypes which can be successful in the container supply chain context.

First of all, actors with a connector role in the port environment, such as the port authority and Port Community System, could use the framework to open-up discussion with partners about data-collaboration and their role in the development of those data-collaborations, as stated by the Port of Rotterdam. Data-platforms are most likely to follow the buy & sell archetype of the framework. However, those platforms could use the outcomes of this research to explain why parties are willing or not willing to participate and under what conditions. By doing so, data-services of the platforms can be expanded and be made more suitable for the users. Also for data-providers and -users, such as carriers, terminals and inland transport operators, can this research be helpful. Many times discussions about data-sharing are based on specific jargon and can be overwhelming. This research provides a talk board, mentioned by [Knowledge hub] during the validation interview, for further discussions about data-collaborations in a port environment. Points of discussion are brought up by this framework in the form of dimensions and characteristics. Based on this new data-collaborations can be started and parties could make the consideration to participate or develop data-services by themselves. The position of freight forwarders can be at stake by opening-up information in the container supply chain. Therefore this research could be helpful to those parties to re-investigate what their role in the supply chain could be regarding the provision of transport information.

9.2. Academic relevance

Data ecosystems are difficult to manage due to their diverse set of actors with different goals and incentives. Therefore those goals and incentives have to be aligned in order to enhance collaboration in the chain (Heilig et al., 2017; Aben et al., 2021; Calvin et al., 2021). The right mix of data governance mechanisms is crucial for the further development of data-collaborations (Aben et al., 2021). Previous research has approached inter-organizational data governance on a theoretical level and therefore the application of this theory in a specific field is lacking (Van den Broek & van Veenstra, 2015; Abraham et al., 2019). However, the port competitiveness and performance are strongly connected to the level of collaboration in a port environment (Baştuğ et al., 2020). The aim of this research was therefore to map data governance mechanisms that are capable of enabling data-collaboration in the container supply chain, as defined in Chapter 4. This is done by analyzing previous research about data governance (Abraham et al., 2019; Tornatzky et al., 1990; Van den Broek & van Veenstra, 2015) and two developed taxonomies (Lis & Otto, 2021; Gelhaar et al., 2021). This research analyzed data governance mechanisms proposed by previous research and mapped the possible combinations of mechanisms suitable to the supply chain of containers. Therefore, this research followed the recommendation of Gelhaar et al. (2021) stating that future research could develop and evaluate data governance archetypes consisting of the collected data governance dimensions and characteristics. The developed data governance framework and corresponding archetypes for the container supply chain fill the gap of the application of data governance to a specific case. Besides, little research has touched upon the combination of inter-organizational and data governance (Van den Broek & van Veenstra, 2015; Abraham et al., 2019). More specifically, this research describes three potential archetypes: regulate data, buy & sell data and data-for-data consisting of seven data governance dimensions. This research also gives a view on the market behavior, relevant data and data-sharing applications, identified opportunities and barriers regarding data-sharing and the composition of willingness towards data-collaboration in the context of the container supply chain.

9.3. Limitations & recommendation for future research

This last section discusses the research limitations and recommendations for future research. The aim of a case study is to describe a case as precisely as possible (Yin, 2018). However, it is impossible to state, due to time restrictions and reading capacity, that the conducted case study fully describes case of data-collaboration in the supply chain of containers. The findings of this single case study cannot be automatically generalized to other cases, as stated by Yin. However, the port of Rotterdam is the biggest port of Europe and therefore it could be assumed that the findings of this research can be generalized to some extend to other ports, because many of the interviewed actors are also involved in other port environments. This research is based on different sources and methodologies to substantiate and validate the case study. The interviews were conducted with for each stakeholder a single interviewee, which makes that the conclusions per actor are based on a single stakeholder. The interviewees also referred to the other actors and therefore also validated the case study description. Also the evaluation session and the validation interviews underpin the conclusions. Still, as discussed before, the outcomes are dependent on multiple factors which cannot be totally controlled even if all involved actors in a port environment would be interviewed. The literature review of this research strongly underpins the relevance of data governance in this particular case study. However, it cannot be stated with certainty that all relevant literature has been consulted.

Future research should focus on the further validation and also on a more specified description of the found archetypes. This can be done by conducting validation sessions with stakeholders or by developing a serious game capable of simulating the multi-actor port environment (Bots & Hermans, 2003). It could also be interesting to describe the antecedents, the behavior of this industry and the considerations around data-collaborations, via a game theoretical model as proposed by Heilig et al. (2017); Cunningham, Hermans, and Slinger (2014); Moros-Daza, Amaya-Mier, Garcia-Llinas, and Voß (2019). This future research could give more insights in the distribution of costs and benefits when data-collaborations will be developed in the context of the container supply chain. Another application of this game theoretical model could possibly be the valuation of data-sets. It is now unclear what the exact value of a data-set could be, therefore research should investigate how to evaluate this value of data and how to apply this in practice. Lastly, the legal basis of data ownership should be investigated. Data ownership and control are two main factors of data-sharing, however, this has not yet been clearly defined and there are doubts as to whether this legal basis exists.

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Scientific paper

Mapping inter-organizational data governance mechanisms in the container supply chain

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***Abstract*—Despite the potential benefits regarding data-sharing in the container supply chain, stakeholders still can be skeptical towards data-collaboration. Due to conflicting goals and objectives of companies and the competitive nature of the industry, data-collaboration cannot be easily achieved. Previous research has little touched upon combining inter-organizational governance and data governance. Based on a case study about data-collaboration in the container supply chain and previous data governance research, a new data governance framework with possible data-sharing archetypes is developed. Three data governance archetypes are suggested in order to further enhance data-collaboration: regulate data, buy & sell data and data-for-data. Future research should focus on the further validation of the found archetypes, valorization of data and the legal basis of data-ownership.**

***Index Terms*—data governance, data-collaboration, port, supply chain, container transport**

I. Introduction

Decision making in supply chains is becoming more and more driven by data (Baştuğ, Arabelen, Vural, & Deveci, 2020). By use of data planning and capacity usage of transportation modes and infrastructure could be more efficient and effective. Several benefits regarding data-sharing in the supply chain can be found in literature, for example (based on internal Port of Rotterdam sources and PBI Research Institute (2015); McKinsey (2016); Huttunen, Seppala, Lahteenmaki, and Mattila (2019)):

- Efficiency gains
- Reduction of errors
- Faster flow of containers
- Improved customer service
- Safer logistics

However, still not all stakeholders are willing to share data because of trust, competition and privacy reasons (Heilig, Lalla-Ruiz, & Voß, 2017). The maritime sector also has to cope with sustainability challenges, it is expected that freight transport emissions will rise 2.6 fold by 2050 as compared to 2015 (ITF, 2021). By not participating in data-sharing, these potential benefits are missed, which damages the competitive position of the company or port in question (Baştuğ et al., 2020). This research aims to explain the behavior of the involved actors towards data-collaboration in the supply chain and apply data governance to improve the development of data-collaborations.

II. Literature review

The main challenges of port digitalization, mentioned by Brunila, Kunnaala-Hyrkki, and Inkinen (2021), are: incompatible systems, lack of resources, security threats, and resistance towards digitalization. The focal point of this paper is the resistance or the willingness to data-collaborations in the chain. Heilig et al. (2017) state that the success of digital transformation is not only dependent on technology but rather on the willingness of stakeholders cooperate and collaborate. The question rises how to accomplish data-collaboration if parties are not willing to collaborate. The right governance structure could eventually help to improve the development of data-collaborations, however research about data governance in the context of the container supply chain remains scarce (Moros-Daza, Amaya-Mier, & Paternina-Arboleda, 2020; Barbieri, Ellram, Formentini, & Ries, 2021; Lis & Otto, 2021). Little research is focused on combining inter-organizational governance and data governance and especially not in the context of the container supply chain (Lis & Otto, 2021). Therefore, the aim of this paper is to fill this research gap.

Williamson (2000) defines governance as follows: "governance is an effort to craft *order*, thereby to mitigate *conflict* and realize *mutual gains*". The unit of governance is a transaction and in this particular case it is about the transaction of data between parties. Provan and Kenis (2008) define inter-organizational governance as follows: "[...] the arranged institutions and structures to ensure that individuals behave in line with the collective goals, conflicts between individuals are prevented or resolved, and the effective and fair use of collective resources within the inter-organizational collaboration". This is especially crucial when exchanging data, because data-providers require that the data-user is a trustful partner which uses the data solely for the agreed purpose based on the made agreement. Data governance in particular could be helpful to further explicating, for example, format and levels of detail of the provided data (Aben, van der Valk, Roehrich, & Selviaridis, 2021), but also data-ownership and controllability (Van den Broek & van Veenstra, 2015).

Multiple papers about data governance have been analyzed to systematically describe the container supply chain case and come up with applicable data governance mechanisms. The framework of Abraham, Schneider, and Vom Brocke (2019) is used as basis for this research. The antecedents describe the context of data-collaboration which has an impact of the adoption of data governance. Three contexts are used to describe the antecedents based on the TOE-framework: Technology, Organization and External task environment (Baker, 2012; Tornatzky, Fleischer, & Chakrabarti, 1990). Those will be described further on in this paper. The organizational-scope, data-scope and domain-scope determine what data-governance could be suitable. The organizational-scope follows the scope of this research and is about inter-organizational data-sharing which is further referred to as data-collaborations. Different data-scopes could be taken according to the data that will be shared. In this research the domain scope is about the willingness of parties to share data and collaborate. Two taxonomies, based on data governance literature reviews, are used to describe the suitable data governance mechanisms. The taxonomy of Lis and Otto (2021) focused on data governance in general which consists of eight dimensions: purpose, scope, phase, configuration, structure, mechanism, data ownership and decision rights. The second taxonomy focused on the incentive mechanisms for data-sharing and consists of seven dimensions: data type, data control, motivation, underlying theory, infrastructure, reward and payment model (Gelhaar, Gürpinar, Henke, & Otto, 2021). Both taxonomies are used to develop the data governance archetypes introduced in this paper. Figure 1 shows the overall governance framework which is used to structure this research.

III. Methodology

This overall research follows the case study design proposed by Yin (2018). However, in order to systematically describe the case study, data-collaborations in the context of the container supply chain, multiple sources of information are consulted shown in Figure 2. This case study is conducted in the port of Rotterdam in collaboration with the Port of Rotterdam port authority.

Analysis of the case is done by reviewing scientific literature about inter-organizational governance and data governance, as discussed in the Literature review. But also by analyzing the involved actors in the container supply chain via (grey) literature. Lastly, 13 interviews have been conducted to get the different viewpoint of the stakeholders and, later on, to validate the data governance archetypes. Those closed interviews have been conducted with the following stakeholders:

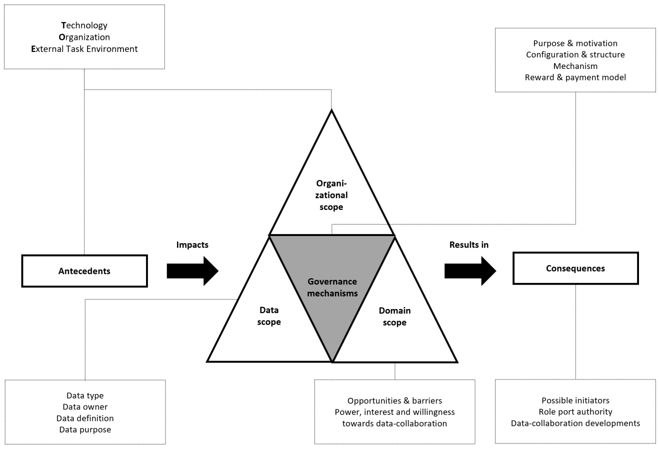

Fig. 1. Data governance framework based on Abraham et al. (2019), Tornatzky et al. (1990), Van den Broek and van Veenstra (2015), Lis and Otto (2021) and Gelhaar et al. (2021)

carrier, customs, freight forwarder, inland shipping, knowledge hub, (two) platform(s), port authority, Port Community System (PCS), inland transport operators (barge and truck), shipper and terminal. Those stakeholders are chosen because these parties have a focus on the individual container and are most prominently present during container transport.

After the case study analysis, the focus on data governance is taken to come up with possible ways to setup (new) data-collaborations. This new data governance framework is mainly based on two papers (Lis & Otto, 2021; Gelhaar et al., 2021) and the previous analysis applicable archetypes are developed.

Both the analysis and the application are validated. The analysis is validated by an evaluation session by the port authority, Port of Rotterdam, attended by 20 professionals with different backgrounds. The archetypes are validated in three validation interviews with knowledge hub, inland shipper and terminal. All interview summaries can be requested from the author.

IV. Case study description

Three aspects of the overall governance framework (Figure 1) will be first discussed before the data governance archetypes will be developed: antecedents organizational scope, data scope and domain scope. These case study analysis steps are based on a multi-actor analysis, (gray) literature and the expert interviews.

A. Antecedents: context of the container supply chain

First the antecedents, which describe the context in which data-collaboration takes place. This particular case focuses on the container supply chain and data-sharing between companies, in other words inter-organizational data-collaboration in the container supply chain. The antecedents are described by following the TOE-framework: Technology, Organization and External task environment. Starting off with the organization scope. The following actors are taken into account: freight

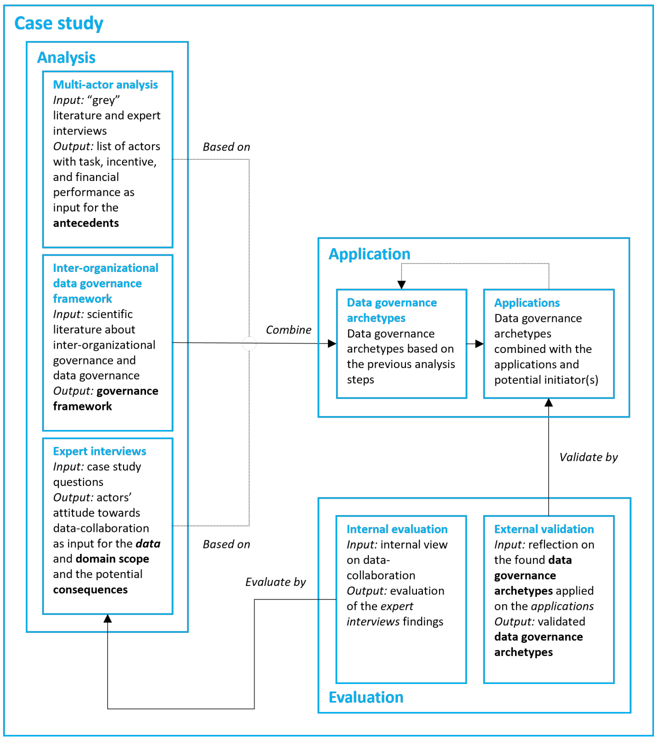

Fig. 2. Methodology

forwarder, carrier, port authority, customs, terminal operator, inland transport operators and shippers. Those actors have different tasks in the container supply chain. Transportation starts at the shipper who has a demand for container transportation. Bigger shippers arrange transport by themselves, smaller shippers outsource this to freight forwarders. Freight forwarders mostly do not own the transportation assets by themselves and therefore outsource the different aspect of transportation to other parties. The carrier is responsible for the maritime part of transportation by the use of massive deepsea vessels with a capacity of around 20,000 containers. The terminal operators loads and unloads deepsea vessels and inland transportation modes but is also a temporary storage place for containers. Before unloading, containers have to be declared at the customs authority which is responsible for container control and tax collection. The port authority is responsible for the smooth and safe handling of vessels but also the competitiveness of the port environment. After the maritime part of transport the container has to be transported to the hinterland. Inland transport operators make use of different transportation modes: trucks, barges or train. Those transportation modes are capable, respectively, to transport 2, between 16 and 250 and 80 containers of 20-foot. Due to the fact that bigger deepsea vessels and smaller hinterland transportation modes come together in the terminal, this place is seen as the major bottleneck of container transport. Coordination between those parties, via information sharing, is required.

The market behavior in the environmental context can be explained by the diversity of actors which consist of different factors: number of players present, formal tasks, objectives, operating scope and profit margins. In each port there is a single port authority and (national) customs office, however, those are public parties. The number of carriers is around 20 and those carriers are mostly part of three alliances responsible for about 85% of container transport (ITF, 2022). In the port of Rotterdam, there are 5 different container terminal owners. As compared to inland transport operators and shippers, where there are thousands of different parties, the market of carriers and terminals is far more consolidated. This also makes that those parties take a more dominant role in the container supply chain. Looking at the profit margins, the margins for terminals and carriers are around 40% in 2022 (Hapag-Lloyd, 2022; APM Terminals, 2022; Hutchison Port Hldg Trust, 2022). This can be explained by the increase of maritime transport fares of the carriers: from 2,000 dollar in January 2020 to 10,000 dollars in June 2022 for transportation between Shanghai and Rotterdam (ITF, 2022). This is due to the COVID-19 pandemic which resulted in increasing container demand and decrease in supply. Looking at hinterland transport profit margins, however, lay around -8% and 8% (Logistiek, 2018). Therefore those parties are more focused on existence and continuity.

For the antecedents the last context is the technology context. Technology is outside of the scope of this research, following the hypothesis that the lack of data-collaboration in the container supply chain is not a technology problem but a people's problem. However, to more technological stakeholders have to be introduced: Port Community System (PCS) and platforms. The International Port Community Systems Association (IPCSA) defines a PCS as: "a neutral and open electronic platform enabling intelligent and secure exchange of information between public and private stakeholders in order to improve the efficiency and competitive position of the sea communities" (IPCSA, 2015). Those systems are mostly developed by the port authority in order to streamline customs procedures. Currently PCSs are extending their role by providing more logistics related data-services. Platforms in general are referred to as privately owned companies which get data from parties in the chain and then sell data-insights and -services to their clients, for example Project44 and FourKites.

B. *Data-scope: enrichment of data during container transport*

Next is the data-scope of data-collaborations. The amount of data present in the container supply chain is enormous. Therefore it is impossible to discuss all different forms of data. In order to get a practical view on available data in the chain, three data-sharing applications will be discussed: between carriers or shippers & customs, terminals & inland transport operators and carriers and terminals.

Before container could be imported, the container or shipment should be declared at the customs office. This is done by the shipper itself or this could be outsourced to the customs agent of the carrier. Multiple forms has to handed in about for example the kind of goods transported, an ADR form if the goods are possibly dangerous for people's health and the value of the shipments. Currently the International Maritime Organization has mandated a maritime single window which standardizes those procedures for all global operating ports (IMO, 2022).

Data-sharing between terminals and inland transport operators also could be fruitful. For example a trucking company transports multiple containers from a deepsea terminal to the hinterland. If it would be possible to communicate to the terminal which containers have to be picked-up for that day, the terminal could pick the most obvious container first. This could result in less waiting times at the terminals and also less movements of cranes and straddle carriers on the terminals. On the other hand, terminals could also aggregate the data of all hinterland transport operators and share this with them to give insight in terminal congestion. In that way hinterland operators could adjust their planning to reduce waiting times at the terminal.

As third example carriers share updates of an Estimated Time of Arrival (ETA) of their ships to the terminal and nautical service providers. This is required for orchestrating the whole port call of a deepsea vessel. The involved parties in a port has to be coordinated in order to effectively handle vessels. This means that there is no single planning, but multiple plannings which have to be aligned. Real-time ETA updates could help to make planning more flexible and adaptive.

The requirements for sharing data can be dependent of the involved actors and are crucial to successfully develop data-collaborations. Five categories of data-sharing requirement are identified by the interviewees related to: ownership, data quality, standardization, trust and security. First, data ownership. Parties could fear that their commercial sensitive data can be exposed and therefore those parties want to maintain in control over their data (Van den Broek & van Veenstra, 2015). Geisler et al. (2021) add to this that sovereignty should be maintained and that the involved actors should also be part of data quality assessment. Data quality should be, according to Geisler et al., transparent fit for sharing, trustful and reliable. Data should also be accurate, timely and secure stated by Van Baalen, Zuidwijk, Van Nunen, et al. (2009). However, data-sharing should also be technologically made possible. Nowadays, systems are heterogeneous and fragmented and therefore incompatible (Praditya, Janssen, & Sulastri, 2017; Brunila et al., 2021). Interoperability of systems and standardization initiatives are crucial to make data-sharing happen (Gelhaar & Otto, 2020). Costs and time delays regarding administrative complications can be reduced by those data standards (Van Baalen et al., 2009). Data should also be trustful and shared without any bias, as stated by Roehrich, Selviaridis, Kalra, Van der Valk, and Fang (2020); Geisler et al. (2021). Many relationships the container supply chain are based on previous experiences, therefore data-collaborations will follow these earlier business relations (Praditya et al., 2017; Gelhaar & Otto, 2020). Lastly, due to the sensitivity of data regarding the shipment and real-time location, safety should be safeguarded (Geisler et al., 2021). Besides, data-sharing has to comply with data protection legislation (Van den Broek & van Veenstra, 2015).

C. Domain scope: willingness towards data-collaboration

Based on the conducted interviews four categories of opportunities could be identified related to: future proof supply chain, effective logistics, efficient asset utilization and safety. Also four categories of barriers are identified related to: competition position, business model, attitude and data-standards. Based on the experienced opportunities and barriers, companies will (or will not) consider to share data. The willingness towards data-collaboration is dependent, based on the findings of this case study, on the stakeholder in question, the other involved stakeholders and the data which will be shared. The found opportunities and barriers are strongly connected to the willingness towards data-collaboration and are case dependent. Based on this case study, it can be concluded that companies with high margins have a lack of urge to take part in data-collaborations in which the costs and benefits are uncertain and mostly long-term focused. On the other hand, companies with low margins and no transportation assets could potentially loose their role in the supply chain and therefore those parties can also be skeptical towards data-collaboration. In order to handle with those uncertainties, data governance mechanisms could help to overcome these kind of problems (Lis & Otto, 2020).

V. Governance archetypes: possible setups for data-collaboration in the chain

After describing the case study of data-collaboration in the container supply chain, possible setups for data governance mechanisms derived from the case study are described in this section. This data governance framework consists of seven dimensions: purpose, motivation, configuration, structure, mechanism, reward and payment model. Those dimensions consist of multiple characteristics describing the possible data governance setups. Purpose, configuration, structure and mechanism are taken from the taxonomy for ecosystem data governance proposed by Lis and Otto (2021). Motivation, reward and payment model are taken from the taxonomy for incentive mechanisms for data-sharing proposed by Gelhaar et al. (2021). The selection of dimensions and characteristics is made based on the findings of the case study. Two main reasons led to this selection. First, the scope of this research: inter-organizational data-collaboration in the container supply chain. Second, the finding that parties want to maintain control over their data, therefore distributed data governance mechanism are not viable. The developed framework (Figure 3) is first explained and then the found archetypes are described.

The first layer of the framework is about the foundation of a data-collaboration and consists of purpose and motivation. Lis and Otto (2021) define purpose as "the need for establishing some form of structure to balance collective goals and different interests". Control can be the motivation when data is shared for customs purposes, collaboration can only take place if both parties have valuable information and value is created when actors are developing own data-services in order to gain revenue. The motivation can be legal, economic or social & ecological and follows from the described purpose. The next layer answers the question which governance structure to apply. The configuration can be centralized, decentral or self-organizing. Those characteristics are also strongly connected to the structure of data governance: hierarchy, market and network. The data governance structure is also described by Van den Broek and van Veenstra (2015). Centralized and hierarchical assume that there is a single dominant body which direct data-collaboration. Decentral and market are based on data-providers and data-users resulting in supply and demand for data. The last combination of self-organizing and network assume that parties strive for collaboration in order to jointly improve the overall performance of the container supply chain. The mechanisms behind those configurations and structures can be formal or informal in which formal mechanisms are codified and enforceable promises and informal mechanisms are codified patterns of behavior expected to be conform to (Keller, Lumineau, Mellewigt, & Ariño, 2021). The last layer entails the implementation of data-collaboration and answers the question of what will be given in return for sharing data. The reward can be none, money or data based and the corresponding payment model can be free, usage- or revenue-based or fixed.

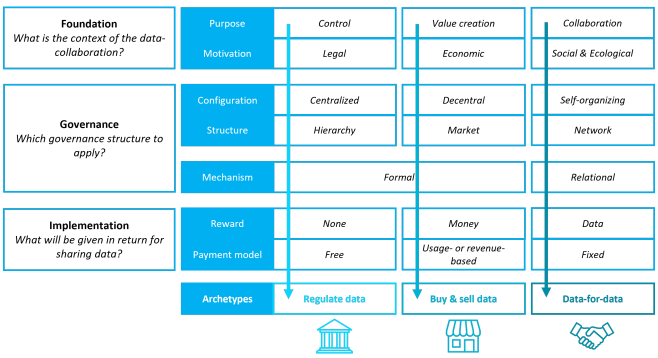

Fig. 3. Data governance archetypes for the container supply chain

Based on the data governance framework, three archetypes could be developed: regulate data, buy & sell data and data-for-data. A framework has the purpose of structuring a complex system or problem. Therefore it is impossible to take all different possibilities into account. Based on this case study and the outcomes of the interviews, a selection of most connecting characteristics is made in order to develop contrasting archetypes. By having those contrasting archetypes, discussions about the setup of data-collaboration can be discussed.

Regulate data is most likely in cases where the purpose of data-collaboration is to be in control the supply chain with a legal motivation to regulate this data-collaboration. In general this archetype is most suitable in cases where data-owners are not willing to share data and other stakeholders' processes are dependent of this data. If there are multiple parties experiencing loss in performance and this also has a societal impact, authorities could consider regulation of data-sharing by regulation and law. Another example could be between shipper and transport operator(s) in which a shipper regulates the transport operator(s) to be transparent and provide end-to-end visibility of their shipments.

If there is a certain imbalance of opportunities and barriers regarding data-collaborations between stakeholders, this imbalance can be compensated by buying or selling data. Buying data in this case means that a data-consumer, with a specific demand for data, initiates a data-collaboration. Selling data is the opposite way where a data-producer has valuable data that can be transformed to own services or sold to other parties in the chain or data-platforms.

The last archetype is focused on bilateral agreements in which data is exchanged for data. This could be the case if both stakeholders have or perceive to have valuable data for each other. Also in this data-for-data concept, the value of data is important to have an agreement on equally valuable data-sharing. However, this could also be dependent on the stakeholders involved and the (previous) relationship between those two parties. These kind of data-collaborations will only take place if there is a certain basis of trust between the involved stakeholders (Van den Broek & van Veenstra, 2015).

VI. Conclusion & Recommendations

Despite the potential benefits of data-sharing, stakeholders can be still skeptical towards data-collaboration in the container supply chain. The willingness towards data-collaboration is dependent on the stakeholder in question, the other stakeholders involved and the data which will be shared. The identified opportunities and barriers regarding data-collaboration are strongly connected to this willingness. Data-sharing should also comply to five categories of requirements, identified by the interviewees, regarding: ownership, data quality, standardization, trust and security. The right mix of data governance mechanisms could help to overcome the experienced barriers and to satisfy to the requirements. However, it can be concluded that there is no one fits all solution for data-collaboration in the container supply chain. Therefore developing such collaborations requires craftsmanship, but foremost awareness about what to discuss given the data-collaboration case lying on the table. Three archetypes are suggested in this research: regulate data, buy & sell data and data-for-data. These archetypes could be valuable in different data-sharing cases which should be further validated by future research.

The **societal relevance** of this research is that the developed data governance framework could help opening the discussions about data-collaborations and getting the involved actors on the same page. Stakeholders with a overall port overview, such as the port authority and Port Community System, could use this framework as a talk board with their partners to enhance data-collaboration. Data-platforms can adjust their data-services and make these more fit to their clients using the found archetypes. This framework could also be helpful for the port authority and freight forwarders in re-assesing their role in the supply chain regarding data-sharing.

Previous research has little touched upon the combination of inter-organizational governance and data governance, especially not in a port context (Lis & Otto, 2021). The right mix of data governance mechanisms could help to improve data-collaboration in the port environment (Aben et al., 2021). However, research was lacking regarding this right mix of data governance mechanisms. Therefore, Gelhaar et al. (2021) recommended to investigate what possible archetypes could be valuable with respect to data-collaboration. Therefore the **academic relevance** of this research is in a new combined field of research of both inter-organizational governance and data-governance and based on this an applied data governance framework to the supply chain of containers.

Some notions regarding the **limitations** of this research has to be mentioned. It is impossible to state that a case study fully describes the real-life case. A limited set of interviews has been conducted and also not all literature related to this case could be reviewed. However, by using different sources and methods, the validation of this research can be underpinned. Both the internal evaluation session, by the Port of Rotterdam, and three validation interviews have sharpened and underlined the outcomes of this research. This case study followed the design of a single case study. Therefore, the results of this research could not automatically be generalized for other cases for example in other industries or in other maritime ports (Yin, 2018). Still, the port of Rotterdam is the biggest port of Europe and therefore it could be assumed that the findings of this research can be generalized to some extend to other ports, because many of the interviewed actors are also involved in other port environments.

Three recommendations are given with respect to **future research**. First of all, the developed data governance framework and corresponding archetypes should be further validated and described. This can be done by conducting validation sessions with stakeholders or by developing a serious game capable of simulating the multi-actor port environment (Bots & Hermans, 2003). Another interesting research topic could be to investigate what the possible distribution of costs and benefits regarding data-collaboration in the supply chain of containers could be by developing a game theoretical model (Heilig et al., 2017; Cunningham, Hermans, & Slinger, 2014; Moros-Daza, Amaya-Mier, Garcia-Llinas, & Voß, 2019). This future research could also help to value data-sets in a monetized way. Lastly, the legal basis of data-ownership should be researched upon, because this is still uncertain among stakeholders in the container supply chain if there is a legal basis and what this legal basis implies.

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B Interview setup

As mentioned in Chapter 3, multiple interviews has been conducted. Those interviews were focused interviews which used a standard set of questions, shown below. All different actor types were interviewed once, following the multi-actor analysis. Those interviews took a maximum of one hour and were recorded in order to write out a conversation impression. The interviews were not fully transcribed, due to the sensitivity of the subject. After working out the impressions, the interviewees could give feedback which was used to get the conclusions clear. The interview setup is shown below.

Introduction
My name is Marijn van Adrichem student at the TU Delft and for my graduation I work together with the Port of Rotterdam. My research focuses on data collaboration in the port and mapping the different perspectives from companies. Although I work together with the Port of Rotterdam, I conduct my research on behalf of TU Delft and this research must have a scientific basis. This interview will take approximately 60 minutes and will follow a standard set of questions. The purpose of this interview is to get a picture of your vision, and the vision of the company you work for, with regard to data collaboration in the field of container transport in a port. This specifically concerns operational data, for example: ETA, ATA, gate in, gate out. Afterwards, a conversation impression will be drawn up which will be sent to you for checking. If approved, the interview impression itself will only be available to my supervisors. References in the thesis itself will only be used anonymously. To simplify writing the conversation impression, I ask you if you are okay with me recording this interview. After drawing up the conversation impression, I will delete the recording. Do you currently have any questions about the structure of this interview?

Interview questions
Data-collaboration in general

- Would (extending) data-collaboration in the port be beneficial for logistics processes? Why, or why not?
- Tot what extend is your company involved in data-related initiatives in the port?

Data-needs

- *Data-production*: To what extend is your own data important to (logistics) processes in your company? And what kind of data is this?
  - What data could be relevant to other parties in your supply chain?
- *Data-consumption*: To what extend is (or could) data of other companies (be) important to (logistics) processes in your company? And what kind of data is this? *consumption*

Attitude towards data-sharing

- To what extend is your company willing to share data both in vertical and horizontal direction of the logistics chain?

- Under which conditions would that be?
- What opportunities (pro's) and barriers (con's) for data-sharing do you notice in the container supply chain?

- Is there a role for a port authority in the development of data-collaborations? What would that be?

Future

- What kind of (data-)developments do you expect in the supply chain of containers in the coming 10 years?
- What data-related developments do you expect internally in your company?
- Do you have any further questions or final remarks regarding this interview or the topic?

After having the interviews, the conversation impressions were made and reviewed. Then the outcomes of the interviews were analysed by categorizing phrases of the interviews and then labeling them. These steps are known as open and axial coding. Lastly, the labels were counted and corrected by the number of interviewees to have a look at the importance of a specific notion. This analysis is used further through the hole report to underpin the case study and give practical insights. The conversation impressions and analysis are not part of the appendix and can be given upon request at the author of this thesis.

B.1. Internal brainstorm session

To get an overview of the internal perspective of the Port of Rotterdam regarding data-collaboration, a brainstorm session is held. This follows mainly the same questions as the conducted interviews.

Brainstorm questions

- Would (extending) data-collaboration in the port be beneficial for logistics processes? Why, or why not?
- What are the major reasons, that you experience, for companies to be part or not to be part of data-collaborations?
- What are the main requirements to make data-collaboration or -sharing possible?
- Should the port authority have a role in developing data-collaborations? If yes, what should be the role of a port authority?
- What kind of (data-)developments do you expect in the supply chain of containers in the coming 10 years? And what is the role of the port authority then?

The participants were given a question form in order to receive their input on this topic. After the brain storm session the outcome of the forms and the brainstorm itself were combined. Also these outcomes are used through this thesis.

C
Interview summaries

In this appendix, the interview impressions are given. All interviews were conducted in Dutch, therefore all interview impressions are in Dutch. Because the confidentiality and the interview criteria, impressions of the interviews were made instead of full transcriptions. After that the impressions were analyzed in order to use them systematically through this research.

The interview summaries are only available at the author. If interested, the author can be informed.

D
Data categories

This appendix explains the described data categories in the interviews and connects those different views. Some of the interviewees have a different interpretation of the classification of data, shown in Figure D.1. Blue mentioned by [Inland shipping], orange by [Customs] and green by [Terminal]. Status data was especially mentioned by [Platform 1]. The connections show the relations between the mentioned categories. Compliance data, which is mandatory for customs affairs, are connected to the container information and type. Those data are all about characteristics of the container and the shipment. The logistics data is all connected with each other because the involved modality and corresponding data is also connected with the logistics processes or events. Therefore the distinction is made between modality data or mode data mostly based on object information and time and logistics data which mostly consists of actions, status and logistics control data.

Concluding, after combining the findings of the interviews, three levels of data can be distinguished: logistics process, mode (referred to as object) and container. These three levels of data have their own characteristics and behavior. The major difference between these two is that the information about the container itself is (mostly) static, and therefore does not change during transportation, and the information about the mode and some of the logistics processes are dynamic and subject to alterations. The overall conceptualization of data in the container supply chain can be found in Figure 6.1.

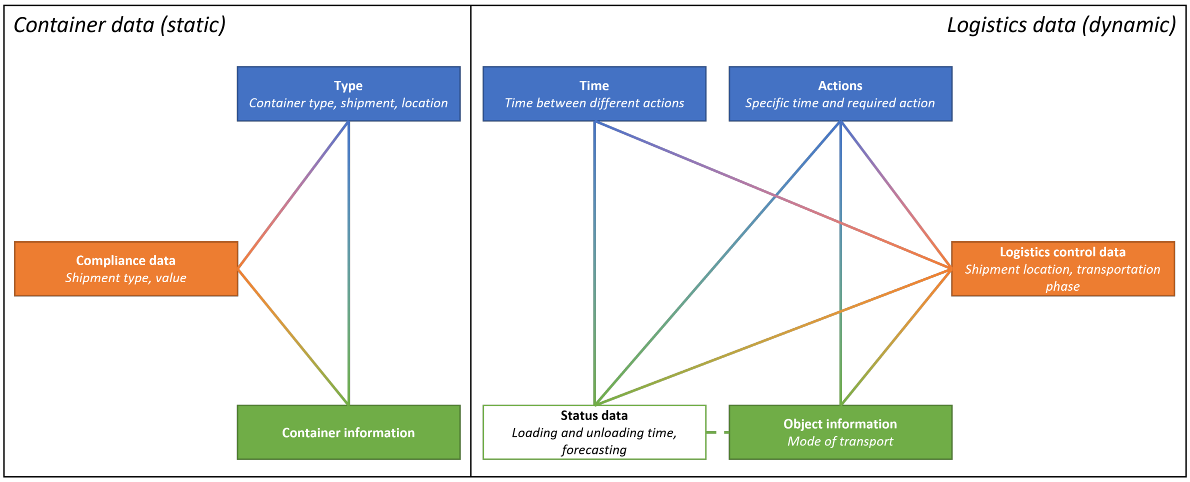

Figure D.1: Data categories

E

Data governance archetype design

This appendix exemplifies which dimensions and characteristics are chosen in Appendix E based on the two taxonomies of Lis and Otto (2021) and Gelhaar et al. (2021). Figure E.1 shows the selection of dimensions and characteristics. Before explaining the archetypes, the design assumptions have to be explained. The idea is to combine those characteristics and develop archetypes which can be applied in order to enhance data-collaborations in the container supply chain. Therefore two lines of reasoning are combined: the analysis steps describing this particular case study and the literature review focused on inter-organizational data governance. The found characteristics, discussed in Chapter 8, are shown below. The next step would be to combine both taxonomies and structure the dimensions and corresponding characteristics.

Purpose and *Motivation* are strongly connected, because those dimensions describe the reason behind data-collaboration. Therefore, this forms the **Foundation** layer in the newly developed framework. *Configuration*, *Structure* and *Mechanism* already were connected in the taxonomy of (Lis & Otto, 2021). This describes the choices in the **Governance** layer. Lastly, *Reward* and *Payment model* are connected because these two dimensions focus on what parties get in return for sharing their data. This is the last **Implementation** layer.

The combinations of characteristics are further described in Chapter 8. The characteristics are reshuffled in order to improve readability of the found archetypes. It is chosen to describe the most obvious pathways for the found archetypes to get contrasting archetypes which can be discussed. Of course, hybrid forms of archetypes or combinations of other characteristics are possible. However, those combinations are, based on this research and the validation interviews, less viable.

Ecosystem data governance by Lis & Otto (2021)

Purpose	*Control*	*Collaboration*	*Value creation*
Configuration	*Centralized*	*Decentral*	*Self-organizing*
Structure	*Market*	*Hierarchy*	*Network*
Mechanism	*Formal*		*Relational*

Incentive mechanisms by Gelhaar et al. (2021)

Motivation	Economic	Social & ecological	Legal	
Reward	Money	Data	None	
Payment model	Free	Fixed	Usage-based	Revenue-based

Figure E.1: Conceptualization of physical and digital flows in the container supply chain