Information Sharing in the Swedish Rail Freight Industry

Barriers and Mitigation Strategies

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Abstract

Title	Information Sharing in the Swedish Rail Freight Industry *Barriers and Mitigation Strategies*
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Supervisors	Henrik Pålsson, Faculty of Engineering, Lund University Sandra Nordahl, Swedish Transport Administration Nicklas Blidberg, CLOSER
Background	Low fill rates of goods transportation causes low overall utilization of resources in the logistics sector. The total goods flow is expected to increase and thus CO_2-emissions. Rail freight is a low emission alternative to e.g. road haulage. To counter this development, initiatives have been aiming for achieving better efficiencies and promoting rail freight. Information sharing is considered an enabler for many of these initiatives.
Purpose	The purpose of this study is to explore the current barriers to effective information sharing within the rail freight industry. Further, the study proposes strategies to mitigate the identified barriers.
Methodology	A deductive research approach using a systems view is employed. Semi-structured interviews are conducted to collect empirical data.
Conclusions	Five general categories of barriers are proposed. Nineteen barriers specific for the Swedish rail freight industry are identified, the most significant being; *lack of capabilities; fragmented information; fear of losing business; antitrust regulations*, *intangible returns; misaligned incentives;* and *lack of customer pressure*. Five strategies for mitigating barriers are proposed, namely; *Clarify, Prove potential, Create burning platform, Create favorable conditions* and *Turn around fear.*
Keywords	Information sharing, Barriers, Rail freight

Sammanfattning

Titel	Informationsdelning i den Svenska Järnvägstransportbranschen *Barriärer och att överkomma dem*
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Bakgrund	Låga fyllnadsgrader hos godstransporter orsakar lågt resursutnyttjande i transportsektorn. Det totala godsflödet förväntas öka och så även CO_2-utsläppen. Järnvägstransporter är ett utsläppseffektivt alternativ till exempelvis vägtransporter. För att motverka denna utveckling har initiativ tagits för att öka effektiviteten och andelen järnvägstransporter. Informationsdelning ses som en möjliggörare för många av dessa initiativ.
Syfte	Syftet med studien är att utforska barriärer för verkningsfull informationsdelning inom den svenska järnvägstransportbranschen. Vidare föreslås strategier för att överkomma identifierade barriärer.
Metod	Ett deduktivt förhållningssätt med systemperspektiv tillämpas. Semistrukturerade intervjuer används för insamling av empiri.
Slutsatser	Fem generella kategorier av barriärer för informationsdelning föreslås. Nitton barriärer identifieras specifikt för den svenska järnvägstransportbranschen, mest signifikanta är; *brist på förmågor; fragmenterad information; rädsla att förlora affärer; konkurrenslagstiftning; ej påvisad nytta; motstridiga incitament* och *brist på kundpåverkan*. Fem strategier för att överkomma barriärerna föreslås; *Klargöra, Visa på potential, Skapa nödvändighet för förändring, Skapa fördelaktiga förutsättningar* och *Vända rädslan*.
Nyckelord	Informationsdelning, Barriärer, Järnvägstransport

Acknowledgments

Table of contents

1 Introduction

This chapter presents the background and problem statement of this study. Purpose, research questions and objectives is stated and delimitations are presented.

1.1 Background

Low fill rates of goods transportation and dead-heading due to unbalanced flows cause low overall utilization of resources in the transport sector (Transportstyrelsen, 2011). Road haulage, a mode of transport anchored in fossil fuels, performs a large share of the land transport and as the flow of goods is expected to increase, it is a concern that so will carbon dioxide emissions (Trafikanalys, 2016). Rail freight is a mode causing far less carbon dioxide emissions per ton-kilometer compared to road transport. However, the share of the total transport work performed by rail has steadily decreased in Sweden since the 1980's (Trafikverket, 2012). Multiple reports address the need for a more competitive railway system for freight transport.

To counter this development, initiatives have been aiming for achieving better efficiencies. There are examples of companies with one-sided flows in opposite directions sharing resources, i.e. horizontal collaboration, but also large cooperative research projects such as SWIFTLY Green, iCargo and Shift2Rail. Some have outlined what a service offering with combined physical resources from multiple carrier solutions could look like for goods owners (Boschian, Paganelli and Pondrelli, 2013; Dalmolen *et al.*, 2015). Reports have brought up the idea of a spot market for spare freight capacity in order to achieve better fill rates and the technology supporting such a development is continuously improving (Trafikanalys, 2016). This is not a new idea, as several initiatives have been taken since the 1990's[1]. There are existing online transport brokers, mainly focusing on road, visualizing spare capacity of transports (Trafikanalys, 2016).

However, in the forum Sustainable Transport Corridors at the neutral platform for collaboration for transportation efficiency, CLOSER, questions regarding the availability of sustainable transports have been raised. Some participants have

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[1] Lennart Hammarbäck, WSP Consulting. Interview 2017-02-21.

argued that buying sustainable transport solutions is too complicated, while others see spare capacity going to waste when transporters cannot fill their freight carriers. In the light of these discussions, this Master's thesis has been issued.

Long-haul rail freight is more energy-efficient and offers larger economies of scale than road transport. However, when it comes to flexibility, availability, security, service and costs for smaller shipments, it cannot compete with road haulage. Thus, rail is mainly used as a transport mode for low-value, high-volume products such as wooden mass, steel and ore (Lumsden, 2007). Those are also typical Swedish export products going by rail (Trafikanalys, 2016), while the import flow is usually balanced with tile, pasta and other low-value goods[2]. Intermodal transport, with freight carriers such as trailers or containers, is an area where much focus have been put in research (Vierth *et al.*, 2012). Although there are some successful intermodal setups, the high risk and low profitability of rail freight have impeded the development of service offerings. Usually, the profit in rail freight lies in the last few slots on the train, thus increasing fill rates on freight trains implies a great financial potential[1].

1.2 Problem Statement

Achieving higher fill rates in rail freight and balancing flows, thus maximizing the potential of the railway system, is an approach for the industry to become more competitive. As the demand for transport services fluctuates, spare capacity occurs in the system. Effective brokering through an open data platform could make use of such occurrences, while also consolidating flows to create inter-regional shuttles. However, such a concept would have to be supported by effective flows of information regarding the freight trains, goods flows, prices and supporting activities.

Lotfi *et. al.* (2013, p. 300) defines information sharing as *"distributing useful information for systems, people or organizational units"*, which is how this study will use the term. Further, the flow of information should be multidirectional between organizations in a structural, digital and automated way.

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[2] Per Anders Winge, Swedish Transport Administration. Interview 2017-02-10.

The level of information sharing in the rail freight industry is described as low, both between partnering organizations and with other stakeholders[3,4,5]. Consequences from this are:

- difficulties in planning operations;
- poor control of goods and physical assets;
- difficulties coordinating flows to obtain synergies;
- lack of transparency and;
- barriers hindering customers to buy rail freight transport.

Access to information as such might not be a solution itself, but rather a key component for development. The potential gains for the entire system are however undiscovered.

As digitalization has progressed over the last decade, it can support the activities of gathering, consolidating and distributing data efficiently and instantaneously. Digitalization is considered an enabler of a development towards more inter-organizational communication (Irani, Themistocleous and Love, 2003). At the same time, digitalization will also make the transportation sector face many challenges (Leviäkangas, 2016).

Although the possibilities are immense and research have circled this area for some time, the development towards more effective and efficient information sharing has not been of impact yet. This study aims to pinpoint and understand the barriers and underlying mechanisms hindering information sharing in the rail freight industry.

1.3 Purpose

The purpose of this study is to explore the current barriers to effective information sharing within the Swedish rail freight industry. Further, the study proposes strategies to mitigate the identified barriers.

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[3] Magnus Swahn, Conlogic. Interview 2017-02-07.

[4] Per Anders Winge, Swedish Transport Administration. Interview 2017-02-10.

[5] Lennart Hammarbäck, WSP Consulting. Interview 2017-02-21.

1.4 Research Questions

- RQ1: What barriers to information sharing exists in the Swedish rail freight industry?
- RQ2: How can existing barriers to information sharing be mitigated?

1.5 Objectives

The objectives of this study and its contribution to the academic field of information sharing and the industry are as follows:

1. Map and summarize general barriers to information sharing that has been identified in previous research.
2. Create a frame of reference to understand the barriers to information sharing in a rail freight industry context.
3. Explore existing barriers to information sharing in the Swedish rail freight industry.
4. Present strategies to mitigate barriers to information sharing in the Swedish rail freight industry.
5. Summarize the insights and present recommendations for further projects.

1.6 Delimitations

The study is exploring existing barriers to information sharing within the rail freight industry in Sweden. Whenever it is referred to the "rail freight industry", it refers specifically to the Swedish rail freight industry. The focus is on exploring the interrelations between actors in the industry and what mechanisms that are present in their interaction.

The study is concerning all types of rail freight transport, although when discussing information sharing between several companies the focus often turns to intermodal transports. This is because the interfaces between companies are larger and more complex when the cargo is carried by several transport modes. Therefore, the study is focusing more on intermodal transport networks but do not exclude other types of rail freight.

2 Methodology

This chapter presents the methodology employed in this study. The research approach is described as well as what methods is used in the study. Further, the procedure for the data analysis is outlined followed by a discussion about the validity and reliability of the results.

2.1 Research Approach

This study uses three strategies to explore the field of information sharing in the rail freight industry; literature review, reconnaissance interviews and in-depth interviews. The literature review and reconnaissance interviews help to build a frame of reference for the study and create important insights in the preparation for the in-depth interviews. The empirical results from the in-depth interviews contribute with detailed knowledge and create understanding for what the barriers and the underlying causes for them are.

There are two common approaches to research; *inductive* and *deductive*. The inductive approach means that the researchers collects and analyze data and then develop concepts from it. This differs from the deductive approach where the study compares the data with already stated theories or hypotheses (Yin, 2011). This study is using a deductive research approach. First, existing theory and concepts are studied in order to create an analytical framework that is used when analyzing the empirical data.

The process of the methodology is visualized in Figure 1 below.
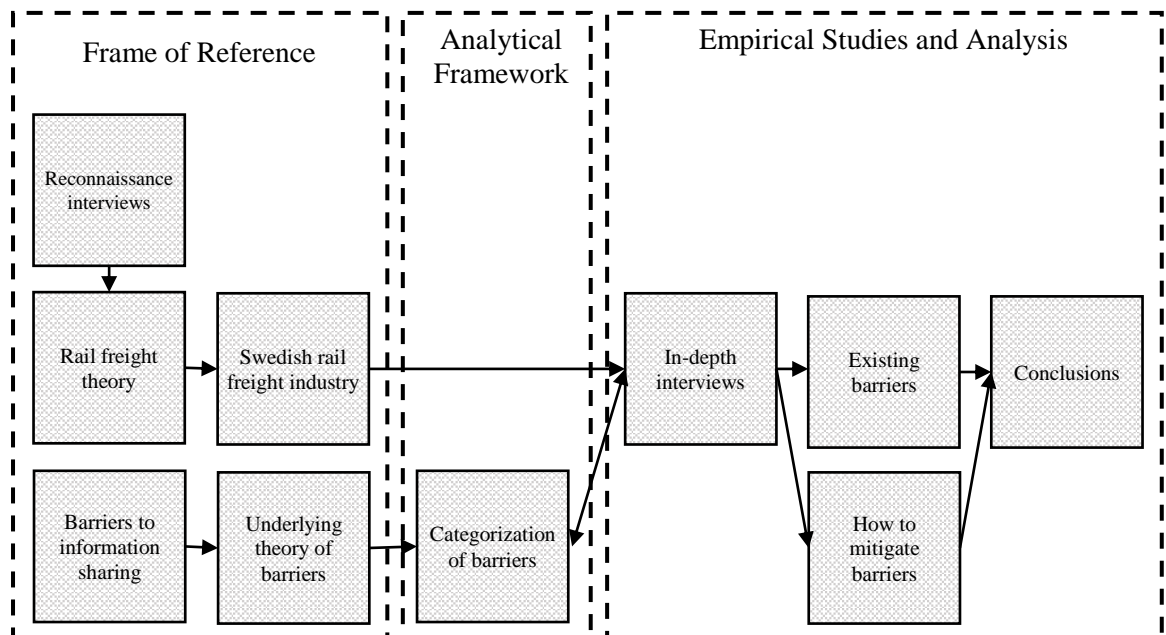
Figure 1. Summarized picture of the methodology.

2.1.1 Systems Thinking

To properly assess and analyze the industry in a holistic manner, the study approaches the problem from a systems' view. The rail freight industry is a system where involved organizations act and interact in relation to each other. The actions of each organization, including regulatory organs, affects the system. Further, the rail freight industry is a sub-category to the larger transport system, and is highly influenced by trends and developments in that system. Thus, aiming to understand how the system is set up will provide a more comprehensive study.

A system is defined as *"a set of elements or components that work together in relationships for the overall objectives/vision of the whole"* (Haines, 2010, p. 2).

Systems thinking is an approach to analyzing systems of all sorts. It is based on the principle to look to the entire system before examining its parts. The idea is that since all elements in the system are affecting each other, it is of no use to optimize one part without taking the system implications into account. This holistic approach is more realistic compared to how the world works and it is more goal-oriented when considering the goal of the system (Haines, 2010).

Systems thinking, systems theory, systems engineering, holism and other related concepts goes back at least to ancient philosophers as Aristotle. He reasoned that the function of separate body parts only is relevant in the context of the body function as a whole (Jackson, 2006). The modern system thinking was formulated

by von Bertalanffy in 1954 in his book "General Systems Theory". Since then, the field has been thoroughly researched from different angles and applied to many different fields (Haines, 2010).

Jackson (2006) argues that today's managers in business are facing a more complex environment than ever before. In a global and rapidly changing world, competition can come from anywhere and customers change preferences and behavior quickly. To survive, all organizations must swiftly respond to changes in their environment, and to deal with these complex problems a holistic view is necessary. Without a holistic view of the problem, the effects on the system from optimizing performance in one part is overseen, commonly known as sub-optimization (Jackson, 2006).

Haines (2010) presents a number of advantages in systems thinking. It makes it easier to;

- understand complex problems;
- see what is going on in an organization;
- integrate strategic development;
- and design better solutions.

It also promotes finding root causes to problems instead of relying on quick-fixes, and enables better communication, teamwork and cross-organizational learning.

Jackson (2006) also points out a few major benefits of a holistic view on problems. He says that it highlights the importance of both process and structure in a system and how they are interdependent. The approach also gives a good basis for critical thinking since you must consider all possible system effects of an action. Moreover, system thinking makes it easier to make use of transdisciplinary analogies, which can further expand perspectives on problems.

2.2 Literature Review

The literature review is based on two types of literature; academic research and research carried out by the industry. The purpose of analyzing academic research is mainly to gain knowledge about general theories connected to the research questions but not necessarily connected to the specific industry. The industry research contributes to specific understanding of rail freight and the Swedish rail freight industry. The reviewed theory is about three themes:

1. Theory regarding transportation, rail freight and the Swedish rail freight industry.
2. Theory to get a deeper understanding of the barriers. Mainly in a supply chain context.
3. General barriers to information sharing identified by previous research.

2.3 Interviews

The main data collection in this study is carried out through two types of interviews in different stages of the project and with different purposes. The two types are referred to as reconnaissance interviews and in-depth interviews.

Table 1. Summary of the main purposes for the two interview types.

Type of interview	Purpose
Reconnaissance interviews	Mapping the structure of the rail freight industry
	Mapping the process and structure of rail freight transportation services
	Provide information valuable when problematizing the study and preparing for in-depth interviews
In-depth interviews	Understanding of the relations between the actors in the industry
	Understanding of what opportunities, challenges and threats different actors see in increased collaboration within the industry
	Identify barriers to information sharing
	Provide background data on how to mitigate barriers

2.3.1 Reconnaissance Interviews

The reconnaissance interviews' purpose is to acquire basic knowledge of how the rail freight industry works. These interviews are carried out in an early stage of the project to use as a foundation when moving forward. Insights from these interviews are used to support the problem statement (Section 1.2), to decide on delimitations (Section 1.6) and to gather data for Chapter 3 Frame of Reference. The reconnaissance interviews are conducted as open-ended interviews in order to get as exhaustive answers as possible.

The chosen informants for the reconnaissance interviews will be persons that have an extensive experience from different parts of the industry and therefore possesses a holistic knowledge of it.

Table 2. Summary of the interview objects for the reconnaissance interviews with location and date for the interview.

Name	Organization	Location, Date
Catrin Wallinder	Swedish Transport Administration	Telephone, 2017-01-25
Magnus Swahn	Conlogic	Telephone, 2017-02-07
Per Anders Winge	Swedish Transport Administration	Telephone, 2017-02-10
Lennart Hammarbäck	WSP Consulting	Telephone, 2017-02-21

2.3.2 In-depth Interviews

The purpose of the in-depth interviews is to acquire detailed information from all categories of actors in the industry. Thirteen in-depth interviews are conducted with different types of actors connected to the rail freight industry. Ten interviews are carried out face-to-face and three over the phone.

The interviews are carried out in a semi-structured format where the questions are organized in an interview guide, but they are used mainly as a basis for discussion around the topic. The main objective for all interviews is to get an understanding of what barriers to information sharing each actor experienced. Secondly, thoughts about how these barriers could be mitigated are collected. Within both these topics, the interviewees view on other actors in the industry and their interdependencies are of great interest to reach an understanding for how the industry is behaving as a system, and give further insights to how barriers can be mitigated.

The semi-structured format allows the interviewees to put more or less focus on certain topics during the interview. This results in that some interviews are going deeper into a few barriers while others are not discussed. When reviewing the empirics, it is therefore important to keep in mind that if an interview does not identify a certain barrier it does not imply that the interviewee disagrees with this barrier. It only means that the interviewee did not leave any information about the barrier.

Further, it is important to note that the interviewees are asked to answer the questions as a part of the industry, not as an isolated entity. Therefore, the answers from one interviewee do not necessarily refer only to its own organization. It might as well describe business partners or the entire industry.

To make the results easier to present, the around one hundred barriers to information sharing that the interviews indicated is divided into nineteen themes. Within a theme, the meaning of the answer is the same but expressed in various wordings. These nineteen themes are compared with and fitted into the five categories of barriers presented in the analytical framework in Chapter 4.

The authors have continuously evaluated ethical aspects of the interview procedure. It is made sure that all interviewees are given the chance to review how their answers are used in the study and any confidential information has been anonymized or excluded from the report.

2.3.3 **Interview Objects**

A stratified approach is used when choosing informants to obtain a representative selection for the entire industry despite the limited number of interview objects. The desired population is divided into the following categories.

a) Train Traction Providers
b) Freight Forwarders
c) Terminal service providers
d) Goods Owners
e) Online Transport Broker Services
f) Researchers in Transportation

The interview objects must meet the following criteria.

a) Sufficient experience from the rail freight industry.
b) Insight in internal and cross-organizational information sharing.
c) Insight in business models and market behavior.

The process of choosing interview objects is carried out as follows.

1. Potential interview objects are identified through the network of the Swedish Transport Administration (STA) and CLOSER, and a long-list is created.
2. All long-listed persons are contacted via e-mail. The e-mail explains the background and purpose of the study, asks for more information about the person and asks if the person is interested in participating in an interview. All potential interview objects were contacted at least four weeks prior to planned interview date.
3. Using the e-mail responses and the criteria stated above a short-list of interview objects is created.
4. The short-listed persons are contacted for booking an interview time. Face-to-face interview is suggested to all interview objects, although due to geographical or scheduling reasons phone interview is an option.
5. Thirteen in-depth interviews are booked. See Table 3 below for a summary of the chosen interview objects.

The criteria and selection process does not define what role the interview object should possess in its organization, causing the chosen interviewees to have several different roles. This spread of interviewed roles is contributing with more perspectives to the study and promotes the system approach.

Table 3. Summary of the interview objects for the in-depth interviews with location and date for the interview.

Name		Role	Company Description	Location, Date
Traction Provider 1	TR1	Product manager intermodal	Providing traction and freight forwarding services	Stockholm, 2017-04-05
Traction Provider 2	TR2	CIO	Providing traction services	Stockholm, 2017-04-06
Freight Forwarder 1	FW1	Environmental affairs	Freight forwarder operating extensive transportation network using mainly road transport	Gothenburg, 2017-03-29
Freight Forwarder 2	FW1	Business controller, Key account manager	Freight forwarder operating intermodal and conventional rail routes	Malmö, 2017-04-04
Freight Forwarder 3	FW1	Sales manager	Freight forwarder operating several intermodal routes	Telephone, 2017-04-12
Terminal service provider 1	TE1	Manager for rail terminal property	Property owner for several rail terminals	Stockholm, 2017-04-06
Terminal service provider 2	TE2	Logistics manager	Operator of RO-RO port	Trelleborg, 2017-04-10
Terminal service provider 3	TE3	Sales manager	Operator of a port-based container terminal with rail connection	Gothenburg, 2017-03-28
Goods Owner 1	GO1	Logistics manager	Manufacturer of steel products	Telephone, 2017-03-31
Goods Owner 2	GO2	Logistics manager	Grocery retailer	Stockholm, 2017-04-05
Online Transport Broker	OB	Founder, business developer	Online service for transportation brokerage	Gothenburg, 2017-03-27
Researcher 1	RE1	Professor Logistics and Transport Management	Göteborg University	Gothenburg, 2017-03-14
Researcher 2	RE2	Professor Technology Management and Economics	Chalmers Institute of Technology	Telephone, 2017-03-28

2.4 Data Analysis

The semi-structured in-depth interviews results in a large set of data of varying structure. To transform this data into accurate conclusions the analysis must be carefully conducted. Yin (2011) proposes a set of methods to analyze qualitative data, the following methods will be used in this study.

To ensure high quality of the final results and conclusions these three steps is the basis to how the data analysis is handled.

1. Checking and rechecking the accuracy of data.
2. Making the analysis as thorough and complete as possible rather than cutting corners.
3. Continually acknowledging the unwanted biases imposed by own values when analyzing the data.

The actual analysis of the qualitative data will follow five steps, as proposed by Yin (2011).

1. **Compiling.** Interview guides, recordings, transcriptions and other documentation from each interview is compiled in one folder for each interview. All documentation is restructured to follow the same structure in all interviews. The interview folders are then sorted based on what category of interviewees it belongs to.
2. **Disassembling.** All transcriptions are reviewed and coded using two coding themes. The themes are (1) Barriers to information sharing, (2) Opportunities for information sharing.
3. **Reassembling.** All coded transcriptions are summarized based on the coding. Information about both codes are then extracted from the summaries and placed in two matrices. The axes used are the interviewee and the categories of barriers from the analytical framework (Chapter 4). The results from this mapping are presented in Chapter 5 Empirics.
4. **Interpreting.** The results from step 3 are combined and compared with theory from Chapter 3 Frame of Reference and Chapter 4 Analytical Framework. The goal is to achieve comprehensive interpretations based on the specific data that are answering the research questions. A structured approach is used to explore the interdependencies between the barriers and the importance of each barrier. Finally, strategies for how to mitigate the most important barriers are designed. The result of the interpretation is presented in Chapter 6 Analysis.
5. **Concluding.** The significance of the study and recommendations to the industry presented.

2.5 Validity and Reliability

Maxwell (2009) presents seven actions to strengthen the validity in a qualitative study;

1. **Intensive long-term field involvement.** Produce a complete and in-depth understanding of field situations, including the opportunity to make repeated observations and interviews.
2. **"Rich" data.** Fully cover the field observations and interviews with detailed and varied data
3. **Respondent validation.** Obtain feedback from the people studied, to lessen the misinterpretation of their self-reported behaviors and views.
4. **Search for discrepant evidence and negative cases.** Test rival or competing explanations.
5. **Triangulation.** Collect converging evidence from different sources.
6. **Quasi-statistics.** Use actual numbers instead of adjectives, such as when claiming something is "typical," "rare," or "prevalent".
7. **Comparison.** To compare explicitly the results across different settings, groups, or events.

Time constraints for the study are limiting the possibility of a long-term field involvement. The study is conducted during five months, why repeated interviews are not used.

The combination of the reconnaissance interviews and the semi-structured in-depth interviews provide a wide range of data that contains far more information than what the research questions ask for. This data can be considered "rich" since it is presenting a broad picture of the history and current situation in the rail freight industry, as well as detailed information about the research questions. These two perspectives in combination strengthen the analysis of the data and promote the accuracy of the findings.

All interview objects are given the opportunity to provide feedback on the study. The interviewees can point out any misinterpretation or question conclusions made from their answers. This type of feedback is making the findings more rigid.

The analysis seeks to explore any discrepancies in the empirics. Inconsistent data found in this study is either elaborated on or discarded, depending on if it is evaluated as interesting for the analysis or if it is simply an error.

Quasi-statistics is used when presenting the empirical findings, showing how frequent a certain barrier is mentioned in the interviews. Although, too much emphasis should not be put on those numbers since the semi-structured interviews are aiming to discuss the topic rather than collect quantifiable data. Many qualitative adjectives are therefore used in order to forward the sense of these discussions rather than presenting numbers.

The comparison of theoretical findings and the empirics is the foundation for the analysis. Comparisons of different answers from different interviewees are creating further room for analysis. The comparative approach is not only supporting the analysis but also validating the findings through triangulating information from different sources.

The selection of interview objects affects both the validity and reliability of the study, even though they are chosen in a structured way with validity in mind. There is a risk that persons that are willing to participate in a study about information sharing is more interested in the field and e.g. have a more positive opinion about it than the industry in general. Another risk is that interview responses are affected by a kind of confirmation bias. The interviewees may try to please the interviewers by adjusting their answers to become closer to what they think is a "favorable" answer for the study. It is hard to evaluate the impact on the results from these circumstances but they are continuously considered throughout the study.

Further, the number of interviews may limit the level of representativeness, although the authors experience a clear saturation of interview answers along the interview process. The last third of the interviews are bringing up very few aspects that the first two thirds not already mention. This implies that the marginal effect of conducting a larger number of interviews would be limited.

Finally, all parts of the study are conducted as a teamwork by the two authors. This teamwork is strengthening the validity and reliability of the study through introducing a cross-check function in all preparation, observation, interpretation, analysis and presentation. The positive impact of teamwork in research is supported by Yin (2011).

3 Frame of Reference

This chapter describes the frame of reference for the study. First, the function of the chapter and reasoning for its outline will be explained. From there, the chapter will contain definitions and concepts, with the intention of providing context of transportation, the studied industry and lay a theoretical foundation for the analytical framework.

The areas covered are many, and in a vacuum, they might not seem all that connected. However, the initial phases and development of the problem specification make it clear that to properly assess and analyze the subject, a cross-disciplinary approach has to be employed. Thus, while the rail freight system has its special characteristics, the authors aim to maintain a general framework for analysis.

Part I of the chapter provides a basic explanation of transportation, the two markets of transportation and the components of a transportation network. Following, the actors involved in transportation and the concept of third-party logistics are explained. This is to provide the reader with a general understanding of the larger system that the study explores. Then, to give more background to the specific market studied and make a proper assessment of the market, the chapter dives deeper into rail freight. That includes describing the Swedish railway system and the actors in the rail freight market.

As information sharing is central to the study, Part II of the chapter starts by describing information and its characteristics in the area of transportation. Then the concept of information sharing is explained, followed by a description of the technology and systems supporting information flows. Part II ends with a brief segment on digitalization's potential impact on the transportation sector, especially regarding the opportunities for effective information sharing.

Part III of the chapter aims to lay a theoretical foundation for the analytical framework. A company's possibility to conduct and leverage information sharing is closely connected to its capabilities. Background to organizational capabilities and how to develop them is therefore outlined. Moreover, the chapter explores several topics regarding inter-organizational interaction. To answer the RQs, the authors find that theory explaining what drives collaboration, and what influences how collaborations are structured, e.g. pricing and incentive alignment, support the conduction of the study. This theory is mainly originating in the field of supply chain management. Then, the concepts of *Transaction cost economy* (TCE) and *Agency theory* further explain the motives and behavior of actors in the market.

The sections included in each part are presented in Table 4 below.

Table 4. Clarification of the three parts in the Frame of Reference.

Part	Section
Part I	5.1 Transportation
	5.2 Rail Freight Transportation
Part II	5.3 Information in Transportation
Part III	5.4 Organizational Capabilities
	5.5 Inter-organizational Interactions

3.1 Transportation

3.1.1 Definition of Transportation

Lumsden (2007) divides the transportation system into *material flow*, *transport flow* and *infrastructure system*. The material flow can be described as the flow of products within and between companies. The material has a point of entry into the system as well as a point of exit from the system. The transport flow is the movement of resources, e.g. containers, between organizations. These resources do not enter or leave the system, but instead circle back and forth through the system. The infrastructure for transports is the system of assets that makes the transportation flow possible, i.e. those assets and equipment that are part of, for example, the railway network and the coupled terminals. The infrastructure conditions the existence of the transportation flow systems (Lumsden, 2007). See Figure 2 below for a visualization of the different flows.
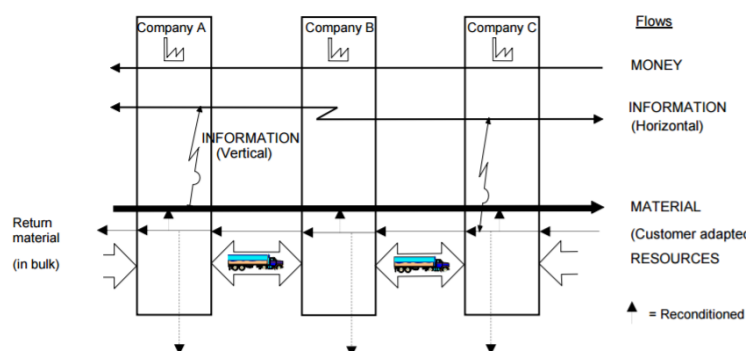
Figure 2. The different flows in a transportation assignment (Lumsden, 2007).

The connections between the different transport systems create two different markets. The transport market arises in the connection between the need of transporting goods (the material flow) and the supply of vehicles and goods carriers (the transport flow). A second market, the traffic market, arises between the need of moving resources (the transport flow) and the available transport routes (the infrastructure) (Lumsden, 2007).

A transportation network consists of a combination of nodes and links, see Figure 3. Nodes are points where goods are stopped for activities such as production or consolidation, whereas links are the physical movement of goods between the nodes (Lumsden, 2007).
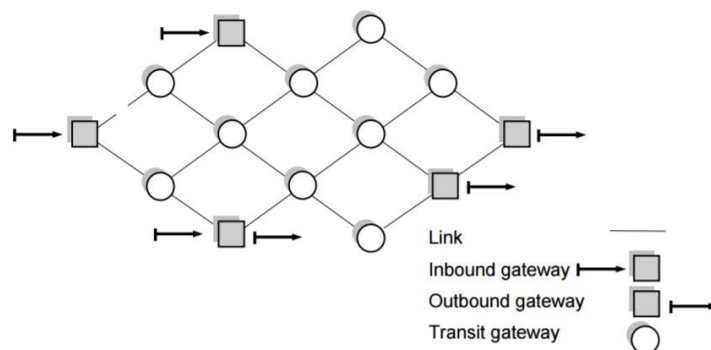
Figure 3. A transportation network with different kind of gateways (Lumsden, 2007).

3.1.2 **Actors in a Transportation Network**

Third party logistics providers (3PL) are defined by McGinnis *et al.* (1995, p. 93) as *"the third party to a transaction other than the buyer (first) and seller (second) which performs logistics activities that could be performed by the buyer or seller"*. Coyle *et al.* (2010) defines two classifications of 3PL companies; the *asset-oriented* and the *activity-oriented* classification. In the asset-oriented classification, the only distinction is between asset based and non-asset based providers, i.e. whether the provider owns physical resources to perform services or not. The activity oriented classification identifies five classes;

- transport based;
- distribution based;
- forwarder based;
- financial based;
- and information based.

The different transportation service offerings include freight movement, freight management, intermediary services and specialty services (Coyle *et al.*, 2010). In

the transportation network, multiple service providers can be involved. For instance, a non-asset based provider can perform the freight management while an asset based provider carries out the freight movement.

Another, more general, distinction of parties involved in a transportation system is the one from Stefansson (2006);

- Carrier;
- logistics service provider (LSP);
- and logistics service intermediary (LSI).

This distinction defines carriers as an actor who performs haulage from one point to another, LSP as an actor with a more diverse offering of logistics services and LSI as a customized service provider mainly offering administrative activities such as designing a distribution setup. On each side of the transportation is, of course, the shipper and the receiver of the shipment.

3.2 Rail Freight Transportation

The fundamental advantage of rail transport is the low amount of traction needed for movement, due to the low friction between the rail and the wheels. This makes it possible for consolidation into large convoys, i.e. freight trains, towed by a locomotive. For large, well-defined flows, rail transport is thus lucrative as it offers economies of scale. Alternatively, a system design for concentration of smaller goods flows can provide similar advantages (Lumsden, 2007). However, the high fixed costs of railway transport, such as assets, shunting operations and access to the infrastructure, as well as the need for transshipment for last mile deliveries only makes it economically justifiable if the volumes are large enough (Lumsden, 2007).

In 2014, twenty-three percent of the total goods transport work in Sweden were performed by rail freight. While the total volume is steadily increasing, the share of the transport work by rail has decreased since the 1980's, mainly losing ground to road transport (Nelldal and Wajsman, 2014).

3.2.1 **The Railway System**

For a long time, railways in Europe were considered natural monopolies, owned and operated by a national rail operator (Cullinane et al., 2016). In 1988, Sweden legislated to vertically separate the ownership of infrastructure from traffic operations, opening accessibility to the system to private actors. This was made in the belief that rail services would become more competitive against other modes if they were forced to adapt to what the market wanted (Cullinane et al., 2016). However, although multiple actors entered the market since (Laisi, Makitalo and

Hilmola, 2012), Cullinane *et al.* (2016) points out that there has been a great deal of flux, with many companies going bankrupt and new companies entering the market. The report Structural Reform in the Rail Industry (OECD, 2005) states that the development of the freight market in Sweden towards a competitive market with different competing operators has been slow. Further, the private operators have not obtained as significant a market share as in other deregulated markets (Mäkitalo and Hilmola, 2010). Some of the identified barriers to new entrants are rolling stock acquisition, bureaucracy, entry deterrence by the incumbent railway company and access to other companies' services (Mäkitalo and Hilmola, 2010).

As railway has a limited capacity in the amount of traffic it can support, companies looking to utilize the railway applies for slots[6,7]. The Swedish Transport Agency is then responsible for a non-discriminatory allocation of the network capacity, which is developed on a yearly basis (Mäkitalo and Hilmola, 2010; Cullinane *et al.*, 2016).

3.2.1.1 Actors

A categorization of the actors involved in a rail freight transport is not completely straightforward since many actors can take different roles depending on the transport setup. Ahlberg (2016) states that the commonly involved actors in an intermodal transport solution are shippers, transporters, terminal service providers, freight forwarders and receivers of goods.

In this study, the following taxonomy is used to define the roles involved in a rail freight transport:

- **Swedish Transport Administration (STA).** Governmental authority that owns and maintains the rail infrastructure. Allocates the network capacity to train operators.
- **Freight Forwarder.** Designs a transport solution for goods owners. Consolidates shipments and buys transport capacity.
- **Traction provider.** Offers a solution of hauling goods between two nodes connected by rail. Provides traction of the main rail haulage.
- **Terminal service provider.** Performs transshipment in the intersection between two modes. This definition includes sea ports.
- **Goods owner.** The customer of the transport sector, shippers looking to relocate goods.

Depending on the setup, other actors involved can include *wagon providers*, *last-mile road haulers* and *shunting operators*.

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[6] Per Anders Winge, Swedish Transport Administration. Interview 2017-02-10.

[7] Lennart Hammarbäck, WSP Consulting. Interview 2017-02-21.

3.2.1.2 The Market

Since the deregulation, the number of traction providers has varied between ten and twenty, with a few entrants and exits each year. The incumbent operator, Green Cargo, holds a steadily decreasing majority of the market, while multiple smaller companies perform smaller shares of the total rail transport work. A few large goods owners, e.g. publicly owned ore company LKAB, have founded their own train operating companies to perform the lion share of the goods owner's transport needs (Vierth and Landergren, 2015).

Some of the train operating companies offer services where they act in the role of a freight forwarder as well (Ahlberg, 2016). Apart from them, the market of rail freight forwarders consists of large forwarders that operate globally in multiple transport modes or their subsidies, more specialized rail forwarders of medium size and some smaller transport brokers. Also, some goods owners with large volumes have developed their own concept without "the middle-man"[8,9].

The intermodal terminals, including port terminals, are usually owned by the public sector and leased to private operators, but there are some terminals that are privately owned (Ahlberg, 2016; Monios and Bergqvist, 2017). Some of the terminals are operated by independent actors, while a few rail operators have integrated terminals into their services (Ahlberg, 2016).

3.3 Information in Transportation

The flow of information runs both within the organization as well as to the other actors involved in the transportation assignment. Demands between a customer and a supplier, such as specifications of functions and time of the service, require an exchange of information. Further, in order for both parties to plan and control their operations, they have a demand for information about the status and physical location of the goods (Lumsden, 2007).

Jacobsson, Arnäs and Stefansson (2017) organizes information in a transportation context along two dimensions. *Sources* describe from where the information can be collected or generated. The sources are categorized as:

- **Actors** involved in a transport, see Section 3.1.2.
- **Resources** required for a transport, e.g. vehicle, personnel, infrastructure or terminals.

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[8] Per Anders Winge, Swedish Transport Administration. Interview 2017-02-10.

[9] Lennart Hammarbäck, WSP Consulting. Interview 2017-02-21.

- **Activities** performed in a transport, namely movement of goods and transshipment between modes.

The second dimension, *types*, is categorized as:

- **Static information** is defined as present prior to the transport and constant during the time of transport. Examples are characteristics of the cargo and the vehicle or contracts.
- **Dynamic information** changes over the time of the transport, such as the geographical position of the goods.
- **Historical information** is accumulated over the time of the transport, and can be gathered retrospectively. (Jacobsson, Arnäs and Stefansson, 2017).

3.3.1 **Information Sharing**

Lotfi (2013, p. 300) defines information sharing as *"distributing useful information for systems, people or organizational units"* and states that organizations must answer four questions to get the desired value from information sharing; when to share, with whom, how to share and what to share. This can be compared with the four communication facets described by Mohr and Nevin (1990); *frequency* (when), *direction* (with whom), *modality* (how) and *content* (what). Frequency refers to the amount of communication. The direction can be either along a supply chain or horizontal across multiple supply chains, intra-organizational or inter-organizational, unidirectional or bidirectional (Jacobsson, Arnäs and Stefansson, 2017). Modality describes the medium (or channel) of information flow, e.g. telephone, digital or face-to-face. Another aspect of modality is whether the communication is formal or informal, i.e. regular or spontaneous (Mohr and Nevin, 1990; Jacobsson, Arnäs and Stefansson, 2017). The last facet, content, regards what is actually conveyed in the message (Mohr and Nevin, 1990).

As for the structure of information sharing, Wilson (2010) identifies the number of actors as a dimension, i.e. one-to-one, one-to-many and many-to-many. In the many-to-many structure, which is what this study focuses on, there exist the two extremes; *dyadic configuration* and *multilateral configuration*, see Figure 4 below. In the dyadic configuration, organizations exchange information between a selected number of partners, while the multilateral configuration supports communication with a larger number of partners through e.g. an electronic market (Singerling *et al.*, 2015).
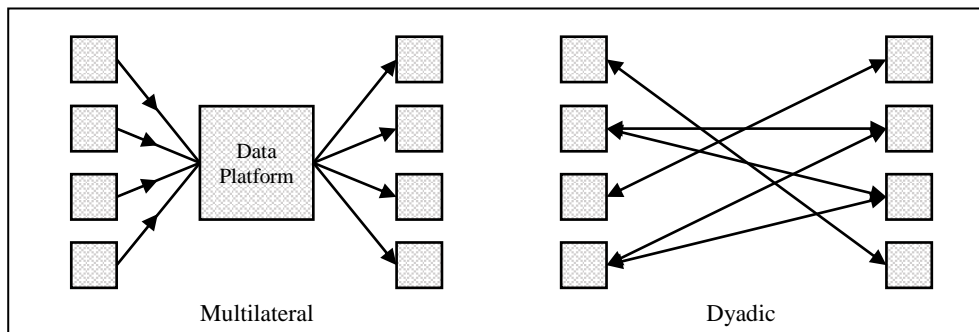
Figure 4. Illustration of Multilateral and Dyadic information sharing (Singerling *et al.*, 2015).

The availability of information is imperative to how well organizations can plan their operations (Sternberg, 2008). Further, effective information sharing positively impacts the performance of supply chains in many aspects, such as total cost, order fulfillment rate and order cycle times (Lee and Whang, 2000; Li and Lin, 2006).

Information exchange among competing firms can increase the transparency within a market and benefit consumers by reducing search costs and helping them to choose products more effectively, while producing efficiencies for the firms involved. However, it can also stimulate collusive behavior and other anticompetitive effects (OECD, 2010).

In a logistics context, properly designed information sharing strategies can improve the control of flows of goods and assets (Lee and Whang, 2000; Sternberg, 2008).

3.3.2 **Information Technology and Information Systems**

Stefansson (1999) distinguishes information technology (IT) as the hardware and the software, while information system is the system that uses IT for various applications in business processes.

IT consists of the hardware, i.e. physical devices, and software, i.e. programs (Stefansson, 1999). From an organizational view, IT is a tool to enable a more efficient flow of information (Stefansson, 1999; Lee and Whang, 2000; Auramo, Kauremaa and Tanskanen, 2005). The advancements made in IT drive more and smarter applications, creating potential for improved efficiency and coordination of information flows, supporting cost-saving measures (Stefansson, 1999; Lee and Whang, 2000; Fawcett *et al.*, 2007). Examples of IT advancements related to transportation is GPS and RFID, providing the possibilities to access real-time information of transports and goods in a more automated fashion (Sternberg, 2008). However, many publications stresses that IT in itself is not enough for creating value for an organization, and that managers over-estimate the impact from investments in IT without supplementing investments in people or business processes (Fawcett *et al.*, 2007; Fawcett, Magnan and McCarter, 2008; Almotairi *et al.*, 2011).

Stefansson (1999, p. 31) states that information systems are more a matter of organizational behavior and management than of computer science, and describes information systems as support to decision-making. It is stated that *"information technology has significance only when it is used as a part of an information system that supports a business process."* The nature of information systems is omnipresent and ever-changing, as the technology supporting them develops and allows for new applications (Irani, Themistocleous and Love, 2003).

To counter system uniformity problems, Enterprise resource planning (ERP) systems is a commonly used application software package, where a large share of a company's systems can be integrated (Hong and Kim, 2002; Irani, Themistocleous and Love, 2003). However, difficulties of successfully implementing ERP systems in organizations and high investment costs have limited the adoption of such products, especially among smaller businesses (Hong and Kim, 2002; Buonanno *et al.*, 2005; Seethamraju, 2015).

3.3.3 Digitalization in the Context of Transportation

The future of information technology and how information systems will be designed is related to the continued progress of digitalization. The development towards a digital society is by many seen as an enabler for innovation, increased competitiveness and streamlining of operations (Digitaliseringskommissionen, 2016). In transportation, the term *digitalization* is mainly referring to the concept of Intelligent Transport Systems (ITS), defined as *"the application of modern information and communication technologies to transport systems"* (Leviäkangas, 2016, p. 2). The development changes the way people use the infrastructure, the way transport services and related manufacturing industries operate and supply their own services and products (Leviäkangas, 2016). Some more specific applications within the goods transportation sector are (Boschian, Paganelli and Pondrelli, 2013):

- Synchronize vehicle movements and logistics operations across various modes and actors to lower CO_2 emissions.
- Adapt to changing conditions through dynamic planning methods involving intelligent cargo, vehicle and infrastructure systems.
- Combine services, resources and information from different stakeholders, taking part in an open freight management ecosystem.

In this sense, digitalization is considered an enabler of a development towards more inter-organizational communication, and part of that is the development towards more common used architecture and standards between organizations' systems (Irani, Themistocleous and Love, 2003; Liang, 2015).

Leviäkangas (2016) states that while the transport sector has not been at the forefront of digitalization, it will experience digitalization in an unprecedented

manner as it challenges human labor, current business logic and the common procedures of businesses and administrations. Further, digitalization will transform many things that we count as a service, function, and activity within the transport sector.

3.4 Organizational Capabilities

As information sharing can impact the business of companies, the way they perceive and approach a changing environment influences how well they will manage. This is related to the internal capabilities of a company.

In literature, organizational capabilities are commonly defined as an organization's abilities and capacities expressed in terms of;

- **Human resources.** Number, quality, skills, experience.
- **Physical resources.** Machines, land, buildings.
- **Financial resources.** Money, credit.
- **Information resources.** Copyrights, design, patents.

Gryger, Saar and Schaar (2010, p. 1) explains it as *"anything an organization does well that drives meaningful business results"* and Ulrich and Smallwood (2004, p. 2) says it is *"the collective skills, abilities, and expertise of an organization"*.

The human resources are less tangible than the other categories and therefore also harder for competitors to imitate. The intangibility makes them harder to evaluate and develop, but in the end, it is often these capabilities that create a competitive advantage (Ulrich and Smallwood, 2004).

To continuously develop capabilities is more important than ever for businesses due to intensified competition, technology development and ever changing customer preferences. Organizations need to be constantly learning to stay competitive in a rapidly changing environment. To possess human resources that are skilled in creating, acquiring and transferring knowledge is a crucial part of a learning organization (Edmondson and Gino, 2008).

To change and develop processes are tough since the change is challenging people's old ways of thinking and doing. A change project does implicitly say that all familiar tasks, jobs, procedures and structures are wrong. Therefore, change initiatives will often face initial resistance (Nadler, 1981).

The field of change management has been researched for a long time and is still today. Cameron and Green (2009) has put together the most used change management frameworks from 1951 to 2009. While these frameworks are different in many ways there are two basic factors that are recurrent. First, it is the importance of understanding the organizations and the current situation prior to a change

initiative. Second, is the need of a clear vision for where a change project is heading and why it is desirable to go there. These two factors seem to be basic requirements for a successful implementation of changes in an organization. The purpose of the change effort is often emphasized, why it is needed to make a change. Kotter (1998) states that the most common reason that change projects fail is because the organization is lacking a sense of urgency to conduct the change.

3.5 Inter-organizational Interactions

To employ the systems approach to the study, it is necessary to consider the inter-organizational interactions in the market. Supply chain management is a field that covers many of the aspects impacting a companies' operations, and is useful to assess the business environment for customers, suppliers and intermediaries. Further, theory on different forms of collaborations between actors in a market, as well as what influences them, is relevant to assess the rail freight markets structure. *TCE* and *Agency theory* help to explain underlying mechanisms in the market.

3.5.1 **Defining Supply Chain Management**

The term supply chain management was introduced in the beginning of the 1990´s and rapidly became a hot topic. At start, many different definitions were presented and confusion around what supply chain management really meant existed (Mentzer *et al.*, 2001). Mentzer *et al.* (2001) explores and compares definitions of and approaches to a supply chain and supply chain management that was presented during the first ten years. These are the definitions used in this study.

A supply chain is defined as;

"A set of three or more entities (organizations or individuals) directly involved in the upstream or downstream flows of products, services, finances, and/or information from a source to a customer." Mentzer *et al.* (2001, p. 4)

To be noted is that the supply chain refers to, not only the flows of product, but also *"flows of services, finances, and/or information"*. The rail freight industry is supporting the flow of products involved in supply chains but there are no or few exchanges of physical products between the actors in the industry. However, there is a clear flow of services, finances and information with the purpose of delivering a transportation service to the customer.

The rail freight industry can, therefore, be said to be simultaneously involved in two types of supply chains. The external one where the customers of the industry are sending their goods through the rail network and the internal one in which the rail freight services are produced.

Further supply chain management is defined as;

"The systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole." (Mentzer *et al.*, 2001, p. 18)

This definition is aligned with the purpose of this study. It is the coordinated interaction *"within a particular company and across businesses"* that are to be explored. Furthermore, the wider scope of the study is to present findings that can be a part of *"improving the long-term performance"* of the industry.

3.5.2 Supply Chain Collaboration

Supply chain collaboration can be defined as *"two or more companies working together to create a competitive advantage and higher profits than can be achieved by acting alone"* (Simatupang and Sridharan, 2002, p. 258). Simatupang and Sridharan (2005) researched previous literature in the field and identified five important features of a collaboration. These features are;

- **Collaborative Performance System (CPS).** Performance measures that guide the chain members to improve overall performance.
- **Information Sharing.** Access to all partners' data.
- **Decision Synchronization.** Orchestrating decisions around planning and execution to optimize chain profitability.
- **Incentive Alignment.** Distributing costs, benefits and risks among the partners in a fair way.
- **Integrated Supply Chain Processes.** Design of processes that deliver customer value in the right time at a lower cost.

3.5.3 Horizontal Collaboration

The European Union (2001) defines horizontal collaboration (HC) as a concerted practice between companies operating at the same level(s) in the value system. In practice this could be e.g. collaboration between two or more goods owners, two or more carriers or two or more LSPs (Saenz, Gupta and Makowski, 2017).

The objectives for HC is to reveal and leverage win-win situations among multiple companies that operate at the same level of the supply chain (Pomponi, Fratocchi and Tafuri, 2015). A common example is synchronization of transportation activities, which can realize cost savings through a fewer number of transports with higher fill rates (Saenz, Gupta and Makowski, 2017).

Saenz, Gupta and Makowski (2017) divides HC into four categories from what actors in the supply chain that are collaborating. The characteristics and objectives are slightly different in the different categories.

- **Suppliers HC.** Suppliers coordinate their logistics activities associated with a certain customer.
- **Customer HC.** Customers coordinate their logistics activities associated with a certain supplier.
- **3PL HC.** Multiple 3PLs collaborate to extend their total network and achieve higher efficiencies.
- **Inverse needs HC.** When companies with inverse flows pair up to increase their combined fill rate and avoid dead heading.

Although there exist some clear advantages of practicing HC, it is not yet widely spread. Saenz, Gupta and Makowski (2017) have identified the following barriers that hinder effective implementation of HC;

- Capability and skill of personnel
- Legal restrictions regarding competition
- Fear of losing competitive advantage
- Lack of cross-network visibility
- Fear of the unknown
- Increasing operational complexity

In addition, Pomponi, Fratocchi and Tafuri (2015) stresses the importance of mutual trust for building an effective and sustainable HC relationship. To achieve this, the level of cooperation should evolve over time in pace with the evolvement of trust. The collaboration should always start at an operational level and later spread to a tactical and thereafter to a strategic level if this is desired by the parties (Pomponi, Fratocchi and Tafuri, 2015).

3.5.4 Vertical Collaboration

Vertical collaboration in a supply chain context refers to the collaboration between companies operating at the different level of the supply chain, e.g. between a customer and a supplier (Mason, Lalwani and Boughton, 2007). The objective is to achieve increased total performance and efficiencies in the supply chain. Through collaboration some of the advantages of integrated supply chains can be realized without facing some of the disadvantages an integrated supply chain implies (Mason, Lalwani and Boughton, 2007).

One example of a vertical collaboration activity is Collaborative Planning, Forecasting and Replenishment (CPFR). When using this method, two or more tiers in the supply chain are collaborating over those three activities to optimize the

processes as a chain and not as individual companies (Mason, Lalwani and Boughton, 2007).
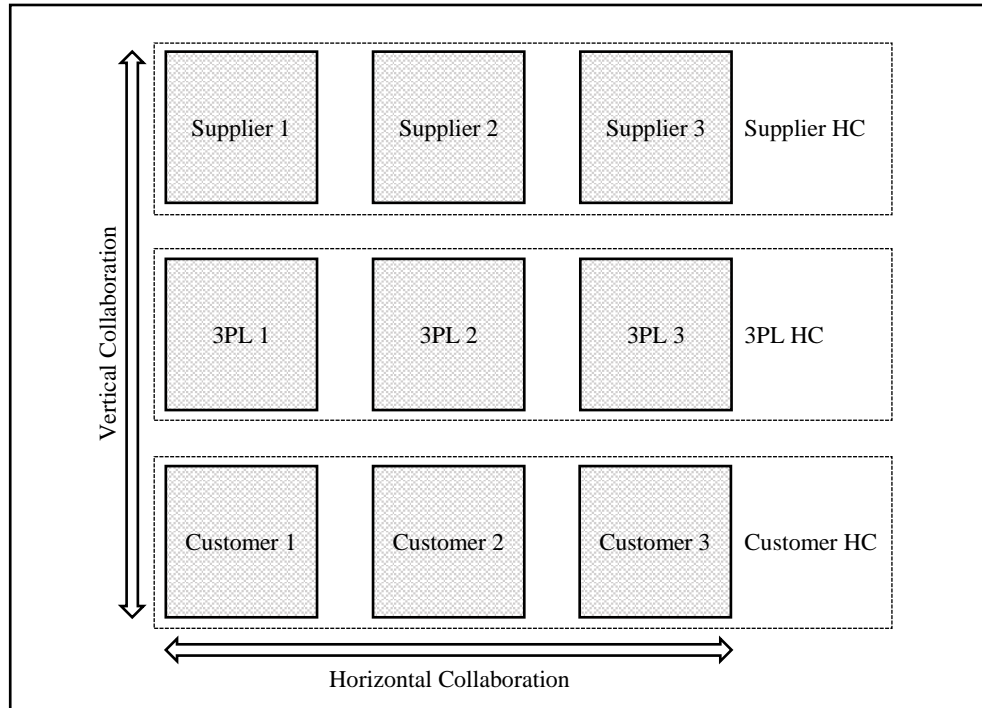
Figure 5. Illustration of horizontal and vertical collaboration.

3.5.5 Incentive Alignment in Supply Chains

Close relationships between supply chain partners is an established core concept within Supply Chain Management. Although, collaboration over organizational borders has shown to be a difficult task for many companies. A crucial component to succeed in supply chain collaborations is to distribute both risks and gains between the actors in a fair way. If this is not managed in a careful way, each company tend to prioritize their own interest over the network's interests (Agrell, Lindroth and Norrman, 2004). Simatupang and Sridharan (2005) presents a framework for successful supply chain collaboration. The framework describes incentive alignment as one crucial part in achieving a collaboration where common goals are prioritized, and where risks and gains are shared in a fair way.

Narayanan and Raman (2004) studies the topic through analyzing more than 50 supply chains. It discovers that companies often do not act in the best interest of the network, they rather optimize their own profit. This makes the supply chains perform poorly. Also, internal problems were handled to a wider extent than inter-organizational problems since the latter are harder to detect as well as more

complicated to resolve because of governance structures and accountability issues. In addition to this, different companies have different cultures, different beliefs and different loyalty to their partners. The conclusion from this is that supply chain partners cannot assume that all actors will pull in the same direction, and that the collaboration automatically will be fruitful for the network. To make sure that all partners behave in a way that is beneficial for everyone, monetary incentives must be used and be designed in a way that this behavior is rewarded.

Furthermore, Narayanan and Raman (2004) identifies three reasons to why problems related to incentives arises.

1. **Hidden actions**. Difficulties connected to monitoring actions of partner companies.
2. **Hidden information.** Difficulties that is caused by asymmetric distribution of information among the partners.
3. **Badly designed incentives.** Incentives are designed in a way that does not support the network objectives.

A three-step method to meet the problems related to incentives is suggested. First, the executives must realize that the problem exists and be committed to making a change. Second, the root causes of the problem must be identified and understood. The final step is to align or redesign the incentives to achieve a better fit to the network objectives. The new incentive system can be either contract-based, information-based or trust-based. Out of these three types of incentive systems Narayanan and Raman (2004) suggests the contract-based as a first step since it is relatively quick and easy to implement.

3.5.6 **Pricing of Transportation**

Pricing of goods and services is an important example of monetary incentives, and can be designed to align actors' incentives.

3.5.6.1 Pricing Strategies
There exist five pricing strategies that are mainly used in the transportation system. The strategies differ in who pays for what. A certain strategy is chosen when contracting to fit the aim of the transport or service (Lumsden, 2007).

- **Pricing to cover cost.** The price is set so that the transporter's long-term average expenses for providing the service is covered. There are two methods to determine the price in this strategy. The prime cost method is based on the idea that the sum of all fees collected from the customers should cover the transporter's costs (Lumsden, 2007).
- **Margin Pricing.** The aim is to cover the short-term marginal cost of the service. This could be the cost of adding one extra pallet to a container or

adding one more container to a freight train. This strategy is mainly used to achieve cost efficiency (Lumsden, 2007).

- **Rationing Pricing.** Is used when the supply of services is limited. To correspond to the limited supply, the prices are raised in order to also limit the demand (Lumsden, 2007).
- **Market Pricing.** This way of pricing is based on the current situation in the market. There exist two sub-strategies, *competitive pricing* and *time pricing*. Competitive pricing is used to gain market shares through offering a more attractive price than the competition. Time pricing is based on that factors like capacity and demand are subject to variation over time, it can be said to be an on-the-spot-price, which is why it is often called a *spot price* (Lumsden, 2007).
- **Related pricing.** Determining the exact costs caused by a certain transportation service can be hard. A way of pricing that avoids this is the related pricing, which instead compares the service with another similar service that is already priced. Characteristics of the compared services such as time, quality and capacity must be considered and the price adjusted thereafter (Lumsden, 2007).

3.5.6.2 Pricing Methods

The pricing method is derived from the pricing strategy. The method specifies how the transport service is priced.

- **The Contract Method.** This method is used for single agreements between the buyer and seller of a transportation service. It is used for well-defined services that include a single or a few shipments over a limited period of time. It is also commonly used when an entire transport system is contracted to a transporter. Examples of situations when the contract method is preferred is large transportations volumes, very large or in other ways unusual items, unusual transport routes, etc. The agreement is well documented in a contract that is valid for this certain agreement only (Lumsden, 2007).
- **The Rate Method.** The rate method is based on price lists with fixed prices for standard services. The prices are based on weight and volume of the goods, the transportations distance and sometimes additional characteristics of the service. This is the most common pricing method, and works well in a market with few sellers in comparison to the number of buyers and where each buyer has a small impact on the market (Lumsden, 2007).
- **The Agreed Rate Method.** This is a mix of the contract method and the rate method. It is used mainly for large buyers that will transport large volumes over a longer period of time. The characteristics of the need might suit the contract method but it would be too time-consuming to negotiate an agreement for every shipment. Therefore, a more long-term agreement with

fixed rates for specific transport needs is negotiated between the buyer and the seller (Lumsden, 2007)

3.5.7 **Transaction Cost Economics**

Transaction Cost Economics (TCE) is the theory about where to set the boundaries for a company, and to analyze the question of whether a company should perform a certain function or activity in-house or contract it to an external company. Within TCE, the cost for a company to produce something themselves are compared to the cost of contracting the job to someone else (Selviaridis, 2010).

Coase (1937) was the first one to present the idea of differential transaction costs between markets and firms. He meant that when a company contracts a job to another firm, *marketing costs* occur because of the effort spent on searching for relevant prices, negotiating and contracting. Considering this approach, one can wonder why it is not always cheaper to produce yourself and why not all products are produced within one huge company. Coase (1937) presented three reasons to why this is not the case and why the market exists. First, rising costs of organizing additional transactions. Second, sub-optimum use of production factors and third, rising supply price of production factors. These reasons can be concluded as the returns are decreasing with increased number of internal transactions, why an infinite expansion of a company is not desired (Selviaridis, 2010).

These theories have been further developed and Williamson (1975) based his analysis of TCE on the following assumptions about human nature and organizations;

- **Bounded rationality.** Humans are restricted in their ability to collect and analyze information. Therefore, all decisions, even rational ones, are based on limited information. This also applies to business contracts since they possibly cannot consider all possible future events.
- **Opportunistic behavior.** Humans seek self-interest by being dishonest, distort information and confuse transactions.
- **Uncertainty.** Future events of the transaction and the environment are unknown.
- **Small numbers bargaining.** Few suppliers exist that can offer the demanded task and therefore their bargaining power increases.

When combining bounded rationality and opportunistic behavior with uncertainty and small numbers bargaining, problems connected to market exchanges arise. The conclusion is that in this case vertical integration may be more efficient than markets, since it is limiting the uncertainty and opportunistic behavior (Williamson, 1975). However, when a company reaches a certain size, the advantages of an internal organization compared to markets disappears because of issues like lack of

40

flexibility, administrative costs and decreasing levels incentives and motivation (Williamson, 1985).

Williamson (1985) further presented the following attributes of transactions. These attributes describe the characteristics of a certain transaction and they are key when linking TCE to contracts and other governance structures;

- **Frequency of transactions.** How often a transaction between the buyer and seller take place.
- **Uncertainty.** Due to the limited possibility to consider future events. More uncertainty usually implies higher costs for being proactive towards risks.
- **Asset specificity.** Investments in assets that are specifically designed for certain future transactions. The key is that the investment is somehow costly to modify for alternative use.

3.5.8 Agency Theory

Agency theory is the theory around a common risk-sharing situation in business often referred to as the agency problem, the agency dilemma or the principal-agent problem. The agency relationship is defined as *"contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf which involves delegating some decision-making authority to the agent"* (Jensen and Meckling, 1976, p. 308). The agency theory focuses on two major problems that are probable to arise in this situation. First, discrepancies between the self-interests of the principal and the self-interests of the agent and the difficulties or costs for the principal to verify and control the performed work of the agent. Second, the risk-sharing problem that occurs when the principal and the agent has different risk preferences (Eisenhardt, 1989).

The goal of the principal is to make sure that the agent accepts the assigned task and performs it in a satisfactory way. To reach this goal, the correct sets of rewards must be offered to the agent. How these incentives should be designed depends on the structure of the task, risk preferences, internal goals among the actors and the possibility of effective monitoring of the agent's actions. The agency theory assumes that opportunism, self-interests and asymmetric information exists in the relationship between the principal and the agent (Eisenhardt, 1989).

Although the theory was first researched and applied in Economics in the 1970s Stock (1997) have identified several potential applications within logistics. Among these are:

- Defining and understanding inter- and intra-firm organizational relationships.

- Supply chain management issues such as risk sharing, capital outlay, power and conflict between channel intermediaries and the determination of costs and benefits of supply chain integration.

4 Analytical Framework

This chapter presents the analytical framework designed to analyze the empirics in this study.

4.1 Linking the Frame of Reference to the Analytical Framework

The theory presented in the Frame of Reference provides a deeper understanding of the barriers in the analytical framework. It is the viewpoint from where the barriers to information sharing are examined, and it will be the basis for the analysis of the empirical data. This theory will be an important background for analyzing how the existing barriers to information sharing can be mitigated. What theory the authors link to what barrier is then presented in Table 6 at the end of the chapter.

4.2 Barriers to Information Sharing

Prior studies point out several possible barriers to inter-organizational information sharing. Twenty-three publications, mainly in the field of supply chain management, are reviewed and five categories of barriers were distinguished; *Organizational, Business Environment, Incentives, Technological* and *Data Quality*, see Table 5 below. Within these categories, a number of barriers are identified.

Table 5. Summary of literature review and identified categories of barriers to information sharing.

Publication	Organizational	Business Environment	Incentives	Technological	Data Quality
Almotairi et al. 2011	x		x	x	
Barson et al. 2000		x			
Cragg et al. 2002	x				
European Commission 2011		x			
Fawcett et al. 2007	x	x		x	
Fawcett et al. 2008		x	x		
Ganesh et al. 2014			x		
Gil-Garcia et al. 2007	x				
Kamal & Themistocleous 2006	x				
Khurana et al. 2011	x			x	
Lee & Whang 2000	x	x	x	x	x
Liang 2015	x		x		
Lotfi et al. 2013			x	x	
Love et al. 2001	x				
Marsch & Flanagan 2000			x		
McCarter & Northcraft 2007		x			
Moberg et al. 2002	x	x			x
OECD 2010		x			
Patnayakuni et al. 2006		x	x		
Shaw et al. 2016	x	x			
Shore and Ventachalam 2003	x		x	x	
Stephenson & Blaza 2001	x				
Stewart et al. 2004	x				

4.2.1 **Organizational**

This category of barriers refers to internal organizational circumstances that stand in the way of inter-organizational information sharing.

To implement inter-organizational information sharing, internal processes, working methods, techniques and corporate culture must be challenged. Khurana, Mishra and Singh (2011) and Moberg *et al.* (2002) both mention this need of change as a barrier itself since many organizations are reluctant to change.

Low technological literacy in the organization is another factor hindering information sharing (Stephenson and Blaza, 2001; Stewart, Mohammed and Marosszeky, 2004). If the workforce is not capable of understanding or using technological tools for sharing data, it is even harder to implement these processes.

Lee and Whang (2000) states that information sharing only is of use when each organization possesses capabilities to utilize the information in an effective way. Some companies are afraid that their shared information will be misinterpreted or misused (Kamal and Themistocleous, 2006). Shaw, Grainger and Achuthan (2016) and Liang (2015) also describes that companies want to know how to make use of more data prior to investing in information sharing initiatives.

Lack of financial resources for adopting information sharing technology hinders organizations from exchanging information (Cragg, King and Hussin, 2002). Love *et al.* (2001) points to the high initial investment as well as maintenance cost, while Almotairi *et al.* (2011) and Fawcett *et al.* (2007) stress the high complexity and the time and work needed to implement and integrate systems.

Moberg et al. (2002) connects the matter of resources to the size of the organization and says that a larger company is more likely to accept the risk-taking connected to investment in information technology. This view is supported by Ramon Gil-Garcia, Chengalur-Smith and Duchessi (2007) which states that small and medium sized companies feel that information sharing is suited only for big companies and that the investment will not bring any major returns. Shore and Venkatachalam (2003) says that financial capability and stability are criteria for investing in information sharing.

4.2.2 **Business Environment**

Business environment barriers are related to the companies' business models and the interaction between the companies in the market. These barriers either arise from the competition between firms or from how the companies look upon their partnerships with other actors in the market.

A wide range of research identifies competition as an important barrier for information sharing. Companies are afraid that confidential information will end up

in the hands of their competitors, they fear losing market positions or other competitive advantages and therefore want to keep data for themselves (Barson *et al.*, 2000; Lee and Whang, 2000; Fawcett, Magnan and McCarter, 2008; Lotfi *et al.*, 2013; Shaw, Grainger and Achuthan, 2016).

Another aspect of competition is connected to antitrust regulations. Increased information sharing leads to increased market transparency, which is not only beneficial. Information sharing between competitors may enable coordination which can lead to collusion in the market. To prohibit such behavior, *antitrust regulations* control what and how information is allowed to be exchanged (OECD, 2010). It is mainly information regarding prices and quantities that are considered to harm the competition in a market. The European Commission is continuously monitoring and legislating these issues to promote fair competition in all markets in Europe (European Commission, 2011).

Lee and Wang (2000) puts this in a supply chain context and stresses the fact that the sender of the information have to be sure that the receiver is using the data as it was intended. If the receiver uses the data in a way that is prohibited by antitrust regulations, both parties face the risk of being accused of collusive behavior. Fear of ending up in this situation may hinder companies from sharing information.

The level of trust in a partner relation is positive related to the level of information exchange between the partner companies (Moberg *et al.*, 2002). Fawcett, Magnan and McCarter (2008) states that lack of partner trust is a barrier for information sharing and Patnayakuni, Rai and Seth (2006) says that information sharing is more common in partnerships with a high level of trust.

Closely related to trust is the level of commitment the companies perceive from their partners. To share information the companies want to see a commitment to the collaboration in form of participation and long-term orientation (Moberg *et al.*, 2002; Patnayakuni, Rai and Seth, 2006; Fawcett *et al.*, 2007).

4.2.3 **Incentives**

To invest in increased information sharing the company must be motivated by a future return on the investment.

Lack of incentives as a barrier for information sharing is stated by Shore and Venkatachalam (2003), Patnayakuni, Rai and Seth (2006) and Lotfi *et al.* (2013). Liang (2015) says that the gains of information sharing often is non-financial and intangible. Marsh and Flanagan (2000) states that managers do not see the benefits of information sharing and Almotairi *et al.* (2011) explains that the interest in multi-enterprise integration usually is low because the companies do not see how it can help them reach their goals.

Not only incentives as such but also how the incentives are distributed in the partner network is a barrier to information sharing. Lee and Whang (2000) says that the first and foremost barrier is misaligned incentives. Fawcett, Magnan and McCarter (2008) points at misaligned motives and behavior as a problem, and Ganesh, Raghunathan and Rajendran (2014) says that distorted incentives discourage information sharing.

4.2.4 Technological

The different technological barriers to information exchange are frequently suggested by prior studies, usually pointing out that there is yet much to be improved. It should be noted that while the technology supporting information systems develops rapidly, the presented barriers related to information sharing are still relevant.

The challenge many publications brings up is the difficulties of achieving seamless inter-organizational communication between IT systems, i.e. without manual intervention. The reasons for these issues are numerous. Khurana *et al.* (2011) mentions the issue of companies using systems from different suppliers, both in terms of hardware and software. This includes differing data standards and definitions, as well as a variety of programming languages, making interaction and integration difficult. Further, Shore *et al.* (2003) argues that the IT infrastructure and the capability of a potential supplier to exchange information effortlessly is an important criterion to consider when sourcing. Developing cross-organizational information systems, however, is costly, time-consuming and risky, and technical specifications can be troubling to agree on (Lee and Whang, 2000). Even with partners that have developed EDI solutions, the transfer of data is not necessarily smooth. Fawcett *et al.* (2007, p. 366) states that *"it is not unheard of for a company to receive customer orders through EDI only to end up manually re-entering the information into its own systems. This happens because the systems do not talk to each other."*

Another aspect which impedes the interoperability of systems is the different levels of connectivity companies operate at. The full potential of connectivity can only be realized when all partner companies connect at the same level, preferably through automatic integrations (Fawcett *et al.*, 2007; Almotairi *et al.*, 2011). While some buy off-the-shelf systems from software vendors, others use their self-developed legacy systems and some mainly use Microsoft Excel. As the latter two types are rarely designed for automatic data exchange between systems, companies using them will have a hard time communicating without manual processing (Almotairi *et al.*, 2011). Fawcett *et al.* (2007) states that as smaller firms do not have the financial resources to invest in multiple connectivity systems, and instead of selecting among diverse standards, these companies opt out of the new technologies altogether. As a consequence, the companies using more advanced systems have a

hard time leveraging full benefits from them, as they cannot connect with all of their partners (Fawcett *et al.*, 2007). The article points out that these issues can arise when industry standards do not exist or are not used, resulting in connection problems between systems.

Other technical barriers mentioned include the user-friendliness of systems, the learning curve of employees for using the system and the reliability of the technology itself (Lotfi *et al.*, 2013)

4.2.5 **Data Quality**

Some studies point out the data quality as an issue for achieving more effective information exchange. The receiver of information must be able to trust that the information is correct. If the timeliness and accuracy of information are not aligned with what the receiver requests, it can impede the benefits of sharing and the practice misses its purpose (Lee and Whang, 2000; Moberg *et al.*, 2002; Lotfi *et al.*, 2013). Moberg *et al.* (2002) also identifies proper formatting as a quality parameter which has to be present to fully realize the potential of information exchange. Without these parameters being fulfilled, managers will not use the information. Hence, the value of the information sharing diminishes, and as a consequence, less information will be shared (Moberg *et al.*, 2002).

4.2.6 **Summary of Categories**

As presented above the common stated barriers to information sharing is categorized into the five categories; O*rganizational, Business Environment, Incentives, Technological* and *Data Quality*. In the authors' view, theory from the Frame of Reference is useful to support analysis of the different barriers. How the sections in the Frame of Reference relates to categories of barriers is presented in Table 6 below.

Table 6. Categorization of barriers to information sharing found in literature review and connection to the Frame of Reference.

Category of barrier	Barrier	Section in the Frame of Reference
Organizational	Reluctance to change	3.3 Information in Transportation 3.4 Organizational Capabilities
	Low staff technological literacy	
	Lack of capabilities	
	Lack of financial resources	
Business Environment	Fear of losing competitive advantage and market position	3.1 Transportation 3.2 Rail Freight Transportation 3.3 Information in Transportation 3.5 Inter-organizational Interactions
	Antitrust regulations	
	Low level of external trust	
	Short-term partnership commitments	
Incentives	Non-financial and intangible returns	3.3 Information in Transportation 3.5 Inter-organizational Interactions
	Misaligned incentives	
Technological	Cross-organizational IT incompatibility	3.2 Rail Freight Transportation 3.3 Information in Transportation 3.4 Organizational Capabilities 3.5 Inter-organizational Interactions
	Different level of connectivity	
	Complex implementation	
	Low reliability in technology	
Data Quality	Lacking timeliness and accuracy of data	3.3 Information in Transportation
	Formatting issues	

5 Empirics

In this chapter, the results from the in-depth interviews are presented. First the findings are described in text and in the end summarized in two tables. This chapter provides the basis for the analysis in chapter 6. The interview objects are referred to with names as presented in Section 2.3.2 In-depth Interviews.

5.1 Organizational

5.1.1 **Barriers**

A general organizational barrier is the lack of capabilities and financial resources to develop and adapt to new systems, processes and procedures needed to conduct information sharing. Most interviews are either explicitly or implicitly expressing that time and cost are problems connected to information sharing. Some are focusing on the capital investment in new IT systems, while others are saying that they are pressured in time and simply does not have the hours needed to develop their working procedures. TR2 says that many modern organizations do not have any slack in their everyday work, to develop new processes, resources need to be clearly dedicated to this purpose.

One issue raised by five of the respondents is lacking internal processes for handling or sharing more data. The internal information flows are too poorly designed to handle an increased exchange of information. This issue is connected to the issue of capabilities to utilize more information. If the organization cannot gain advantages from received or shared information it is of no use to conduct the exchange of information. Mentioned capabilities that are lacking revolve around IT and how to leverage an increased access to data in the company.

Further, five interviewees are stating that a general reluctance to change in the industry is a barrier to information sharing as well as to other development initiatives. Many routines in the industry are said to be stuck and often motivated by the mindset of *"we always did it like this"*. Another cause of this stagnation is the pressured margins in the industry. Few companies do not dare to change because they cannot afford to make a mistake and therefore choose to stay passive. TE1 raises the aging workforce in the industry as a part of the problem. Many people

have been in the industry for a long time and therefore have a hard time to see alternative solutions. Understanding and trust for modern technology are also lower in this group.

5.1.2 **Opportunities**

Three interviewees, TE1, GO1 and OB, are seeing opportunities connected to organizational capabilities. Although the industry currently is characterized by slow development and reluctance to change, they predict that in time new perspectives and mindsets will emerge in the industry. A younger workforce and innovation spreading from other industries are mentioned as possible events developing the internal capabilities.

Table 7. Summary of barriers and opportunities in the organizational category.

Barriers	Opportunities
Lack of financial resources	Business innovation
Reluctance to change	
Poor internal processes	
Lack of capabilities	

5.2 Business Environment

5.2.1 **Barriers**

The most common answer in the business environment category and also among all categories is that fear of losing business is a barrier. This type of answer contains a few different angles of the problem. The interviews suggest that increased information sharing could decrease the importance of freight forwarders in the market and thereby hurt their business. Another common thought is that more open information could increase the downward pressure on transport prices. Most interviews also indicate that transportation companies' goods flows are a secret due to the fear that a competitor would try to steal the customers if they knew about them and their flows.

TE2 and TE3 say that they are concerned about sharing information that can be related to their customers. This is because of the reason mentioned above, that their customers, mainly forwarders, would suffer damage from it.

FW1, FW3 and TE2 explain that there are some competitors in the market that would never cooperate because of principles. Examples are given about big forwarders that would never cooperate with another big forwarder.

A couple of interviewees also mention antitrust regulations as a problem. They express that they are not sure about what information is legally allowed to share with whom. GO1 also mentions uncertainty regarding what information that STA is allowed to share on the market. No one knows exactly what is allowed or not, and the uncertainty is creating a barrier to sharing information in general.

Concerning the interaction between the market actors, it is mainly the fact that the market structure is complex and the information is fragmented that is mentioned as a problem. Nine respondents say that the fragmented information creates problems in collaboration. Since many companies are usually involved in a rail freight transport, it is unclear who possesses what information and how to access it. Instead of searching the holistic view, interviewees state that many companies focus on their own parts and forget about the cross-organizational processes they are involved in.

A few respondents also bring up that companies rather not trust another company to act as the information hub in the system. It is preferred to control the system everyone else is integrating with over integrating your own data with someone else's system.

A few respondents point out a general short-sighted thinking in the industry as a problem. This in combination with the high fixed costs that rail freight is associated with makes it risky to invest in information sharing for the future, both regarding capital investments as well as investing in long-term partnerships.

5.2.2 Opportunities

Many of the interviewed actors express that they do not believe that certain information is as secret and strategically important as many companies think. Some of them say that information regarding customers and flows of goods is already available for those who really want it. *"Just take a look at the physical trains running"*, one traction provider states. Some of the respondents believe that prices are more sensitive to share, while others say that the market prices are already generally known among competitors and frequent customers, and price differentiation in the industry is almost non-existent. To ease confidentiality concerns, one traction provider and two forwarders suggest that the data could be *masked* prior to sharing, without losing intended applications. Further, one forwarder says that its company, and probably others, possess a lot of useful information that is not currently being used.

Another opportunity identified is that large goods owners could set the trend, and lead the development. This in the form of sharing transport information with other companies interested, to gain synergies. GO1 expresses willingness for horizontal

collaboration and connection of transport systems, and has already started a pilot project. TE2 mentions a similar project with a major goods owner, focusing on cloud-based coordination of information.

FW3 has vertically integrated most activities connected to their intermodal shuttles and see this as a successful way to avoid cooperation problems. However, they are still contracting train traction, wagon leasing and some terminal services.

The two traction providers propose that the STA, as a trusted and neutral party, can receive, mask and coordinate all shared information. Further, they propose that STA can determine standards and specifications for the information sharing together with involved actors.

Table 8. Summary of barriers and opportunities in the business environment category.

Barriers	Opportunities
Fear of losing business	Overrated secrecy of goods flows
Fragmented information	STA as trusted coordinator
Short-term partnership commitment	
Policy towards collaboration	
Confidential customer data	
Antitrust regulations	
Ownership of data platform	

5.3 Incentives

5.3.1 Barriers

Some respondents argue that either they or other organs of their company fail to see the potential benefits of more developed and effective information sharing. One forwarder asks, *"if we were to receive more information, what are we supposed to do with it?"* Another forwarder backs that position up, stating that the benefits are not clear and probably not substantial enough to motivate any larger efforts. Further, it is pointed out that time pressure on transport services makes it difficult to leverage potential gains from information sharing. Two actors can see clear benefits for other companies in the transport chain, but not for themselves, and argue that those companies should take charge of investing in information sharing initiatives. Large transport buyers such as GO1 often have a high degree of asset specificity and mutual investment with their suppliers limiting the usefulness of more information for them. The researchers suggest the lack of perceived value as a key barrier. One

of them argues that the market actors do not experience the efficiency of transports as low enough to mandate any major efforts to improve it.

Two of the responding terminal service providers experience a general reluctance among transport companies to integrate with the terminals' systems to automate information exchange. OB, with an outside perspective on the market, point to a lack of cost awareness of transport companies, hindering them from seeing the possible gains.

Three of the respondents identify an over-emphasized focus on price as a barrier to developing the transport service. They state that some actors do not consider other aspects that can add value to their business, leaving them without incentives for initiatives. One interviewee listed the priorities of a transport buyer as *"price, price and then price,"* arguing that while such mentalities reign, any development of rail freight services must directly result in reduced prices.

Related to customer priorities, another issue brought up is the lack of pressure from partners to work towards information sharing. Primarily, one of the interviewed terminal service providers suggests that many goods owners do not care how the transport is performed, as long as their setup works satisfactorily.

A more loosely defined barrier regards structural misalignment in how different actors are incentivized to share information. TE1 identifies a gap between how the contractual relations are structured and how the information flow should pass through actors. This is backed up by a forwarder, who implies that the information flow might be hindered when it passes through an actor with little interest in information, thus limiting the downstream access of information. Another misalignment is brought up by RE2, who states that the pricing methods used in the industry do not promote advancements in information sharing.

5.3.2 Opportunities

Almost all interviews indicate that there is potential in information sharing and that there exist incentives for the industry to increase the level of information sharing. The most mentioned incentive, and also most mentioned of all opportunities, is that transport buyers are becoming more aware and is expecting more information about the transportation services they buy.

All types of actors are stressing that the number one information that customers want is information about deviations from the transportation plan. They want accurate, real-time track and trace data and updated estimated-time-of-arrival (ETA). Many interviewees are mentioning that most customers care more about knowing when the shipment is arriving than the actual transportation time, an accurate ETA is key for the customers to plan their operations. Track and trace information is also interesting from a quality and liability point of view. Some customers want to be able to see what is happening to their goods, where it is, where it has been, who is

handling it, what transport modes are used, etc. FW3 states that many customers are shifting towards valuing high quality and transparency over fast delivery, making information sharing more relevant.

Customers are also becoming more and more aware of the environmental effects of their transportation. This is positive for the competitiveness of rail transport in general, while also putting pressure on the industry to present accurate data on emissions. Track and trace data combined with general emission data is one way to present total emissions caused by a single customer.

Another aspect of customer expectations is brought up by both traction providers, all forwarders, and RE2. They are all proposing that information sharing would help to meet the customer needs in a better way. They are saying that increased information sharing both before and during the transport would facilitate all parties planning and execution of operations.

Most actors can also see business potential in information sharing, either as increased volumes or decreased costs. All terminal service providers are saying that they think better information exchange in the industry would increase the total volume of rail transport. Most actors, including the terminal service providers, see potential in gaining efficiencies and lowering costs if information sharing can be increased. FW1 and GO1 are mentioning the potential of data that the STA possesses. Although they are not sure exactly what information exists, they believe it would be of interest for the entire industry.

Regulations, legislation or economic incentives decided by the authorities is also proposed as a way to incentivize increased information sharing. This is brought up by TR2, FW1, GO1 and OB. They are not pointing out measures directly towards information sharing, rather actions promoting higher fill rates, lower emissions or other efficiencies that in turn can incentivize increased information sharing.

Finally, the role of the terminal service providers is pointed out as an opportunity by TE1, TE3, and RE2. They all mean that since the terminal service providers are collaborating with most other market actors and are providing a crucial service they are in a position where they could push the development forward. By pushing their customers to share information and integrate to the terminal's IT systems the mindset in the industry could change and standards could develop. TE1 mentions that all terminals the organization controls, and many other terminal service providers are already using the same IT system, thus an integration towards that particular system would enable better interaction with a wide range of terminals.

Table 9. Summary of barriers and opportunities in the incentives category.

Barriers	Opportunities
Intangible returns	Customer expectations
Misaligned incentives	Regulations
Lack of customer pressure	Terminal service providers can push integration
Exaggerated price focus	Increase total volume
	Increase efficiencies

5.4 Technology

5.4.1 Barriers

The most frequently discussed technological barrier is the incompatibility between different information systems. This is especially stressed by actors involved with a wide range of partners, such as terminal service providers and freight forwarders. Some use integrated systems towards larger customers, but those solutions are highly specialized. This issue leads to a lot of manual handling of data in the intersections between systems, and thus reduces both the speed and the efficiency of information exchange. FW2 comments that it is required to allocate a lot of human resources to extracting and translating data in both directions, i.e. from its information systems and from its business partners' systems. The respondent also points to the lack of standards in information systems, complicating automated communication between systems. More than the systems, OB adds that there are disagreements on what technologies to invest in, e.g. equipping load carriers with RFID or with GPS technology for tracking, which causes even more divergence.

The other major barrier in respect to technology is the overall low level of companies' systems, i.e. the IT maturity is low. Many companies work with basic spreadsheets for storing data and communicates by e-mail. This also leads to more manual handling and increases the risk for errors. Further, companies with more advanced systems still have to perform manual handling if their customers or suppliers use spreadsheets, disincentivizing investments and stalling the industry-wide development.

The two traction providers mention that years of ad-hoc solutions and isolated development of programs have left them with a large catalog of systems, leading to a poor overview of what information they possess and where it can be accessed. RE2 describes this issue further, that self-developed legacy systems lead to difficulties knowing what they contain and where, and how they are connected to

other systems. Although not explicitly expressed, many other actors imply that specialized solutions with large partner's and other varying development initiatives have led to poor control of their systems.

5.4.2 Opportunities

In general, respondents are optimistic about what technology can do to support information sharing. The overall awareness of how to leverage technology is increasing, they state. Some say that they already have the IT necessary to transfer, receive and process data. Those actors already perform such practices in other settings. Two of the terminal service providers interviewed use the same system, and state that many terminals are connected to it. They have integrated their systems with a few willing customers, but express frustration that not more partners have shown interest in integration. Others are less developed, but state that managers have at least started to realize the benefits of adopting more advanced technology, and also that developing processes are vital to the success of technology implementation.

The development of technology is also mentioned as an opportunity. A few respondents argue that the continuous improvement of technology will improve companies' practices, and one of the interviewed researchers states that the adoption pace of new technology will increase. TE3 thinks that companies have a more holistic thinking in their technology investments nowadays, and issues such as interoperability between systems are being considered. TR2 believes that cloud services can enable information sharing, and sees hardware independence as a positive development.

Table 10. Summary of barriers and opportunities in the technological category.

Barriers	Opportunities
Cross-organizational IT incompatibility	Technology already exists
Low IT maturity	Continuous development
Lack of internal IT control	

5.5 Data Quality

5.5.1 Barriers

Somewhat related to the low level of digitalization is the quality of data that actors send out and receive. Many of the interviewees suggest that they often obtain

information too late for them to use it properly. Forwarders and traction providers argue that they receive demand data from customers too late to plan their capacity accordingly. The goods owners and some terminal service providers wish to get information of transport deviations, such as new ETAs, earlier for them to adjust. Further, some actors do not feel that they can fully trust the accuracy of data, both from their own systems and from others'. This is mainly due to the many steps of manual transfers between different systems, spreadsheets, emails and phone calls.

Differing units of measures, e.g. net weight versus gross weight, is also a cause for confusion, causing actors not to find use for all the information they possess. However, some of the interviewed companies are on the other side of the spectrum, claiming full confidence in the quality of the data they have. These actors are mainly involved with a small number of other actors in their transport setting, and have often integrated systems with key partners.

5.5.2 **Opportunities**

The interviewees did not present any opportunities connected to data quality.

Table 11. Summary of barriers and opportunities in the data quality category.

Barriers	Opportunities
Timeliness and accuracy of data	-

Table 12. Summary of the barriers to information sharing presented in the empirics.

Category of barrier	Barrier	TR1	TR2	FW1	FW2	FW3	TE1	TE2	TE3	GO1	GO2	OB	RE1	RE2
Organizational	Lack of financial resources	x	x	x			x	x		x	x			x
	Reluctance to change						x	x		x	x			x
	Poor internal processes					x			x		x	x		x
	Lack of capabilities						x				x			
Business Environment	Fear of losing business	x	x	x			x	x	x	x	x	x	x	x
	Fragmented information	x		x	x	x	x		x	x		x		x
	Short-term partnership commitment	x		x			x					x		
	Policy towards collaboration			x		x		x						
	Confidential customer data							x	x					
	Antitrust regulations			x					x					
	Ownership of data platform										x			x

Category of barrier	Barrier	TR1	TR2	FW1	FW2	FW3	TE1	TE2	TE3	GO1	GO2	OB	RE1	RE2
Incentives	Intangible returns			x		x	x						x	x	x
	Misaligned incentives			x			x			x					x
	Lack of customer pressure						x	x	x					x	
	Exaggerated price focus			x				x					x		
Technological	Cross-organizational IT incompatibility	x		x	x	x	x	x	x		x	x		x
	Low IT maturity	x	x		x	x	x				x			x
	Lack of internal IT control	x	x											
Data Quality	Timeliness and accuracy of data				x	x	x	x		x	x			x

Table 13. Summary of opportunities for information sharing presented in the empirics.

		TR1	TR2	FW1	FW2	FW3	TE1	TE2	TE3	GO1	GO2	OB	RE1	RE2
Organizational	Business innovation						x			x		x		
Business Environment	Overrated secrecy of goods flows	x	x	x			x			x		x		
	STA as trusted coordinator	x	x											
Incentives	Customer expectations	x	x	x	x	x	x	x		x	x	x		x
	Regulations		x	x						x		x		
	Terminals can push integration						x		x					x
	Increase total volume						x	x	x					
	Increase efficiencies			x	x	x	x		x	x	x	x		x
Technological	Technology already exists	x	x	x		x	x	x	x					
	Continuous development		x		x				x			x		x
Data Quality														

6 Analysis

In this chapter, the empirical findings are analyzed and compared with the theoretical findings. The impact of each barrier to information sharing is discussed and the interdependencies to other barriers are explored. Finally, strategies to mitigate the most significant barriers are presented.

6.1 Structure of the Analysis

The purpose of the analysis is to further explore the identified barriers to information sharing and their interrelations, ranking the importance of barriers and present strategies to mitigate the most important barriers. The analysis is carried out in four stages; analysis of barriers, ranking of categories, exploring interdependencies of most important barriers and designing mitigation strategies.

Phase 1 discusses each category of barriers and compares the empirics with theory in order to present a more comprehensive view of the identified barriers. Further, the interdependencies between the barriers within each category are determined. The aim is to identify which barriers that are root causes and which barriers that are consequences from them. The barriers within each category are divided into two groups, Level 1 and Level 2. Level 1 barriers cannot be derived from any other barrier within the category, they are root cause barriers. Level 2 barriers are possible to derive from Level 1 barriers within the category, i.e. they are part of or consequences from one or more Level 1 barriers.

Phase 2 seeks to explore the interdependencies between the five categories of barriers based on the discussion in Phase 1. The categories of barriers are placed in a hierarchy consisting of Level A, Level B and Level C. Level A barriers cannot be derived from other barriers but their impact can be affected by barriers from Level B. The existence of Level B barriers can be derived from Level A barriers. Level B barriers can also affect the impact of Level A barriers. Level C barriers are consequences from Level A and Level B barriers.

Phase 3 combines the result of Phase 1 and Phase 2 in order to present the interrelations between the most significant barriers. The root cause barriers (Level 1 barriers) from Phase 1 are merged with the ranking of categories in Phase 2. This

analysis results in a framework presenting the most significant barriers and their interdependencies. The barriers are ranked from Level A to Level C, as in Phase 2.

Phase 4 compiles findings from the previous three phases with theory from the frame of reference and the analytical framework, in order to design strategies for mitigating the most significant barriers.
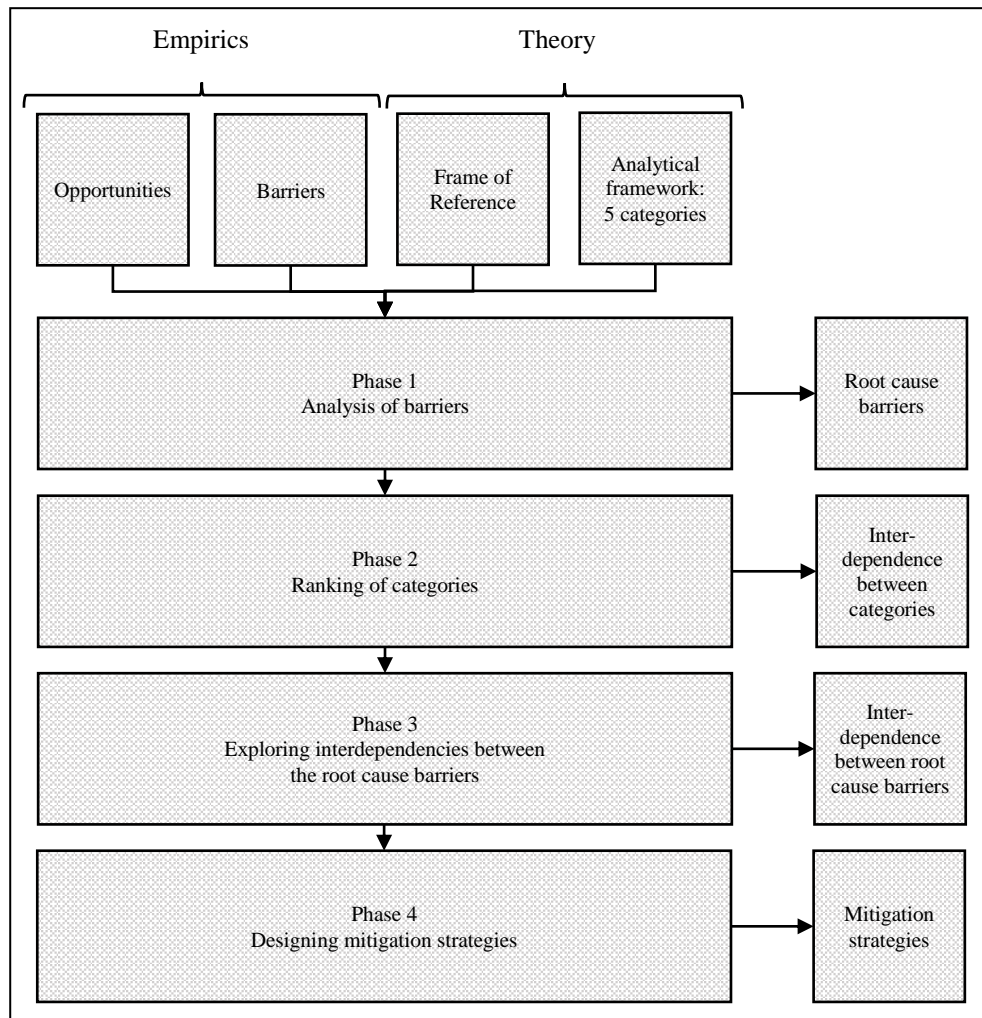
Figure 6. The structure of the analysis.

6.2 Analysis of Barriers

When comparing the barriers identified in the Analytical Framework with the barriers identified in the Empirics, it is clear that some barriers are directly

corresponding, while others are less or not related. The identified barriers are compared in Table 14 below and in the following discussion.

Table 14. Comparison of barriers to information sharing found in the Analytical Framework and the empirical data.

| Category of barrier	Analytical Framework	Empirics
Organizational	Reluctance to change	Reluctance to change
	Low staff technological literacy	
	Lack of capabilities	Lack of capabilities
	Lack of financial resources	Lack of financial resources
		Poor internal processes
Business Environment	Fear of losing competitive advantage and market position	Fear of losing business
	Antitrust regulations	Antitrust regulations
	Low level of external trust	
	Short-term partnership commitment	Short-term partnership commitment
		Fragmented information
		Policy towards collaboration
		Confidential customer data
		Ownership of data platform
Incentives	Non-financial and intangible returns	Intangible returns
	Misaligned incentives	Misaligned incentives
		Lack of customer pressure
		Exaggerated price focus
Technological	Cross-organizational IT incompatibility	Cross-organizational IT incompatibility
	Different level of connectivity	
	Complex implementation	
	Low reliability in technology	
		Low IT maturity
		Lack of internal IT control
Data Quality	Timeliness and accuracy of data	Timeliness and accuracy of data
	Formatting issues	

6.2.1 **Organizational**

It is clear that many companies in the industry are lacking both human, physical and financial resources to invest in more advanced information systems. Many companies face a major challenge in improving their processes and transforming to enable meaningful information sharing. The internal processes and capabilities for employing more sophisticated information sharing practices are currently not in place. Low staff technological literacy along with time-consuming handling of data limit the amount of data that can be processed, and thus the benefits of increased information sharing.

Theory suggests that companies must not only adopt new processes and new technologies, but also modify company culture in a way that it promotes openness, sharing of information and knowledge both internally and externally. The culture must also include a positive attitude towards change in general. Leveraging information sharing is partly about continuously adapting to external information. "*We always did it like this"* and "*not invented here"* attitudes do not go well with that.

The described industry-wide reluctance to change enhances the other organizational barriers. Actors in the industry must be even more convinced of the benefits for them to pursue change efforts. Until someone can prove the potential, the ideas of information sharing will have a hard time finding sufficient traction. While some have faith in changed mindsets as new people and new innovations impact the industry, there is no certainty that such development will emerge.

Developing more advanced solutions for information handling and information sharing requires large investments. When the payback of such initiatives is uncertain, it can be understood why companies are reluctant to allocate resources to them. Some are more concerned with keeping their heads above water, and do not have the capacity to look into future developments.

The overarching barrier is, however, the *lack of capabilities*. The overall level of financial, human, physical, and information resources must be improved to enable information sharing. The barriers; *lack of financial resources, reluctance to change,* and *poor internal processes*, are merely subsets to that.

Level 1

Lack of
capabilities

Level 2

Lack of
financial
resources

Reluctance to
change

Poor internal
processes
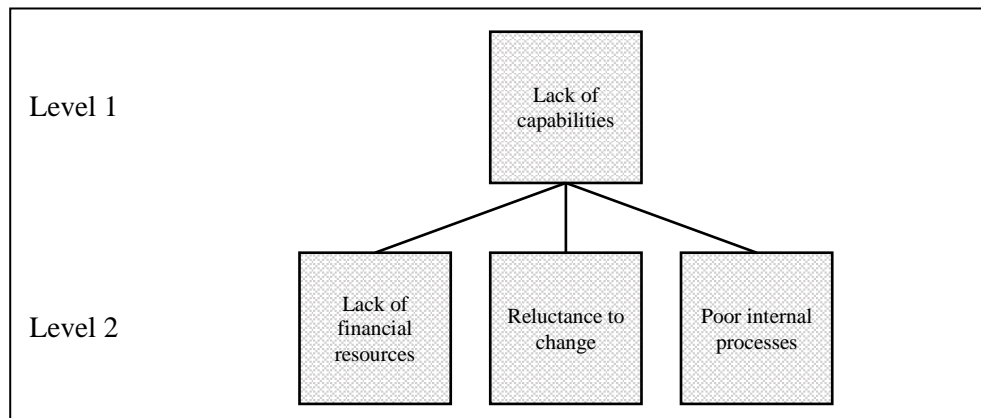
Figure 7. Summary and interdependence of organizational barriers.

6.2.2 Business Environment

When viewed from the lens of Transaction Cost Economics (TCE) (Section 3.5.7), freight forwarders fear of losing business can partly be explained on a foundational level. Even though some forwarders have their own assets, the service they sell, i.e. planning and controlling customers' transportation setup, is non-asset based. They merely leverage their network of asset-based sub-contractors to deliver solutions to their customers. This means that they have a relatively low asset specificity in their relationships, making them interchangeable, especially for customers with whom they have a low transaction frequency. The threat for the forwarders comes from both competitors and from customers performing their transport planning in-house. Increasing the transparency and accessibility of information in the transport market makes it easier for customers to find more beneficial solutions for them. Making it easier for customers to compare services through increased transparency might have the effect of reducing prices, when transport companies try to differentiate themselves. The level of trust in existing partner relationships has a strong correlation with how the respondents view information sharing, which also is aligned with what is stated in Section 4.2.2.

The same is partly true for traction providers. They offer a relatively standardized service, and unless there are some special prerequisites, such as locomotive power, customers can switch to other suppliers. However, there are few actors in the market, due to the high entry barriers to the market, limiting their fear of losing business.

The fear of losing competitive advantage because of information sharing is a frequently mentioned barrier in theory, so it does not come as a surprise that many actors bring it up as an issue. Information sharing of spare capacity can also lead to odd scenarios from a competition perspective. If Forwarder A, in an effort to sell all the slots on a train, uploaded this information globally, Forwarder B could potentially buy slots for one of their customers. This becomes a conflict of interest,

since Forwarder A would rather sell directly to the customer to obtain better margins, and has little interest in helping Forwarder B make profit. On the other hand, Forwarder A still gets its share and achieves a higher fill rate on the train with little effort, thus increasing its volumes.

The concerns regarding what is legal to share due to antitrust regulations are very speculative, and this is partly due to the open format of the interview question. The concept of information sharing contains several different categories of information and categories of use, which is why it is hard for interviewees to answer specifically. The collusive action that both theory and empirics refer to as a potential consequence of information sharing is coordinated pricing among transport companies or cooperation to exclude certain actors from the marketplace. However, if information regarding demand (goods to be moved) and supply (transport capacity) would flow both vertically as well as horizontally and be accessible equally to all parties, it can instead support monitoring of collusive actions.

Except for competitive reasons, the complex market is hindering information sharing, scattered information is making it difficult to find and consolidate information in a useful way. The low level of trust in other market actors due to fear of losing business is cementing this situation.

Many business relations in the industry can be compared with the principal-agent problem in agency theory (Section 3.5.8). Since business partners are kept at arm's length and information sharing is limited, it is hard for the principal to monitor the agent, and this causes both hidden information and hidden actions. To manage this, it is crucial for the principal to offer the agent appropriate incentives, which is discussed in Section 3.5.8.

In Section 3.5.3, six barriers to horizontal collaboration are presented. Three of them, namely *fear of the unknown*, *lack of cross-network visibility* and *fear of losing competitive advantage*, are present in the industry and are thus hindering the development of collaboration and thereby also information sharing.

The theory of TCE gives further perspective on the complex market. It suggests that when the market is lacking a holistic view, there exists opportunistic behavior, uncertainty is present and the number of suppliers is limited, problems will arise in the market. TCE suggests that in these cases, it is more efficient to vertically integrate the value chain over using the market. This relates to e.g. the situation of FW3, who has integrated more services and have a more positive experience from their setup compared to actors in less integrated chains.

In section 5.2.2, statements questioning the secrecy of information are being made, and such conflicting views are difficult to properly assess. Masking information through an independent actor, e.g. STA, and achieving transparency would mitigate the trust-related concerns many actors express. However, uncertainty of what information sharing would cause, both short and long term, remains troubling as companies do not want to lose any competitive advantages.

Most of the barriers in this section can be derived from a fear of losing business, either directly or indirectly. Trust, or a lack thereof, is a main theme. This includes lack of trust in competitors, which is not surprising, but also in their partners and in their own business. Fragmented information in the industry is an isolated barrier, as it stems from the structure of the market. Antitrust regulations stand out, as they are very tangible and set the boundaries of where businesses operate in.
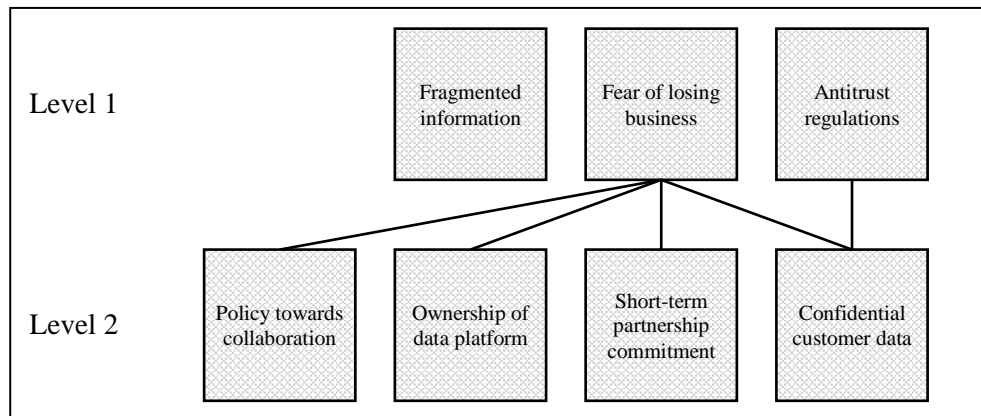

Figure 8. Summary and interdependence of business environment barriers.

6.2.3 **Incentives**

Many companies do not see how they would benefit from exchanging more information with surrounding companies. Some say they see potential for others, but not for themselves while some, especially the terminal service providers, see advantages for everybody involved. There is a wide range of beliefs, but the industry as a system is uncertain about how information sharing would be beneficial. This description goes well with the theory described in Section 4.2.3, stating that since the gains of information sharing often are intangible and non-financial, it is harder for managers to see them.

While many interviewees bring up the problem of realizing potential in information sharing, most interviewees also state that they see potential in e.g. increased volume or lower costs by using information sharing. These conflicting views are interesting, but might be more natural than it seems. The theory raises the intangible and non-financial benefits as a problem and states that top managers value those benefits lower than more tangible ones. The interviewed persons are seeing the operations in practice and can therefore relatively easy imagine how information sharing could be of use. This is different from top managers or other employees of the company realizing the potential. This may explain the contradictive answers.

That the terminal service providers realize potential in information sharing might be because of the nature of their business. They are working together with all actors

that want to ship goods through their terminal. Further, they are usually the only terminal service provider at their specific location, and therefore does not face immediate competition as e.g. the freight forwarders do, and they are getting paid per unit passing through the terminal. Their major business objective is thus to increase the total volume at the terminal, it does not matter which customer is bringing it there. If they believe that information sharing in the industry can increase volumes in the long run, they do not have much to lose. Additionally, they can benefit from increased information exchange with their customers, since it can help them to plan and execute the terminal operations more efficiently.

TE1, TE2 and RE2 see a potential key role for the terminal service providers. Because of their market position, they can take a leading role in the development of information sharing, both by promoting the concept as well as addressing technological issues. It is positive that the terminal service providers both see information sharing as something useful, and that they feel they have the opportunity to affect the development, but there are also problems related to terminal service providers leading the development. First, there are several different terminals and terminal operators in the market, and to reach the desired effect on the entire industry, all of them must agree on a common heading for the development. Second, terminal service providers are only one part of the industry and if they drive development, the risk of sub-optimization is still present. The holistic view is important to design solutions that attract all different industry actors. Third, terminal service providers taking the lead in information sharing does not necessarily solve problems related to other categories of barriers even though it might create incentives for other actors to join.

One researcher says that the pricing methods used in the transportation sector rarely promotes information sharing or collaboration. The rate method (Section 3.5.6.2) is a common pricing method in the industry. This method does not consider factors like fill rate on the train, when the booking is placed or return flows. In addition, OB states that many transport companies are lacking in cost awareness, they do not know what actual costs their products cause and therefore use the related pricing strategy (Section 3.5.6.1). Worst case, the result of this is a fixed price list where prices are based on qualified guesses. This does not encourage any cooperation between the buyer and seller because of two reasons. First, there does not exist any monetary incentives to share information in order to increase the efficiency in the interaction, the fixed prices will stay the same. Second, if one or both company has limited understanding of their own cost structure, it becomes harder to get a number on how much cost increased efficiency can save.

A few respondents mention that the transport buyers rarely demand additional information about a transport as long as it is running according to plan. Freight forwarders also express that many transport buyers lack interest and knowledge about transportation and therefore want to have as little contact as possible. This customer behavior does not give the transporters or freight forwarders any incentives to improve their information flows. However, there are also many

interviewees stating that customers are becoming more aware and want to receive more information about transportation services. Deviations, ETA and environmental declarations are mentioned as top prioritized information for customers to receive. This is also aligned with theory presented in Section 3.3.3. Section 3.5.3 is stating that status information about a transport is crucial for the receiver in planning purposes.

It is probable that both views on customer expectations are true, meaning there exist customers that want to and customers that do not want to receive more information. This is natural considering the wide range of companies that are purchasing transportation services, from small single-person firms with no knowledge of transportation to global enterprises with large logistics departments that are experts in the field. In general it is positive for the development of information sharing that some customers are demanding more information about their transports. Several interviewees highlight the importance of the customers in all product development, in the end, the one paying has the power. Environmental impact, transparency and the need for accurate planning are all issues that many modern companies are struggling with, further reinforcing the potential in the benefits of information sharing. As customers become more aware and capable of handling additional information, it is reasonable to believe that the pressure on the transport industry to provide this information will increase accordingly.

Another angle of incentives that is raised is that the contractual relations do not match the natural information flow which hinders information sharing. It might be that company A contracts company B that contracts company C. Company A and B do not see any benefits in exchanging information and so do company B and C. However, company A and C would see clear benefits in information sharing if they had a closer relation. Mismatches like this may be consequences from e.g. lacking knowledge of and understanding of the business network or simply low interest in collaboration.

Misalignment of incentives in company interactions is a part of the existing problem and a further barrier to collaboration. In Section 3.5.2 five features important for a successful supply chain collaboration is described. One of these features is incentive alignment. Incentive alignment is further described in Section 3.5.5, and three reasons to why incentive alignment-related problems arise are presented. These are *hidden actions*, *hidden information* and *badly designed incentives*. From the empirics it is clear that all three of these are present in the rail freight industry.

When comparing the situation described above while also considering Section 6.2.2 with the theory around Systems Thinking (Section 2.1.1) it is clear that the industry is, in general, lacking a holistic view of the full system. Most companies fail to see much further than their company borders and they do not see long-term and intangible gains of collaboration and information sharing. The theory refers to this phenomenon as *silo-thinking* or *sub-optimization.* The lack of holistic view and the presence of sub-optimization indicates that there is potential for both individual

companies as well as the entire industry to improve processes in order to drive more sustainable and competitive business.

Regulations, legislation or economic incentives decided by the authorities can create pressure on the industry to change. Even though it is an effective way to stimulate change, it can cause unforeseen and unwanted side-effects.

To conclude, the empirics bring up four barriers connected to incentives; *intangible returns, lack of customer pressure, misaligned incentives* and *exaggerated price focus*. Exaggerated price focus is connected to the lack of customer pressure and therefore categorized as Level 2. The price focus is one type of customer pressure but it is not promoting efforts for information sharing, rather the other way around. The three other barriers are categorized as Level 1.
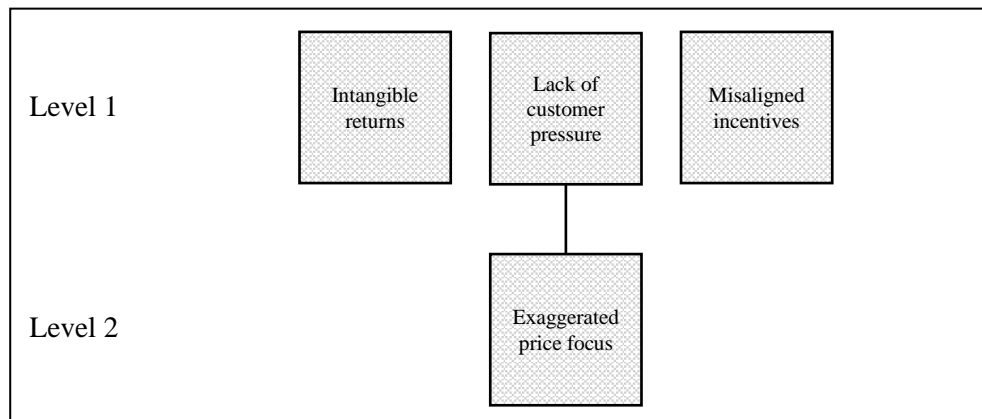
Figure 9. Summary and interdependence of incentive barriers.

6.2.4 **Technological**

One technological problem stressed by the interviewees is cross-organizational IT incompatibility. Theory around IT and IS also raises system uniformity problems as an issue, although the focus is usually somewhere else. Several authors referred to in Section 3.3.2 are focusing on the relation between business processes and IT. The baseline is that the IT should support an information system that in turn supports the business processes, not the other way around. However, many organizations are expecting IT to solve problems in their business processes. This mindset seems to be present also in the rail freight industry.

The transportation sector is said to be lagging in the digitalization, and the empirics show that the rail freight industry is not an exception, as many companies are using old and basic IT tools. They are experiencing problems due to manual handling and they are lacking resources and capabilities for developing their IT solutions. Regarding incompatibility, the technology for integration exists but it is a matter of time and money to put it into place. At the same time, most companies do not have

a clear picture of how and, more importantly, why they should exchange more information within the company and with business partners. The low IT maturity has also, in some cases, led to uncoordinated in-house development of customized solutions that in the end create a wide range of systems and routines that are difficult due to lack of internal IT control.

Even if implementation problems and large investments have been slowing down the adoption of modern IT, the overall trend is clear that digitalization will continue to impact the transportation sector. This is stated by both the respondents and the theory presented in Section 3.3.3. As the technology matures, it is also probable that prices will decrease, enabling smaller businesses to make use of the technology as well. But development of technology will not solve the question of why companies should share information and thus why companies should invest in required IT. And it will not solve how organizations adopt technology and implement new routines and working methods.

All this is implying that technology as a category of barriers to information sharing is a sub-problem to organizational barriers, business environment barriers and incentive barriers. It must certainly be dealt with, but to gain full potential, the other barriers must be handled as well.

The technological category consists of three barriers, *cross-organizational IT incompatibility, low IT maturity* and *lack of internal IT control*. The Level 1 barriers are cross-organizational IT incompatibility and low IT maturity. As mentioned above, lack of internal IT control is a cause of low IT maturity and is therefore categorized as a Level 2 barrier.
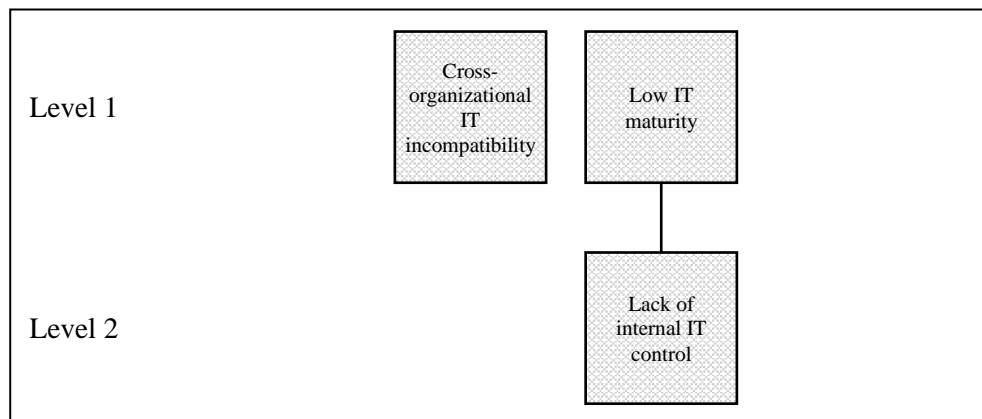

Figure 10. Summary and interdependence of technological barriers.

6.2.5 Data quality

The issue of data quality consists of timeliness and accuracy of information. These problems more or less exist only because of manual handling, which slows down

communication and adds error sources. If all transfer of information were automatic it would be available to the receiver in the same moment as the data is created and the risk of errors would be significantly lower. Considering this, the barrier of data quality is in many ways a sub-problem to the technology barrier. As the IT adoption in the industry continues the problem of data quality will be one aspect of many to consider when designing processes and IT solutions. Although, the importance of data quality will not decrease, rather the other way around. If automated solutions for processing and exchanging information increases and the trust in the information, it becomes even more important that it is correct. If business decisions are made based on incorrect information from the information systems, they might affect the companies negatively and further decrease the trust in technology and information exchange.

The only barrier within the category is timeliness and accuracy of data, which is a Level 1 barrier.

Level 1	Timeliness and accuracy of data
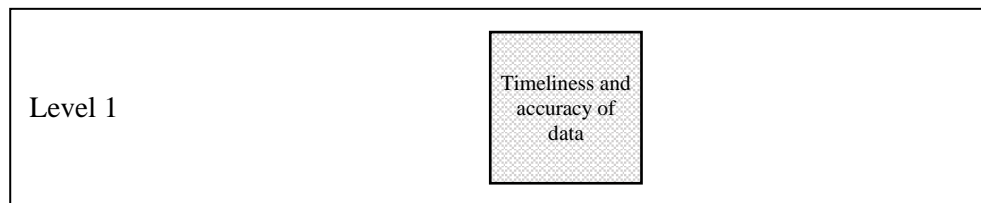
Figure 11. The data quality barrier.

6.3 Ranking of Categories

When examining the barriers on a category level (Section 6.2), it is apparent that there exist hierarchies between the different types of barriers. Some categories can be derived as consequences from others. Thus, identifying which categories of barriers that cause others is necessary for understanding where the deeper issue lies.

Below the categories of barriers are placed in a hierarchy consisting of Level A, Level B and Level C. Level A barriers cannot be derived from other barriers but their impact can be affected by barriers from Level B. The existence of Level B barriers can be derived from Level A barriers. Level B barriers can also affect the impact of Level A barriers. Level C barriers are consequences from Level A and Level B barriers. The idea behind this hierarchy is that if barriers on a higher level were to be mitigated, so would the subsequent barriers.

The barrier regarding data quality is directly caused by the technological barriers, as discussed in Section 6.2.5. Further, the technological barriers; low IT maturity and cross-organizational IT incompatibility, are sub-problems of organizational, incentives and business environment barriers, as discussed in Section 6.2.4.

Incentive barriers are discussed in Section 6.2.3, and it is clear that those barriers are caused by either the business environment or organizational capabilities. The business environment set the terms for incentives and the organizational capabilities define how the organization perceives incentives from the business environment. Therefore, the incentives category is a subordinate to organizational capabilities and business environment. Although, the design of incentives can to some extent affect the business environment as well as the organizational barriers.

The existence of organizational barriers cannot be explained by other categories of barriers. They are derived from the set of resources that the organization possesses, as discussed in Section 6.2.1.

The business environment is made up of all actors in the market and their interrelations. The characteristics of this structure cause the business environment barriers, as discussed in Section 6.2.2.

Organizational and business environment barriers cannot be derived from other barriers, they stand as the last line of categories. A visualization of the hierarchy of the categories of barriers is presented in Figure 12 below.
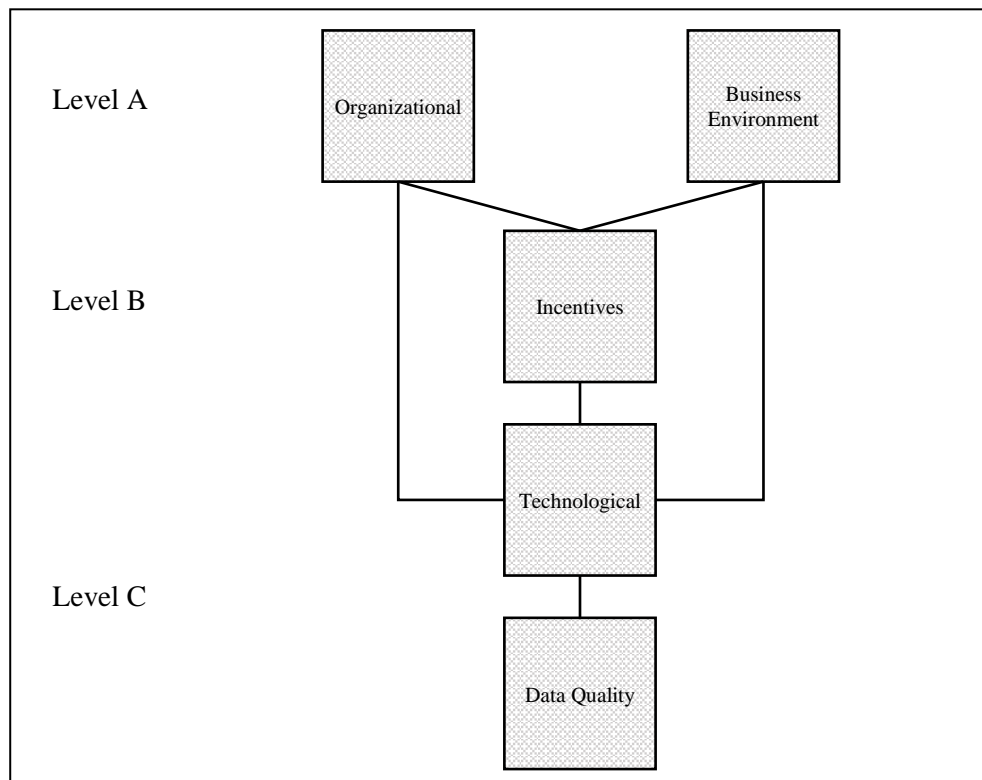
Figure 12. Hierarchy of the categories of barriers. Ranging from most important (Level A) to least important (Level C).

6.4 Interdependencies Between Barriers

Section 6.2 dissects the hierarchy of barriers within each category. Applying the Level 1 barriers from each category to the hierarchy of categories (Figure 12) results in a more detailed figure displaying the interrelations and structure of barriers, see Figure 13.

The lack of capabilities is the root cause of the organizational barriers. An organization lacking capabilities can have difficulties both identifying opportunities and generating leverage from additional information, thus finding little interest in investments with unclear or uncertain returns. Further, the lack of capabilities, both physical and human resources, can contribute to a low IT maturity in an organization. Lack of capabilities is considered a Level A barrier.

The barrier of fragmented information causes difficulties for all actors involved to obtain a holistic view, making it even more difficult for companies to see the potential of information sharing. It can also cause misalignment of incentives between organizations, as companies act on their limited information, stimulating opportunistic behavior and sub-optimization. When several actors possess small parts of the information regarding a transport, many organizations must participate to attain the holistic view. This can be difficult when companies at different levels do not have the same capabilities or interest to support information sharing. Fragmented information is considered a Level A barrier.

The fear of losing business relates to all the incentive barriers, as it drives much of companies' reluctance to information sharing, or change whatsoever. It boils down to a lack of belief that the change will impact companies positively. Fear of losing business is considered a Level A barrier.

Antitrust regulations do not cause or impact other barriers explicitly, but they create boundaries that information sharing initiatives must reconcile with. Antitrust regulations is considered a Level A barrier.

The three incentive barriers are all driven from the business environment and organizational capabilities, but the relation is not completely one-sided. Intangible returns, misaligned incentives and lack of customer pressure all enhance companies' fear of losing business. Further, the incentive barriers impact organizations' willingness to allocate resources to information sharing initiatives, as well as interests in technological investments. The three incentive barriers are all considered Level B barriers.

How the Level A and Level B barriers causes the barriers of low IT maturity and incompatibility between information systems has been discussed in Section 6.2.4. The two barriers do not have a significant influence on the barriers above them. They do however cause the issues of data quality, since manual handling and incompatibility create many touchpoints where errors and delays can occur which is discussed in Section 6.2.5.

To conclude, the Level A barriers are the root cause barriers. The Level B barriers are not root cause barriers but they are of great importance since they have influence on barriers on Level A as well as Level C. The Level C barriers are not considered as important because they are not influencing the barriers on the higher levels. It is thus found that the barriers; *lack of capabilities; fragmented information; fear of losing business;* and *antitrust regulations* are the root causes for the other barriers. However, the barriers; *intangible returns; misaligned incentives;* and *lack of customer pressure* are also important. Efforts to increase information sharing in the rail freight industry should first-hand consider these seven barriers to achieve significant results.
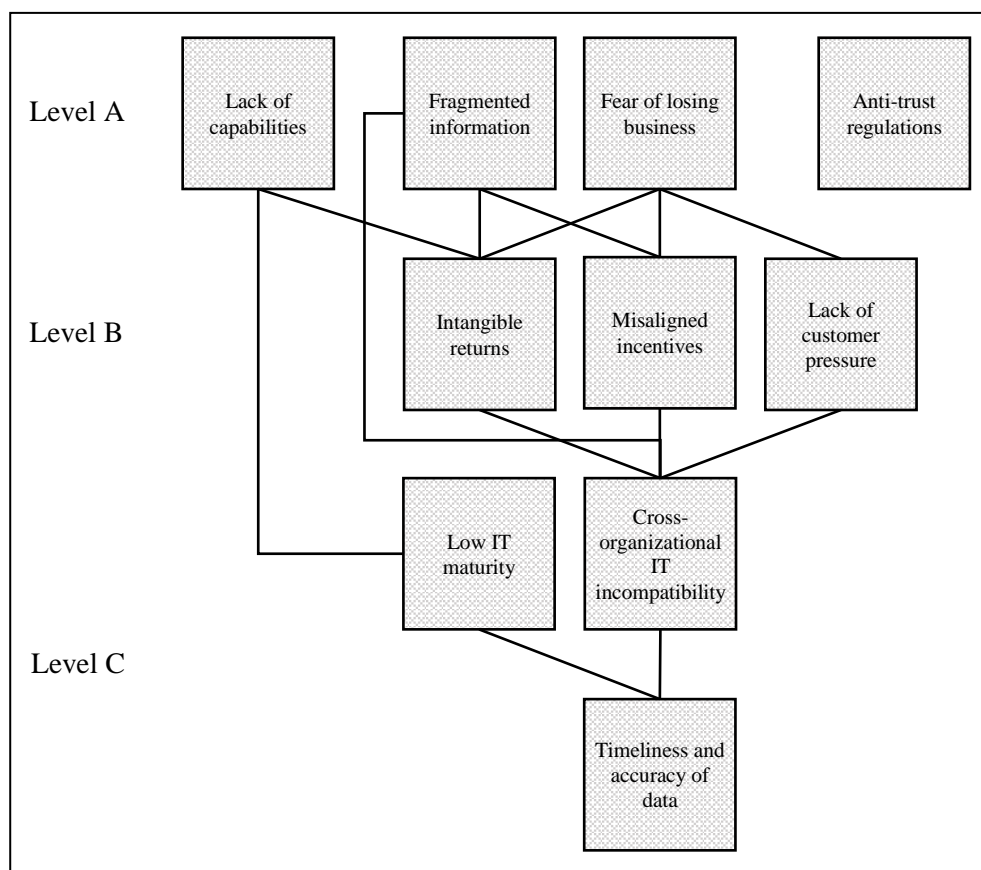
Figure 13. Hierarchy of Level 1 barriers from Section 6.2. Ranging from most important (Level A) to least important (Level C).

6.5 Mitigation Strategies

To design strategies for mitigation of the most significant barriers, this section combines findings from the previous section with theory from the frame of reference and the analytical framework. Further, it involves the identified opportunities from Chapter 5 as well as additional theory to support and expand the strategies.

6.5.1 **Clarify**

6.5.1.1 Confidential Information

The general attitude in the industry is to rather conceal information than sharing it, because of the fear of losing competitive advantage. At the same time, it is suggested that the secrecy of information is overrated. A clarification of what information that really is secret and why would help the industry to move forward. The possibility of masking information prior to sharing in order to resolve confidentiality issues, without losing the value of the information, should also be investigated.

6.5.1.2 Antitrust Regulations

Antitrust regulations can stop companies from sharing information that promotes collusive behavior in the market. The uncertainty of what is allowed and not allowed to share in the rail freight industry constitutes a barrier to information sharing.

Any efforts for increased information sharing must respect the boundaries that antitrust regulations set. Although, in this case, the barrier is not the actual regulations, it is the confusion around what is allowed and what is not. This barrier is mitigated through clarifying how information sharing can be conducted without interfering with regulations. When it is clear what information the industry actors possibly could share among them, this needs to be analyzed from a legal point of view. This clarification of how the regulations apply to the rail freight industry can then be used when moving forward.

6.5.2 **Prove Potential**

Intangible returns of information sharing are making companies hesitant whether to invest in it. The risk is considered too high and the returns are considered unsure. To promote investments in information sharing, examples of clear, measurable returns must be proven. This can be done in many ways.

To search for existing comparable cases where information sharing is used is one way. This case may be the rail freight industry in another country or another industry with similar prerequisites as the Swedish rail freight industry.

Pilot projects can be conducted, which will contribute with information both on how the information sharing could be done and the results from it. It is important to be open for both positive and negative outcomes, as the focus is at finding out if and how information sharing can be useful.

Forums where the industry actors are brought together to discuss the issues are useful for creating natural interactions. They create opportunities for exchanging experiences and ideas which can lead to initiation of collaboration projects. In these forums, it is also suitable to discuss the outcomes from case studies and pilot projects to spread knowledge. The overall idea of creating discussion forums is to overarch organizational siloes and promote the systems thinking. A more holistic mindset will make it easier to realize the value of intangible returns.

6.5.3 Create Burning Platform

To successfully drive changes in an organization, a sense of urgency is needed (Kotter, 1998). Implementing an industry-wide information sharing process in the rail freight industry will require change efforts from all industry actors. To increase the participation rate in this kind of project, it is important that there exist both company specific and industry-wide incentives. There must exist a feeling of urgency to move forward, a burning platform. The empirics suggest two types of incentives that affect the whole industry, namely customer pressure and regulations or economic incentives.

6.5.3.1 Customer Pressure

The buyers of transportation services have the power to request improvements that are related to information sharing but they need to see the benefits as well. Some transport buyers see clear benefits as discussed in section 5.3.2 and 6.2.3 but an increased awareness is needed among many transport buyers to affect the entire transport sector including the rail freight industry.

Transport buyers need to be aware of what implications the transportation services have for their business. They need to see the connections between what they ask for when purchasing transportation, and the transport price, delivery time, environmental impact, etc. The customers of the transportation buyers also have an important role to play since their expectations will spread upstream.

The long-term perspective and the willingness to accept risks when implementing changes also need to be present among the customers.

A wide range of companies is purchasing transportation services where rail freight is used. To approach all of these simultaneously is probably not an efficient strategy. A more feasible strategy is to include a few strategic transport buyers in industry-wide collaboration projects such as research studies, pilot projects, discussion forums, etc.

The consumers are difficult to target with these relatively complex implications. Although, opinions and trends, e.g. care for the environment, can be used to put pressure on market actors.

6.5.3.2 Regulations and Economic Incentives

Regulations and economic incentives force a sense of urgency over the industry and probably stimulate changes. However, potential side effects must be carefully considered.

6.5.4 Create Favorable Conditions

6.5.4.1 Internal Conditions

To cope with the lack of capabilities, creating favorable conditions must be pursued internally in organizations. Fawcett *et al.* (2007) lists five bridges for companies to obtain *"world-class information sharing capabilities"*;

- **Maintain a balanced perspective.** Technology should enhance managerial decision making, not replace it.
- **Avoid technology traps.** Companies often buy technology for the wrong reason.
- **Match technologies to specific value-added capabilities**
- **Understand the 3Ps of technology implementation.** Processes, Performance measures, People.
- **Invest proactively in a culture of willingness**

These bridges are to mitigate the organizations' lack of capabilities. Companies that can leverage information sharing practices to their advantage will find opportunities in their own operations as well as towards their customers.

6.5.4.2 External Conditions

To decrease the number of touchpoints for each organization and to connect many actors, a multilateral configuration of information sharing is proposed. Such a configuration requires a monolithic data platform which all actors can exchange information through. This is an approach that has been used before in other settings. However, there are difficulties involved with uniting everyone around one platform, such as competition and agreeing on standards.

A commonly proposed strategy from the empirics is that STA should provide the data platform, as it is a trusted and neutral party which many industry actors already exchange information with. Further, STA can develop common standards for the information sharing in terms of frequency, direction, modality and content.

Boudreau and Hagiu (2009) discusses several cases with multi-sided platforms, and concludes that platforms can serve as governing mechanisms of a market. By

77

employing legal, technological, informational, and other instruments, the platform can be used to *"minimize costs associated with a range of externalities, complexity, uncertainty, asymmetric information and coordination problems the multi-sided platform was in a position to address".* Strategies for developing a platform will have to be further researched.

A platform solution like this addresses the barrier of fragmented information and does not risk displaying confidential information if the information can be masked. Thus, it also mitigates the short-term risk of losing business to competitors.

6.5.5 Turn Around Fear

Fear of losing business is identified as one of the most important barriers to information sharing. The risk of losing competitive advantage is considered bigger than the potential returns. In the end, all mitigation strategies seek to challenge this balance and turn it around.

The strategies *Clarify* and *Prove potential* can be said to even out the balance between risk and gains. Some uncertainties are straightened out and small scale projects investigate and present the potential of information sharing for the industry. To further shift the balance the strategies *Create a burning platform* and *Create favorable conditions* suggests more incentives and measures to affect conditions both internally and externally. Other actions that either diminish the risk or creating more incentives to conduct information sharing will further facilitate the transformation.

The desired state is a situation where the fear of losing business has changed sides. Companies should feel that participating in information sharing is increasing their competitiveness. Not participating should be concerned a competitive disadvantage. The information sharing has then become an important part of satisfying customer needs and staying effective and efficient as an actor in the rail freight industry.

7 Conclusions

This chapter summarizes the main finding from this study. The research questions are answered, the contributions to theory presented and suggestions for future research are made.

7.1 Findings and Contributions

The study explores barriers to information sharing through theoretical research and empirical research. Through a literature review the authors develop an analytical framework for categorizing barriers. Five categories of barriers are proposed; *Organizational, Business Environment, Incentives, Technological* and *Data Quality*. Within these categories, sixteen barriers, commonly stated in theory, are identified.

Through thirteen in-depth interviews with a wide range of actors in the Swedish rail freight industry, barriers to information sharing specific for this certain industry are identified. Answering RQ1, nineteen barriers are found and categorized according to the analytical framework. The barriers are presented in Table 15 below.

Table 15. Identified barriers to information sharing in the Swedish rail freight industry.

Category of barrier	Barrier
Organizational	Lack of financial resources
	Reluctance to change
	Poor internal processes
	Lack of capabilities
Business Environment	Fear of losing business
	Fragmented information
	Short-term partnership commitment
	Policy towards collaboration
	Confidential customer data
	Antitrust regulations
	Ownership of data platform

Category of barrier	Barrier
Incentives	Intangible returns
	Misaligned incentives
	Lack of customer pressure
	Exaggerated price focus
Technological	Cross-organizational IT incompatibility
	Low IT maturity
	Lack of internal IT control
Data Quality	Timeliness and accuracy of data

Through analysis exploring the interrelations between all barriers, it is found that the barriers; *lack of capabilities; fragmented information; fear of losing business;* and *antitrust regulations* are the root causes for the other barriers. However, the barriers; *intangible returns; misaligned incentives;* and *lack of customer pressure* enhance the barriers above, while also causing other barriers. Efforts to increase information sharing in the rail freight industry should first-hand consider these seven barriers to achieve significant results.

With the root cause barriers in mind, strategies for facilitating increased information sharing in the rail freight industry are developed.

- **Clarify** what information that is confidential and investigate if masking of this data can enable it to be shared. Clarify how antitrust regulations apply to the rail freight industry and its implications on information sharing.
- **Prove potential** in information sharing. Conducting research, pilot projects, discussion forums in order to find opportunities for collaboration and concretize intangible returns from information sharing.
- **Create burning platform** for change. Through increased customer pressure and possible regulations and economic incentives the industry will experience a need to change, facilitating the implementation of information sharing practices.
- **Create favorable conditions,** both internally and externally. Develop organizational capabilities to leverage an increased access to information. Create a common data platform to enable multilateral information sharing.
- **Turn around fear** of losing business due to participating in information sharing into fear of losing business due to not participating in information sharing.

The study's contribution to literature and practice are;

- Development of an analytical framework through compiling and categorizing barriers to information sharing commonly stated in the literature.

- Exploration of existing barriers to information sharing in the Swedish rail freight industry.
- Formulation of strategies to mitigate barriers to information sharing in the Swedish rail freight industry.

7.2 Limitations and Suggestions for Future Research

The limited number of interview objects and the limited number of interview rounds are affecting the validity of the findings. Future research can seek to validate findings through conducting more interviews, making observations or case studies. Interviews can be conducted with the same population as in this study in order to confirm and elaborate on the results, or with another population to involve additional aspects in the empirics. New empirical data can confirm or challenge the findings and provide a more solid foundation for further analysis. The findings are based on interpretations of the empirics and theory. These interpretations are not unambiguous and can therefore be challenged.

Moreover, the mitigation strategies can be further explored. The area of confidential data and antitrust regulations must be investigated. Potential applications for information sharing, such as utilizing spare capacity, in the rail freight industry and their benefits should be analyzed. For each potential application it is needed to be more specific on what type of information that has to be shared, as this study only takes a general view on information sharing. Drivers for conducting information sharing and technological and organizational prerequisites needed can also be further explored. An interesting approach would be to benchmark the Swedish rail freight industry against its counterparts in other countries or other relevant industries.

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Appendix A Interview Guide

The following interview guide is used during all in-depth interviews. All interviews were carried out in Swedish. Below is the English translation as well as the Swedish original.

Introduction to the project

- Purpose
- Research questions
- About the authors

Module 1 – General information about the interviewee

English

- Name
- Company
- Role
- Job assignments
- Professional background

Swedish

- *Namn*
- *Företag*
- *Tjänst*
- *Arbetsuppgifter*
- *Yrkesmässig bakgrund*

Module 2 – About the company

English

- What role does the company have in the transport system?
- What are your main customer offers?
    - What do you get paid for? How do you get paid?
- Relations to other industry actors in rail freight/intermodal freight
    - Partners?

- o What types of contracts are typically used towards suppliers and customers?
- What customer segments are you facing?
  - o What characteristics do your average customer have?
  - o How do your customers develop to the business development?

Swedish

- Vilken roll har ni i transportsystemet?
- Vilka är era främsta kunderbjudanden?
  - o Vad tar ni betalt för? Hur tar ni betalt?
- Relationer till branschaktörer inom järnväg/intermodal
  - o Samarbetspartners?
  - o Vilka typer av avtal används typiskt mot kunder/leverantörer?
- Vilka kundsegment vänder ni er mot?
  - o Hur ser er genomsnittliga kund ut?
  - o Hur bidrar era kunder till utvecklingen av er verksamhet?

Module 3 – Information sharing

English

- What information about a rail transport are you interested in?
- What of this information are you generating internally?
- What of this information is shared with other actors?
  - o How and when is it shared?
- What information do you receive from other actors?
  - o How and when do you receive it?
- Do you experience increased expectations to exchange more information?
  - o If yes, from who?
- Do you see advantages in sharing more information about a transport?
- Do you see advantages of receiving more information about a transport?

Swedish

- *Vilken information är önskvärd för er att inneha kring en järnvägstransport?*
- *Vilken av denna information genererar ni internt?*
- *Vilken av er information delas med andra aktörer?*
  - o *Hur och när delas den?*
- *Vilken information erhåller ni från andra aktörer?*
  - o *Hur och när får ni den?*
- *Upplever ni att det ställs krav på att ni ska utbyta mer information? Om ja, från vilket håll?*

- *Ser ni fördelar i att dela mer information om transporten?*
- *Ser ni fördelar i att ta emot mer information?*

Module 4 – Barriers to information sharing

English

- Is there anything hindering you from sharing information about a transport more openly?
  - If yes, what?
- Is there anything hindering you from receiving more information than today?
  - Internal barriers?
  - Barriers at other actors'? Both horizontal and vertically.
- Do you have any ideas how these barriers can be mitigated?

Swedish

- *Finns det något som hindrar er att dela information om en transport mer öppet?*
  - *Om så - vad för typ av hinder?*
- *Finns det något som hindrar er att ta emot mer information än idag?*
  - *Hinder internt hos er?*
  - *Hinder från andra aktörer? Både horisontellt och vertikalt.*
- *Har du några idéer för hur dessa hinder kan överkommas?*