

THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

# **DRY PORTS – RESEARCH OUTCOMES AND APPLICATIONS**

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Gothenburg, Sweden 2019

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Licentiate Thesis Report No. L2019:116

ISSN 1654-9732.

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Printed by Chalmers Reproservice  
Gothenburg, Sweden 2019

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ALENA KHASLAVSKAYA

## Abstract

Functional seaport's hinterland transport system may benefit multiple stakeholders, i.e., seaports, transport operators, shippers, regions; however, expectations and benefits vary. Well-developed seaport's hinterland transport system serves to increase seaport's competitiveness; to improve accessibility of the hinterland regions; to enhance economic and environmental indicators of transport operators and shippers. As means of hinterland transport system development in past decade, a dry port concept has attracted attention among academics and practitioners. The concept represents an intermodal terminal located in the seaport's hinterland, directly connected to the seaport by rail, where the shippers can pick up/leave their standardized units as if directly at the seaport. Considering multi stakeholder environment of dry ports operations, this thesis attempts to advance knowledge on dry ports' benefits for the stakeholders and ability of the dry ports to generate the same, by both focusing on benefits for a bigger system (supply chain) and also by taking perspective of each individual stakeholder. Several types of dry ports varying in services provided are analyzed to study their ability to generate the benefits for stakeholders and hence to help them to meet their various objectives (Multi-Actor Multi-Criteria Analysis). By combining findings from a Systematic Literature Review and empirical evidences from the stakeholders involved in dry port operations in Sweden, the thesis aims to identify dry ports' benefits for the stakeholders in a seaport's hinterland transport system in order to increase understanding about the dry ports' role in that system.

The thesis is built upon three studies: Systematic Literature Review, interview based case study and personal interview survey study. The systematic literature review on dry ports-related research serves as a basis for the further studies and the thesis itself and summarizes all potential benefits of various dry ports. Interview based case study reveals the country-specific insights and a broad (supply chain) perspective on the studied issues. In turn, interview survey study takes into consideration multiple stakeholders' objectives and studies dry ports ability to contribute to achieving those (or generate respective benefits).

The results revert in identification of potential benefits of dry port derived from the academic literature (classified into economic, environmental and performance-related) as well as benefits identified empirically for the stakeholders relevant to the Swedish context (in addition to the literature finding: benefits classified under responsiveness, resilience, security and innovativeness). Results also show that the identified stakeholders experience gradual improvement of their objectives (hence gaining benefits generated by the dry ports) with advancement of the dry ports' configuration. Experts' evaluation validates the findings, although is more "restrained" than the stakeholders' one.

The thesis contributes to the field of intermodal transport with focus on dry ports in seaports' hinterland transport system by summarizing already existing knowledge and by providing insights into country-specific context (Sweden). The results may also have managerial implications in form of information support for the stakeholders' decision-making processes regarding seaport's hinterland transport business as well as for related policy making processes.

**Key words:** Dry port concept, intermodal transport, Multi-Actor Multi-Criteria Analysis, potential and actual benefits, seaport's hinterland transport system, services, stakeholders, supply chain outcomes



# List of appended papers

## Paper I

Khaslavskaya, A., Roso, V. (2019), "Dry Ports: Research Outcomes, Trends, and Future Implications".

*Submitted to an international journal.*

*An earlier version of the paper with the title "Dry Ports – Systematic Literature Review" was peer-reviewed, presented and published in the proceedings of the 30th Annual Nordic Logistics Research Network Conference (NOFOMA), 14-15 June 2018, Kolding, Denmark.*

*The conceptualization, analysis and writing were equally shared among the authors. The first author was responsible for metadata collection and presentation / description.*

## Paper II

Khaslavskaya, A., Roso, V. (2019), "Outcome-Driven Supply Chain Perspective on Dry Ports", Sustainability, 11(5), p.1492.

*An earlier version of the paper with the title "Dry Port Integration into a Supply Chain: Outcome-Driven Supply Chain Perspective" was peer-reviewed, presented and published in the proceedings of the 15th World Conference on Transport Research (WCTR), 26-31 May 2019, Mumbai, India.*

*The first author took the lead role and was responsible for data coding. Data collection, analysis, and writing were equally shared among the authors*

## Paper III

Khaslavskaya, A., Roso, V., Sanchez-Dias, I. (2019), "Multi-Actor Multi-Criteria Analysis of Services at Dry Ports in Sweden".

*Work in progress paper to be submitted to an international journal.*

*An earlier version of the paper with the title "Swedish Dry Ports' Services" was peer-reviewed, presented, and published in the proceedings of the International Conference of Maritime Science & Technology NAŠE MORE, 17-18 October 2019, Dubrovnik, Croatia.*

*The first author was responsible for a major part of data collection and wrote method chapter. Second author contributed to data collection. Analysis and writing were equally shared among the first and second author. The third author was involved in planning and application of the method.*



## Acknowledgements

To all my colleagues who truly became my family at work, for all the fun discussions, encouraging words and “vacant ears” when it especially was needed. With most of you I have shared some special moments and have some special memories (this is a good moment to remember something special that we share).

To my fellow PhD colleagues, for all the advice from your best knowledge, care, and conversations about tough fate of pursuing our PhDs.

To my favorite colleague from “other side” (from across the bridge) who became my closest friend from the very first days.

To my management team, for always finding a good solution and a kind word.

To my family spread across countries, for the unbelievable support, love, understanding, trust and *patience*, and for letting me follow my heart and go my way.

And to Violeta, who has always been there for me to educate, guide, argue, remind, cheer up, help out, repeat, wonder, laugh, doubt, have fun, chat, share secrets, encourage, inspire, appreciate, sympathize, share tea and chocolate, let my ideas shine and fail, to set and to postpone deadlines, ... well, you have been far beyond just a supervisor. Thanks to you and together with you my work has never been a duty, but always a great fun!

*Alyona*

*Gothenburg / Helsinki, October 2019*



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# Terminology

## **Dry port**

an inland intermodal terminal directly connected to seaport(s) with high capacity transport mean(s), where customers can leave/pick up their standardized units as if directly to a seaport (Roso et al., 2009)

## **Intermodal transport**

movement of goods in one and the same loading unit or road vehicle, which uses successively two or more traffic modes without handling the goods themselves in changing modes (European Commission, 2001)

## **Hinterland**

the interior region served by the port (van Klink and van den Berg, 1998)

## **Stakeholders**

people/company who/which “has an interest, financial or otherwise, in the consequences of any decision taken” (Macharis et al., 2009; Macharis & Baudry, 2018);

“stakeholders” and “actors” are used in the thesis interchangeably

## **Supply Chain Outcomes**

benefits from a supply chain (Melnyk et al., 2010)

## **Benefit**

an advantage or profit gained from something;

in the thesis: a gain in any manner potentially or actually obtained due to interaction with a dry port

## **Utility**

the state of being useful, profitable, or beneficial;

in the thesis: usefulness of a dry port due to services provided



# 1 Introduction

Chapter present the introduction of the thesis, first describing its background, then a purpose, research questions, research scope, and finally the outline of the thesis.

## 1.1 Background

Global container trade that has grown significantly in the last decades – “Over 80 per cent of global trade by volume and more than 70 per cent of its value being carried on board ships and handled by seaports worldwide” (UNCTAD, 2017) – increased demand on all actors of the transport chain to meet this growth. As the consequence, on one hand, the maritime part of the intermodal transport chain now employs larger ships to cope with this demand, the latest vessels on order reach 20,000 TEU to fully utilize the economies of scale (Notteboom and Rodrigue, 2017). On the other hand, seaports are facing challenges related to terminal capacity, fairway drafts, equipment to handle those vessels and in particular challenges related to their inland access (J. Jeevan et al., 2015). In general, increase in the sea flow generates almost proportional increase in the inland flow (Parola and Sciomachen, 2005), and efficiency in the hinterland part of the transport chains has not followed the progress at the sea. Significant amount of research has been done on discovering and trying to find solutions for the challenges of matching sea and hinterland transportation systems. To help resolve these challenges, research has investigated possibilities to both improve seaport operations and seaport development (e.g., Paixão & Bernard Marlow, 2003), as well as to improve the hinterland transportation system (Notteboom and Rodrigue, 2017).

Despite seaport development in the form of, e.g., physical expansion, rethinking seaport and container yard management, and capacity increase (e.g., Korovyakovsky & Panova, 2011; Flämig & Hesse, 2011), larger flows of containers severely strain seaports; therefore, progress in hinterland operations must match. Thus, effective solutions to connect and expand seaports inland and develop matching hinterland transportation and logistics are in demand by practitioners, and also, in focus for academic research (Witte et al., 2019).

The research addressing the issue of hinterland transportation has gained importance in recent years (Witte et al., 2019). It has often been discussed in the context of development of inland intermodal facilities (ibid); in particular, on hinterland infrastructure development that enhances seaport performance, and among others on dry ports (e.g., Roso, 2008; Chen et al., 2016; Fanti et al., 2015; Mirzabeiki et al., 2016; Notteboom & Yang, 2017). A dry port “*is an inland intermodal terminal directly connected to a seaport, with high-capacity traffic modes, preferably rail, where customers can leave and/or collect their goods in intermodal loading units, as if directly to the seaport*” (Roso et al., 2009). Several questions in these regards have been raised by academics. For example, influence of hinterland terminal facilities on seaports’ strategies (e.g., Monios, 2011); efficiency of hinterland terminals and their ability to support growing seaports’ capacity (e.g., J. Jeevan et al., 2015; Jeevan et al., 2019); and cooperation issues between seaports and dry ports (Li & Jiang, 2014). As such, the research on dry ports has branched out into several directions.

A significant part of the research field focuses on single or several cases of dry ports (e.g., Alam, 2016; Flämig & Hesse, 2011) or, to take a dyad perspective focusing on dry ports and seaport engagement (e.g., Bask et al., 2014; Bentaleb et al., 2015). A dry port phenomenon is an element that functions in a complex transport system, engaging multiple actors, and should be studied in the setting of a network covering not only seaports, but also hinterland actors and even those operating in the foreland of the seaport. It is incorrect to say that this approach has not at all been taken by the researchers in the research community: the research has, in contrast, identified several issues of dry ports acting as a part of the multi-actor environment. However, in line with successful examples of dry ports’ implementation (Monios, 2011), some dry ports are seen as competitors to the seaports (Black et al., 2018); others experience implementation or development issues caused by a series of reasons, including failure to meet the actors’ expectations (Roso, 2008); while the third ones lack shippers with sufficient volumes

to stay competitive and hence remain underutilized (Ng & Gujar, 2009). In addition, the development of dry ports undergoes dissimilar paths and the dry ports themselves are shaped differently, depending on several parameters. According to Nguyen and Notteboom (2019), dry ports appear in different configurations due to the direction of development, characteristics of the seaports they serve, modality of the connection, among other reasons. Dry ports may also serve different purposes depending on geographic characteristics and economic development of their location, e.g., to serve primarily as custom clearance inland points as, e.g., in India (e.g., Ng & Gujar, 2009), to enhance regional development by attracting investments and new business to the area as, e.g., in Iran (e.g., Dadvar et al., 2011) or to contribute to decongestion of the seaports and seaports cities as e.g., in New Zealand and Australia (e.g., Roso, 2008).

In Sweden, following the growth of the Port of Gothenburg, a number of actors, i.e., rail operators, seaport, municipality, and shippers, have been involved in implementation and development of efficient and matching to the seaport's growth hinterland transport network. There have been several studies published on dry ports in Sweden. Roso (as a single author but also with co-authors) has addressed multiple questions, e.g., the concept definition (Roso et al., 2009), environmental considerations (Roso, 2007), and industry perspective on dry ports (Roso, 2009). Roso et al. (2015) compared dry port services in cases in Australia, the US, and in Sweden; and Roso and Rosa (2012) made comparison of cases from Italy, Spain, and Sweden. Bask et al. (2014) compared the preconditions of dry port development in Sweden and Finland; meanwhile, Bergqvist et al. (2010) researched what it takes to establish an intermodal terminal in Sweden. Still, despite an exceptional network of dry ports (only Port of Gothenburg has a network of 26 inland terminals connected by railway (Port of Gothenburg, 2019)), there has not been a recent attempt to study the whole network of these dry ports together with other relevant stakeholders, context (Sweden), and by taking the multiple-actors' perspective. The last identified attempt is dated back by ten years, when Roso (2009) compared inland terminal facilities in Sweden against the academic understanding of dry ports, and the results showed that only two facilities were recognized as dry ports. However, now, 10 years later, the facilities have changed and developed as well as new players have appeared that both influence and are influenced by these inland facilities.

## **1.2 Purpose and research questions**

Given the results of the academic research introduced above, it can be noted that dry ports have great potential to contribute to multiple objectives of a number of hinterland and foreland actors operating through seaports. At the same time, the research on dry ports has identified various benefits that dry ports may generate for different actors in the transport system, e.g., lower environmental impact or better service for the customers inland, hence to help them meet their various objectives, e.g., lower transport cost or better image (e.g., Jeevan et al., 2017; Lättilä et al., 2013; Roso & Lumsden, 2010). At the same time, the dry ports configurations (or types) vary in functions (services) and other characteristics and, thus, vary in the benefits that may be gained through interaction with them. In addition, given that Sweden has a wide network of dry ports and at the same time scarce research on the subject, especially on the variety of the types of dry ports, there is a need and an opportunity to contribute to the research on dry ports' benefits and their ability to generate the same. Therefore, the purpose of the thesis is:

**to identify dry ports' benefits for the stakeholders in a seaport's hinterland transport system in order to increase understanding about the dry ports' role in that system.**

Meeting this purpose will allow to better understand dry ports' usefulness in the given context (Sweden) and how it can be translated into actual benefits for the stakeholders, thus to increase understanding of the stakeholders and further to support their decision-making on development and utilization of existing dry ports in an optimal way. These results may be of use for the stakeholders as well as to support policymaking.

To further explain the purpose:

1. Benefits for the stakeholders refer to a gain in any manner that the stakeholders want and are able to, potentially or actually, obtain due to interaction with a dry port; it appears in an interaction of an object (dry ports) and a receiver of it (a stakeholder or a system (supply chain));
2. Stakeholders are defined as people/company who/which “has an interest, financial or otherwise, in the consequences of any decision taken” (Macharis et al., 2009; Macharis and Baudry, 2018); the list of the stakeholders varies among the studies included in the thesis, however, finally includes the seaport (Port of Gothenburg), dry ports (operators), transport operators (rail, road and shipping lines) and the shippers;
3. Seaport’s hinterland transport system – transport system in the interior region served by the port (based on Van Klink and van Den Berg, 1998);
4. Given context refers to the fact that the empirical evidences for the studies are collected from dry ports operating in Sweden and connected by rail to the Port of Gothenburg. Given that all the dry ports are unique due to features of the environment where they operate, extrapolation of the research results requires additional research and considerations.

To meet the research purpose, two research questions (RQ) were formulated.

The first RQ was formulated to identify dry ports’ *potential* benefits, i.e., those generated from the literature:

**RQ1:** What are the potential benefits that dry ports generate for stakeholders in the seaport’s hinterland transport system?

The second RQ is formulated to place dry ports in the context, to identify actual benefits as perceived by the stakeholders and hence the ability of dry ports to generate the same:

**RQ2:** What are the actual benefits that dry ports generate for stakeholders in the seaport’s hinterland transport system?

It implies identification of stakeholders relevant to the given context, the benefits that they want and are able to obtain due to interaction with a dry port, and dry ports’ ability to generate the same.

During the research process, the following issues were studied:

1. Dry port concept:
  - a. Definition of the concept;
  - b. Dry port taxonomies;
  - c. Benefits related to dry ports;
  - d. Services available at dry ports;
  - e. Development features of dry ports:
    - i. Conclusions from a global sample;
    - ii. Country-specific development features;
2. Stakeholders involved in dry ports operations in Sweden;
3. Supply chain perspective on dry ports.

By studying the listed issues, it was possible to answer the RQs and hence to meet the research purpose.

### 1.3 Research scope

The research started by analyzing secondary sources (academic literature, Study 1) and continued by collecting and analyzing empirical data (Study 2 and Study 3). In other words, the research has gone from the very generic stage (Study 1) that allowed for getting to know the research field, research directions, trends, and community, and make first steps toward meeting the research purpose; to a more narrow and in-depth perspective, involving a case study of one particular Swedish dry port, the Skaraborg dry port (Study 2); and wider still, to a broad perspective on dry ports in Sweden (Study 3) (Figure 1).

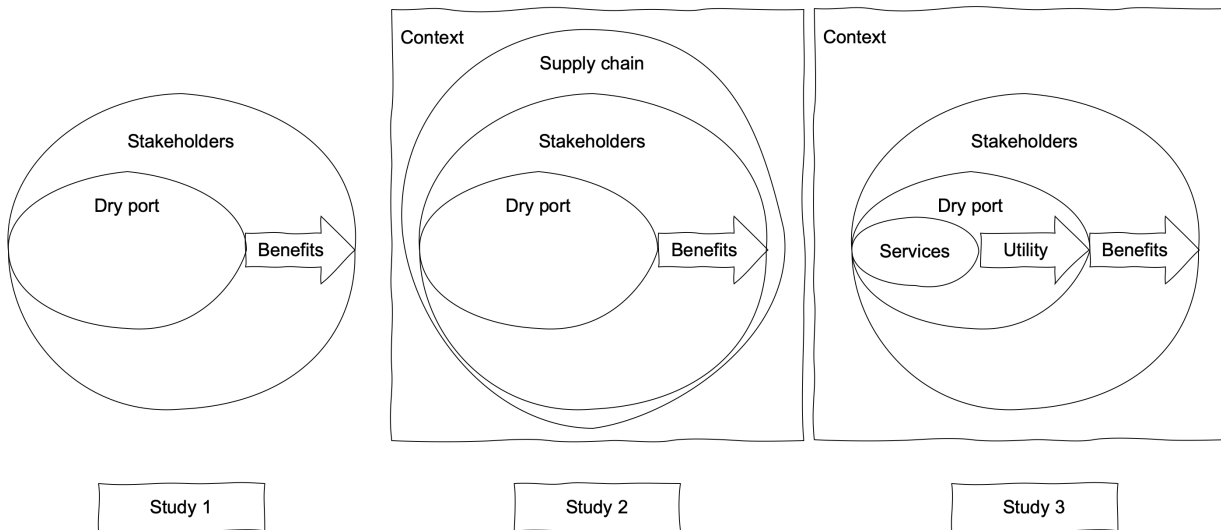


Figure 1. Research scope of the studies

Figure 1 shows building blocks of every study included in the thesis. Study 1, as it is shown, covers broadly benefits generated by the dry ports to the stakeholders. Study 2 takes a perspective of a supply chain and adds a specific context (Sweden) to the picture; the evidences are collected empirically. Study 3, in contract to the Study 2, takes a perspective of each individual stakeholder in the same context (Sweden) and looks “inside” the dry ports, on how their configuration (amount and types of services) affects dry ports’ ability to generate benefits (help the stakeholders to achieve their objectives).

The research is positioned based on Van de Ven (2007) (Table 1). Foreground (or focus), background, level and scope are identified for each study and for the thesis altogether where possible.

Table 1. Research scope

Aspect	Study 1	Study 2	Study 3
<b>Foreground (focal area)</b>	Dry ports’ benefits		
<b>Background (context)</b>	Global examples	Given context (Sweden), relevant stakeholders	
<b>Level</b>	Seaport’s hinterland transport system		
	-	Supply Chain	Service level

<b>Scope</b>	All identified, peer-reviewed, relevant academic publications	Dry port and transport operators, dry port owners, municipalities, seaports, shippers	
		In addition: consultant, potential shipper	In addition: shipping lines

---

Throughout the whole research, the benefits of dry ports remained in focus (foreground); they were studied from several perspectives. Study 1 generated the list of potential benefits by extracting information from the secondary sources covering examples from around the globe recorded in the peer-reviewed scientific publications (background). Study 2 and Study 3 had the same context of Sweden and focused on the similar list of stakeholders (background). As for level of the studies – focus on the dry ports – it remained the same, the seaports’ hinterland transport system, as this is where the dry ports belong to. More particularly, Study 2 took broader perspective and looked “outside” of the dry ports (supply chain) while the Study 3 looked “inside” the same (services). The scope of the studies in regard to the thesis can be defined by the stakeholders considered, and the list of them remained similar throughout the studies (with less details in Study 1 and with only small modifications in Study 2 and Study 3) (Table 1).

## 1.4 Outline of thesis

The thesis consists of seven chapters.

Chapter 1 introduces the research topic and its importance; it also contains research purpose, research questions and research scope. Chapter 2 is dedicated to the frame of reference of the current thesis. It presents the issues studied during the research process, i.e., dry port concept, taxonomies and services, benefits, development features (including country-specific development features), but also supply chain perspective and a dry port’s role in the supply chain. Chapter 3 presents the research design of the included studies with particular focus on methods, data collection, and data analysis choices per each study; it also separately discusses the research quality of the included studies. The research question formulated for each particular study included in the thesis can be found in the same chapter, as well. Chapter 4 contains the summary of the appended papers; it briefly summarizes the papers; the full versions of which can be found at the end of the current thesis. Chapter 5 is dedicated to the presentation of the research results; the results are presented as per research question with a brief summary of all of the research contributions and emphasis on what is most relevant to the research purpose of the current thesis. Chapter 6 is the discussion of the results of the papers included in the current thesis, with one against the other and against academic literature on dry ports. Chapter 7 contains concluding remarks of the current thesis and indicates possible ways to continue the research.



## 2 Frame of reference

Frame of reference presents the issues that have been studied during the research process (see more details in the subchapter 1.2). The main focus in this chapter is the dry port concept (definition, taxonomies, benefits, services, development features). Perspectives that are covered in the studies are also introduced.

### 2.1 Dry port concept

#### 2.1.1 Definition of the concept

A dry port “is an inland intermodal terminal directly connected to a seaport, with high-capacity traffic modes, preferably rail, where customers can leave and/or collect their goods in intermodal loading units, as if directly to the seaport” (Roso et al., 2009). This definition is used as a reference in this research as it is commonly cited in academic papers and provides a unique definition of the concept. Figure 2 depicts the concept (from Roso et al., 2009).

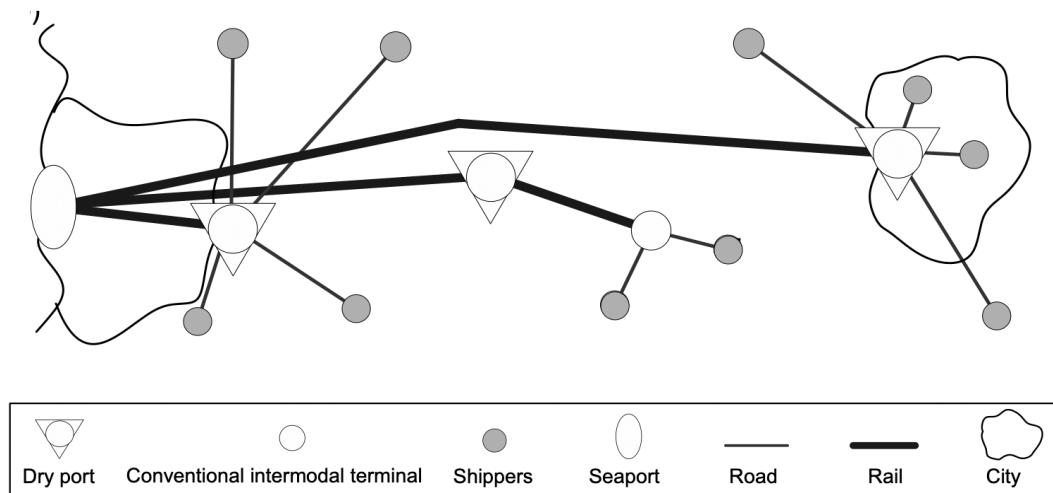


Figure 2. Dry port concept (from Roso et al., 2009)

However, there are several definitions and interpretations of a dry port in academia; examples are presented in Table 2.

Table 2. Interpretations of a dry port in research

Definition	Source
A dry port is an inland intermodal terminal directly connected to seaport(s) with high capacity transport mean(s), where customers can leave/pick up their standardized units as if directly to a seaport	Roso et al. (2009)
A common user facility with public authority status, equipped with fixed installations and offering services for handling and temporary storage of any kind of goods (including containers) carried under customs transit by any applicable mode of transport, placed under customs control and with customs and other agencies competent to clear goods for home use, warehousing, temporary admissions, re-export, temporary storage for onward transit and outright export	Beresford & Dubey (1990)
An inland terminal, which is directly linked to a maritime port	European Commission (2001)

Several attempts to advance the concept have been identified. Extended Gate concept is argued to be an extension of a dry port concept and refers to “an inland intermodal terminal directly connected to seaport terminal(s) with high capacity transport mean(s), where customers can leave or pick up their standardized units as if directly with a seaport, and where the seaport terminal can choose to control the flow of containers to and from the inland terminal” (Veenstra et al., 2012). Even though Extended Gate is claimed to be a concept advancing the dry port concept (Veenstra et al., 2012), the authors conclude that conceptually it does not “go beyond the dry port idea” (ibid). Moreover, the same (or a similar) concept is often referred to by many different terms. Wilmsmeier et al. (2011) refer to Inland Clearance (or Container) Depot (ICD), Beresford et al. (2012) parenthesizes offshore ports as a synonym, Jeevan et al. (2015) label African Dry ports to be Forward-Ports, Hanaoka and Regmi (2011) list the terms “inland port,” “inland container depot,” “freight terminal,” “freight station,” and “consolidation center” to be synonymously used.

The research work covered in this thesis is limited to the facilities meeting the academic definition given by Roso et al. (2009) (see Table 2).

### 2.1.2 Dry ports taxonomies

There are different dry port taxonomies; the summary of the identified from the literature taxonomies is in Table 3 (results of the Study 1).

Table 3. Dry ports taxonomies

Classification criteria	Types of dry ports	Reference
<b>Location and functions</b>	Close, midrange, distant	Roso et al. (2009)
	Seaport-based, city-based, border	Beresford et al. (2012)
<b>Development direction</b>	Outside-In, Inside-Out	Wilmsmeier et al. (2011)
	Bi-directional	Added by Bask et al. (2014)
	Land-driven, sea-driven	Monios (2011)
<b>Maturity level</b>	Pre-, start-up, growth phase	Bask et al. (2014)
<b>Dedication</b>	Shared (or public), dedicated to particular enterprises or cargoes	Ng and Cetin (2012), Feng et al. (2012)
<b>Orientation</b>	Supply chain, cluster oriented	Ng and Cetin (2012)
<b>Geography of operations</b>	Domestic, international	Do et al. (2011)
<b>Transportation mode</b>	Rail-based, barge-based	Rodrigue and Notteboom (2012)

Some of the identified taxonomies are the results of the research efforts (e.g. Roso et al., 2009) while others are implicitly evident, but only scarcely mentioned by the researchers in the papers (e.g. Do et al., 2011).

### 2.1.3 Benefits related to dry ports

Dry ports as facilities aiming to improve seaport's hinterland transport system, have a number of benefits for multiple stakeholders – economic, i.e., stimuli for regional development, environmental, i.e., reduction of harmful emissions, and social, i.e., noise reduction and job creation. Firstly, a dry port might be an important element of regional development (see, e.g., Beresford et al., 2012; Lättilä et al., 2013; Roso et al., 2009; Veenstra et al., 2012). Establishment of a dry port in a region stimulates the development of intermodal transportation with consequent benefits such as, e.g., attracting investments by focusing on logistics and therefore providing new opportunities for new business to open up and for large established companies to move to the region (Flämig & Hesse, 2011; Hanaoka & Regmi, 2011; Jeevan et al., 2015) and improving of the services along the transport chain (Bask et al., 2014). Seaports gain better accessibility, i.e., faster cargo transportation to destination point/from origin point and greater coverage of the hinterland (Hanaoka & Regmi, 2011; Rodrigue & Notteboom, 2010; Roso et al., 2009). In turn, better accessibility means more efficient integration of the seaport to distribution system (Bask et al., 2014) and by that a gain of competitive advantages (Jeevan et al., 2015), which is especially important for landlocked countries (Hanaoka & Regmi, 2011). Conversely, inland (remote) locations gain better access to new import and export possibilities (Jeevan et al., 2015). In addition, heavy investments into a seaport expansion are avoided, and at the same time valuable space at the seaport area is released in favor of new shipments to arrive (Roso et al., 2009), thus decreasing turnaround time (Korovyakovskiy & Panova, 2011). This is also accompanied by seaport capacity increase and potential productivity rise (Roso, 2007). Finally, a port city experiences a decrease in traffic and therefore a decrease in associated congestion, road maintenance costs and rate/probability of accidents that eventually translates into better quality of life (Rodrigue & Notteboom, 2010; Roso, 2007).

The dry port concept is claimed to be environmentally friendly. It assures reduction of CO<sub>2</sub> emission generated by trucks during waiting time at the seaport and overall by substituting road transportation with rail (Hanaoka & Regmi, 2011; Roso, 2007). In addition, emissions generated during waiting time at the seaport gate are more harmful than emission generated during operational time, and those can be decreased or fully eliminated when a dry port is in the hinterland transportation system (Roso, 2007). The emission associated with the hinterland transport leg associated with cargo going through the seaport can be decreased by 25% (Roso, 2007) to 32-45% (Lättilä et al., 2013) in case when a dry port is in the hinterland transportation system if compared to transportation routes without a dry port.

Roso (2009) summarizes the knowledge on benefits for several stakeholders from several types of dry ports (distant, midranged, and close) (Table 4).

*Table 4. Dry port's advantages (benefits) for the actors of the transport system (taken from Roso & Rosa, 2012)*

<b>Actor</b>	<b>Distant</b>	<b>Midrange</b>	<b>Close</b>
<b>Seaports</b>	Less congestion	Less congestion	Less congestion
	Expanded hinterland	Dedicated trains	Increased capacity
	Interface with hinterland	Depot	Depot
		Interface with hinterland	Direct loading ship-train
<b>Seaport cities</b>	Less road congestion	Less road congestion	Less road congestion
	Land use opportunities	Land use opportunities	Land use opportunities
<b>Rail operators</b>	Economies of scale	Day trains	Day trains
	Gain market share	Gain market share	Gain market share

<b>Road operators</b>	Less time in congested roads and terminals	Less time in congested roads and terminals	Less time in congested roads and terminals Avoiding environmental zones
<b>Shippers</b>	Improved seaport access “Environment marketing”	Improved seaport access “Environment marketing”	Improved seaport access
<b>Society</b>	Lower environmental impact Job opportunities	Lower environmental impact Job opportunities	Lower environmental impact Job opportunities

This is the only identified attempt to connect types of dry ports to benefits of relevant stakeholders, and the research included in the thesis may contribute to these results, however, with focus on services as a varying characteristic of dry ports.

#### 2.1.4 Services available at dry ports

As the focus of the research is on dry ports’ benefits, and one of the studies focuses more particularly on what generates these benefits for the stakeholders, a several types of dry ports were identified. Given the taxonomies identified (Table 3), it was possible to conclude, that there is no much focus in academia on types of dry ports in regard to services they provide. Only the taxonomy related to the “location and functions” (Roso et al., 2009) is explicitly connected to functionality (hence services) of dry ports, but as per the taxonomy the functionality is correlated with a location (distance from the seaport), but not with the services.

Services have been seen as key elements of growth and profitability. Value-added services (VAS) in logistics have changed over time due to the appearance of new requests among customers. Originally, VAS would refer to, e.g., electronic data interchange, tracking and warning of late shipments, warehousing, and later the services of, e.g., packaging, sorting, labelling, assembly operations, and sequencing entered the picture (summarized from Bask et al., 2014). Nowadays, the services that may be considered as standard offerings at an inland terminal, according to Roso et al. (2015) are rail drayage transportation, transshipment, storage, and customs clearance. The authors argue that due to availability of these services at inland terminals the cargo does not need to be customs cleared or stored at the seaports. This is interpreted as a considerable benefit to the shippers in terms of time, as handling is brought much closer to the destination and can take place much faster (ibid). Services that in one or another set are expected at a dry port location are listed in Table 5 (identified from the existing literature). Those services are typically provided by the dry port operator, or outsourced.

*Table 5. Services typical to be performed at the dry ports’ facilities*

<b>Service</b>	<b>Source</b>
Consolidation	Roso (2009)
Cross docking	Bask et al. (2014)
Customs clearance	Jeevan et al. (2015), Roso (2007)
Depot	Roso (2007)
Forwarding	Roso and Lumsden (2010)
Goods reception	Bask et al. (2014)
Handling of dangerous goods	Bask et al. (2014)

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Handling of empty and loaded containers	Roso and Lumsden (2010)
Kitting and sequencing	Bask et al. (2014)
Maintenance/repair of containers/wagons	Roso and Lumsden (2010)
Material control	Bask et al. (2014)
Online booking	Port of Gothenburg (2019)
Pre-assembly	Roso et al. (2015)
Quality and inventory control	Roso et al. (2015)
Quarantine	Roso et al. (2015)
Reefer plugs	Port of Gothenburg (2019)
Repacking and relabeling	Bask et al. (2014)
Road haulage	Roso et al. (2015)
Safe parking	Port of Gothenburg (2019)
Storage	Jeevan et al. (2015), Roso (2007)
Stuffing	Bask et al. (2014)
Subassembly	Bask et al. (2014)
Tracing and tracking	Roso (2007)
Trailer lifts	Port of Gothenburg (2019)
Transshipment	Roso (2007), Roso and Lumsden (2010)
Transit	Bask et al. (2014)
Warehousing	Bask et al. (2014), Jeevan et al. (2015)

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Service portfolio is to a large extent shaped by directional development, seaports' specifics, connectivity and distance to the seaports, and development of regional and industrial activity (Nguyen & Notteboom, 2019). According to Bask et al. (2014) the services – which to a great extent are customized in accordance with the customers' needs and preferences – also depend on market characteristics. Simplest dry ports perform basic logistic services, i.e., transshipment and storage (Roso et al., 2009), transport, and logistics (Jeevan et al., 2015), while the more advanced may in addition provide a wide variety of VAS (Andersson & Roso, 2016; Roso et al., 2015). In accordance with Beresford et al. (2012), the primary functions of a dry port include “*domestic trade, material distribution, international distribution, [...], cargo loading, storage, tallying and bonded logistics*”. Additional services of laden containers storage, empty containers storage, in-transit storage, cargo consolidation and deconsolidation, maintenance and repair of containers and/or trailers, track and trace, customs clearance, information processing and forwarding are common in dry port; constant and uninterrupted access by a high capacity transportation mode is also expected (summarized from Beresford et al., 2012; Jeevan et al., 2015; Ng & Gujar, 2009; Roso, 2007; Roso et al., 2009). According to Ng and Gujar (2009), in addition to services listed above, a dry port also should perform functions of “aggregation and unitization of cargo”, “customs brokerage”, “issuance of bill of lading in advance”, provide support in inventory management and “deference of duty payment for imports stored in bonded warehouses”. Although an important role of VAS in the development and functioning of dry ports is emphasized (Bask et al., 2014), the role of basic logistics services remains crucial for dry port functionality.

## **2.1.5 Development features of dry ports**

### **2.1.5.1 Conclusions from a global sample**

Citing Rodrigue and Notteboom (2012), “no two dry ports are the same,” and there are many factors that influence development of an inland terminal into a particular type of a dry port. Based on a large global sample of dry ports, Nguyen and Notteboom (2019) summarized the factors affecting dry ports’ type and development, and the character of this dependency. According to the authors, the following observations are proven to be true:

- Development level of a country where dry ports are located does not affect the direction of development, and both foreland and hinterland actors may play an important role in the dry port development, regardless of the level of the country’s development;
- Characteristics of dry ports are dependent on the direction of development, e.g., the location of a dry port tends to be closer to the seaport in the outside-in development process, while inside-out initiated dry ports tend to be located closer to production facilities or large industrial areas; in other words, there is a dependency of a dry port’s type and the actors involved in its development;
- Dry ports develop dependently on the characteristics of a seaport they serve; larger seaports tend to have a larger network of smaller dry ports, and vice versa, while smaller seaports tend to have a smaller network of larger dry ports;
- Dry ports’ “outlook” is among other framed by the modality of the terminal; thus, the size of a dry port is normally larger when more transport modes are available. The size of a dry port is also affected by the volume (and thus the dry ports tend to be bigger in proximity to industrial areas).

### **2.1.5.2 Country-specific development features**

In addition to the above listed factors, the development of dry ports is strongly connected to the geographical context where they develop. As argued by Bask et al. (2014), there is not one single dry port solution that suits everyone’s needs; therefore, regions around the globe develop various types of dry ports. Consequently, the same has been studied, for example, in Australia (Roso, 2013), South America (Padilha & Ng, 2012), the United States (Roso et al., 2019), Asia (Ng & Gujar, 2009; Hanaoka & Regmi, 2011), Russia (Korovyakovsky & Panova, 2011), and in Europe (Henttu & Hilmola, 2011; Monios, 2011).

In India, with a strong need to process large volumes at the seaports, the dry ports gained popularity, and following a two-fold governmental policy, private dry ports entered the competition with the public ones. Characteristic to the dry ports in India is also the availability of the custom clearance service at the facility (Ng & Gujar, 2009). In China, as another example, there is a wide network of dry ports, and the supply of their services overrun the demand; thus, some of the facilities go bankrupt and shut down (Wang et al., 2018). At the same time, “conflicts between planning, operating and regulating inland intermodal systems” leads to the underperformance of the facilities (Beresford et al., 2012). In Malaysia, dry ports face a numerous challenge in development, summarized (Jeevan et al., 2015) as “insufficient railway tracks, unorganized container planning on the rail deck, use of a single mode of transportation, less recognition from seaports about the credibility of dry ports, [and] competition from seaports”. Close dry ports prevail in Australia and New Zealand and play an important role in decreasing the congestion in ports and port cities as in the case of Port Botany, Australia, with its five close dry ports (Black et al., 2018); or to gain competitive advantage in the case of Port of Tauranga, New Zealand (Roso, 2013). According to Rodrigue et al. (2010) and Rodrigue and Notteboom (2012) main differences between European and American dry ports is in the major actors driving the implementation. In Europe, the major actors in the development of dry ports tend to be port authorities and terminal operators while in North America the major actors are rail operators and real estate promoters and managers (ibid).

## 2.2 Supply chain perspective on dry ports

The purpose of a supply chain is to build customer value, and to generate competitive advantages in the overall SC, as well as to improve the long-term performance of the individual organizations included in it (Mentzer et al., 2001). To generate value for the end customer, and to fulfil changing demands, SCs need to remain competitive, therefore sustainable SC management is gaining importance as the means of companies' performance evaluation (Lu et al., 2018).

Traditional SCs are price-driven, which is not always enough to retain competitiveness in the changing environment. In contrast to traditional SCs, outcome-driven SCs focus on multiple aspects (or supply chain outcomes (SCO)) important for target customers such as responsiveness and/or security. Some of the SCO can be "mixed" together while others enter a trade-off relation e.g. SCOs of cost and innovation (Melnyk et al., 2010). SCOs in their variety have been covered from different perspectives such as, e.g., modal shift, information technology, and rail and seaports perspective. For example, Chuanwen et al. (2018) argue that one of the hindrances to shift goods from road to rail is that many stakeholders do not consider the overall SC impact (outcomes) of multimodal transportation. High-capacity transport modes are in general cheaper and greener, but not flexible or fast enough, resulting in logistics managers perceiving the straight modal shift leading to increases in inventory, and consequently having negative impacts on the SC (Chuanwen et al., 2018). Closely related to this issue is transportation as a part of SC, which has been analyzed by e.g., Woodburn (2013), who observed that managers' perception of rail impairs SC performance, and consequently creating a barrier to this mode increasing its market share. Furthermore, according to Bichou (2006), seaports, as sites/nodes that bring together variety of actors in the SC, contribute to the SC and its outcomes by creation of competitive advantage and value-adding services. More specifics on SCO and its measurements can be found in the report by Singh and Teng (2016) who specified two measures for SCOs: performance and transaction cost; and concluded that the application of information technology and inter-organizational trust influences those SCOs. According to Melnyk et al. (2010), important SCOs for the actors are cost, security, sustainability, responsiveness, resilience, and innovation in various combinations of them. More specifically, an outcome-driven SC, apart from focusing on cost optimization, can at the same time focus on the enhancement of SCO of environmental performance, resilience, innovation, responsiveness, and/or security. However, instead of being "overly focused" on one SCO, or trying to focus on all of them, a "blend" or a mix of SCOs, corresponding to the key customer preferences, should be found, in order to maintain a competitive SC (ibid).

As a facilitator to increased hinterland freight movement emerged the concept of improved seaport inland access in the form of dry ports or extended gates, which demands extended forms of SCM in which inland terminals play an active role (Rodrigue & Noteboon, 2012). As the freight flows, associated with environmental effects, increase and put pressure on port regions, dry ports are gaining more important role in maintaining efficient and sustainable commodity chain (Rodrigue & Noteboon, 2012). Veenstra et al. (2012) emphasize the strong overall trend towards efficient, reliable, and sustainable SCs.

## 2.3 Synthesis

The frame of reference covers dry ports (definition, taxonomies, benefits, services, development features), their place and role in a bigger system (supply chain). To summarize, the research is concentrated around dry ports that possess utility due to services that they provide, and at the same time they belong to a bigger system (supply chain). The stakeholders located in the outer to the dry ports in the seaport's hinterland transport system may gain the benefits while interacting with dry ports, according to their objectives. The literature suggests that there are different types of dry ports (Table 3) as well as different services that the dry ports may provide (Table 5). Depending on certain configuration (type) of the dry ports the benefits for the stakeholders vary. However, not only types of dry ports and services affect the utility of dry ports, but more aspects (2.1.5.1 Conclusions from a global sample). Moreover, the benefits can

be gained by the entire system (seaport's hinterland transport system, supply chain) and individually by each stakeholder. Figure 3 depicts the framework of the thesis.

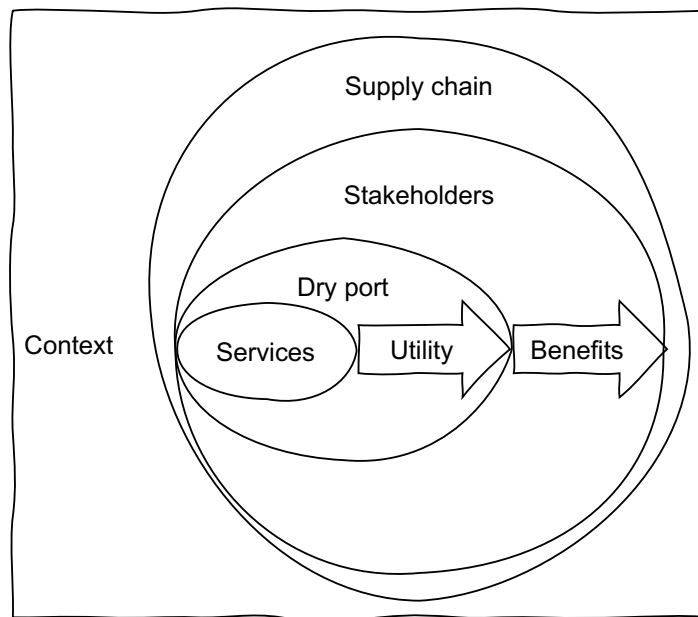


Figure 3. Thesis framework

Figure 3 summarizes the research scope of the included in the thesis studies (Figure 1) and hence represents the research scope of the whole thesis. As can be seen from Figure 3, the research addressed the benefits of the dry ports from “outside”, i.e., how the benefits are perceived by the stakeholders and how they impact the larger system (supply chain) to which the dry ports belong; and from “inside to outside”, i.e., how the dry ports’ services generate the benefits for the stakeholders. The research is limited to the context (Sweden).

### 3 Research design

The research design constitutes a set of research methods and techniques that are applied to achieve the research purpose while at the same time to sustain the research quality (Bell et al., 2018). This chapter describes how the studies included in the thesis were planned and designed, with particular focus on method, data collection, and data analysis choices for each study; it also separately discusses the research quality of the included studies.

#### 3.1 Research process

The research included in this thesis started with a Systematic Literature Review (SLR) on the topic of dry ports, focused widely to assure better learning about the field. It appeared to be an educative process that was both relevant and timely for the research field; with the very first articles on dry ports in the current interpretation from 2007-2009 (e.g., Roso, 2007; Roso et al., 2009), the number of peer-reviewed research publications on the topic has grown to more than 100 for the moment of writing the current thesis. The initial idea was to learn what has been done in the research field to advance the knowledge about dry ports; but it was also a good way to find a research problem. However, finding, understanding and defining the research problem has proven to be an iterative process, partly grounded to the literature, partly to practical, close-proximity evidence, and partly to the inner drive to “explore an unclear issue” (Van de Ven, 2007, p.73). The first presentation of the research purpose was held during the Research Proposal seminar two years ago, and it was formulated in the following way:

*“...the purpose of the research is to enrich scientific knowledge of the dry port research field and to investigate opportunities for higher utilization of dry ports from hinterland transportation chain actors’ perspective. Generated knowledge will contribute to dry ports’ management for assisting policy making, and to academia by broadening research field on dry ports by taking new perspectives”* (Khaslavskaya, 2017).

The purpose formulated then had a focus on dry ports; background, hinterland transportation actors; and an audience, academics, and practitioners. The research direction has not deviated far to disregard the above cited statement and the research results presented in the thesis to fulfil both ambitions: 1) contribute to the academic knowledge on dry ports; and to 2) address problems identified for practitioners with regard to operations through dry ports. However, since the first presentation of the research purpose, the research also has gained a context, i.e., the Swedish perspective. (Yet) the research (papers included in the current thesis) has not gone far enough to suggest ways to improve dry ports’ utilization, nor has it contributed to policy making; but the current thesis has got a potential to make its own contribution.

The research included in the current thesis is constituted by three separate studies that took place, for almost two and a half years, and that resulted in three respective papers. The representation of the studies and papers as well as the timeframe is depicted in Figure 4.

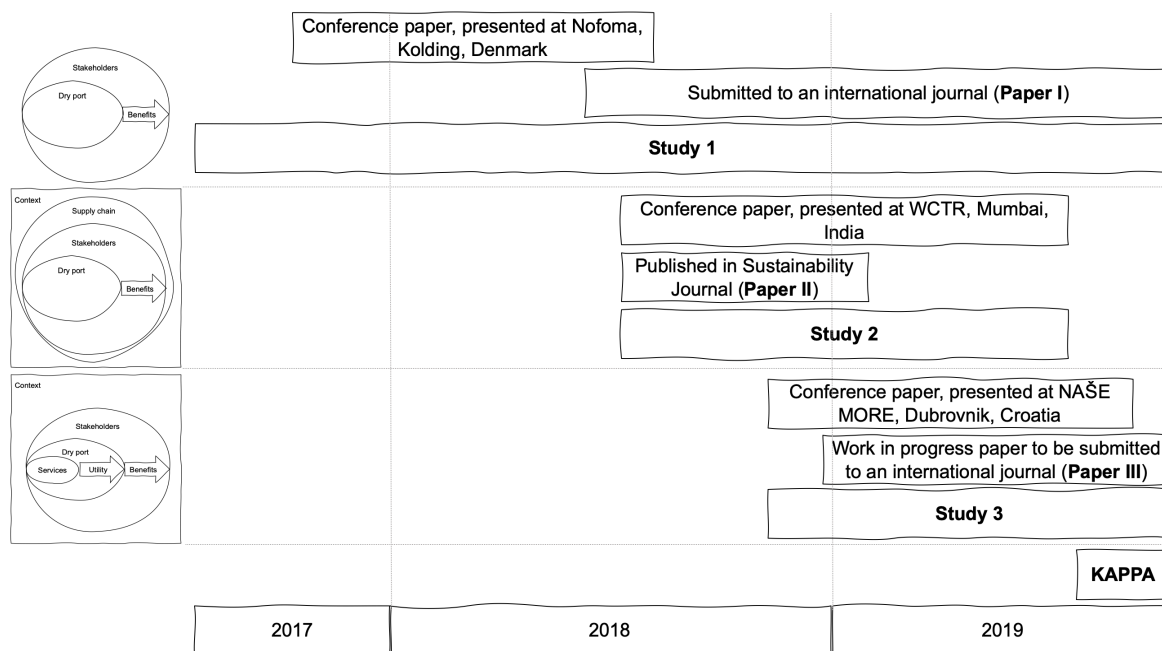


Figure 4. Research timeframe, studies, and resulting papers

### 3.2 Addressing RQs and the research purpose

Considering the multi-stakeholder environment of dry ports' operations, this thesis attempts to advance knowledge on how dry ports benefit the stakeholders involved, by both studying common benefits and the ability to achieve them (from the supply chain perspective), and also by taking the perspective of each stakeholders' objectives in relation to several types of dry ports' varying in services provided (Multi-Actor Multi-Criteria Analysis). By combining findings from the SLR (RQ1) and empirical evidences from the stakeholders involved in dry port operations in Sweden (RQ2), the thesis investigates stakeholders' perspective on dry ports' benefits and dry ports' ability to generate the same for the stakeholders.

To answer the RQs, the research takes several steps. First, the dry ports' potential benefits were identified from academic literature and reported as a table of benefits. Second, benefits for stakeholders were identified from empirical studies focused on dry ports in Sweden. Finally, an investigation on dry ports' ability to generate those benefits for the stakeholders was undertaken.

### 3.3 Data collection and analysis

The description of the data collection and analysis per each study is presented in the current subchapter. Data collection and analysis techniques were selected to the best meet the purpose of each described study.

#### 3.3.1 Study 1

Study 1 is a Systematic Literature Review (SLR). It is commonly suggested to start the research process with a literature review on the studied topic. Firstly, conducting a literature review allows a (novice) researcher to familiarize oneself with a research area. Secondly, as outlined by Tranfield et al. (2003), conducting a literature review serves as a tool to assess and evaluate the scientific knowledge in the research area and to identify potential gaps to be filled in, while proceeding with the research process. Seuring and Gold (2012) strongly recommend following the systematic way, while conducting the review, otherwise, according to the authors, the review might lack replicability and traceability.

### 3.3.1.1 Data collection

Given the nature of Study 1 – SLR – the data for the study is solely retrieved from academic publications, specifically research articles from peer-reviewed academic journals. Initially, the broad search was conducted (the most current search for the updated version of the paper is from July 2019); of which resulted in a long list of research paper candidates to be included in the review. Further on, the initial list was refined and reduced independently by two authors to make a better choice on inclusion/exclusion of each paper-candidate; this was made with the help of specially-designed software Rayyan QCRI (Ouzzani et al., 2016). Summary of the data collection and selection is presented in Table 6.

Table 6. Overview of the data collection process for the Systematic Literature Review

Parameter	Decision / result
<b>Review scope</b>	Peer-reviewed academic publications on topic of dry ports in the meaning relevant to logistics and transportation research areas
<b>Databases</b>	Scopus, Science Direct
<b>Date of search</b>	July 2019 (for the conference version: June 2017)
<b>Search string</b>	TITLE-ABS-KEY ("dry port" OR "dry ports" OR "dryport*" OR "dry-port*" AND "transport*")
<b>Search limitations</b>	Scopus: all publication types except of "Conference Papers" and "Conference Reviews" Science Direct: limited to "Review articles", "Research articles", "Book Chapters", and "Other"
<b>Initial results of the search</b>	Scopus: 104 Science Direct: 238 Cross-referencing: 12
<b>Refining process</b>	Independently by both authors in Rayyan QCRI (Ouzzani et al., 2016)
<b>Exclusion criteria</b>	Wrong population (irrelevant); Background article; Wrong publication type; Foreign language; Full text is not available
<b>Final list</b>	102

### 3.3.1.2 Data analysis

The analysis of the data followed the purpose of a SLR – assessment and evaluation of scientific knowledge in a research area and identification of potential gaps and trends (Tranfield et al., 2003). Major part of the SLR is data analysis and synthesis. Overall, the conducted SLR followed the steps identified by Durach et al. (2017); the steps that contributed to the data interpretation (analysis and synthesis) are summarized in Table 7.

Table 7. Overview of the data analysis process for the Systematic Literature Review

Step	Execution
<b>Defining the research question</b>	<p>What is the status of the current knowledge on dry ports?</p> <p>RQ1 What are the main thematic areas in the field?</p> <p>RQ2 What are the research findings?</p> <p>RQ3 What are the gaps, i.e., the potential for further research?</p>
<b>Determining the required characteristics of primary studies</b>	Peer-reviewed academic publications on the subject of dry ports
<b>Retrieving a sample of potentially relevant literature</b>	Search in Scopus and ScienceDirect databases (see details below)
<b>Selecting the pertinent literature</b>	<p>Exclusion of irrelevant items from the retrieved sample based on the criteria:</p> <ul style="list-style-type: none"> <li>- Wrong population (irrelevant);</li> <li>- Background article;</li> <li>- Wrong publication type;</li> <li>- Foreign language;</li> <li>- Full text is not available.</li> </ul> <p>This step is conducted independently by both authors in Rayyan QCRI software (Ouzzani et al., 2016)</p>
<b>Synthesizing the literature</b>	Bibliometric analysis. Categorizing the selected research items into thematic areas/categories and synthesizing the knowledge on the phenomenon for each theme (RQ1)
<b>Reporting the results</b>	Reporting the results of the analysis and synthesis and answering RQ2 and RQ3

The research questions were defined broadly to give the researchers “space” to describe the research field; such formulation of the questions allowed for inclusion of the results of information that “emerged” from the review.

The analysis of the literature was performed by coding the articles in the qualitative data analysis software NVivo 11.4.3 that allowed for the creation of a database of the studied articles and to manage, analyze, store, and learn about the data in an efficient manner (Bazeley & Jackson, 2013). The coding was conducted in two rounds: first, general data was extracted from the articles; second, the results of the first round of the coding were coded again to the “nodes” suggested by the first round of coding. The code structure is shown in the Table 8.

Table 8. Structure of the codes for the Systematic Literature Review

First round of coding	Second round of coding
Main findings	Benefits
Method	- Economic
Research focus / purpose	- Social
Questions stated by researchers for future research	- Environmental
Other ideas	Challenges / impediments
	Definitions / understanding of the concept
	- Functions of dry ports / services
	- Development
	- Actors
	- Investments
	- Policy / regulations
	- Types of dry ports
	- Other
	Location
	Performance
	Research opportunities

The nodes (code structure) for the second round of coding were derived from the results of the first round of coding and suggested a structure for the results of the SLR (Table 8, on the right).

However, the research papers in most had a multiple focus and were difficult to classify definitely; thus, the structure of the categories of the results differ from code structure, though the results description is well-supported by the second round of the coding. The categories were defined by assigning labels by the authors in Rayyan QCRI (Ouzzani et al., 2016) in blind mode that allowed independent judgement on each article; the conflicting judgements were discussed to reach a consensus after the blind mode was switched off.

In addition, information about sources was also extracted with the help of software Rayyan QCRI (Ouzzani et al., 2016). This software allows to extract metadata about the research publications, i.e., types and year of publications, journals of publishing, and authors. This, in turn, helped to identify the position of the research field in the bigger picture and to outline the development of the research field.

### 3.3.2 Study 2

Case study was the research method used for conducting Study 2. The method is related to qualitative in-depth studies. A single case study is suitable for a critical case for testing well-established knowledge, an extreme or unique case, or a case that can add value by generating new insights (Ellram, 1996).

#### 3.3.2.1 Data collection

The selection of the case partially was purposeful but also convenient. For the moment of the research the Skaraborg dry port was in process of changing ownership for the private one (it was being purchased by the retailer company Jula AB), and at the same time the news about

the dry port were reporting stable volumes and plans of expanding the operations further (Skaraborgsbygden, 2018). It appeared to be a relevant case as the preliminary investigation suggested that the future owner of the dry port is very proactive in the idea to develop the operations, but also to do it in cooperation with the rail operator and the municipality (in other words, the future owner was very considerate of the benefits for other stakeholders and worked together with them in order to develop own (and others) business setup in regard to the dry port). In addition, the fact that the operations of the dry port were stable and were expected to grow, the case had a promise to identify potential customers (shippers) and a hope to reach them, which was of interest of the study, as well. The convenience of the sampling comes down to the fact that the research team had established contacts with some of the potential interviewees.

To collect data for the case study, a series of semi-structured interviews (totaling eight interviews) and site visits were undertaken (Table 9). First-hand data was collected by interviewing representatives of the municipality of Falköping, the Skaraborg dry port owner, rail transport operator, seaport authority, seaport terminal operator, the customer (retail company using the dry port), potential customer (retail company located in the vicinity of the dry port), and the consultant closely engaged in the design and development of the dry port integrated setup. The data was collected in June, July, and September 2018 during site visits, at a meeting during one conference, and by phone calls, consisting of face-to-face or semi-structured phone interviews of 20–60 minutes each, which were conducted by two researchers. Each interview-guide was adapted for each exact interview; the interview guides were developed further during the meetings (Flick, 2018). Most of the interviews were recorded with the permission from the interviewees, then transcribed, validated by the interviewees, and after the sensitive aspects were removed from the transcripts, coded and analyzed. None of the removed aspects (e.g., information related to names, titles, internal financial information) were of a special importance for the analysis thus the results and conclusions were not affected by removing the same.

*Table 9. Information about the eight interviews conducted for Study 2*

<b>Actor</b>	<b>Interviewees' Positions</b>
<b>Municipality of Falköping</b>	Manager, logistics, and infrastructure at Municipality of Falköping
<b>Jula AB, retail company, dry port's owner</b>	Freight Manager
<b>Rail transport operator</b>	Key Account Manager
<b>Seaport authority</b>	Senior Manager Business Development
<b>Seaport terminal operator</b>	Business Development Manager and Commercial Manager Rail
<b>Customer</b>	Logistics Manager
<b>Potential customer</b>	SCC & Launch Manager
<b>External consulting</b>	Consultant

The interviewees received the interview guides in advance. During the interviews, the respondents were asked to describe their business relationships with the Skaraborg dry port, and their perception of how the supply chain outcomes can be enhanced by a dry port; the interviewees were asked both general questions on potential influence of a dry port on the SC, and more specific questions on the six proposed SCOs (Appendix A).

### 3.3.2.2 Data analysis

The validated transcripts of interviews were coded and analyzed in the qualitative data analysis software, NVivo 11.4.3. In this case, NVivo was used as a tool for thematic coding of the interview transcripts. Thematic coding implies the use of a priori defined categories that arise from the literature, and that correspond to the research purpose (Bazeley & Jackson, 2013). In this case, the categories were cost, responsiveness, security, environmental performance, resilience, and innovation, in accordance with Melnyk et al. (2010), whose classification of the supply chain outcomes was used as a reference in this study. This means the data was categorized and reduced, and the conclusions were derived (Flick, 2018).

### 3.3.3 Study 3

Study 3 uses a Multi-Actor Multi-Criteria Analysis, since it aims at multiple stakeholders (actors), and their benefits (criteria). Academic literature was consulted to design the study. Namely, based on input from the results of Study 1 and verified by the data collected for Study 2 and its outcome (the interview transcripts of the Skaraborg case study indirectly contained information that helped to verify the design of Study 3), the following elements of the study were defined:

- the list of dry ports to be analyzed;
- the list of services typically available at the dry ports (formulated as scenarios);
- stakeholder groups;
- stakeholders' objectives (criteria and indicators).

After preliminary work had been complete, the questionnaire was designed. It was designed with the intention to collect stakeholders' opinions regarding the following issues:

- Relative importance of their own criteria and indicators (before and after the scenario assessment);
- Scenario assessment;
- Importance of each individual service at a dry port;
- Sufficiency, completeness and relevance of the study design.

#### 3.3.3.1 Data collection

The study is based on the personal interview survey method, which is used when a specific, limited target population is of interest to the research. The sampling strategy is therefore again mix of purposeful and convenience sampling techniques. Given that Sweden (Port of Gothenburg) has a wide network of Rail Ports (refer to inland terminals located in the port's hinterland; 26 of them (ibid)) and at the same time there has not been an attempt to study the whole network of these together with other relevant stakeholders, the limitation was chosen to be dry ports of the Port of Gothenburg (all located in Sweden; list of the Rail Ports were compared against the academic definition of a dry port, and shortened to 13). The taken perspective covers a large geographical area where the associated with the dry ports' operations take place in the same economic environment, and all the dry ports have connection to the same seaport. Other stakeholders (representatives of the stakeholders' groups), i.e., rail operators and municipalities, were identified from the report of the Port of Gothenburg (ibid) while the remaining ones were identified by convenience sampling technique – mainly by requesting information and contacts from the already identified and reached stakeholders. Table 10 includes the list of the stakeholders that were reached during the data collection. In total, 16 interviews were conducted.

Table 10. Information about the interviews conducted for Study 3

Stakeholder	Description	Representation in Study 3
<b>Dry port operators</b>	Operators running the dry port operations	7/13
<b>Municipality/region of a dry port</b>	Municipality / region where the dry port is located	2/13
<b>Seaport*</b>	Maritime port (including authorities and terminal operators)	2/1
<b>Shippers**</b>	Cargo owners	1
<b>Shipping lines**</b>	Operators that transport cargo by sea	1
<b>Rail operators</b>	Operators that transport cargo by rail	1/5
<b>Road operators**</b>	Operators that transport cargo by road	2

\* Two respondents from the same organization;

\*\* There is no information for the total amount of companies representing marked stakeholder groups.

During phone calls and meetings with the stakeholders, the authors help the respondents complete personal interview surveys; the stakeholders were additionally asked to reflect on whether the lists of criteria and indicators as well as the list of the stakeholders itself were sufficient, complete, and relevant to the study. The responses, however, did not affect the design of the study at that point, as they appeared during the data collection; the need to remain consistent with the questionnaire prevailed.

All of the respondents were first contacted by e-mail to initiate the contact, provided with information about the study goals, questionnaire, and offered the suggestion to have a phone call or meeting to help with filling in the questionnaire. In most cases, the respondents filled in the questionnaire with the help of at least one of the researchers involved in the study. An example of the questionnaire (as they were adapted for each group of stakeholders) is in the Appendix B.

### 3.3.4 Data analysis

The results were obtained in accordance with the MAMCA method; the output of it was discussed against literature findings. Several findings were in focus of the discussion:

- relative importance of the criteria;
- individual and overall result of the MAMCA evaluation;
- importance of individual services.

In addition to the discussion of the results, these results were compared to the evaluation of individual services; differences were discussed, however, in most cases the results validated one another. Moreover, evaluation was conducted by two groups – stakeholder groups and academic experts – both to validate the interview findings but also to strengthen the results; the differences and similarities are also presented in the results of the paper written as a result of the study.

## 3.4 Research quality

Given the nature of the three studies included in the thesis – all different in terms of the research method – the discussion of the research quality is done separately as different criteria

of quality are applied. Study 1 is conducted by applying the SLR method, and its quality is discussed according to Durach et al. (2017), who summarized the knowledge of conducting SLRs in the Supply Chain Management research domain. Study 2 has a qualitative character and Study 3 applies a method of quantification qualitative data (based on experts' opinions and evaluations). Qualitative methods are referred to as being "trendy" in the recent research in the field of logistics by Halldorsson and Aastrup (2003); thus, the authors suggest a set of criteria altogether assuring trustworthiness of the research in the field. These criteria include credibility, transferability, dependability, and confirmability criteria, which supposedly benefit the research in the field of logistics and are applicable to the research based on various research methods. Conclusions by Halldorsson and Aastrup (2003) are used to depict the quality of Study 2 and Study 3.

### 3.4.1 Research quality of Study 1

The research quality of Study 1 is addressed according to suggestions of Durach et al. (2017) (Table 11).

Table 11. Research quality of Study 1

<b>Bias</b>		<b>Meaning</b>	<b>Remedy action</b>
<b>Sampling bias</b>	<b>Retrieval bias</b>	Sample is not representative	Consideration of multiple spelling of the "dry port"  Customization of search strings for each database
	<b>Publication bias</b>	Publishing studies depending on the results (new, original)	Not addressed
<b>Selection bias</b>	<b>Inclusion criteria bias</b>	Inaccurate selection of inclusion/exclusion criteria	Co-authorship  Literature support on designing inclusion/exclusion criteria
	<b>Selector bias</b>	Subjective application of inclusion/exclusion criteria	Blind individual decision-making process of inclusion/exclusion of articles based on abstracts  Collective decision-making process of inclusion/exclusion of the articles when disagreement after blind decision-making process
<b>Within-study bias</b>		Variability in coding	Developed methodology for coding  Collective work on the data analysis stage  Preliminary education on using coding software to enhance quality of coding
<b>Expectance bias</b>		Influence on the results by prior experience and expectations	Collective work of an experienced and novice-to-the-topic researcher  Peer-review processes (prior to the conference version and a journal publication)

### 3.4.2 Research quality of Study 2 and Study 3

Research quality of Studies 2 and 3 is addressed according to suggestions by Halldorsson and Aastrup (2003) (Table 12).

Table 12. Research quality of Study 2 and Study 3

Criteria	Meaning	Study 2	Study 3
<b>Credibility</b>	Reality is a construct of an individual	Co-authorship	
		Multiple respondents representing the same interviewee group (when possible)	
		Data validation and triangulation by multiple sources of data collection (interviews, site visits, official web-resources, academic literature)	
		Confirmation and validation of the study results with the industry participants	
		Data validation by comparison to the literature findings	
		Literature support in the research design (deriving framework, designing interview questions)	Literature support in the research design (identification of criteria and indicators, designing questionnaire)
			Expert evaluation as a reference
			Data triangulation by multiple methods applied to collect evidences (MAMCA, individual services evaluation)
<b>Transferability</b>	General application of the findings	Multiple respondents representing the same interviewee group (when possible)	
		Contextualization	
		Description of the research limitations	
<b>Dependability</b>	Possibility to replicate a study or to track methodological decisions	Research diary	Detailed method description
			Contextualization
			Methodological support from experts / method developers
			Extended method chapter
			Sampling choice description
		Detailed context description	
		Detailed data collection description	
<b>Confirmability</b>	Findings represent the results	Peer-review and presentation of the results at a conference and during academic courses	
		Co-authorship	
		Data triangulation by comparison to the literature findings	
		Data triangulation by multiple sources of data	
		Review before the journal	Confirmation, validation and

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publication	sharing the study results with the industry participants
Peer-review and presentation of the results at a conference and during academic courses	Expert evaluation as a reference
Confirmation, validation, and sharing the study results with the industry participants	

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## **4 Summary of appended papers**

The research included in the current thesis is constituted by three separate studies that resulted in three respective papers. Summary of these papers is presented in the chapter.

### **4.1 Paper I: Dry Ports: Research Outcomes, Trends, and Future Implications**

#### **4.1.1 Annotation**

Paper I summarizes knowledge on dry ports accumulated as peer-reviewed research articles by identifying research categories (distinctive focus of the research), presenting summarized knowledge according to those categories and their trend; and making conclusions on what the future research in the field might look like. It also contains metadata about the research community as such.

#### **4.1.2 Summary**

The concept of dry ports has gained significant interest since 2007, both among practitioners and researchers. The purpose of Paper I is to review the research and to summarize the knowledge in the research field. A theoretical goal of summarizing is reduction of knowledge to simplify the perception of the whole body of knowledge (MacInnis, 2011). It is also meant to link the existing studies, and to draw apt and accurate conclusions from “many disparate instances” (ibid).

The study has four research questions aiming to best describe (summarize) what is already known in the research field, but also how the research field looks. Consequently, the research questions are as follows:

- What is the status of the current knowledge on dry ports?
  - RQ1 What are the main thematic areas in the field?
  - RQ2 What are the research findings?
  - RQ3 What are the gaps, i.e., the potential for further research?

At first, Paper I shapes the research community by providing meta-data about the same. The contributing authors are spread around the world, with 11 authors being especially active in the research on the topic. Most publications are written by the researchers affiliated in Sweden and Malaysia; the top 11 researchers are involved in 57% of all identified peer-reviewed research publications. The most research articles have been published in the Journal of Transport Geography and Transportation Research Part E: Logistics and Transportation Review. In total, 52 journals have published articles on the topic, with several special issues.

### **4.2 Paper II: Outcome-Driven Supply Chain Perspective on Dry Ports**

#### **4.2.1 Annotation**

Paper II is an exploratory case study of Skaraborg dry port, Sweden, based on stakeholders' evidences (interviews) that show the benefits of the dry port from the supply chain perspective; it shows awareness of the stakeholders on how the supply chain benefits from the dry port in it. The study also contributes to the knowledge of the Swedish context for dry ports' operations.

#### **4.2.2 Summary**

Paper II combines two aspects: a dry port's potential to improve hinterland transportation, and an outcome-driven nature of supply chains (SCs); and focuses on relationships between the two. The purpose of the paper is formulated as to explain how a SC can benefit or enhance its outcomes of cost, responsiveness, security, environmental performance, resilience, and innovation, by the integration of a dry port.

The paper is based on a case of a Swedish dry port in Skaraborg, that after many ups and downs, reached full operations in 2013 together with Swedish retail company Jula AB able to assure sufficient volumes. Jula AB together with Schenker AB as the rail operator developed a well-functioning business model that allowed to attract more clients to the shuttle train and to the dry port itself to assure the growth handled at the dry port volumes.

Conclusions of the study are drawn based on interview findings; in total, eight interviews with industry representatives were conducted: municipality of Falköping, Jula AB (retail company), dry port's owner, rail transport operator, seaport authority, seaport terminal operator, customer, potential customer, external consultant.

The finding suggests that the industry players are aware of the benefits that SC gains by integrating a dry port, however, mainly concentrate on own business rather than SC perspective. Still, the case is a good example of cooperation between the stakeholders (e.g., the rail operator and the retail company) to reach common good. In addition, the findings are representative to the Swedish context. In such a way, the study reveals the importance of environmental performance and resilience (caused by strike history in the Port of Gothenburg) in line with prevailing, classical interest in cost benefits.

### **4.3 Paper III: Multi-Actor Multi-Criteria Analysis of Services at Dry Ports in Sweden**

#### **4.3.1 Annotation**

Paper III is focused on functionality (services) of the dry ports in Sweden and their ability to enhance individual stakeholders' objectives; it has been validated by expert evaluation in order to highlight the difference (gap) between industry and academic experts' perspectives.

#### **4.3.2 Summary**

The purpose of Paper III is to investigate which services of Swedish dry ports have the largest positive influence on stakeholders' criteria (objectives); in order to suggest a configuration of a dry port that brings the most benefits to the stakeholders. The paper aims to include stakeholders' individual objectives and find an optimal configuration of a dry port for all. This paper brings the entire research included in the current thesis closest to answering the main research questions of the same.

Conclusions are drawn based on interviews and results of the questionnaires of 16 respondents in total representing all the considered stakeholders' groups (dry port, municipality, seaport, shippers, shipping lines, rail, and road operators). The findings show that the basic services of the studied dry ports were crucial for establishing operations; however, further advancement of service portfolio by adding value-added services (VAS) and customer-oriented services continue to bring extra benefits to the stakeholders, both from financial and environmental points of view. The majority of Swedish dry ports develop their service portfolio toward the wider range of VAS and specific customized services according to their customers' and potential customers' demand; still, some services have high cost and low demand. Validation with the academic experts shows that the stakeholders assume that the shift from basic toward more advanced (in terms of provided services) dry ports have a strong influence on their objectives while the academic experts are more restrained in the same regard.

## 5 Results

The results of the three papers included in the current thesis aimed to answer two RQs:

**RQ1:** What are the potential benefits that dry ports generate for stakeholders in the seaport's hinterland transport system?

**RQ2:** What are the actual benefits that dry ports generate for stakeholders in the seaport's hinterland transport system?

RQ1 was formulated to identify dry ports' potential benefits, while RQ2 implied identification of stakeholders relevant to the given context, the benefits that they want and are able to gain due to interaction with a dry port, and dry ports' ability to generate the same.

### 5.1 Contribution to the RQ1

To begin, it was important to identify potential benefits of all kinds of dry ports from existing academic literature, which was done in the Paper I. The identified benefits of dry ports were presented in a table (Table 13) containing stakeholders of the dry ports' operations frequently referred in the academic literature, i.e., transport operators and shippers, seaports and regions, and respective to their benefits; those are listed without categorization. Table 13 is a summary of research efforts and contains benefits that are extracted from the findings of the respective publications (last column) or implicitly referred in those academic papers. Many of the benefits have a repetitive character and therefore multiple authors are referred. The benefits are not classified into categories in the results reported in Paper I. However, the same study suggests that the benefits might be classified into economic, environmental, and performance-related.

*Table 13. Dry ports' benefits for different actors in the transport system*

Actor	Benefits	Source
<b>Transport operators and shippers</b>	Optimized logistics (shorter time and lower costs) / lead time reduction	Jeevan et al., 2015a; Wang et al., 2016; Panova, 2011
	(Total) transportation / logistics costs minimization / decrease / reduction due to optimized design of hinterland transportation leg	Wilmsmeier et al., 2011; Roso et al., 2009; Lättilä et al., 2013; Zeng et al., 2013; Henttu & Hilmola, 2011; Feng et al., 2013; Castagnetti, 2012; Jeevan et al., 2015b; Henttu et al., 2011; Talley and Ng, 2018; Khaslavskaya & Roso, 2019
	Obtaining added value through vertical integration	Rodrigue et al., 2010
	Improved rail-sea intermodal capacity	Roso, 2008; Wang et al., 2016; Roso, 2013
	Increased seaport-hinterland accessibility	Roso, 2008; Roso, 2013; Jeevan et al., 2015a; Othman et al., 2016
	Improved hinterland network	Jeevan et al., 2015a
	Reduction of border crossing and transit delays	Roso & Lumsden, 2010; Do et al., 2011

Lowered customs staff costs / lowered customs costs	Do et al., 2011; Wang et al., 2016
Reduction of external transportation costs	Henttu & Hilmola, 2011
Revenue source (private interest)	Rodrigue et al., 2010
Lower door-to-door freight rates / tariffs	Do et al., 2011; Panova, 2011
Railway share increase	Roso, 2008; Bask et al., 2014; Panova & Hilmola, 2015
Good services for shippers and transport operators	Roso et al., 2009; Roso & Lumsden, 2010; Jeevan et al., 2015b
Improved customer services	Roso & Lumsden, 2010; Roso, 2013; Castagnetti, 2012
Reduced external costs associated with road congestions / and associated accidents	Roso et al., 2009; Henttu & Hilmola, 2011; Korovyakovsky & Panova, 2011; Othman et al., 2016
Elimination of congestions and waiting time at a seaport	Roso, 2007; Roso, 2009; Roso, 2013; Roso & Lumsden, 2010
Costs reduction due to lower CO <sub>2</sub> emissions / efficient use of energy	Lättilä et al., 2013; Do et al., 2011
Elimination of forwarding fees	Panova, 2011; Do et al., 2011
Elimination of demurrage and late documentation fees	Do et al., 2011
Increased quality of life	Roso et al., 2009
Reduced risk of road accidents	Roso, 2007; Roso, 2009; Othman et al., 2016
Reduced congestions in seaport cities	Korovyakovsky & Panova, 2011, Onyemechi, 2013, Roso, 2013, Othman et al., 2016
Less traffic	Roso, 2008; Roso, 2013, Khaslavskaya & Roso, 2019
CO <sub>2</sub> emission reduction along the roads and seaports	Roso, 2007; Korovyakovsky & Panova, 2011; Hanaoka & Regmi, 2011; Jaržemskis, 2007; Lättilä et al., 2013; Zeng et al., 2013; Dorostkar et al., 2016; Henttu & Hilmola, 2011; Muravev & Rakhmangulov, 2016; Roso & Lumsden, 2010; Roso, 2009, Regmi & Hanaoka, 2013; Henttu et al., 2011; Do et al., 2011; Khaslavskaya & Roso, 2019
Facilitating international trade	Hanaoka & Regmi, 2011
Increased reliability for shippers	Khaslavskaya & Roso, 2019
Secure and expend hinterland	Roso et al., 2009; Roso et al., 2019;

**Seaports**

		Khaslavskaya & Roso, 2019
	Increased reliability of a seaport	Jeevan et al., 2015a
	Minimization of negative environmental impact by better utilization of seaports capacity	Muravev & Rakhmangulov, 2016
	CO2 emission reduction at seaport's area and local roads	Roso, 2007; Korovyakovsky & Panova, 2011; Hanaoka & Regmi, 2011; Lättilä et al., 2013; Zeng et al., 2013; Dorostkar et al., 2016; Henttu & Hilmola, 2011; Muravev & Rakhmangulov, 2016; Roso & Lumsden, 2010; Roso, 2009, Regmi & Hanaoka, 2013; Henttu et al., 2011
	Increase of a seaport's throughput / capacity increase	Roso et al., 2009; Jeevan et al., 2015a; Werikhe & Jin, 2015; Talley & Ng, 2018; Talley & Ng, 2017; Fazi & Roodbergen, 2018; Khaslavskaya & Roso, 2019; Wilmsmeier et al., 2011; Rodrigue & Notteboom, 2012
	Increased seaport competitiveness	Roso, 2013; Jeevan et al., 2015a; Roso et al., 2019
	Releasing expensive land at a seaport / better land utilization	Panova, 2011; Fazi & Roodbergen, 2018
	Increased market share	Wilmsmeier et al., 2011
<b>Regions</b>	Obtaining added value through job creation (public interests)	Roso et al., 2009; Rodrigue et al., 2010; Jeevan et al., 2015a; Roso & Lumsden, 2010; Do et al., 2011; Panova, 2011
	Stimulation of national business	Jeevan et al., 2015a; Ng & Tongzon, 2010
	Regional development / creating new economic clusters	Bask et al., 2014; Jeevan et al., 2015a; Do et al., 2011; Panova & Hilmola, 2015; Panova, 2011
	Employability / job creation	Bask et al., 2014; Jeevan et al., 2015b; Rodrigue et al., 2010; Jeevan et al., 2015a; Roso et al., 2009; Roso & Lumsden, 2010; Do et al., 2011; Panova, 2011; Khaslavskaya & Roso, 2019; Ng & Tongzon, 2010
	Smaller infrastructure investments	Roso et al., 2009; Bask et al., 2014; Jeevan et al., 2015b
	Stimulation for international business	Jeevan et al., 2015a; Dorostkar et al., 2016; Wang et al., 2016

The results were drawn from an “all-inclusive” sample of the academic literature on dry ports, thus there was no differentiation of the benefits in connection to types of dry ports (although possible taxonomies of dry ports were also identified). In other words, a “glossary” of benefits was written, and each entry there requires a specific context to be relevant. These results are considered potential benefits that dry ports might generate for stakeholders in the hinterland

transport system; in other words, they constitute the answer to the RQ1. The most substantial contribution to the RQ1 comes from Paper I (corresponding to the Study 1).

## 5.2 Contribution to the RQ2

The research empirically investigated what kind of benefits are perceived as desirable (Paper II) and achievable (Paper III) by the stakeholders and also challenged the findings of the SLR by both suggesting framework (overlapping with, but also) complementing the findings of Paper I and posing open questions to the respondents. Paper III, in turn, even though focused on categories rather than very specific benefits (translated there into objectives of stakeholders), questioned the ability of dry ports to actually generate the selected categories of benefits to the stakeholders.

Building on the results of Paper I (there was not any differentiation of the benefits in connection to types of dry ports), Paper II contributes to categorization of the benefits while Paper III attempts to distinguish between dry ports types (varying in the services available) and their ability to generate the benefits to the stakeholders. Even further, the study attempted to avoid “expectancy” bias and confronted the “reality out there” with the “hard knowledge” of the peer-reviewed scientific publications, as well as opinions of those experienced in the field of academics.

To the current thesis, the findings of Paper II contribute by generating the following:

- Generated knowledge about stakeholders of dry ports’ operations in Sweden;
- Captured opinions of the same stakeholders on dry ports’ ability to generate value for the entirety of them (supply chain) (Table 14);
- Objective identification for the design stage of Study 3.

*Table 14. Means of achieving supply chain outcomes by integration of a dry port in a supply chain*

<b>SCO</b>	<b>Means to enhance the SCO by integration of a dry port from the literature findings</b>	<b>Stakeholders’ reflection on the enhancement of the SCO</b>
<b>Cost</b>	<p>Increased capacity of hinterland transportation system</p> <p>Benefits from networking among dry ports;</p> <p>Lowered risks associated with hinterland leg of transportation due to intermodal setup</p> <p>Elimination and decrease of storage and road transportation fees</p>	<p>Literature findings are confirmed</p> <p>Risks of financial losses due to private ownership of a dry port and overcomplicated hinterland transportation setup are expressed</p>
<b>Responsiveness</b>	<p>Flexible and adaptive setup</p> <p>Reliable and frequent transportation arrangement</p> <p>Less delays</p> <p>Customization of service</p>	<p>Literature findings are confirmed</p> <p>In addition, more accuracy in short-term planning is expected; risks with high magnitude of financial loss in case of transportation interruption are expected.</p>
<b>Security</b>	<p>Safety and security assured by a dry port assured security due to consolidation of cargo</p>	<p>Literature findings are confirmed</p> <p>Fewer human errors are expected in the dry port integrated setup.</p>

<b>Environmental performance</b>	CO2 reduction due to modal shift, eliminated congestions and alternative fuels for trucks	Literature findings are confirmed
<b>Resilience</b>	resilient setup towards potential labor conflicts in a seaport	Literature findings are confirmed
<b>Innovation</b>	Constitution of new thinking in the environment of changing needs	Literature findings are confirmed

Paper III was fully dedicated to study the ability of dry ports to generate the identified (categories of) benefits. The results are presented in Figure 5.

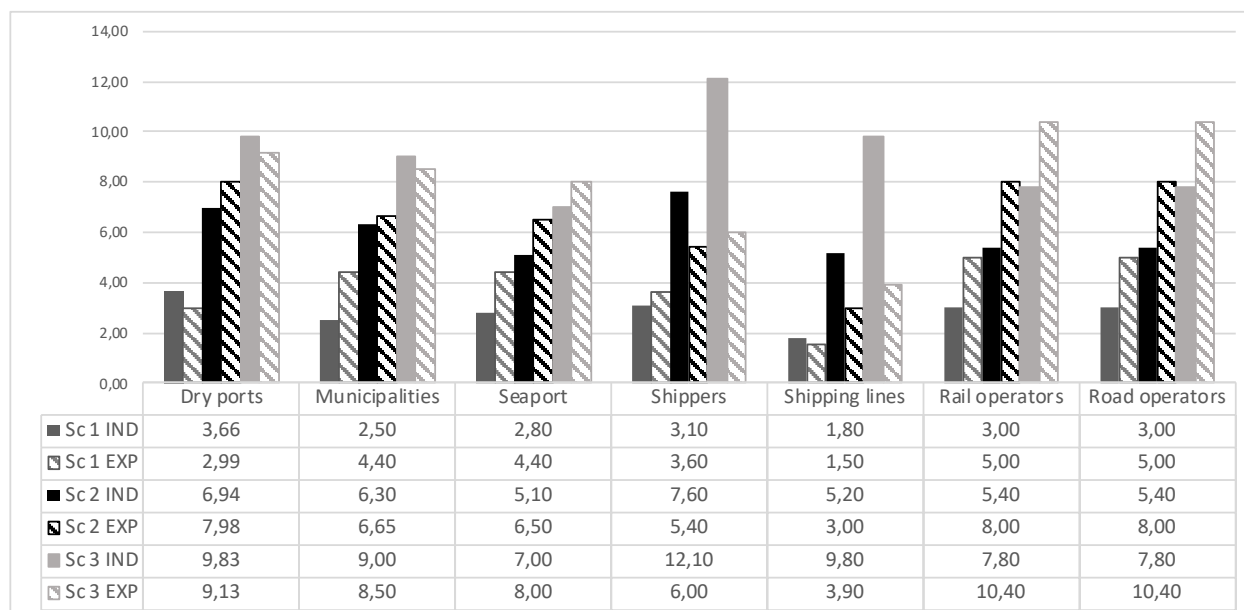


Figure 5. Ability of dry ports with different services to generate benefits for stakeholders

Figure 5 shows evaluation by the stakeholders (IND from “industry”) and also by the experts (EXP). Figure 5 shows that the more services a dry port has, the better it can help each stakeholder to meet its own objectives.

## 5.3 Summary of the contributions

### 5.3.1 Summary of the contributions to the thesis, its purpose and RQs

In Table 15 the contribution of each paper included in the current thesis, its purpose, and the research questions is presented.

Table 15. Summary of the papers’ contributions to the research questions

Paper	Purpose	Contribution to the thesis, its purpose and RQs
<b>Paper I</b>	To find out what the current knowledge on dry ports is	Thesis: Background for the further research RQ1: potential benefits identified from academic literature of dry ports for multiple actors of the transport system Purpose: Identified potential benefits and implication for the list of stakeholders
<b>Paper II</b>	To explain how a supply chain can benefit or	Thesis: confirmation and confrontation of the results of

	enhance its outcomes of cost, responsiveness, security, environmental performance, resilience, and innovation, by the integration of a dry port	Paper I; input for Paper III; RQ2: identified actual desirable benefits for the stakeholders in the given context (Sweden); Purpose: insights about the given context (Sweden); modified list of relevant stakeholders; input for identification of actual benefits
<b>Paper III</b>	To suggest a configuration of a dry port that brings the most benefits to the stakeholders, by identifying services of the dry ports that have the largest positive influence on stakeholders' objectives	Thesis: aggregating all the input from previous research included in the current thesis; providing opportunity to meet the research purpose of the thesis RQ2: Conclusions on dry ports ability to generate desirable benefits to help the stakeholders achieve their objectives Purpose: Meeting the research purpose; implications for the discussion

### 5.3.2 Other contributions

Papers included in the current thesis contribute not only to the thesis purpose, but also have extra contributions to the research field; they make their own, broad contribution to the research on intermodal transport, with focus on transport terminals, and specifically to the research on dry ports.

#### 5.3.2.1 Contribution of Paper I

As mentioned above, the research started with the literature review that was undertaken to summarize the knowledge in the field and identify stakeholders and their potential benefits. The contribution of the review to the research field is in itself. Among academic papers identified and included in the review (Paper I) there were several reviews including the notion of a dry port, but always taking a broader perspective, i.e., Roso and Lumsden (2010), Rožić et al. (2016), and Witte et al. (2019). Contribution of the same is shown in Table 16.

Table 16. Contribution of identified review papers

Paper	Purpose	Results
<b>Roso and Lumsden (2010)</b>	“the purpose of this article is to clarify the concept by showing potential discrepancies or agreements between theory and practice”	“synthesizing a literature review on the subject of dry ports; moreover, it provides an overview of dry ports in the world”
<b>Rožić et al. (2016)</b>	“summarize the literature related to development, classification, technological processes and location of inland terminals”	“the paper identifies a new proposition for further research based on the current trends and developments in inland terminals as an important factor of intermodal transport”
<b>Witte et al. (2019)</b>	“a systematic and integrated review of inland port studies, covering 80 international peer-reviewed academic journal papers on inland port development between 1992 and 2017”	“much attention is paid on inland ports as components of the ‘transport/logistics/supply chain’ systems (follower), while their roles as components of the ‘regional’ systems (leader) are largely overlooked”

**SLR (Paper I)**

the purpose of this paper is to summarize current scientific knowledge on the phenomenon and to identify research outcomes, trends and future research implications

The research area is young and discrete, but several trends were observed: 1) the concept has gained acknowledgment; 2) the concept can be further developed given the amount of published case studies; 3) few publications consider broader perspectives of dry ports; 4) there is a great potential for managerial implications of so-far published research

The role of the SLR in the field is in its aim to focus on the research object referred as a “dry port” in academic research but not to other hinterland transport system nodes and terminals, and to track the development of understanding of the concept and growth of the knowledge about the same.

Table 16 shows that regardless of the fact that several literature reviews in relation to the dry port phenomenon were identified, there is still a place for the SLR and its contribution. While Roso and Lumsden (2010) focus on actual dry ports and in addition to reviewing literature on the same present an overview of the facilities, Witte et al. (2019) and Rožić et al. (2016) take a much broader perspective on inland nodes and terminals.

The publications are broadly categorized in the thematic areas, i.e. concept, environmental impact, economic impact, performance impact, network perspective, miscellaneous; and further into subcategories. It is obvious from the review that certain topics have gained more attention among the researchers while the others are still scarcely researched (Figure 6).

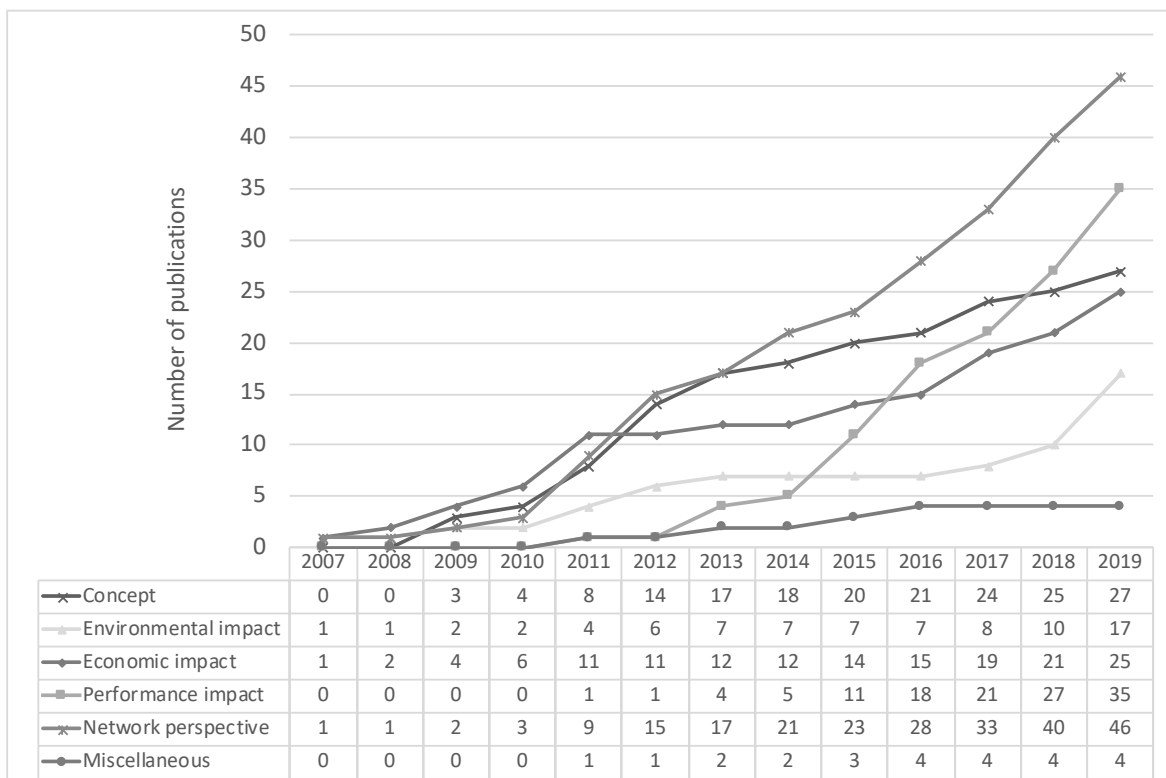


Figure 6. Publications trend per category

Accumulated numbers of publications per category per year; exceeds 102 publications as most of the reviewed publications cover more than one of the identified categories and are thus counted several times.

The research has grown in a divergent set of knowledge, but few trends have been observed. Firstly, the concept has gained significant acknowledgment in the transportation research field, although the discussion on terminology and taxonomy periodically re-appear. Overall, there are relatively few publications aiming to develop the concept further. Aspects related to dry ports' functions, strategies, and operations might be constructed and conceptualized from already published case studies and new empirical evidences. Secondly, research has been taking a perspective on dry ports that investigates the phenomenon as an element of hinterland transportation system, often as an element of seaport-dry port dyad (locating it as a port regionalization concept). Thirdly, the environmental perspective is more recent to the research on dry ports but very few publications consider the broader perspective of dry ports' sustainability. Finally, a significant part of research studies has focused on models for the optimal location of dry ports within the hinterland of a port.

### 5.3.2.2 Contribution of Paper II

Paper II provides evidence of the effect of a dry port on a supply chain and dry ports' role in enhancing supply chain outcomes from multiple stakeholders' perspectives in Sweden. The study was framed based on the assumption that the individual stakeholders can identify and also gain benefits as part of a supply chain. Thus, the background of this study was a supply chain and a framework focusing on supply chain outcomes was used for structuring the discussion with the stakeholders. Paper II empirically confirmed what kind of benefits are perceived as desirable and achievable by the stakeholders in Sweden and also challenged the findings from Paper I by both suggesting framework (overlapping with, but also) complementing the findings of Paper I and posing open question to the respondents. In addition, by taking a Swedish perspective Paper II unrevealed context specific insights.

### 5.3.2.3 Contribution of Paper III

The results of Paper III suggest that there is an optimal configuration of a dry port for the given context (Sweden) that allows to better reach objectives for all the identified stakeholders, and that is the configuration that corresponds to Scenario 3 as defined in Paper III. Scenario 3 in the Paper III implies that a dry port should provide different services ranging from the most basic, i.e., transshipment, storage/depot, handling of empty and loaded containers, road haulage, to VAS and customer-oriented VAS for the identified stakeholders to be best able to reach their objectives, hence to benefit from dry ports. By expanding service portfolio dry ports become attractive for new customers, which in turn leads for expansion of operations. This is beneficial not only for the dry port operators, but for all the involved transport operators, seaports, and the municipalities of the dry port location. For the latter, more operation in the region does not necessarily bring new businesses to the area but helps to retain existing ones.

Summary of the contributions is presented in Table 17.

*Table 17. Contribution of the papers to the research field*

<b>Paper</b>	<b>Contribution to the research field</b>
<b>Paper I</b>	<p>a review, or summary, of the research field on dry ports that has grown from 2 to more than 100 publications within the past decade;</p> <p>suggested categories (concept, environmental impact, economic impact, performance impact, network perspective) that describe and summarize the scientific input that had been peer-reviewed and published (Figure 6)</p>
<b>Paper II</b>	<p>an exemplification of dry port operations in the given context (Sweden) from multiple stakeholders' perspective in the given framework (supply chain);</p> <p>empirical evidence of the effect of a dry port on a supply chain;</p> <p>dry port's role in enhancing supply chain outcomes of cost, responsiveness, security, environmental performance, resilience, and innovation</p>

- Paper III** the study identified stakeholders in the Swedish context and their objectives in relation to the dry port operations (modified list compared to Paper II);
- the stakeholders' evaluation of those criteria shows the relative importance of their objectives in relation to the operations through dry ports;
- an optimal configuration of a Swedish dry port is identified by applying Multi-Actor Multi-Criteria Analysis-based method;
- finally, the configuration of existing Swedish dry ports is judged against findings;
- managerial implications:
- to assist in the implementation of dry ports currently under consideration and develop the ones in early stages;
  - to minimize risk of insufficient cargo flows and excess infrastructure.
-



## 6 Discussion

As per design of the current thesis, three independent studies (resulting in three papers) served to answer the research questions and to meet the research purpose. The purpose of the thesis was to identify dry ports' benefits for the stakeholders in a seaport's hinterland transport system in order to increase understanding about the dry ports' role in that system. Although the studies had independent purposes, they all contributed to the research purpose. The studies were interconnected: while antecedent studies served as a background for design of the subsequent ones, the subsequent studies utilized, advanced, and challenged the findings of the antecedent ones.

The following discussion first looks at the studies in relation to one another, and afterwards focuses on answering research questions, and contribution of the studies to the research field.

### 6.1 Discussion of the studies in relation to one another

Interrelation of the studies is presented in Figure 7.

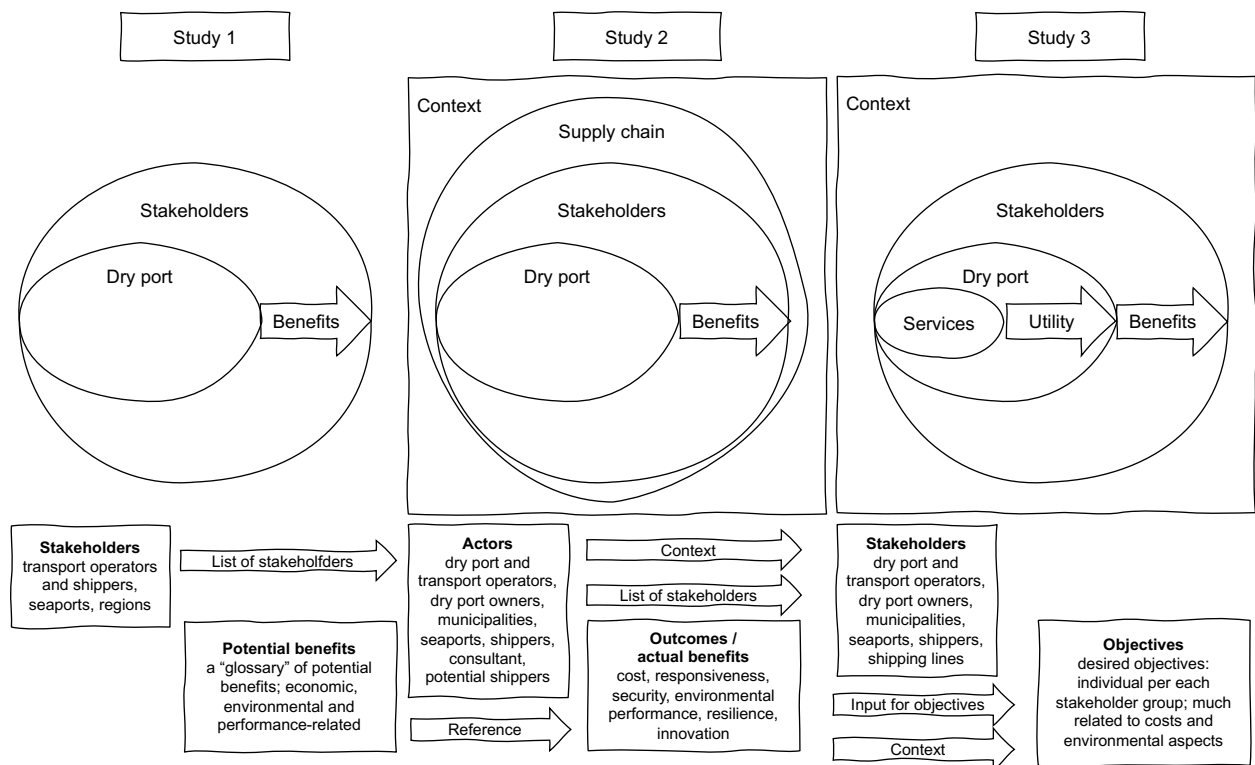


Figure 7. Interrelation of studies

As evident from Figure 7, studies were interconnected; this means that the output of one study affected the design of the subsequent one(s); while subsequent ones confirmed, clarified, or challenged the output of the previous one(s) (however, this did not affect the studies/papers as such).

Of interest is how the notions of benefits and objectives relate to one another as well as the relation of stakeholders and actors as referred to in Figure 7.

The potential benefits were identified by broad search in already existing research publications and resulted in the list (Paper I). Although the categorization corresponding to broad categories resembling sustainability pillars was suggested already (in Paper I), the categories as such were not identified. This is due to the fact that there is no generic dry port that would be able to generate the whole list of the identified benefits, and also because it was beyond the scope of Study 1 to match dry port types and their potential benefits for relevant stakeholders, as well as

to place them into a relevant context. However, as further research picked up this direction, both potential benefits and stakeholders' notions were migrated to Paper II.

The building blocks of Study 2 are "actors" that practically refer to the same as stakeholders in other studies as well as in the thesis, and "outcomes" that practically mean categories of benefits that may be gained by a bigger system uniting the actors (supply chain). This study, even though having a strong reference to the previous academic knowledge (output of Study 1), took an inductive approach while collecting data. That means that even though the respondents were guided by suggested framework (SCO), they were free to interpret and discuss what the categories of benefits (outcomes) would mean for them and for the bigger system (supply chain), how important and achievable they are, as well as to relate to practical examples from their own industry experience to "form" the context. This resulted in the new interpretation of categories of benefits (outcomes) in regard to operations through dry ports. This twofold approach now allows to combine academic and industrial views and to obtain a list of actual benefits that is placed in context (Sweden), but also to assign these benefits to particular stakeholders. To exemplify this research effort, I can bring up an example of the outcome of responsiveness.

#### *Example*

*Responsiveness as such was not evident to be of interest for the stakeholders from the results of Study 1, however, it was suggested as an option during Study 2, with its interpretation gained from the respondents in Study 2. By connecting the interpretation of the responsiveness suggested by the respondents in Study 2 to the potential benefits of Study 1, it was possible to categorize the potential benefits, identify which were relevant to the given context (Sweden) and to use this pair (stakeholder – category of benefit with detailed interpretation from the respondents of Study 2) as a basis for the stakeholders objectives in Study 3 (and hence criteria and indicators).*

In such a way, it was possible to identify objectives (criteria and indicators) of the stakeholders, respective to the benefits of their interest. Table 18 shows the result of this effort and also the results of objectives (hence categories of benefits) evaluation.

Table 18. Interconnection of the studies' results

Study 1 (categories of benefits)	Study 2 (outcomes)	Study 3 (objectives)						
		Dry port	Municipality	Seaport	Shippers	Shipping lines	Rail operator	Road operator
Economic	Cost	Profit (67%)	Boosting regional economic development (55%)	Profit (35%)	Logistics costs (50%)	Profit (30%)	Profit (60%)	Profit (85%) / avoiding environmental zones (10%)
Environment	Environmental performance	Green image (33%)	Environmental performance (45%) / Green image (25%)	Green image (25%)	Green image (20%)			
Performance	(Partly same with responsiveness, resilience, cost, innovation)			Competitiveness (40%)		Competitiveness (70%)	Competitiveness (20%)	
	Security							
	Responsiveness				Service level (30%)		Reliability (20%)	Avoiding congested roads (15%)
	Resilience							
	Innovation							

Table 18 shows “transformation” of the notion of benefits throughout the research. First column contains the categories identified in the Study 1; second column shows the SCO that can be associated with the classification of the benefits from the Study 1 (first column), economic and environmental aspects overlap, while other benefits are perceived (classified) differently. However, if to look into interpretations (Table 13 and Table 14), the categories/SCO overlap, too. All the rest of the table represents the objectives (respective to the categories of benefits) of the stakeholders identified as an input for the Study 3 based on output from Study 1 and Study 2. Percentage in parenthesis mean relative importance of the objectives (result of the Study 3), should be read from up to down (per each stakeholder it sums up to 100%).

## 6.2 Discussion of the results in relation to the literature

Dry ports’ benefits for stakeholders and dry ports’ ability to fulfil the stakeholders’ expectations were the focus of the study. Their interconnection resulted in describing relations between them, contextualization, as well as giving them meaning.

It is difficult to discuss identified potential benefits of dry ports in relation to the academic literature, as these benefits are derived from the same literature. However, none of identified research publications directly addressed the issue of creating an “all-inclusive” description of the dry ports’ potential benefits. In a way, the identified potential benefits of a dry port resemble a “collective image” of the phenomenon and serves as a “glossary” of a dry port’s usefulness, and can be useful only when contextualized.

This is where the research path shifts: onto the path of contextualization of the potential benefits, or placing potential benefits to the context to filter the actual ones for the relevant stakeholders in the given context (Sweden). This result is similar to the previous attempt by Roso and Rosa (2012), which in a similar manner identifies stakeholders and the benefits they may gain from interaction with a dry port. Contributing to that attempt, the current research takes a different classification of dry ports (based on services they provide).

On one hand, the contribution of a case-based research of a particular dry port (Paper II) in a particular geographical and economic setting stands in a row with many other publications doing the same – providing exemplification of a dry port’s development path and functionality in a certain context. A major part of the research on dry ports is represented by a geographic-specific case studies; as examples, studies from Australia (Roso, 2013), South America (Padilha & Ng, 2012), the United States (Roso et al., 2019), Asia (Ng & Gujar, 2009; Hanaoka & Regmi, 2011), Russia (Korovyakovsky & Panova, 2011) and Europe (Henttu & Hilmola, 2011; Monios, 2011). On the other hand, the research (Paper II) also stands out by taking the rare perspective of a supply chain and also by challenging contributors from the industry to think “outside of the box.” This means that the respondents were challenged to think about the benefits that a dry port may generate for a supply chain and to associate themselves with a bigger system. Expected results were obtained; the cost of any solution prevails over other outcomes (benefits) well in line with other significant parts of the research on dry ports, e.g., Bask et al. (2014) and Henttu and Hilmola (2011), whose conclusions are that the financially optimal solution wins over the less profitable (often) regardless of other aspects. It is also supported by the authors of the applied framework, Melnyk et al. (2010), who claim that at least one of the outcomes should stand out (and it is a cost outcome in this case). However, at least four outcomes appear to be of greater interest, according to the results, and those are cost and environmental performance (as previously discussed by, e.g., Henttu and Hilmola, 2011; Lättilä et al., 2013) but also responsiveness and resilience and relatively lower attention is drawn to the security and innovation outcomes. Altogether, as according to Booth et al. (2003), the “challenge” of a new-to-the-research-field framework provided additional support to what had been known (cost and environmental performance outcomes prevail) and confirmed the unsupported claim (novel view on dry ports’ benefits through the lenses of responsiveness and resilience).

This part of the research also made its contribution to the framework borrowed from Melnyk et al. (2010), by exemplifying a supply chain that can and should adapt a SCO model, where a transport element of the same has a great potential to deliver the outcomes (generate the benefits). This approach also contributes to better awareness of the stakeholders on how dry ports as elements and triggers of intermodal transportation may contribute to more efficient SCs. This problem has been brought up, e.g., by Chuanwen et al. (2018) who argued that one of the hindrances to shift goods from road to rail is that many stakeholders do not consider the overall SC impact (outcomes) of multimodal transportation. High-capacity transport modes are in general seen as cheaper and greener, but not flexible or fast enough, resulting in managers perceiving the straight modal shift leading to increases in inventory, and consequently having negative impacts on the SC (Chuanwen et al., 2018), while the current research has counterarguments towards increased responsiveness (flexibility). Similarly, Woodburn (2013) noted that managers' perception of rail transportation is impairing SC performance, and consequently create a barrier to this mode, increasing its market share; while Bichou (2006) emphasized, seaports bring together actors of the SC, contribute to the SC, and its outcomes by creation of competitive advantage and value-adding services.

Picking up on services, the research continues towards being specific about how well the outcomes (now they transform from output of the research into input for the next step of the same in the form of stakeholders' objectives) can be achieved by means of different types of dry ports, varying in services they provide. This part of the research is built upon the earlier ideas presented by Bask et al. (2014) where the researchers focus on dry port development in dyads with a seaport, but also on the services' role in value creation. The referred study classifies dry ports depending on the distance from a seaport, but also on their functionality that depends on the same (Roso & Rosa, 2012). The claim is that VASs are important for the development of dry ports and different services can offer the shippers' different benefits, hence different dry ports are better suitable to help the stakeholders to meet their objectives.

To the point, the next step of the research picks up from this conclusion and develops more detailed and multi-actor framework on what the stakeholders are and what benefits they desire for; and how the dry ports with different service portfolio are able to generate the benefits. Similarly to the Bask et al. (2014), the findings show the primary importance of basic services. VASs bring extra benefits with regard to all the identified objectives, provided that the basic services are in place and in sufficiency. Further on, if this is fulfilled, extra services have potential to significantly contribute to the stakeholders' achievements of goals in a gradual manner; according to the results, the more varying and inclusive the service portfolio is, the greater extent the objectives are met. However, similar to Bask et al. (2014), as the development of dry ports proceed, some services are abandoned while the others appear, and this is closely related to the market demands and change of preferences.



## 7 Conclusions

The chapter contains conclusions and final thoughts about the research included in the thesis. It also suggests a possible continuation of the research.

### 7.1 Main insights

The research focused on the notions of dry ports' potential benefits, actual benefits for stakeholders, and dry ports' ability to generate the same.

A "collective image" of a dry port has a utility that if contextualized can bring multiple benefits to all relevant stakeholders in accordance to their objectives. The benefits can be classified differently, e.g., as per in Study 1, they would include economic, environmental, and performance-related categories; and as per Study 2, the benefits can be seen as cost, environmental performance, responsiveness, resilience, (and to lower extent) security, and innovation categories.

The set of relevant stakeholders/actors was modified during the research process; the final one relevant to the context of Sweden included the following: seaport, dry port's operator, transport operators, i.e., shipping lines, rail and road operators, shippers, municipalities. Their objectives respective to the benefits identified in the earlier steps of research were proven relevant (with minor exceptions) and were evaluated. The evaluation showed that the finance-related objectives have the largest importance in the stakeholders' agenda; relative importance of all the objectives and hence benefits is presented in Table 18. It also showed (by conducting an extra expert evaluation of the same) that the stakeholders' perception of gaining benefits is greater than the one given by the experts; however, the trend is the same. In other words, both evaluations show that extra services have potential to contribute significantly (and slightly less significantly, according to expert opinion) to the stakeholders' objectives in a gradual manner. According to the results, the more varying and inclusive the service portfolio of a dry port is, the objectives are met to the greater extent (Figure 5).

The results show that development of a dry port towards having more VAS enhances most of the objectives of the stakeholders. This is especially true for the finance-related criteria.

As per their pattern of development, dry ports keep up a steady improvement of the objectives as they evolve toward more complex scenarios, in relation to both financial- and environmental-specific criteria. Their patterns of growth are similar to the situation for the seaports: the expansion of the financial-specific criteria (profit and competitiveness) are observed to have an improvement followed by a slower and smaller rise of environmental-specific criteria.

In the case of the municipality, a trade-off between economic rise and environmental performance should be noted. It can be seen that the environmental-specific criteria emerging from the evaluation of certain indicators – traffic and congestion reduction, emission reduction; noise and vibration reduction – is not perceived positively; in contrast, enhancement of dry port operations seems to have a negative influence on the criteria. However, due to its relatively low importance, the absolute influence is relatively low, too.

The biggest advantage for the shippers is a reduction in costs together with the development of the dry port's service portfolio. After all, the services are often of a high quality but remain competitively priced due to the remote location. The indicator of "avoiding road tolls," though, has not been considered of importance by the stakeholders during the evaluation process. Other criteria are growing steadily.

For the transport operators, the similar pattern related to the profit: improvement of the financial criteria caused by an increase in number of services at the dry port. However, for rail operators, the effect on reliability seems to be limited and only gets its rise from scenario 1; while road operators' priority is clearly concentrated on profit with just a slight interest in reliability.

The research generated knowledge capable to educate the stakeholders about dry ports' benefits in the context, one another's objectives and the importance of them and also about their ability to meet the objectives in scenarios with different dry ports configurations.

## **7.2 Future research**

This is when a problem formulation takes a new loop. The result of the current research suggests that there is a higher expectation among practitioners in the defined context from what they have in reality as dry ports. Even though strongly relying on demand, the perception is strong towards an improvement and advancement of already existing dry ports; however, if to consider the degree of dry ports' utilization, that might not be the need. Dry ports' development should consider the changing needs of a stakeholder to achieve better utilization. In other words, the research can be continued towards strategies to achieve better utilization of dry ports, given the generated knowledge about their benefits and ability to assist the stakeholders in meeting their objectives.

In addition, the stakeholders that are "further" (by distance or as elements of transport system or a supply chain) from the dry ports might have less knowledge about the utility of the same and the benefits they may gain from the dry ports. Though the research has already suggested that some shipping lines do see a potential to reach their own objectives in a better way by closer engagement with dry ports' operations (MAERSK, 2019).

Furthermore, the research touched upon dry ports utility generated by the services; utility in connection to other characteristics of dry ports might be of interest for the research community and stakeholders. And finally, there is a great opportunity to connect the "glossary" of the dry ports' potential benefits to the context of all possible taxonomies of dry ports (Table 3) in a given (or "collective"?) context.

## References

- Alam, J., 2016. Role of effective planning process in boosting dry port effectiveness: A case study of central Pakistan. *International Journal of Supply Chain Management* 5, 153–164.
- Andersson, D., Roso, V., 2016. Developing dry ports through the use of value-added services, in: *Commercial Transport*. Springer, pp. 191–203.
- Bask, A., Roso, V., Andersson, D., Hämmäläinen, E., 2014. Development of seaport-dry port dyads: Two cases from Northern Europe. *Journal of Transport Geography* 39, 85–95. <https://doi.org/10.1016/j.jtrangeo.2014.06.014>
- Bazeley, P., Jackson, K., 2013. *Qualitative data analysis with NVivo*. Sage Publications Limited.
- Bell, E., Bryman, A., Harley, B., 2018. *Business research methods*. Oxford university press.
- Bentaleb, F., Mabrouki, C., Semma, A., 2015. A Multi-Criteria Approach for Risk Assessment of Dry Port-Seaport System. *Supply Chain Forum* 16, 32–49.
- Beresford, A., Pettit, S., Xu, Q., Williams, S., 2012. A study of dry port development in China. *Maritime Economics & Logistics* 14, 73–98.
- Beresford, A.K.C., Dubey, R.C., 1990. *Handbook on the management and operations of dry ports*, UNCTAD. RDP/LDC/7, Geneva, Switzerland-256 p.
- Bergqvist, R., Falkemark, G., Woxenius, J., 2010. Establishing intermodal terminals. *World Review of Intermodal Transportation Research* 3, 285–302. <https://doi.org/10.1504/WRITR.2010.034667>
- Bichou, K., 2006. Review of port performance approaches and a supply chain framework to port performance benchmarking. *Research in Transportation Economics* 17, 567–598.
- Black, J., Roso, V., Marušić, E., Brnjac, N., 2018. Issues in dry port location and implementation in metropolitan areas: The case of Sydney, Australia. *Transactions on Maritime Science* 7, 41–50. <https://doi.org/10.7225/toms.v07.n01.004>
- Booth, Wayne C., Booth, William C., Colomb, G.G., Colomb, G.G., Williams, J.M., Williams, J.M., 2003. *The craft of research*. University of Chicago press.
- Chuanwen, D., Boute, R., McKinnon, A., Verelst, M., 2018. Investigating synchromodality from a supply chain perspective. *Transportation Research Part D: Transport and Environment* 61, 42–57.
- Dadvar, E., Ganji, S.R.S., Tanzifi, M., 2011. Feasibility of establishment of “Dry Ports” in the developing countries-the case of Iran. *Journal of Transportation Security* 4, 19–33. <https://doi.org/10.1007/s12198-010-0056-x>
- Do, N.-H., Nam, K.-C., Le, Q.-L.N., 2011. A consideration for developing a dry port system in Indochina area. *Maritime Policy and Management* 38, 1–9. <https://doi.org/10.1080/03088839.2010.533712>
- Durach, C.F., Kembro, J., Wieland, A., 2017. A new paradigm for systematic literature reviews in supply chain management. *Journal of Supply Chain Management* 53, 67–85.
- Ellram, L.M., 1996. The use of the case study method in logistics research. *Journal of business logistics* 17, 93.
- European Commission, 2001. *Freight intermodality, Transport RTD Programme of the 4th Framework Programme*.
- Flämig, H., Hesse, M., 2011. Placing dryports. Port regionalization as a planning challenge – The case of Hamburg, Germany, and the Süderelbe. *Research in Transportation Economics* 33, 42–50. <https://doi.org/10.1016/j.retrec.2011.08.005>

- Flick, U., 2018. An introduction to qualitative research. Sage Publications Limited.
- Halldorsson, A., Aastrup, J., 2003. Quality criteria for qualitative inquiries in logistics. *European Journal of Operational Research* 144, 321–332.
- Hanaoka, S., Regmi, M.B., 2011. Promoting intermodal freight transport through the development of dry ports in Asia: An environmental perspective. *IATSS Research* 35, 16–23. <https://doi.org/10.1016/j.iatssr.2011.06.001>
- Henttu, V., Hilmola, O.-P., 2011. Financial and environmental impacts of hypothetical Finnish dry port structure. *Research in Transportation Economics, Intermodal Strategies for Integrating Ports and Hinterlands* 33, 35–41.
- Jeevan, Jagan, Chen, S., Lee, E., 2015. The Challenges of Malaysian Dry Ports Development. *The Asian Journal of Shipping and Logistics* 31, 109–134.
- Jeevan, J., Chen, S.-L., Cahoon, S., 2019. The impact of dry port operations on container seaports competitiveness. *Maritime Policy and Management* 46, 4–23. <https://doi.org/10.1080/03088839.2018.1505054>
- Jeevan, J., Ghaderi, H., Bandara, Y.M., Saharuddin, A.H., Othman, M.R., 2015. The implications of the growth of port throughput on the port capacity: the case of Malaysian major container seaports. *International Journal of e-Navigation and Maritime Economy* 3, 84–98.
- Jeevan, J., Salleh, N.H.M., Loke, K.B., Saharuddin, A.H., 2017. Preparation of dry ports for a competitive environment in the container seaport system: A process benchmarking approach. *International Journal of e-Navigation and Maritime Economy* 7, 19–33.
- Khaslavskaya, A., 2017. Hinterland transport actors' perspective on dry ports. Research Proposal Seminar. Chalmers University of Technology.
- Korovyakovskiy, E., Panova, Y., 2011. Dynamics of Russian dry ports. *Research in Transportation Economics* 33, 25–34. <https://doi.org/10.1016/j.retrec.2011.08.008>
- Lättilä, L., Henttu, V., Hilmola, O.-P., 2013. Hinterland operations of sea ports do matter: Dry port usage effects on transportation costs and CO<sub>2</sub> emissions. *Transportation Research Part E: Logistics and Transportation Review* 55, 23–42. <https://doi.org/10.1016/j.tre.2013.03.007>
- Li, J., Jiang, B., 2014. Cooperation Performance Evaluation between Seaport and Dry Port; Case of Qingdao Port and Xi'an Port. *International Journal of e-Navigation and Maritime Economy* 1, 99–109.
- Lu, Y., Zhao, C., Leimeng, X., Lei, S., 2018. Dual Institutional Pressures, Sustainable Supply Chain Practice and Performance Outcome. *Sustainability* 10. <https://doi.org/10.3390/su10093247>
- Macharis, C., Baudry, G., 2018. Decision-Making for Sustainable Transport and Mobility: Multi Actor Multi Criteria Analysis. Edward Elgar Publishing Limited, UK.
- Macharis, C., De Witte, A., Ampe, J., 2009. The multi-actor, multi-criteria analysis methodology (MAMCA) for the evaluation of transport projects: Theory and practice. *Journal of Advanced transportation* 43, 183–202.
- MAERSK, 2019. A.P. Moller – Maersk to accelerate growth in Logistics & Services through further integration. URL [https://www.maersk.com/news/articles/2019/05/16/maersk-to-accelerate-growth-in-logistics-and-services?utm\\_source=linkedin&utm\\_medium=organicpost&utm\\_campaign=ML\\_2019\\_MAY\\_GL\\_GrowthinLogistics\\_EN&utm\\_content=STCP](https://www.maersk.com/news/articles/2019/05/16/maersk-to-accelerate-growth-in-logistics-and-services?utm_source=linkedin&utm_medium=organicpost&utm_campaign=ML_2019_MAY_GL_GrowthinLogistics_EN&utm_content=STCP)
- Melnyk, S.A., Davis, E.W., Spekman, R.E., Sandor, J., 2010. Outcome-driven supply chains. *MIT Sloan Management Review* 51, 33.

- Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D., Zacharia, Z.G., 2001. Defining supply chain management. *Journal of Business logistics* 22, 1–25.
- Monios, J., 2011. The role of inland terminal development in the hinterland access strategies of Spanish ports. *Research in Transportation Economics, Intermodal Strategies for Integrating Ports and Hinterlands* 33, 59–66.
- Ng, Adolf K.Y., Gujar, G.C., 2009. Government policies, efficiency and competitiveness: The case of dry ports in India. *Transport Policy* 16, 232–239. <https://doi.org/10.1016/j.tranpol.2009.08.001>
- Ng, A.K.Y., Cetin, I.B., 2012. Locational Characteristics of Dry Ports in Developing Economies: Some Lessons from Northern India. *Regional Studies* 46, 757–773. <https://doi.org/10.1080/00343404.2010.532117>
- Ng, A.K.Y., Padilha, F., Pallis, A.A., 2013. Institutions, bureaucratic and logistical roles of dry ports: the Brazilian experiences. *Journal of Transport Geography, Institutions and the Transformation of Transport Nodes* 27, 46–55. <https://doi.org/10.1016/j.jtrangeo.2012.05.003>
- Nguyen, L.C., Notteboom, T., 2019. The relations between dry port characteristics and regional port-hinterland settings: findings for a global sample of dry ports. *Maritime Policy and Management* 46, 24–42. <https://doi.org/10.1080/03088839.2018.1448478>
- Notteboom, T., Rodrigue, J.-P., 2017. Re-assessing port-hinterland relationships in the context of global commodity chains, in: *Ports, Cities, and Global Supply Chains*. Routledge, pp. 67–82.
- Ouzzani, M., Hammady, H., Fedorowicz, Z., Elmagarmid, A., 2016. Rayyan — a web and mobile app for systematic reviews, *Systematic Reviews*.
- Padilha, F., Ng, A.K., 2012. The spatial evolution of dry ports in developing economies: The Brazilian experience. *Maritime Economics & Logistics* 14, 99–121.
- Paixão, A.C., Bernard Marlow, P., 2003. Fourth generation ports—a question of agility? *International Journal of Physical Distribution & Logistics Management* 33, 355–376.
- Parola, F., Sciomachen, A., 2005. Intermodal container flows in a port system network:: Analysis of possible growths via simulation models. *International journal of production economics* 97, 75–88.
- Port of Gothenburg, 2019. Railport Scandinavia.
- Rodrigue, J.-P., Debie, J., Fremont, A., Gouvernal, E., 2010. Functions and actors of inland ports: European and North American dynamics. *Journal of Transport Geography* 18, 519–529. <https://doi.org/10.1016/j.jtrangeo.2010.03.008>
- Rodrigue, J.-P., Notteboom, T., 2012. Dry ports in European and North American intermodal rail systems: Two of a kind? *Research in Transportation Business and Management* 5, 4–15. <https://doi.org/10.1016/j.rtbm.2012.10.003>
- Rodrigue, J.-P., Notteboom, T., 2010. Foreland-based regionalization: Integrating intermediate hubs with port hinterlands. *Research in Transportation Economics, The Port and Maritime Industries in the Post-2008 World: Challenges and Opportunities* 27, 19–29. <https://doi.org/10.1016/j.retrec.2009.12.004>
- Roso, V., 2013. Sustainable intermodal transport via dry ports—importance of directional development. *World Review of Intermodal Transportation Research* 4, 140–156.
- Roso, V., 2009. The emergence and significance of dry ports: The case of the Port of Goteborg. *World Review of Intermodal Transportation Research* 2, 296–310. <https://doi.org/10.1504/WRITR.2009.026209>

- Roso, V., 2008. Factors influencing implementation of a dry port. *International Journal of Physical Distribution & Logistics Management* 38, 782–798.
- Roso, V., 2007. Evaluation of the dry port concept from an environmental perspective: A note. *Transportation Research Part D: Transport and Environment* 12, 523–527.
- Roso, V., Lumsden, K., 2010. A review of dry ports. *Maritime Economics & Logistics* 12, 196–213.
- Roso, V., Rosa, A., 2012. Dry port in concept and practice.
- Roso, V., Russell, D., Rhoades, D., 2019. Diffusion of Innovation Assessment of Adoption of the Dry Port Concept. *Transactions on Maritime Science, ToMS* 8, 26–36. <https://doi.org/10.7225/toms.v08.n01.003>
- Roso, V., Russell, D., Ruamsook, K., Stefansson, G., 2015. Inland port services for seaport's competitive advantage. *World Review of Intermodal Transportation Research* 5, 263–280.
- Roso, V., Woxenius, J., Lumsden, K., 2009. The dry port concept: connecting container seaports with the hinterland. *Journal of Transport Geography* 17, 338–345.
- Rožić, T., Rogić, K., Bajor, I., 2016. Research trends of inland terminals: A literature review [Istraživački trendovi sustava pozadinskih terminala: pregled literature]. *Promet - Traffic - Traffico* 28, 539–548. <https://doi.org/10.7307/ptt.v28i5.2090>
- Seuring, S., Gold, S., 2012. Conducting content-analysis based literature reviews in supply chain management. *Supply Chain Management: An International Journal*. <https://doi.org/10.1108/13598541211258609>
- Singh, A., Teng, J.T., 2016. Enhancing supply chain outcomes through Information Technology and Trust. *Computers in human behavior* 54, 290–300.
- Skaraborgsbygden, 2018. Julia köper Dryport Skaraborg. Skaraborgsbygden. URL <https://skaraborgsbygden.se/nyheter/skaraborg/jula-koper-dryport-skaraborg/> (accessed 10.10.19).
- Tranfield, D., Denyer, D., Smart, P., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management* 14, 207–222.
- UNCTAD, 2017. Review of Maritime Transportation. United Nations Publication.
- Van de Ven, A.H., 2007. Engaged scholarship: A guide for organizational and social research. Oxford University Press on Demand.
- Van Klink, H.A., van Den Berg, G.C., 1998. Gateways and intermodalism. *Journal of transport geography* 6, 1–9.
- Veenstra, A., Zuidwijk, R., Van Asperen, E., 2012. The extended gate concept for container terminals: Expanding the notion of dry ports. *Maritime Economics and Logistics* 14, 14–32. <https://doi.org/10.1057/mel.2011.15>
- Wang, C., Chen, Q., Huang, R., 2018. Locating dry ports on a network: a case study on Tianjin Port. *Maritime Policy & Management* 45, 71–88.
- Wilmsmeier, G., Monios, J., Lambert, B., 2011. The directional development of intermodal freight corridors in relation to inland terminals. *Journal of Transport Geography* 19, 1379–1386.
- Witte, P., Wiegman, B., Ng, A.K.Y., 2019. A critical review on the evolution and development of inland port research. *Journal of Transport Geography* 74, 53–61. <https://doi.org/10.1016/j.jtrangeo.2018.11.001>

- Woodburn, A., 2013. Effects of rail network enhancement on port hinterland container activity: a United Kingdom case study. *Journal of Transport Geography* 33, 162–169. <https://doi.org/10.1016/j.jtrangeo.2013.10.010>
- Woxenius, J., Roso, V., Lumsden, K., 2004. The dry port concept—connecting seaports with their hinterland by rail, in: *ICLSP Conference Proceedings*. pp. 305–319.



## Appendix A: Interview guide (invitation) used for Study 2 (example)

The invitation below is an example of the document that was sent to all the (potential) interviewees as an initial request for the interview. The interview guide was adapted per each stakeholder as some questions/aspects were more (or less) relevant for some of the stakeholders.

### Invitation to take part in the interview

The aim of the research is to identify and categorize benefits / outcomes that could be gained by integrating a dry port into a supply chain from individual supply chain actors' perspectives. Your personal answers shall be anonymous (no names) but we'd like to note your role as the actor in the system.

The results of the study are planned to be presented on 15<sup>th</sup> World Conference on Transport Research and to be further developed for a scientific journal publication.

### Topics of interest for the interview

#### 1. General information

Introductory information about the company; main business activities. How inclusion of a dry port into a supply chain might affect business of your company? What strategic goals might be achieved by including a dry port into a supply chain?

#### 2. How inclusion of a dry port into a supply chain might affect the following aspects:

- Do you focus of any of these parameters in your strategy, which and why those?
- What attributes of a dry port would prevent you from using the dry port?

#### 3. How does ownership of a dry port matter for you as a customer? Owned by municipality or some other stakeholder (transport operator, retailer, port, etc)

#### 4. Relation to Skaraborg dry port:

- What kind of cooperation if any?
- Plans / considerations for developing cooperation?

#### 5. Potential benefits / outcomes gained by integrating a dry port into a supply chain:

Innovation, resilience, responsiveness, cost, security, sustainability (definitions are given below, definitions adapted from Melnyk et al, 2010), other?

Table 1. Supply chain outcomes

Outcome	Explanation
Innovation	e.g. increase of innovativeness by collaboration with supply chain partners
Resilience	ability of a supply chain to recover quickly and cost-effectively from disruptions caused by natural disasters, social factors (e.g. employee strikes), economic setbacks (the bankruptcy of a critical link in the chain) or technological failures (a software crisis)
Responsiveness	the ability of a supply chain to change quickly in terms of volume or location as a function of changing conditions
Cost	ability to reduce costs

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Security	assurance of goods safety
Sustainability (environmental performance)	contribution in a positive manner to improving the quality of the environment

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If you have questions regarding the research and/or topics for the interview please contact:

\*contact information\*

## Appendix B: Questionnaire used for Study 3 (example)

The questionnaire below is an example of the document that was sent to all the (potential) respondents together with an invitation to take part in the study; the same was filled in by the respondents during meetings or phone calls. The questionnaire was adapted per each stakeholder as objectives of each stakeholder group were different.

### Dry port services – Multi-Actor Multi-Criteria Analysis of actors' preferences

(seaport (terminal operators and authorities) perspective)

#### Introductory information

The study aims to analyze how different actors involved in dry ports' operations are affected by different services available at the respective dry ports. The method applied is a Multi-Actor Multi-Criteria Analysis; it requires data collection from all the actors involved. The respondent is asked to fill in the tables in this document as they appear.

#### Assessment

Please assign weights to the criteria depending on their relative importance (1, 2, 3... 8, 9 so that they sum up to 10). First assign the weights to each criterion (numbered as 1, 2, 3... in the table below) so that the sum equals to 10, then assign the weights to indicators (numbered as 1.1, 1.2... ) when available so that the sum of indicators' weights equals to previously assigned value of respective criterion. Please fill in column N1 now. Revisit the table to fill in column N2 later when suggested.

Table 1. Objectives

Objectives	Clarification	N1	N2
1. Profit	Maximization of profit by means of improving indicators (see below)		
1.1. Volume increase	Increase of volumes handled		
1.2. Operational efficiency	Optimized movement of containers within the port area, optimized container handling, land use, turn-around time		
2. Competitiveness / competitive advantage			
2.1. Secure hinterland	Keep existing shippers / (keep customers in the existing hinterland)		
2.2. Expand hinterland	Attract new shippers (attract new customers in the close and distant hinterland)		
2.3. Attractiveness for new customers (in foreland)	Attracting new exporting/importing shippers		
3. Green image	Positive image related to environmental performance		
Total for criteria		10	10

Please provide any additional comments regarding the objectives/criteria or evaluation of objectives/criteria.

The next step is to assess effect of each scenario on the objectives/criteria.

### Scenarios

Please get familiar with the scenarios and advise whether the services fit the description of scenarios well. Should any services be added, detailed, substituted, moved, or removed?

*Table 2. Scenarios*

Scenarios	Service available at the dry port
Reference scenario: All the services are performed at the seaport	No dry port in the system
Scenario 1: Essential / basic (standard terminal services) are available at the dry port	Transshipment Storage / depot Handling of empty and loaded containers Road haulage
Scenario 2: Scenario 1 + Extra value-added services (VAS) (available to any customer as VAS) are available at the dry port	Customs clearance Tracking and tracing Maintenance/repair of containers Forwarding Container consolidation Handling of dangerous goods Cross docking Online booking Reefer plugs
Scenario 3: Scenarios 1 and 2 + Customer-oriented VAS (requested by specific customer) are available at the dry port	Warehousing Stuffing Material control Repacking and relabeling Subassembly Kitting and sequencing Quarantine Quality and inventory control Safe parking for trailers/trucks

The questions to help to fill in the assessment table is:

*How does the scenario affect the objective/criterion?*

*Table 3. Scale to be used*

-5	-3	0	3	5
Strong negative effect	Negative effect	Neutral relation	Positive effect	Strong positive effect

### Assessment

Please fill in only the empty cells, the rest will be calculated.

*Table 4. Assessment*

Criteria (objectives) & indicators (measures)	Reference scenario	Scenario 1	Scenario 2	Scenario 3
	Score	Score	Score	Score
<b>1. Profit</b>	-	-	-	-
<b>1.1. Volume increase</b>	-			
<b>1.2. Operational efficiency</b>	-			
<b>2. Competitiveness / competitive advantage</b>	-	-	-	-
<b>2.1. Secure hinterland</b>	-			
<b>2.2. Expand hinterland</b>	-			
<b>2.3. Attractiveness for new customers (in foreland)</b>	-			
<b>3. Green image</b>	-			

Please provide any additional comments regarding the evaluation of impact of different scenarios.

Please revisit Table 1 now and check whether you chose to assign different weights now after you have put more thoughts to the relation between the criteria and the scenarios. Please fill in column N2.

### Commentary

According to your opinion, is the list of actors sufficient, complete and relevant? Should any actors be added, detailed, substituted, or removed?

Table 5. Actors

Actor	Comment
Dry port operators	Operators running the dry port operations
Municipality / region of a dry port	Municipality / region where the dry port is located
Seaport	Maritime port (including authorities and terminal operators) connected to the dry port
Shippers	Cargo owners
Shipping lines	Operators that transport cargo by sea
Rail operators	Operators that transport cargo by rail
Road operators	Operators that transport cargo by road

### Service importance assessment

Please assess the importance of services at dry ports. The list can be extended if some relevant services are missing. Use the scale from 1 (not important) to 5 (very important). Irrelevant services can be graded 0.

Table 6. Individual services assessment

Service	Grade
Transshipment	
Storage / depot	
Handling of empty and loaded containers	
Road haulage	
Customs clearance	
Tracking and tracing	
Maintenance/repair of containers	
Forwarding	
Container consolidation	
Handling of dangerous goods	
Cross docking	
Online booking	
Reefer plugs	
Warehousing	
Stuffing	
Material control	
Repacking and relabeling	
Subassembly	
Kitting and sequencing	
Quarantine	
Quality and inventory control	
Safe parking for trailers/trucks	

