Intermodal Transportation within Green Supply Chain Management and Green Logistics

An Analysis of the Relationship between the Topics in the Literature and in Practice
Master Thesis in Business Administration

Title: Intermodal Transportation within Green Supply Chain Management and Green Logistics – An Analysis of the Relationship between the Topics in the Literature and in Practice

Authors: Kevin Kiy and Florian Scanvic

Tutor: Leif-Magnus Jensen

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Key terms: Green Supply Chain Management, Sustainable Supply Chain Management, Green Logistics, Sustainable Logistics, Logistics Firms, Green Transportation, Sustainable Transportation, Modal Transportation, Intermodal Transportation

Abstract

Background: Efforts to reduce the environmental impacts of the human activities got greater attention from global politics as well as from logistics service providers. As a consequence, theory such as the triple-bottom-line approach was developed. Parallel, the theory about intermodal transportation got more important to reduce the environmental impact of logistics and supply chain management. However, literature about intermodal transportation in combination with green supply chain management (GSCM)/green logistics is limited.

Purpose: The purpose of the thesis is to further develop the theoretical background at the intersection of the topics of intermodal transportation, GSCM and green logistics. It is the authors' objective to create a theoretical model about the convergences of the topics based on an extensive systematic literature review. In a second step, it is the purpose to verify the designed model by including experts from the business side. Moreover, this thesis intends to collect practical examples of the application of intermodal transportation in the GSCM/green logistics context as well as advices for its implementation.

Method: The methodology considerations are based on the critical realism view of the authors. A conceptual theory-building method is used, which implies conducting a systematic literature review. In order to collect empirical data, a qualitative study design is chosen using qualitative interviews which are analyzed through a qualitative content analysis.

Conclusion: This thesis shows that GSCM/green logistics and intermodal transportation are connected theoretically and practically using a validated and adapted model with empirical results, whereby common points regarding benefits, drivers, challenges, and measurement/metrics of the topics are found. Practical examples to illustrate intermodal transportation applications were given by the interviewed experts. However, further research will need to validate the true sustainability of those examples. Additionally, advices to implement intermodal transportation within GSCM/green logistics were given but need to be tested with a quantitative study design in further research.
Table of contents

1. Introduction............................................................................................................. 1
   1.1 Background............................................................................................................ 1
   1.2 Problem statement.............................................................................................. 2
   1.3 Research purpose and research questions......................................................... 3
   1.4 Outline of thesis ................................................................................................. 3

2. Methodology............................................................................................................. 5
   2.1 Basic philosophical considerations .................................................................. 5
   2.2 Conceptual theory-building .............................................................................. 6
   2.3 Literature review ................................................................................................ 7
      2.3.1 Literature review approach .......................................................................... 7
      2.3.2 Literature review summary statistics and research history ......................... 11
   2.4 Empirical study .................................................................................................. 15
      2.4.1 Empirical study approach .......................................................................... 15
      2.4.2 Semi-structured interviews as data collection technique ......................... 16
      2.4.3 Data collection process and topic guide ..................................................... 17
      2.4.4 Content analysis as data analysis method ............................................... 18
      2.4.5 Ethical considerations ............................................................................... 18
      2.4.6 Quality considerations .............................................................................. 20

3. Literature review .................................................................................................... 21
   3.1 Key definitions .................................................................................................... 21
   3.2 Green supply chain management and green logistics ....................................... 23
      3.2.1 Sustainability in SCM and logistics ............................................................. 23
      3.2.2 Benefits of GSCM and green logistics ......................................................... 25
      3.2.3 Drivers for GSCM and green logistics ......................................................... 25
      3.2.4 Problems and challenges for GSCM and green logistics ......................... 28
      3.2.5 Measurement and metrics of GSCM and green logistics ......................... 29
   3.3 Intermodal transportation .................................................................................... 30
      3.3.1 Intermodal concept presentation ................................................................. 31
      3.3.2 Benefits of intermodal transportation ......................................................... 31
      3.3.3 Drivers for intermodal transportation ......................................................... 32
      3.3.4 Problems and challenges for intermodal transportation .......................... 32
      3.3.5 Measurement and metrics of intermodal transportation ............................ 35
      3.3.6 Costs of intermodal transportation .............................................................. 36
   3.4 Connection between GSCM/green logistics and intermodal transportation ....... 36
      3.4.1 Intermodal transportation as a green solution for SCM/logistics ........... 36
      3.4.2 Factors influencing green performance of intermodal transportation ....... 37
      3.4.3 Common aspects between those topics .................................................... 39
   3.5 Gaps identification .............................................................................................. 40

4. Results ..................................................................................................................... 42
   4.1 Interview summaries ......................................................................................... 42
   4.2 Interviewees’ understanding of the key definitions .......................................... 44
   4.3 Feedback about the model ................................................................................. 45
   4.4 Social impact of intermodal freight transportation ......................................... 49
   4.5 Relation between GSCM/green logistics and intermodal transportation ........ 51
4.6 Application of intermodal transportation in a GSCM/green logistics context...........52

5. Empirical analysis.................................................................55

5.1 Differences in understanding of key definitions...........................................55

5.2 Feedback about the model..................................................................56
  5.2.1 Experts’ disagreement with the model.......................................................56
  5.2.2 Agreement with the model from a business perspective..............................58
  5.2.3 Analysis of the connection from a business perspective.............................58
  5.2.4 Outcome: Adapted model...................................................................61

5.3 Usage of intermodal freight transportation in a GSCM/green logistics context.......63
  5.3.1 Practical examples of intermodal transportation in GSCM/green logistics........64
  5.3.2 Experts’ advices how to apply sustainable intermodal transportation..............67

5.4 Critical assessment of findings ..................................................................70

6. Conclusion .........................................................................................72

6.1 General conclusion..............................................................................72

6.2 Contribution of findings.........................................................................73

6.3 Limitations and further research ............................................................74

7. Reference list.......................................................................................76
List of abbreviations

AoM Academy of Management
CSR Corporate Social Responsibility
ESPMS Enterprise Sustainability Performance Measurement System
GHG Greenhouse Gas
GSCM Green Supply Chain Management
KPI Key Performance Indicator
LSP Logistics Service Provider
SCM Supply Chain Management

List of illustrations

Illustration 1: Literature review process ................................................................. 9
Illustration 2: Reviewed literature – publication years ........................................ 13

List of tables

Table 1: Summary statistics – Geography ............................................................. 12
Table 2: Summary statistics – Journal names ....................................................... 13
Table 3: Models presented in the reviewed literature ........................................... 14
Table 4: GSCM categories from literature coding ................................................. 23
Table 5: Drivers for GSCM and green logistics .................................................... 27
Table 6: Intermodal transportation categories from literature coding .................. 30
Table 7: Problems and challenges for intermodal transportation ......................... 33
Table 8: Green performance drivers of intermodal transportation ....................... 38
Table 9: Convergences of GSCM/green logistics and intermodal transportation ...... 40
Table 10: Overview of conducted interviews ....................................................... 42
Table 11: Interviewees’ understanding of the key definitions ............................. 45
Table 12: Convergences of the topics ................................................................. 52
Table 13: Intermodal transportation examples .................................................... 53
Table 14: Convergences of GSCM/green logistics and intermodal transportation – Final model .......................................................... 62
Table 15: Criteria for implementing intermodal transportation in a sustainable context...... 69
List of appendices

Appendix 1: Theme blocks GSCM/green logistics and intermodal transportation .............. 83
Appendix 2: Interview topic guide .................................................................................. 84
Appendix 3: Email for interview invitation ...................................................................... 87
Appendix 4: Informed consent .......................................................................................... 88
Appendix 5: Interview process ......................................................................................... 89
1. Introduction

The purpose of this chapter is to give an introduction about the increasing relevance of greening efforts of companies as well as the expanded usage of intermodal transportation solutions. In the beginning of the chapter, recent development is illustrated, both on the academic side as well as on the business side. Since only very few papers bring the concept of green supply chain management (GSCM) and green logistics together with the topic of intermodal transportation, this paper intends to bridge this theoretical gap using empirical data.

1.1 Background

Over the past years, efforts to reduce the environmental impacts of human activities in order to diminish climate change consequences got great attention from European as well as global politics leading to agreements and actions taken by exemplarily the United Nations or the European Commission (European Commission, 2018; United Nations, 2018). This interest of governments combined with the increased awareness of society for this topic are among the drivers that trigger businesses to change towards more sustainable practices (Carbone & Moatti, 2011; Hsu, Keah, Suhaiza, & Jayaraman, 2013; Huang, Huang, & Yang, 2017; Kim & Lee, 2012; Lin & Ho, 2011; Meixell & Luoma, 2015; Mollenkopf, Stolze, Tate, & Ueltschy, 2010; Tacken, Sanchez Rodrigues, & Mason, 2014; Wolf, 2011).

An increasing number of companies is looking for greener solutions to conduct business. In fact, this growing interest to reduce the environmental impact of business operations can be found among firms across the supply chain (Gallego-Alvarez, Ortas, Vicente-Villardón, & Etxeberria, 2017; Hsu et al., 2013; Tacken et al., 2014; Wolf, 2011). Since some authors define logistics as one aspect of supply chain management (SCM), it can be said that the demand for greener logistics also has increased, forcing Logistics Service Providers (LSP) to offer greener transportation solutions (Kim & Han, 2012; Lai, Wong, Veus Lun, & Cheng, 2013; Lun, Lai, Wong, & Cheng, 2015; Tacken et al., 2014). Those new efforts for a greener SCM occur alongside with the development of academic theory to get a better understanding of the different concepts. In this context, theory building such as the development of the triple-bottom-line approach is seen as a theoretical baseline for practical implementation. Thus, concepts can contribute to build a more sustainable supply chain hereby reducing the impact on the environment.
Parallel to those new theoretical trends, the logistics industry has seen the development of new transportation network designs to fulfil increasingly complex demands from supply chain actors. Among others, the concept of intermodal transportation started to gain the interest of transportation industry (Dong, Transchel, & Hoberg, 2018).

Some authors already mention and demonstrate that those new network designs on the one side, reduce transportation costs and on the other side, have the potential to reduce the environmental impact of transportation activities (Eng-Larsson & Kohn, 2012; Inghels, Dullaert, & Vigo, 2016; Limbourg & Jourquin, 2009). However, literature about these concepts in combination with GSCM is still very limited. This paper aims to analyze those interconnections hereby contributing to both, academic literature as well as business implications.

1.2 Problem statement

Despite the relevance of this topic in the media as well as the demand for more theory development in SCM research (Carter & Rogers, 2008; Kent & Flint, 1997; Melnyk & Handfield, 1998; Mentzer & Kahn, 1995; Meredith, 1993; Wacker, 1998), existing literature presents GSCM, green logistics and intermodal transportation network designs separately. Academic literature bringing the concepts of GSCM/green logistics and intermodal transportation together is missing. In addition to this, the authors of this paper also noticed a lack of frameworks/models which illustrate a connection between the benefits, drivers, challenges and measurements of those topics in the literature. This leads to the problem, that there is currently no clear integrated perspective on those topics showing their relationship.

From a business perspective, studies reveal that supply chain managers are increasingly challenged by the contradicting demands of their stakeholder. While many companies strive for cost efficiency and cost reduction on the operative level, those firms also show an increased focus on environmental considerations on the strategic level (Gudehus, 2012). In this business context, existing academic literature is lacking elements to give supply chain managers examples about how companies use intermodal transportation linked with GSCM and green logistics purpose and what companies need to consider when implementing intermodal transportation solutions in a context of sustainability.
1.3 Research purpose and research questions

The primary purpose of the thesis is to further develop the theoretical background at the intersection of the different topics. It is the authors' objective to create a theoretical model about the convergences of the topics based on an extensive systematic literature review; in a second step, it is the purpose to verify the designed model as well as collecting examples of the application of intermodal transportation in GSCM/green logistics and gathering advices for its implementation by including experts from the business side. This dual approach ensures to cover the topic holistically to finally have a contribution to both – academic and business world. As from a theoretical perspective, one existing gap refers to the missing analysis about the relation between the topics GSCM/green logistics and intermodal transportation. It is initially important to bridge this gap and identify the interconnections of those topics, therefore the first research question is:

*RQ 1. How are GSCM/green logistics and intermodal transportation connected?*

While with the first research question primarily the academic requirements are supposed to be fulfilled, it is also the authors' objective to provide additional benefit to the business world. Therefore, the second research question expands the scope of this thesis to also cover the business perspective and present industry examples for the application of intermodal transportation within a GSCM/green logistics context as well as to collect advices on how to implement intermodal transportation solutions in a GSCM context. Thus, a second research question is:

*RQ 2. How can companies use intermodal freight transportation in relation to GSCM/green logistics?*

1.4 Outline of thesis

The remainder of this thesis begins with chapter 2 and an overview about the methodological approach applied to the literature review as well as the empirical study. Having the methodology presented first, helps the reader to understand the systematic literature review approach as well as the conducted empirical research. Next, chapter 3 covers the outcome of the conducted systematic literature review. The following chapter, chapter 4, presents the results from the conducted interviews. In chapter 5, the results from the empirical study are analyzed and discussed by setting the empirical findings in the context of the literature review.
Finally, a conclusion for this thesis is drawn, whereby limitations of the study and further research are included.
2. Methodology

First, this chapter starts by describing the basic philosophical considerations based on the critical realism view of the authors. Second, inspired by the articles of Meredith (1993) and Carter and Rogers (2008), a conceptualization theory-building method is used. This study design results in first conducting a systematic literature review, which’s approach is presented in the third part of this chapter. Last, the empirical study is outlined and explained, whereby a qualitative study design is chosen to validate the theory built previously using qualitative interviews.

2.1 Basic philosophical considerations

The research idea for this paper follows the incentive to provide answers to the controversial issue of sustainable considerations in the context of intermodal transportation. Thus, it is a contribution to solve current problems such environmental challenges, which makes this study worth to be pursued according to management research theory (Easterby-Smith, Thorpe, & Jackson, 2015).

As the topic of GSCM includes the management of greenhouse gas (GHG) emissions this study can be interpreted from a more natural science point of view; in contrast, the topic of intermodal transportation in the context of SCM/logistics can be analyzed from a social science perspective, where discussions about the behavior of people rather than objects are conducted.

From the authors' viewpoint, the thesis is conducted with a critical realist position, which is portrayed as “a compromise position between […] positivism and constructionism” (Easterby-Smith et al., 2015, p. 59). In the context of ontology for natural science, the authors see the topic of this paper at the intersection of internal realism, where the truth is obscure and cannot be assessed directly, and relativism, where the facts depend on the viewpoint of the observer. In the context of ontology for social science, those two viewpoints are reflected in the internal realist position, where concepts exist independently of the researcher and have real consequence for life and the relativistic viewpoint where different observers have different viewpoints.

While this critical realist position, at the intersection of positivism and constructionism, makes a categorization more complicated from a philosophical perspective, it also provides freedom
in the choice of method (Easterby-Smith et al., 2015). Aligned with the ontology standpoint, the epistemology considerations are biased. Tending towards a positivism viewpoint, the authors see the fact that the social world exists externally and can be measured through objective methods. From a more constructionism perspective, this paper not only is pure fact based, but appreciates different opinions that experts on the topic of GSCM/green logistics and intermodal transportation have.

In general, the authors try to combine the benefits of a more positivistic orientation, namely the chance to provide a wide coverage as well as a potentially fast approach, together with the benefits of a more constructionism orientation, which for example accepts the value of multiple data sources and enables generalization beyond the present example (Easterby-Smith et al., 2015).

2.2 Conceptual theory-building

Deriving from the philosophical considerations, the authors scrutinized different articles for possible study designs. As a result, the conceptual theory-building presented by Meredith (1993) and the approach used by Carter and Rogers (2008) are the most suitable for this thesis’ purpose and philosophy. Meredith (1993) presents three main types of conceptual methods: The conceptual models, the conceptual frameworks and the theories. On the one hand, conceptual models are referred to as “set[s] of concepts, with or without propositions, used to represent or describe (but not explain) an event, object, or process” (p. 5). On the other hand, conceptual frameworks are defined as “a collection of two or more interrelated propositions which explain an event, provide understanding, or suggest testable hypotheses” (p. 7). Finally, “[a] theory may be as simple as a straightforward framework” (p. 10). For this thesis, based on the definition given by Meredith (1993), the authors developed a conceptual model.

While reviewing literature, the article by Carter and Rogers (2008) was found which uses the conceptualization theory-building by Meredith (1993) based on a systematic literature review as well as the presentation of the results in front of experts to collect data and validate their results. The authors of this thesis decided to apply the conceptual method approach of Meredith (1993) used by Carter and Rogers (2008) for several reasons.
The article of Carter and Rogers (2008) presents a similar structure than the one of this thesis. As in this thesis, Carter and Rogers (2008) wanted to present different topics and tried to demonstrate a relationship between those. Moreover, the authors of this thesis argument that Carter and Rogers (2008) have a similar methodology and philosophy to them. In fact, Carter and Rogers (2008), such as the authors of this paper, develop in a first step a so called “middle theory” with their framework, which means that the theory built still needs to be tested through quantitative research (Echambadi, Campbell, & Agarwal, 2006). Even though Carter and Rogers (2008) use a larger sample for their empirical study, it can be said that the philosophies of both papers correspond to internal realism/relativism. Third, it is reasonable to have a similar approach as Carter and Rogers (2008) because this article is one of the major theoretical contributions about sustainable SCM, as it is cited in many different articles that where reviewed for this thesis (Golicic & Smith, 2013; Mafini & Muposhi, 2017; Mollenkopf et al., 2010; Quashie, Salmi, & Leuschner, 2016; Rizzi, Bartolozzi, Borghini, & Frey, 2013; Sarkis, 2012; Thomas, Fugate, Robinson, & Tasçioglu, 2016; Wolf, 2011; Wong, 2013). Based on these arguments, the authors applied the conceptualization theory-building method by Meredith (1993), inspired by the approach of Carter and Rogers (2008), using a systematic literature review to build their conceptual model that in a second step is discussed through a qualitative empirical study.

This thesis is based on a mix between inductive and deductive reasoning and research, as this is the reasoning on which the conceptualization theory-building method is built on (Carter & Rogers, 2008; Meredith, 1993).

2.3 Literature review

This chapter covers the literature review design as well as the analysis. A systematic literature review was conducted to gather all relevant data and information which is available in the context of GSCM, green logistics and intermodal transportation. The systematic review approach builds the foundation for a solid analysis.

2.3.1 Literature review approach

According to management research literature, authors can use various types of literature reviews, where traditional reviews, snowballing approaches and systematic literature reviews
are mentioned most frequently (Ganann, Ciliska, & Thomas, 2010). On the one hand, traditional reviews are described as comprehensive and reproducible. On the other hand, systematic literature reviews go even further by striving to comprehensively identify and synthesize all relevant studies on a given topic (Easterby-Smith et al., 2015; Petticrew & Roberts, 2006).

Among the benefits of a systematic review, the aspects of transparency and replicability are mentioned. Additionally, a systematic approach allows a broad range of high-quality sources to ensure that only the most relevant information is gathered. On the drawback side, the authors are aware of the limited creativity of this approach as well as the potential overlooking of grey literature such as reports. Moreover, the authors know that they relied on the quality of the abstracts when filtering information and narrowing down the relevant literature (Easterby-Smith et al., 2015). Despite the drawbacks of a systematic review, the authors consider this approach to be the most appropriate related to the purpose of this paper and to answer the first research question “How are GSCM/green logistics and intermodal transportation connected?” while building a solid baseline for the second research question “How can companies use intermodal freight transportation in relation to GSCM/green logistics?” (Easterby-Smith et al., 2015).

The review of the literature was conducted on January 6th 2018 in the knowledge database Web of Science¹. The authors are aware that there are other science databases such as summarized on EDesiderata (2018); due to familiarity with the database as well as recommendations from the institution where this thesis was composed (Jönköping University), Web of Science was selected. The following process (Illustration 1) illustrates the iterative approach of the authors in five steps.

¹ https://login.webofknowledge.com
First, literature for the two theme blocks, one falling into the category of GSCM and the other falling into the category of intermodal transportation (see Appendix 1), was filtered. In the category of GSCM, the search keywords were used as followed to ensure that the topic is covered holistically. The authors searched for the keywords “Green transportation”, “Green Supply Chain Management” and “Green Logistics” in combination with the keywords “Sustainable Transportation”, “Sustainable Supply Chain Management” and “Sustainable Logistics” since in many articles the adjectives green and sustainable are used substitutable.

For the field of intermodal transportation, a search for the keywords “Intermodal Transportation”, “Modal Transportation” as well as “Logistic Firms” was conducted. The authors decided to include the keyword “Logistic Firms” into this block, since they consider the provider of transportation as a central element of the intermodal transportation category. Since in an initial search, the term “Intermodal Transportation” is the leading term when describing the topic, the authors decided to start with that definition. In the further process, it was revealed by some articles that “Multimodal Transportation” in some cases also is used in the academic literature. When conducting a second search including the term of “Multimodal Transportation” into the Web of Science query, this search revealed no additional relevant articles, hereby confirming the term “Intermodal Transportation” as the leading one for the purpose of this thesis.

As an outcome, the authors received 13,540 articles in the category of GSCM and 5,205 articles on the topic of intermodal transportation. The Venn diagrams in Appendix 1 are intended to note down and identify further keywords (Easterby-Smith et al., 2015) while graphically illustrating the intersection area among the keywords.

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2 As far as not stated differently, all illustrations are designed by the authors
Second, the number of articles was decreased by the help of several approaches. With regard to research theory, Boolean operators were considered carefully, since the authors are aware, that the term “and” is narrowing down the result (Easterby-Smith et al., 2015). As only the intersection of both theme blocks is relevant for this paper, articles in Web of Science were filtered as:

\[
\text{Topic searched} = ((\text{green supply chain management OR sustainable supply chain management OR green logistics OR sustainable logistics OR green transportation OR sustainable transportation}) \quad \text{AND} \quad (\text{modal transportation OR logistic firms OR intermodal transportation}))
\]

This approach let the number of relevant articles decrease to 554.

Third, as the quality of the reviewed articles was an important consideration of the authors, further filters were applied:

- Year of publication: Published between 2008 and 2018
- Journals: Impact factor $\geq 1$
- Web of Science Categories: Management or Transportation, or Operations Research Management, or Transportation Science Technology or Business
- Type of literature: Articles

The decision for the cut-off date was made based on the fact that the topic of integrating intermodal transportation and GSCM/green logistics is an emerging topic, which started to develop in the early 2010s. This was confirmed from a quantitative side, where more than 90% of the published articles found in Web of Science were published after 2008. Looking at the graphical illustration about the publication date (see Illustration 2), this increased relevance is also identified by the sharp increase in published articles between the years of 2010 and 2011. Using the above-mentioned categories, one can see that the authors set a focus on the business perspective of the topic, while leaving engineering-oriented literature out of scope.

Using all those filters, a total of 88 articles remained. This approach is congruent with research literature, which claims that filtering decisions need to be noted down and explained (Easterby-Smith et al., 2015).
Fourth, based on this systematic literature search, both authors screened the abstracts of all remaining 88 articles with the objective to identify the relevance of each article for the topic of this paper. This peer-review approach ensures high-quality and reduces researchers’ ambiguity (Easterby-Smith et al., 2015). When both authors did not consider an article to be relevant, that one was excluded from the literature list; whereas in case of only one researcher assuming the respective article to be irrelevant, a discussion-based consensus was met. A total of 53 articles remained and was used for the theoretical foundation of this paper.

Fifth, with all of the remaining articles, the two researchers applied a systematic coding approach, where content was extracted and coded in a spreadsheet document. A sophisticated peer-discussion of all of the codes coming from the 53 articles provided the theoretical foundation for the subsequent analysis.

While the literature research was conducted in the most throughout way, the authors are aware of potential limitations of their approach. First, only the last ten years of relevant theoretical material was taken into account for the search. There might be additional literature, but the number is expected to be small due to the fact that the connection of the topics started to emerge in the early 2010s. Second, the authors did not consider topic-related websites due to the fact that they wanted to ensure the highest quality of peer-reviewed articles in the theoretical background (Easterby-Smith et al., 2015).

2.3.2 Literature review summary statistics and research history

First, as the analysis reveals, research in this area is from a geographical perspective highly concentrated in Northern America, Europe and Asia, whereas only few articles are written in other parts of the world (see Table 1). This reflects the importance of sustainability especially in European countries but stands in contrast to Carbone and Moatti (2011), Carter and Easton (2011), Carter and Rogers (2008), Eng-Larsson and Kohn (2012), Lam and Dai (2015), Searcy (2016), Thomas et al. (2016), who state that the solution to environmental concerns can only be solved when the topic is covered holistically – from a functional but also geographical perspective. Based on the summary statistics about the country of publication, it would be beneficial to refer to literature also from other parts of the world (e.g. Africa and South America), due to the strict limitations to peer-reviewed quality papers from high-rated journals, this was not possible and needs to be considered when making conclusions about the concept.
Additionally, based on the European focus, the authors are aware of the implications caused by this. For example, it is assumed that the infrastructure for all modes of transportation is relatively balanced, stating that Europe has a relatively good railroad infrastructure whereas the focus in North America is more on railroad and airfreight transportation (Organisation for Economic Co-operation and Development, 2013).

**Table 1: Summary statistics – Geography**

<table>
<thead>
<tr>
<th>NAME OF REGION</th>
<th>FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>24</td>
<td>45%</td>
</tr>
<tr>
<td>Asia</td>
<td>14</td>
<td>26%</td>
</tr>
<tr>
<td>North- &amp; South- America</td>
<td>12</td>
<td>23%</td>
</tr>
<tr>
<td>Australia</td>
<td>3</td>
<td>6%</td>
</tr>
</tbody>
</table>

A quantitative analysis of the journals, in which the articles were published (see Table 2), indicates the relevance of the journals. Also, looking at those statistics, the European focus is underlined as the second most referred journal is the "European Journal of Operational Research". Furthermore, looking at the journals, in which the articles were published, it is revealed that many journals are logistics and operations research oriented. In this study, the authors try to combine the primarily logistics viewpoint, to a more holistically oriented SCM/logistics model.

The 53 analyzed articles were published over the last ten years with a relative constant number of publications between the years 2011 and 2017. Remarkably, a sharp increase of literature from the period of 2010 and before, compared to the period of 2011 and afterwards, is an indicator of the increased relevance of the topic (see Illustration 2). As the cut-off date for the review was conducted in the beginning of January 2018, more literature is expected to be published in that year.
Table 2: Summary statistics – Journal names

<table>
<thead>
<tr>
<th>NAME OF JOURNAL</th>
<th>FREQUENCY</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Journal of Physical Distribution &amp; Logistics Management</td>
<td>9</td>
<td>18%</td>
</tr>
<tr>
<td>European Journal of Operational Research</td>
<td>6</td>
<td>12%</td>
</tr>
<tr>
<td>Transportation Research Part E – Logistics and Transportation Review</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>International Journal of Logistics – Research and Applications</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>International Journal of Logistics Management</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>International Journal of Operations &amp; Production Management</td>
<td>4</td>
<td>8%</td>
</tr>
</tbody>
</table>

Illustration 2: Reviewed literature – publication years

Second, Table 3 presents an outcome of the frameworks or models used in the reviewed literature. As one can see, do not all reviewed articles include a framework, nonetheless a majority applied one within their research. In many cases, the articles refer to the triple-bottom-line approach, where for a sustainable context the three aspects, economic, environmental and social, need to be met; four articles even include a model or framework about the triple-bottom-line into their article. While much existing literature deals with the influences of GSCM, only very few articles aim to bring the topics of GSCM/green logistics and intermodal transportation together. i.e. only the two articles of Eng-Larsson out of 53 total articles provide a model about the intersection of GSCM/green logistics and intermodal transportation.
Table 3: Models presented in the reviewed literature

<table>
<thead>
<tr>
<th>TOPIC OF MODEL</th>
<th># OF ARTICLES</th>
<th>COVERED BY FOLLOWING AUTHORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frameworks about drivers of GSCM</td>
<td>8</td>
<td>(Carbone &amp; Moatti, 2011; Hsu et al., 2013; Lin &amp; Ho, 2011; Lo &amp; Shiah, 2016; Sarkis, 2012; Searcy, 2016; Seuring &amp; Gold, 2012; Wolf, 2011)</td>
</tr>
<tr>
<td>Frameworks in the context of the triple bottom line</td>
<td>4</td>
<td>(Carter &amp; Easton, 2011; Carter &amp; Rogers, 2008; Mollenkopf et al., 2010; Van den Berg &amp; De Langen, 2017)</td>
</tr>
<tr>
<td>Frameworks for or of literature Review</td>
<td>1</td>
<td>(Quarshie et al., 2016)</td>
</tr>
<tr>
<td>Intermodal transportation frameworks</td>
<td>2</td>
<td>(Baykasoğlu &amp; Subulan, 2016; Inghels et al., 2016)</td>
</tr>
<tr>
<td>Other frameworks</td>
<td>5</td>
<td>(Eng-Larsson &amp; Kohn, 2012; Eng-Larsson &amp; Normman, 2014; Hazen, Cegielski, &amp; Hanna, 2011; Mehmood, Meriton, Graham, Hennelly, &amp; Kumar, 2017; Xie &amp; Breen, 2012)</td>
</tr>
</tbody>
</table>

Third, the last part of this chapter deals with the historical development of the two topics to have a closer look at how does the relevant SCM literature look like. While some authors claim that there is little theory building, in the area of SCM and sustainability (Carter & Easton, 2011; Carter & Rogers, 2008; Hazen et al., 2011), many researchers agree that the research focus of GSCM has recently shifted to a more holistic approach which implicates a higher level of complexity in GSCM literature and practice (Carbone & Moatti, 2011; Carter & Easton, 2011; Carter & Rogers, 2008; Eng-Larsson & Kohn, 2012; Lam & Dai, 2015; Searcy, 2016; Thomas et al., 2016). Exemplarily, do Zhu et al. (2013) claim that the observed complexities in the context of GSCM need to be understood from a management and research perspective.

Additionally, the term of GSCM has varied over the last years (detailed explanation about GSCM follows in the definition part 3.1). While GSCM did not evolve as a stand-alone topic, researchers frequently claim, that there are more topics closely related to the research area of GSCM (Sarkis, 2012; Xie & Breen, 2012). Especially the field regarding the impact of intermodal transportation on environment has been studied in an own research area. In this context, much focus has been put on sustainability of transportation (Eng-Larsson & Kohn, 2012; Lam & Dai, 2015).
2.4 Empirical study

This chapter covers the theoretical foundations of the empirical study and thus, is the baseline for a rationalized data collection and data analysis procedure. The method used by Carter and Rogers (2008) was applied for the systematic literature review and the empirical data collection. Same as in the study design of Carter and Rogers (2008), qualitative data is collected. However, not through a presentation, like these authors did, but with qualitative interviews. Moreover, to remain consistent with the conceptualization theory-building method reasoning, a mix between a more deductive and a more inductive analysis was chosen while using a content analysis to analyze the results.

2.4.1 Empirical study approach

A qualitative study is chosen for this thesis. To answer the research questions and following a more relativistic/constructionist approach, the purpose is to validate a model but also to generate theory using a more qualitative study design. An additional reason why the authors have chosen a qualitative research approach is that by definition, qualitative research is exploratory, which means that in the analysis part of this thesis not the frequency, but the meaning of the experts’ statements is analyzed. Since this approach is primarily used, when researchers do not know what to expect or developed an approach to a problem, qualitative research does perfectly fit the scope of this paper. In connection to the research questions about how aspects are related to each other, the authors intend to validate their model and produce research on little-known phenomena (Easterby-Smith et al., 2015). Yin (2003) presents six different methods to collect evidence. Among those are interviews a possible data collection technique. This technique was used in a qualitative way for this thesis to validate but also to generate theory.

To analyze the collected data, a qualitative content analysis is used which is an accepted method within supply chain research to analyze qualitative data such as memory protocols from semi-structured interviews using categories derived deductively and/or inductively (Mayring, 2008; Seuring & Gold, 2012; Vaillancourt, 2016). In fact, this method can be used either in a quantitative or a qualitative way (Seuring & Gold, 2012). The content analysis is a technique that includes positivist as well as constructionist aspects, which perfectly fits with the critical realism approach of this thesis. This method “aims at drawing systematic inferences from qualitative data that have been structured by a set of ideas or concepts” (Easterby-Smith et al.,
One possible drawback of this technique can be that findings are not as objective if analysis is only conducted by one researcher. However, for this thesis, two authors conducted the content analysis, which enhances the validity of the analysis (Duriau, Reger, & Pfarrer, 2007).

The authors are aware of other methods. However, those are not being further discussed as the authors follow the approach by Carter and Rogers (2008) but also because other methods are neither relevant to meet their research purpose nor match their philosophy. For instance, using a case study approach to validate and generate theory is only possible within a particular context and therefore, this does not fit with the purpose of the authors to generalize the findings to the broader field of logistics. Same applies to grounded theory, which is a method that is too constructionist for the philosophy of the authors (Easterby-Smith et al., 2015).

2.4.2 Semi-structured interviews as data collection technique

To collect the relevant data to answer the research questions, validate the created models, bridge the identified gaps and follow the purpose of this thesis, the authors conducted semi-structured interviews based on the six techniques of Yin (2003). In the following, considerations for the technique selection are presented before the interview conducting process is described.

First, the selection of the sample for the interviews was based on a mix between ad-hoc sampling, which means that the interviewees were selected based on their availability and the ease they could be accessed, and snowball sampling, where interviewees were chosen as they were recommended by other research participants. The reason why this sampling is used is because the priority for this study is to rapidly collect data with low cost (Easterby-Smith et al., 2015). Nonetheless the authors checked the expertise of each potential interviewee that only field experts for their study were interviewed.

Second, a semi-structured interview design was selected because it procures more flexibility during the interview in order to let the interviewee decide to address certain topics that are not mentioned in the topic guide and that the interviewee considers to be relevant (Easterby-Smith et al., 2015).
2.4.3 Data collection process and topic guide

To conduct the interviews, a topic guide has been crafted to structure the interview process but also to record the interview results of every interview to better proceed with the analysis of the data, as results can be better compared if the records have a similar structure. However, not all questions were posed to the interviewee, as the topic guide was formulated as a possible pool of questions. The guide is shown in Appendix 2 and is structured into three sections, where the first section consists of opening questions aiming to get some information about the career of the interviewee but also to slowly get to the main topic by discussing how the interviewee defines the relevant concepts. The second section intends to go more into detail about GSCM/green logistics and intermodal transportation with the objective of getting answers to bridge the gaps presented in the research questions. Moreover, with those questions, the authors try also to validate the model developed in the theoretical part of this thesis. The last section covers closing questions formulated to give the interviewee the opportunity to give his/her opinion about the discussed concepts but also about the interview process.

During the interviews the questions have been adapted using the laddering up technique by asking “why” questions and also the laddering down technique by asking for examples. This helps the authors to gain more insights about the given answers (Easterby-Smith et al., 2015).

To organize the interviews, the interviewees were first contacted via email, LinkedIn or telephone to ask for their agreement to participate in the study. Then, if they confirmed, another email was sent (see Appendix 3) containing interview details, as well as a short summary of the thesis and the model developed but also the informed consent (see Appendix 4). Upon agreement, the interview was conducted using the interview topic guide. Although the informed consent mentions the possibility to be recorded during the interview, the authors finally decided not to record to give the interviewee the ability to speak freely without having any concerns about confidentiality due to audio recordings (Easterby-Smith et al., 2015). From the authors’ perspective, this should help to collect data that is not biased by any concerns regarding the recording method. To substitute the audio recording, accurate notes were taken during the interviews by the interviewers and were summarized on memory protocols after the interview and sent to the interviewee for approval. This approval stage was important for the authors in order to ensure that the exact meaning of each interviewee was properly described to guarantee that no wrong deductions would be made later in the analysis. The interview
process is illustrated in Appendix 5. In total, eight interviews were conducted in April 2018, using mostly Skype as a platform to communicate. The interviewed experts were from various countries. Therefore, interviews were conducted in different languages for the convenience of the interviewee, but the memory protocols were written in English. Moreover, the length of each interview varied between 30 minutes to more than 120 minutes. Those differences were caused by the availability of certain experts.

2.4.4 Content analysis as data analysis method
To validate the model developed by the authors as a result of the literature review and to answer the two formulated research questions, a content analysis of the collected data was applied using the data collected. For this study the approach of Marying (2008), who presented four steps to analyze data using content analysis, is applied as it is an accepted and commonly used process in supply chain research (Seuring & Gold, 2012; Vaillancourt, 2016). By separating the process of analysis into different steps, it allows more traceability and inter-subjective verifiability (Duriau et al., 2007; Mayring, 2008; Seuring & Gold, 2012).

Seuring and Gold (2012) presents the process by Mayring (2008) as followed:

1. Material collection: Delimitation of the material that will be analyzed and definition of the unit of analysis
2. Descriptive analysis: Assessment of the formal characteristics of the material
3. Category selection: Selection of structural dimensions and linked analytic categories to apply to the collected material
4. Material evaluation: Analysis of the data regarding the analytic dimensions

In the category selection, the codes and categories were selected based on the theory (deductive approach), but were also derived from the empirical data in a second step (inductive approach) (Seuring & Gold, 2012).

2.4.5 Ethical considerations
For the empirical part of this paper, the authors took several ethical considerations into account in order to ensure a high-quality research approach while simultaneously not harming any of the interviewed experts. As a baseline, the authors refer to professional associations, such as
the Market Research Society³ or the American Academy of Management (AoM)⁴. Those associations have summarized a variety of ethical considerations which need to be considered in management research and thus, are appropriate as a starting point to be enriched with information from Easterby-Smith et al. (2015). In the following, ethical aspects have been considered in the different stages of the research: In the data collection, the data analysis, the data reporting as well as in the data storage as suggested by Bryman and Bell (2011). This includes several considerations, such as respecting the dignity of the research participants as well ensuring privacy and anonymity of the research participants.

In a systematic way, ethical considerations can be broken down into four main areas as Diener and Crandall (1978) outlined. First, harm to participants needs to be avoided. Second, an informed consent should be given to the research participants. Third, the right to privacy has to be ensured, and fourth, deception should be avoided.

According to the AoM, it is the responsibility of the researcher to assess and minimize the possibility of harm to research participants. This is exemplarily ensured by anonymizing the identification of interviewees as well as the organizations they work for. This also includes the confidentiality of records which were taken during the interviews. In connection to the informed consent of the research participants, it is the objective of the researchers to give as much information as needed to the interviewees, so those can base their decision about participating on solid information about the study (Academy of Management Code of Ethical Conduct, 1995). The informed consent for this study can be found in Appendix 4 and was sent to the research participants together with the interview invitation. Privacy was ensured in each step of the empirical study process. This includes e.g. that if in any cases the research participants wished not to answer a question due to privacy concerns – despite that privacy is ensured over the entire research process – that question was skipped. Additionally, all personal data was anonymized by neutralizing the research participants’ names with placeholder such as “Interviewee 1”. Last, “[d]eception occurs when researchers represent their research as something other than what it is” (Bryman & Bell, 2011, pp. 136, 137). As mentioned by the AoM, deception should be minimized. For this study, this involved an accurate explanation to the participants about the research and its intended outcomes at the beginning of each interview.

³ https://www.mrs.org.uk/
⁴ http://aom.org/
plus additional counselling, if required (Academy of Management Code of Ethical Conduct, 1995). Hereby, in all interviews, the authors communicated in an honest and transparent way to avoid any deception about the nature or aims of the research (Easterby-Smith et al., 2015).

For the data collection process, the authors agreed on stopping to collect data, once the amount of new information of each additional interview is diminishing; related to the semi-structured interviews, this was checked by the additional new coding categories.

Regarding anonymity, the authors double-checked with the interviewees their private anonymity as well as the anonymity of their company. When asking for those details in the interview, it was pointed out that the interviewees did not have to give any details. In terms of confidentiality, which includes that access to data must be protected, the authors agreed on saving their interview memory protocols on Office365 until the thesis is finished and delete all personal related data immediately afterwards.

2.4.6 Quality considerations
For the data collection and analysis, the authors relied on the Guba (1981) quality criteria which are credibility, transferability, dependability as well as confirmability. In terms of credibility, it is important for the authors to address the problem of interdependencies between GSCM/green logistics and intermodal transportation as well as the research questions in such a way that it generates authentic findings. On the one hand, a constant comparison after each conducted interview helped to brief the co-author; on the other hand, the explicit search for contradictory statements from the experts was intended to ensure credibility of the research. In contrast, the authors see the limited time of their engagement in the field as the most disadvantageous aspect of their empirical research. With regard to transferability and dependability, where findings can be applied to other contexts, the comprehensive description of the design as well as analysis may help researchers to use this paper as a base for further research. Last, to ensure confirmability – which describes a situation where findings depend on subject and the conditions of inquiry, not on the researcher and his pre-understanding bias – the systematic reporting of the approach and findings in combination with the reflexivity of the authors aims to ensure confirmability along the whole thesis work.
3. Literature review

The purpose of this chapter is to discuss the results of the systematic literature review the topics GSCM, green logistics and intermodal transportation. The results indicate that most of the articles only cover one of the two topic areas, while only few articles try to illustrate interdependencies between the topics. To outline the literature review, in the beginning key definitions for this thesis are determined. Then, the relevant aspects of GSCM/green logistics and intermodal transportation are presented. Moreover, in section 3.4, as a result of the literature review, a model which shows interdependencies between GSCM/green logistics and intermodal transportation is presented.

3.1 Key definitions

To start, some definitions need to be given for a better understanding of the subsequent chapters. There are many definitions about sustainability, SCM and logistics. The authors consider the following to be the most relevant.

First, the term sustainability has to be defined. In the reviewed articles the most commonly used definition is the definition given by the World Commission on Environment and Development (1987) (Carter & Rogers, 2008, p. 363; Thomas et al., 2016, p. 471; Wolf, 2011, p. 221). The World Commission on Environment and Development (1987) defines sustainability as the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (p. 43). Second, a definition of GSCM, also referred as sustainable SCM in some articles, needs to be given before this concept is further explained in the next subchapter. Many reviewed articles give their own definition or refer to other scholars’ definition for this concept (Carbone & Moatti, 2011; Carter & Easton, 2011; Carter & Rogers, 2008; Hazen et al., 2011; Hsu et al., 2013; Lo, 2013; Lo & Shiah, 2016; Mafini & Muposhi, 2017; Meixell & Luoma, 2015; Xie & Breen, 2012). Nevertheless, all give similar aspects that define GSCM. However, some scholars have debated that GSCM definition focuses more on environmental issues instead of social issues (Ahi & Searcy, 2013; Pereseina, 2017). It is not the purpose of this paper to compare the different definitions for this concept but more the content of this concept. Therefore, the authors suggest the following definition based on the reviewed articles in order
to summarize the different thoughts provided by the scholars so far. GSCM in this paper is defined as the management of the different SCM flows and the fulfilment of SCM activities such as purchasing or manufacturing in a sustainable manner by considering economic, environmental and social aspects.

Third, as logistics supports supply chain flows, the definition of green logistics is also relevant for the following chapters (Coyle, Langley, Novack, & Gibson, 2013). Lo and Shiah (2016) see green logistics as part of the different GSCM practices (p. 486). Moreover, Rogers and Tibben-Lembke (1999) define green logistics as “the attempt to measure and minimize the ecological impact of logistics activities” (p. 54). This definition relates back to the previous definition given for GSCM. Therefore, green logistics, for the authors in this paper, is the performance of the logistics activities in a sustainable manner by considering together economic, environmental and social aspects.

Finally, intermodal transportation has to be briefly explained. Baykasoğlu and Subulan (2016) inform that within the global logistics industry different terminologies are used for the multi-mode transportation systems: e.g. multimodal or intermodal. Therefore, only one definition is needed to define all the different terms. Thredbo (2016) gives a definition of intermodal transportation in the context of sustainability by defining “intermodal transport as: the seamless integration of diverse motorized and non-motorized transport systems that are socially, environmentally, and economically sustainable, in response to human diversity and needs, particularly equity and social justice” (p. 722) However, for this thesis a more general definition needs to be given, as intermodal transportation is first presented separated from a sustainability context. Besides this definition by Sagaris, Tiznado-Aitken, & Steiniger (2017), the remaining reviewed articles present similar definitions. To give a common definition for this paper, based on the reviewed articles, it can be said that the intermodal transportation of goods is when the goods are transported within one load unit, such as a container or a box for example, during the entire transportation using more than one transportation mode (e.g. air, rail or truck) without handling the goods themselves to change the transportation mode (Baykasoğlu & Subulan, 2016; Dekker, Bloemhof, & Mallidis, 2012; Eng-Larsson & Kohn, 2012; Sagaris et al., 2017).
3.2 Green supply chain management and green logistics

As a result of the literature review and the related analysis, different main topics were identified. Table 4 shows the range of categories found and the reference chapter.

Table 4: GSCM categories from literature coding

<table>
<thead>
<tr>
<th>CATEGORY FROM LITERATURE CODING</th>
<th>REFERENCE CHAPTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainability in SCM and logistics</td>
<td>3.2.1</td>
</tr>
<tr>
<td>Benefits of GSCM and green logistics</td>
<td>3.2.2</td>
</tr>
<tr>
<td>Drivers for GSCM and green logistics</td>
<td>3.2.3</td>
</tr>
<tr>
<td>Problems and challenges for GSCM and green logistics</td>
<td>3.2.4</td>
</tr>
<tr>
<td>Measurement and metrics of GSCM and green logistics</td>
<td>3.2.5</td>
</tr>
<tr>
<td>Green washing, sustainability reporting, operations research for green logistics</td>
<td>Out of scope</td>
</tr>
</tbody>
</table>

Some topics are considered out of scope, as they are too particular or not directly related to the purpose of this paper.

3.2.1 Sustainability in SCM and logistics

The first main topics identified through the literature coding process are SCM and logistics in the context of sustainability. This section aims at presenting the reason why sustainability within a SCM or logistics context is important, and what the characteristics of a sustainability approach applied to SCM and logistics are. For Wolf (2011), SCM plays an important role to achieve sustainability in two different ways: “First, SCM has a strong and deep impact on the natural environment because it deals with the resources needed for the production of a good or service. Second, buying practices can impact suppliers’ ability to improve their sustainability” (p. 221).

The application of sustainability efforts in SCM results in different changes in the SCM structure such as the addition of new flows. In a paper by Sarkis (2012), a first characteristic for the application of a sustainability approach on SCM is described. This characteristic for the author is that an additional flow, the waste flow, appears within a green supply chain. Furthermore, other characteristics are given by Xie and Breen (2012), Huang et al. (2017) and
Hsu et al. (2013) who explain different GSCM initiatives. Xie and Breen (2012), for instance, present four categories of GSCM practices by Zhu and Sarkis (2004). The first category is the “internal environmental management” which can be translated in the SCM practices of the commitment of GSCM from senior managers, the support for GSCM from mid-level managers, the cross-functional cooperation for environmental improvements, the implementation of a total quality environmental management and/or the integration of environmental compliance and auditing programs. The second category is the so called “external GSCM” which can be implemented through providing design specification to suppliers that include environmental requirements for purchased items, developing cooperation with suppliers for environmental objectives, conducting environmental audit for suppliers’ internal management, requiring the certification of suppliers with ISO 14000, evaluating the second-tier supplier environmentally friendly practice, building cooperation with the customer for eco-design, for cleaner production and/or for green packaging development. The third category is defined as “investment recovery”, which means that for instance the excess inventories/materials and used materials and/or excess capital equipment are sold. Finally, the fourth category is the “eco-design” or “design for environment practices”. This can be implemented through the design of products in order to reduce the consumption of material/energy, to reuse and recycle better, to better recover material and component parts. Besides the categories presented by Zhu and Sarkis (2004), other authors give similar or different dimensions for the application of sustainable SCM.

Huang et al. (2017), based on the results of a review of different articles, describe green supply chain initiatives as being part of five dimensions: internal environmental management, eco-design or design for the environment, green purchasing, customer environmental collaboration and reverse logistics. Additionally, Hsu et al. (2013) give three fundamental green initiatives which are green purchasing, design for the environment and reverse logistics. Despite the fact that different authors consider different characteristics in the context of GSCM to be important, all agree upon the importance of sustainability in the context of SCM. Finally, few articles mentioned that standards such as ISO 14001, which is the environment management certification, are more and more implemented and that suppliers are encouraged to obtain it (Hsu et al., 2013; Prajogo, Tang, & Lai, 2014; Zhu et al., 2013). This again reinforces the increased importance and trend of environmental approaches within the SCM and logistics.
3.2.2 Benefits of GSCM and green logistics

As a result of the literature review, different benefits for GSCM and green logistics are given by the different authors. Mostly, authors have given the benefits for GSCM, but the authors of this paper believe that all the benefits can be applied to both green logistics, as part of GSCM, and to GSCM in general, regardless if the literature is about green logistics or GSCM.

First, the benefit that has been mentioned the most is the potential that GSCM has to increase the financial and the economic performance as well as reducing the costs (Carter & Rogers, 2008; Hsu et al., 2013; Huang et al., 2017; Lai et al., 2013; Lo, 2013; Lo & Shiah, 2016; Mafini & Muposhi, 2017; Xie & Breen, 2012; Zhu et al., 2013). Second, many authors think that GSCM can help an organization to improve its SCM organizational, operational, relational and ecological efficiency (Hsu et al., 2013; Huang et al., 2017; Lai et al., 2013; Mafini & Muposhi, 2017; Xie & Breen, 2012; Zhu et al., 2013). On the one hand, an example is given by Mafini and Muposhi (2017) using the paper from Zhu, Sarkis and Lai (2008) who say that GSCM brings due to cost reduction, better product quality and faster production lead times more operational efficiency. On the other hand, applying a greener SCM approach could for Carter and Rogers (2008), Mafini and Muposhi (2017), Thomas et al. (2016) and Xie and Breen (2012) improve the image of an organization and increase its potential of selection by a firm. Third, the integration of greener SCM is for some authors favorable to better react to stakeholders request for more environmental friendly activities (Lai et al., 2013; Lo, 2013; Lo & Shiah, 2016). Fourth, as a result, authors believe that it will enable the firm to increase its market share (Huang et al., 2017; Xie & Breen, 2012). Finally, other benefits of GSCM and green logistics have been given in the reviewed literature but exclusively by one author only such as the ability to influence shaping future regulations (Carter & Rogers, 2008), decreasing the environmental risk (Huang et al., 2017), being ahead of competitors and legislations, accessing new markets as well as increasing employee motivation (Xie & Breen, 2012).

3.2.3 Drivers for GSCM and green logistics

A manager is influenced by its environment when taking decisions (Carbone & Moatti, 2011). Before presenting the different drivers, the reason why following drivers influence GSCM and green logistics can be explained by the so called “isomorphic pressures”, often mentioned in the reviewed literature and introduced by Dimaggio and Powell (1983). In fact, regarding the institutional literature, the different stakeholders of a firm can pressure a firm to act through
coercive, normative and mimetic pressures. Coercive pressures will come from formal institutions (e.g. from governments through regulations). Normative and mimetic pressures will be applied by more informal social pressures leading and interconnected actors which are seen as successful (also referred to as competitive benchmarking) (e.g. competitors) or because of their expectations (e.g. customers or suppliers) (Carbone & Moatti, 2011; Hsu et al., 2013; Huang et al., 2017; Lo & Shah, 2016; Zhu et al., 2013).

The reviewed articles are extensive about the drivers that motivate firms to adopt a greener approach. To simplify the explanation of the variety of drivers, those can be classified into three major categories based on Lin and Ho (2011): the environmental or external factors, the internal or organizational factors and the technological factors. Table 5 gives the three categories and their respective drivers as well as the articles which mention those. The most important are now briefly discussed.

First, as environmental factors, the reviewed articles mentioned for example that stakeholders in general or, more specific, government and their regulations influence the firms to apply or not a greener approach. However, Lin and Ho (2011) for example said that through their research on logistics companies in China, the influence of customers could not be supported. As one of the most cited external drivers, the transparent collaboration and communication seems to be a key driver for an improved management of green supply chain and green logistics, as it provides for instance traceability and visibility along the supply chain but also increases the efficiency of the supply chain to better serve customers (Carter & Easton, 2011; Carter & Rogers, 2008; Wong, 2013; Wong, Lai, Lun, & Cheng, 2012).
Table 5: Drivers for GSCM and green logistics

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DRIVER</th>
<th>SOURCE MENTIONING DRIVER</th>
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</thead>
<tbody>
<tr>
<td>Environmental (external) drivers</td>
<td>Collaboration, communication &amp; transparency</td>
<td>(Carbone &amp; Moatti, 2011; Carter &amp; Easton, 2011; Carter &amp; Rogers, 2008; Gallego-Alvarez et al., 2017; Hsu et al., 2013; Lai et al., 2013; Lo &amp; Shah, 2016; Lun et al., 2015; Mollenkopf et al., 2010; Wolf, 2011; Wong, 2013; Xie &amp; Breen, 2012; Zhu et al., 2013)</td>
</tr>
<tr>
<td></td>
<td>Competitors</td>
<td>(Carbone &amp; Moatti, 2011; Hsu et al., 2013; Huang et al., 2017; Lin &amp; Ho, 2011; Lo, 2013; Tacken et al., 2014)</td>
</tr>
<tr>
<td></td>
<td>Customers</td>
<td>(Carbone &amp; Moatti, 2011; Hsu et al., 2013; Huang et al., 2017; Kim &amp; Lee, 2012; Lai et al., 2013; Lam &amp; Dai, 2015; Lo, 2013; Mollenkopf et al., 2010; Tacken et al., 2014)</td>
</tr>
<tr>
<td></td>
<td>Government</td>
<td>(Hsu et al., 2013; Huang et al., 2017; Kim &amp; Lee, 2012; Lin &amp; Ho, 2011; Meixell &amp; Luoma, 2015; Mollenkopf et al., 2010; Tacken et al., 2014)</td>
</tr>
<tr>
<td></td>
<td>Market reputation(^5)</td>
<td>(Carbone &amp; Moatti, 2011; Mollenkopf et al., 2010; Tacken et al., 2014)</td>
</tr>
<tr>
<td></td>
<td>Regulations</td>
<td>(Carbone &amp; Moatti, 2011; Hsu et al., 2013; Huang et al., 2017; Lai et al., 2013; Lin &amp; Ho, 2011; Lo, 2013; Tacken et al., 2014; Van den Berg &amp; De Langen, 2017; Zhu et al., 2013)</td>
</tr>
<tr>
<td></td>
<td>Society</td>
<td>(Carbone &amp; Moatti, 2011; Hsu et al., 2013; Kim &amp; Lee, 2012; Meixell &amp; Luoma, 2015; Tacken et al., 2014; Wolf, 2011)</td>
</tr>
<tr>
<td></td>
<td>Stakeholders in general</td>
<td>(Kim &amp; Han, 2012; Kim &amp; Lee, 2012; Lin &amp; Ho, 2011; Lun et al., 2015; Meixell &amp; Luoma, 2015; Mollenkopf et al., 2010; Wolf, 2011; Zhu et al., 2013)</td>
</tr>
<tr>
<td></td>
<td>Supply chain</td>
<td>(Carbone &amp; Moatti, 2011; Hsu et al., 2013; Meixell &amp; Luoma, 2015; Tacken et al., 2014; Wong, 2013)</td>
</tr>
<tr>
<td></td>
<td>Supply uncertainty</td>
<td>(Lo &amp; Shah, 2016)</td>
</tr>
<tr>
<td>Organizational (internal) drivers</td>
<td>Company size</td>
<td>(Kim &amp; Han, 2012; Lin &amp; Ho, 2011)</td>
</tr>
<tr>
<td></td>
<td>Employees</td>
<td>(Hsu et al., 2013; Kim &amp; Lee, 2012; Lin &amp; Ho, 2011; Meixell &amp; Luoma, 2015; Tacken et al., 2014; Wolf, 2011)</td>
</tr>
<tr>
<td></td>
<td>Imperative of cost reduction</td>
<td>(Lo, 2013; Lo &amp; Shah, 2016; Mollenkopf et al., 2010; Tacken et al., 2014)</td>
</tr>
<tr>
<td></td>
<td>Market reputation(^5)</td>
<td>(Lo, 2013; Lo &amp; Shah, 2016)</td>
</tr>
<tr>
<td></td>
<td>Organizational strategic orientation, culture and structure</td>
<td>(Carter &amp; Rogers, 2008, 2008; Hsu et al., 2013; Huang et al., 2017; Kim &amp; Han, 2012; Lai et al., 2013; Lin &amp; Ho, 2011; Lun et al., 2015; Meixell &amp; Luoma, 2015; Mollenkopf et al., 2010; Van den Berg &amp; De Langen, 2017)</td>
</tr>
<tr>
<td></td>
<td>Organizational support</td>
<td>(Huang et al., 2017; Kim &amp; Han, 2012; Lin &amp; Ho, 2011; Lo, 2013; Lo &amp; Shah, 2016; Wolf, 2011)</td>
</tr>
<tr>
<td></td>
<td>Risk management</td>
<td>(Carter &amp; Easton, 2011; Carter &amp; Rogers, 2008; Mollenkopf et al., 2010)</td>
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</table>

\(^5\) driver is present in two categories
Second, as organizational factors, the reviewed articles mentioned often that the organizational strategic orientation, culture, structure and way of supporting initiatives highly influences the success of GSCM and green logistics. For example, innovative firms will more likely implement new environmental innovations (Mollenkopf et al., 2010) and therefore be more friendly to the implementation of green initiatives. Regarding market reputation as a driver, in contradiction to other authors, Carbone and Moatti (2011), Lo (2013) and Lo and Shiah (2016) refer to it as something that is streaming from the inside of the organization rather than from the external environment.

Third, regarding technological factors, only the article from Lin and Ho (2011) mentioned this category as being a relevant driver for GSCM. They say that the success of the implementation of a green innovation depends on its compatibility, meaning how an innovation fits within the already implemented innovations and processes of the firm, its complexity, meaning how difficult this innovation is to understand and use, and its relative advantage, which means to which degree a particular innovation is seen as more advantageous than its substitute.

### 3.2.4 Problems and challenges for GSCM and green logistics

In the reviewed literature, different challenges that GSCM and green logistics face are mentioned. First, an unsuitable legislation can represent a real challenge for firms, as the impact of legislation may have a negative effect, e.g. the raise of costs and prices (Huang et al., 2017; Kim & Lee, 2012; Mollenkopf et al., 2010; Sarkis, 2012; Tacken et al., 2014). Then, the lack of infrastructure for the implementation of greener logistics is also a limitation in the development of green logistics. For instance, the increased usage of one transportation mode might not be feasible due to capacity restrictions (Gangwar & Sharma, 2014; Sarkis, 2012; Tacken et al., 2014). Next, the cost and therefore the impact on price calculation is perceived as challenging by firms willing to become greener, as the customers may not be willing to share the costs of greener solutions (Tacken et al., 2014; Van den Berg & De Langen, 2017).
Furthermore, losing partners in a green supply chain may represent risk and opportunity costs which hinder companies to go green (Mollenkopf et al., 2010; Zhu & Cote, 2004). Moreover, the lack of resources can represent a problem for firms to implement a green approach (Huang et al., 2017; Tacken et al., 2014). Finally, other problems, challenges or barriers that firms face when trying to have a GSCM and green logistics are the effort required to implement measurement systems (Searcy, 2016), the additional coordination effort (Tacken et al., 2014), the lack of support from the management (Huang et al., 2017) or even from suppliers (Mollenkopf et al., 2010) to implement those concepts. The lack of cross-functional relations as well as the lack of information can also hinder the greening process of a supply chain (Sarkis, 2012). Regarding the measurement of green supply chains, challenges are described in the next subchapter.

3.2.5 Measurement and metrics of GSCM and green logistics

Different articles have mentioned the topic of performance measurement of GSCM and green logistics and the metrics used for it. However, Wolf (2011) reveals through her case study that GSCM seems to have a positive impact on firms but that the quantification of this impact is rather difficult. This supports Mollenkopf et al. (2010) who claim a lack of metrics. A study by Tacken et al. (2014) revealed that the majority of the studied companies have already implemented green standards and measurements in their business. Different standards such as ISO 14001, ecological key performance indicators, footprint calculation softwares and ecological reportings are already used by companies.

Moreover, different papers presented green measurements and standards in theory. On the one hand, Tacken et al. (2014), based on a literature review, present various measures for the environmental impacts of logistitical operations for example emissions, land use, noise or total energy consumption. On the other hand, Lun et al. (2015) discuss the greening performance relativity or GPR developed by Lun, Lai, Wong and Cheng (2013) as a possible approach to look at greening operations.

In a paper by Searcy (2016), the author presents a list of key requirements to measure an enterprise sustainability based on an Enterprise Sustainability Performance Measurement System (ESPMS), which is a more holistic way to measure the sustainability of a firm not only considering the focal firm but also its supply chain and the environment of the firm. One of
those requirements is to relate the ESPMS to the partner selection and to the forward supply chain. Moreover, this measurement system needs to consider short- and long-term management of the enterprise.

Finally, Wolf (2011) says that for a complete integration of sustainable SCM, appropriate performance measures and a sustainable strategy are required. Moreover, Mollenkopf et al. (2010) appeal for measurement frameworks to become more holistic and more standardized.

### 3.3 Intermodal transportation

As a second part of the literature review, this part analyzes all the data related to the topic of intermodal transportation. In addition to the similar structure of the subchapters covered in the previous part about GSCM and green logistics (see Table 6), this section also includes one chapter about the costs of intermodal transportation, since costs are seen as a central decision criteria for transportation.

<table>
<thead>
<tr>
<th>CATEGORY FROM LITERATURE CODING</th>
<th>REFERENCE CHAPTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermodal concept presentation</td>
<td>3.3.1</td>
</tr>
<tr>
<td>Benefits of intermodal transportation</td>
<td>3.3.2</td>
</tr>
<tr>
<td>Drivers for intermodal transportation</td>
<td>3.3.3</td>
</tr>
<tr>
<td>Problems and challenges for intermodal transportation</td>
<td>3.3.4</td>
</tr>
<tr>
<td>Measurement and metrics of intermodal transportation</td>
<td>3.3.5</td>
</tr>
<tr>
<td>Costs of intermodal transportation</td>
<td>3.3.6</td>
</tr>
</tbody>
</table>

Since transportation is a factor contributing to economic growth in a globalized world, it is interesting to reveal, that traditional transportation has grown in a similar speed as gross domestic product (Eurostat, 2018). Therefore, transportation and its related emissions have grown significantly and continuously over the last century. As one potential solution to cope with this problem, our thesis sets a focus on intermodal transportation and its connection to sustainability.
3.3.1 Intermodal concept presentation

According to Baykasoğlu & Subulan (2016), a supply chain consists of three components (pre-haulage, long-haulage and end-haulage) which have a connection to the mode of transport. While truck is the preferred transportation mode for the pre- and end-haulage transportation, much long-haulage transportation is conducted by ship, rail or air transportation (Baykasoğlu & Subulan, 2016; SteadieSeifi, Dellaert, Nuijten, Van Woensel, & Raoufi, 2014; UIC, 2015).

There are many reasons mentioned in literature regarding the motivation to use intermodal transportation which will be explained in more detail in the successive part; generally speaking, business-oriented reasons such as traffic safety or the avoidance of congestion and environmental oriented reasons are mentioned frequently. The switch from faster and more polluting modes (truck) to slower and less polluting modes (rail) is highlighted as a trade-off when talking about logistic decisions with environmental considerations. This shift from road to rail transportation has been recommended by researchers as a potential solution to connect business and environmental considerations (Eng-Larsson & Norrman, 2014; European Commission, 2001; Flodén, 2007).

3.3.2 Benefits of intermodal transportation

Even if intermodal transportation gives the chance to reduce emissions when implemented correctly (Eng-Larsson & Kohn, 2012; Ortolani, Persona, & Sgarbossa, 2011), one finding of the systematic literature review is the rare occurrence in the literature of benefits of intermodal transportation. The authors see two reasons to be possible. First, due to the fact that the authors search for a keyword combination of intermodal transportation and GSCM/green logistics, the benefits of GSCM/green logistics are self-explanatory and thus mentioned in the previous part about the GSCM/green logistics literature. Second, research has not yet been able to determine many benefits of intermodal solutions from a business perspective. The benefit of intermodal transportation solutions that is mentioned the most frequently is the advantage of economies of scale to transportation companies when shifting from road to rail transportation (Baykasoğlu & Subulan, 2016; Limbourg & Jourquin, 2009).
3.3.3 Drivers for intermodal transportation

There are only few incentives for modal shift of transportation by companies. Especially in the current market structure, where most transportation decisions are based on costs, there is little incentive for actors in the market to change. As Inghels et al. (2016) say, a “shift only happens when [it is] cost-neutral for decision makers” (p. 68). Even more elementary, price is the primary decision-variable when it comes to transportation services (Eng-Larsson & Norrman, 2014). Another issue, which has been identified by researchers, is the important role of the contract between actors in the supply chain. In most cases, actors in the supply chain are trying to maximize their individual profit instead of optimizing the value adding through the entire supply chain. Therefore, in the paper by Narayanan and Raman (2004), the authors claim the importance of coordination in the contract(s) between the firms. With their proposed solution of a three-part tariff, the authors suggest that changed contracts can increase profitability while shifting to a more sustainable transportation mode (Eng-Larsson & Norrman, 2014). Furthermore, Narayanan and Raman (2004) state that from a long-term perspective the advantages of adapted contracts outweigh the initial costs for an operator and thus, become an attractive option (Eng-Larsson & Norrman, 2014). This is also confirmed by Eng-Larsson and Kohn (2012), who claim, that “costs are perceived to be lower with an intermodal solution” (p.40). Last, policy interventions drive intermodal transportation, e.g. policy incentives to enhance a modal shift from road to rail, can be indirectly achieved by taxation on truck ownership or congestion taxes (Gangwar & Sharma, 2014).

3.3.4 Problems and challenges for intermodal transportation

The reviewed articles are very extensive about the problems and challenges that intermodal transportation is confronted with. To simplify the explanation of the variety of problems, Table 7 gives an overview about the problem categories, the specific problems and about the articles which mention those.
As illustrated by Table 7, there are four major problem categories, which were mentioned most frequently in the review literature. Emissions, dependencies in intermodal transportation, product related risks as well as customer requirements were identified as the central challenges by the authors.

First, regarding emissions, studies reveal, that the freight which is carried by road, accounts for the largest amount of GHG emissions. While some researchers claim, that with the support of intermodal solutions, the amount of emissions can be reduced up to 45%, other researchers criticize the “fire-fighting” approach, where most efforts of research is put on solving the problems of emissions by improving the efficiency of one transportation mode, instead of looking at the entire supply chain system from a holistic view (Eng-Larsson & Kohn, 2012; Gangwar & Sharma, 2014; Kamga & Yazici, 2014; Van den Berg & De Langen, 2017).

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>PROBLEM</th>
<th>SOURCE MENTIONING PROBLEM / CHALLENGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions</td>
<td>Reduction of emissions</td>
<td>(Eng-Larsson &amp; Kohn, 2012; Gangwar &amp; Sharma, 2014; Van den Berg &amp; De Langen, 2017)</td>
</tr>
<tr>
<td></td>
<td>Carrier performance</td>
<td>(Eng-Larsson &amp; Kohn, 2012)</td>
</tr>
<tr>
<td></td>
<td>Firefighting, not rethinking the system</td>
<td>(Kamga &amp; Yazici, 2014)</td>
</tr>
<tr>
<td>Dependencies</td>
<td>Global vs. local transport</td>
<td>(Limbourg &amp; Jourquin, 2009)</td>
</tr>
<tr>
<td></td>
<td>More coordination needed</td>
<td>(Dekker et al., 2012; Eng-Larsson &amp; Kohn, 2012; Inghels et al., 2016)</td>
</tr>
<tr>
<td></td>
<td>Contradicting contract objectives</td>
<td>(Eng-Larsson &amp; Norrman, 2014; Gangwar &amp; Sharma, 2014)</td>
</tr>
<tr>
<td></td>
<td>Inventory issues</td>
<td>(Dong et al., 2018; Limbourg &amp; Jourquin, 2009)</td>
</tr>
<tr>
<td></td>
<td>Capacity constraints</td>
<td>(Gangwar &amp; Sharma, 2014)</td>
</tr>
<tr>
<td>Product related risks</td>
<td>Product quality</td>
<td>(Eng-Larsson &amp; Kohn, 2012)</td>
</tr>
<tr>
<td></td>
<td>Not suitable for all good</td>
<td>(Eng-Larsson &amp; Kohn, 2012)</td>
</tr>
<tr>
<td></td>
<td>Economies of scale</td>
<td>(Dong et al., 2018)</td>
</tr>
<tr>
<td>Customer requirements</td>
<td>Deliver frequency</td>
<td>(Dong et al., 2018; Eng-Larsson &amp; Kohn, 2012)</td>
</tr>
<tr>
<td></td>
<td>Quality</td>
<td>(Eng-Larsson &amp; Kohn, 2012; Eng-Larsson &amp; Norrman, 2014)</td>
</tr>
<tr>
<td></td>
<td>Convenience</td>
<td>(Eng-Larsson &amp; Kohn, 2012)</td>
</tr>
<tr>
<td></td>
<td>Customer demand</td>
<td>(Tacken et al., 2014)</td>
</tr>
</tbody>
</table>
Second, when it comes to intermodal transportation, there are many dependencies which are mentioned in the literature. To start with, while intermodal transportation on the one hand may lead to less transportation for the long-haul distance; on the other hand, in already congested areas, intermodal transportation can lead to even more transportation which can decrease the overall efficiency of the intermodal solution. Limbourg and Jourquin (2009) confirm that “the decision to open a new terminal is most often taken at the […] regional level, ignoring the international network effects” (p. 560, 561). These local decisions can lead to a reduction of the global efficiency of the intermodal transportation system. Another dependency in the field of intermodal transportation is the power situation of actors involved in the supply chain. Researcher claim that the power situation in the trucking market compared to the intermodal rail-road market may change thus, creating changing power situations. Moreover, inventory issues are seen as another challenge to intermodal transportation. Whereas many studies are focusing on inventory models for single-mode truck transportation, only few mention the need to change the inventory model based on the transportation mode selection since slower intermodal transportation solutions cause higher inventory levels and thus higher costs (Dong et al., 2018; Limbourg & Jourquin, 2009).

Third, product related risk refers to problems with the product quality, e.g. the risk of products getting damaged when being switched from one transportation mode to another. Additionally, some products might not be appropriate for an intermodal transportation solution due to perishability or demand of the product. With regard to economies of scale, some freight forwarders hesitate to implement train transportation as part of intermodal solutions, since they are afraid that small companies cannot achieve a large volume to benefit from the economies of scale (Dong et al., 2018; Eng-Larsson & Kohn, 2012).

Fourth, customer requirements and expectations do also belong to the main categories of problems. In connection to the previously mentioned challenge to obtain economies of scale, the delivery frequency is also mentioned as a challenge when considering the implementation of intermodal transportation. In detail, sometimes operation might be limited to shortened schedules with lower delivery frequencies. From a customer perspective, the aspects of quality and convenience must also be mentioned. Especially the quality of transport – such as reliability or speed – provided by the carrier is relevant for customers when selecting a transportation mode. In their study, Eng-Larsson and Kohn (2012) confirm that in many cases
the decision for a transportation provider was not based on evaluating quality and price, but more trading purchase convenience and price.

3.3.5 Measurement and metrics of intermodal transportation

According to SCM literature, the objective of logistics management is to balance logistic costs with customer service (Dong et al., 2018; Fisher, 1997). As mentioned above, intermodal shifts do usually imply a slower transportation alternative (rail vs. road) which in turn can cause the need for a higher inventory level in order to keep the level of customer service constant. Obviously, this trade-off needs to be considered for intermodal transportation decisions (Eng-Larsson & Kohn, 2012). Turning to environmental performance, the authors identified the lack of existing research for SCM decisions incorporating environmental aspects on an operative level. Those findings are confirmed by Eng-Larsson and Kohn (2012), who claim, that “environmental programs or policies were mostly at strategic level and had little or no effect on the transport purchasing process” (p. 45). Above all, several authors agree that the use of metrics in intermodal transportation for the purpose of optimization is essential. Including metrics for environmental performance is needed to better evaluate different alternatives of transportation (Dekker et al., 2012; Quarshie et al., 2016).

Moreover, the measurement of costs is seen as a central consideration and thus, mentioned most frequently in the category of metrics for intermodal transportation. As analyzed, is the cost factor an important driver for LSP to change the mode of transport. Inghels et al. (2016) study results show that multimodal truck and inland water transportation can compete with truck transport applying a model that minimizes transportation costs, external environment costs as well as social costs. In the case study by Eng-Larsson and Kohn (2012), the researchers investigated the modal shift of a company selling non-bulk, fast moving goods delivering from their plant in Germany to a warehouse in Sweden and came to the conclusion, that the analyzed firm “maintain[s] a 98% service level to […] customers […] and […] pay[s] less for […] intermodal solution” (p. 45). Even if this result is positively influenced by the low product value, which did not raise additional inventory costs above the savings for the intermodal solution, those practical examples illustrate two points: First, costs are an important metric to consider when measuring intermodal transportation solutions and second, environmental impacts can be reduced by intermodal solutions.
3.3.6 Costs of intermodal transportation

As costs are defined as the primary decision criteria for many transportation solutions, this analysis is split into internal and external costs of a distribution network to cover this topic holistically. On the one side, from an internal perspective, the costs of distribution, transportation, and handling of goods are considered as the internal costs of the network (Janic, 2007). On the other side, “external costs are burdens that the distribution network imposes on society” (Ortolani et al., 2011, p. 200). Usually, those external costs are caused by the transportation activity and are in most of the cases not paid by neither the user nor the transport provider. Ergo, those costs are not taken into consideration for intermodal transportation decisions (Ortolani et al., 2011).

3.4 Connection between GSCM/green logistics and intermodal transportation

In this subchapter, the based to answer the research question about the interdependencies between the two topics is set using the reviewed theory. First, the relation between both topics is discussed by showing the influence that intermodal transportation has on GSCM and green logistics. Then, the specific factors that determine the sustainability of the intermodal transportation are presented, showing that the triple bottom line principles that GSCM and green logistics are based on, form a frame to evaluate the degree to which an intermodal transportation network design is sustainable. Finally, common aspects between GSCM, green logistics and intermodal transportation are revealed and summarized in a new framework.

3.4.1 Intermodal transportation as a green solution for SCM/logistics

Many articles describe the concepts of GSCM/green logistics and intermodal transportation separately, but only very few are bringing both topics together. For instance, Sagaris et al. (2017) give a slightly different definition of intermodal transportation based on the report of Thredbo (2016). For them, intermodal transportation is “the seamless integration of diverse motorized and nonmotorized transport systems that are socially, environmentally, and economically sustainable, in response to human diversity and needs, particularly equity and social justice” (p. 722). Looking at the presented definitions in the section 3.1, it can be said that this definition combines the sustainability definition with the intermodal transportation definition. This definition can be seen as a first attempt to bring both topics together. In fact, this different definition of intermodal transportation shows that for Sagaris et al. (2017),
transportation network design should consider economic, environmental and social aspects together.

From a general perspective, Limburg and Jourquin (2009) define intermodal transportation as one “of the key elements towards a sustainable freight transport policy over medium and long distances” (p. 560). Therefore, proving that researchers are aware that transportation network design plays a role in the sustainability actions of SCM/logistics especially in freight transport.

The economic benefit of intermodal transportation has already been briefly mentioned in section 3.3.2, whereby economies of scale can be generated using this concept. Moreover, many articles discuss the positive impact that intermodal transportation has on the environment. In fact, several authors describe this transportation network design as a way to reduce emissions in transportation (Dekker et al., 2012; Eng-Larsson & Kohn, 2012; Inghels et al., 2016; Van den Berg & De Langen, 2017). However, the social impact of intermodal freight transportation is not mentioned in the SCM literature.

To sum up, it can be said that the theory has proven that GSCM, green logistics and intermodal transportation are not opposed but rather interrelated. On the one hand, intermodal transportation supports GSCM and green logistics activities as it is a sustainable solution. On the other hand, GSCM and green logistics expect intermodal transportation to offer a greener way of transportation. However, the degree to which intermodal transportation is sustainable depends on different factors that are now discussed.

3.4.2 Factors influencing green performance of intermodal transportation
As activities are defined as being green only if they consider the triple bottom line principles (see section 3.1), it can be said that GSCM and green logistics impose a frame – the triple bottom line principles – to intermodal transportation networks that aim to become green.

Based on the reviewed articles, a summary of factors/drivers influencing the degree to which an intermodal transportation solution is green is given in Table 8. This table only gives factors that influence the environmental and economic aspects, as social aspects were not presented in the literature.
Table 8: Green performance drivers of intermodal transportation

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DRIVER</th>
<th>SOURCE MENTIONING DRIVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract</td>
<td>Formulation of contracts with partners</td>
<td>(Eng-Larsson &amp; Norrman, 2014)</td>
</tr>
<tr>
<td>Costs</td>
<td>Costs of distribution, transportation, and handling of goods</td>
<td>(Janic, 2007; Ortolani et al., 2011)</td>
</tr>
<tr>
<td>Facilities</td>
<td>Facilities used</td>
<td>(Dekker et al., 2012)</td>
</tr>
<tr>
<td>Personal skills</td>
<td>Driver efficiency</td>
<td>(Tacken et al., 2014)</td>
</tr>
<tr>
<td>Logistics management</td>
<td>Inventory type</td>
<td>(Dekker et al., 2012; Eng-Larsson &amp; Kohn, 2012)</td>
</tr>
<tr>
<td></td>
<td>Logistics efficiency</td>
<td>(Tacken et al., 2014)</td>
</tr>
<tr>
<td></td>
<td>Route efficiency</td>
<td>(Tacken et al., 2014)</td>
</tr>
<tr>
<td>Transport characteristics</td>
<td>Distance of shipment</td>
<td>(Eng-Larsson &amp; Kohn, 2012; Van den Berg &amp; De Langen, 2017)</td>
</tr>
<tr>
<td></td>
<td>Drayage distance</td>
<td>(Van den Berg &amp; De Langen, 2017)</td>
</tr>
<tr>
<td>Transport mode</td>
<td>Characteristics of mode used (e.g. size, consumption, fuel/energy used, vehicle efficiency)</td>
<td>(Dekker et al., 2012; Eng-Larsson &amp; Kohn, 2012; Inghels et al., 2016; Tacken et al., 2014; Van den Berg &amp; De Langen, 2017)</td>
</tr>
<tr>
<td></td>
<td>Source of energy/fuel type</td>
<td>(Dekker et al., 2012; Van den Berg &amp; De Langen, 2017)</td>
</tr>
</tbody>
</table>

For this paper, it is assumed that all presented drivers in Table 8 have an economic influence, as for instance the price of the facilities used, the type of inventory, the distance of shipment or the type of fuel will influence the cost level and therefore the economic performance of the intermodal transportation solution. The costs definition and importance of contracts have already been discussed in section 3.3.3 and 3.3.6. Therefore, only the factors that influence the environmental performance are discussed into more details.

The most important factor that influence the environmental performance of intermodal transportation is the characteristics of the mode of transport used such as the size, the consumption or the energy used. In fact, this fact was mentioned the most often in the reviewed literature (Dekker et al., 2012; Eng-Larsson & Kohn, 2012; Inghels et al., 2016; Tacken et al., 2014; Van den Berg & De Langen, 2017). After, the source of fuel used by the mode of transportation determines also the emissions, for example the way electricity is produced also impacts more or less the environment (Dekker et al., 2012; Van den Berg & De Langen, 2017). Moreover, the way storage is done, meaning if for instance the goods need to be cooled or
heated, will impact the environment differently (Dekker et al., 2012). Furthermore, the total distance for the shipment as well as the drayage distance are influencing emissions if they increase (Eng-Larsson & Kohn, 2012; Van den Berg & De Langen, 2017). This goes hand in hand with the route planning, as the efficiency of the route will determine the emissions (Tacken et al., 2014). Finally, two other elements impacting the environmental performance of the intermodal transportation are the type of facilities used for the transportation, e.g. airport, train station, and the personal driver skills (Dekker et al., 2012; Tacken et al., 2014).

3.4.3 Common aspects between those topics
After analyzing literature in a systematic manner, it can be said that on an abstract level, the authors considered four characteristics regarding the two topics, which either converge or diverge. While a relatively large intersection between the benefits of GSCM and intermodal transportation was identified, the overlap of the drivers was smaller. The common points between the topics regarding the benefits are that all topics help to reduce costs, improve the economic performance and reduce the environmental impact. Then, concerning the drivers, the common drivers are costs, regulations and collaboration among the supply chain. In terms of challenges, the authors also revealed several similarities, without neglecting that still many of the challenges do only affect one of the two topics. Coordination, cost and capacity constraints have been identified as shared challenges. Finally, the only joint commonly used measurement/metric is the measure of the environmental impact of activities that is used in all concepts.

To summarize the identified common points between GSCM, green logistics and intermodal transportation based on specific aspects (benefits, drivers, challenges, measurements and metrics) and in order to fill a gap in the literature, a framework is built in Table 9.
### Table 9: Convergences of GSCM/green logistics and intermodal transportation

<table>
<thead>
<tr>
<th>GSCM AND GREEN LOGISTICS</th>
<th>COMMON POINTS</th>
<th>INTERMODAL TRANSPORTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ability to influence shaping future regulations</td>
<td>• Cost reduction</td>
<td>• Economies of scale</td>
</tr>
<tr>
<td>• Access new markets</td>
<td>• Improve economic performance</td>
<td>• Reduce emissions</td>
</tr>
<tr>
<td>• Be ahead of competitors/legislations</td>
<td>• Improve SCM efficiency</td>
<td></td>
</tr>
<tr>
<td>• Better reaction to stakeholder request for green activities</td>
<td>• Improve the image of a firm</td>
<td></td>
</tr>
<tr>
<td>• Decrease the environmental risk</td>
<td>• Increase the employee motivation</td>
<td></td>
</tr>
<tr>
<td>• Improve SCM efficiency</td>
<td>• Increase financial &amp; economic performance</td>
<td></td>
</tr>
<tr>
<td>• Improve the image of a firm</td>
<td>• Increase the market share</td>
<td></td>
</tr>
<tr>
<td>• Increase financial &amp; economic performance</td>
<td>• Reduce costs</td>
<td></td>
</tr>
<tr>
<td>• Increase the market share</td>
<td>• Cost reduction</td>
<td></td>
</tr>
<tr>
<td>• Reduce costs</td>
<td>• Improve economic performance</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drivers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Environmental (external) drivers (e.g. collaboration, communication &amp; transparency, supply uncertainty)</td>
<td>• Costs</td>
<td>• Contracts between firms</td>
</tr>
<tr>
<td>• Organizational (internal) drivers (e.g. company size, employees, market reputation)</td>
<td>• Regulations</td>
<td>• Cost</td>
</tr>
<tr>
<td>• Technological factors (e.g. compatibility of innovation, complexity of innovation)</td>
<td>• Collaboration</td>
<td>• Policy intervention</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Challenges</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cost</td>
<td>• Coordination</td>
<td>• Emissions</td>
</tr>
<tr>
<td>• Effort for the implementation of measurement systems, coordination</td>
<td>• Cost</td>
<td>(e.g. reduction, carrier performance)</td>
</tr>
<tr>
<td>• Lack of cross-functional relations</td>
<td>• Capacity constraints</td>
<td>• Dependencies</td>
</tr>
<tr>
<td>• Lack of information</td>
<td></td>
<td>(e.g. contradicting contract objectives, inventory issues, capacity constraints)</td>
</tr>
<tr>
<td>• Lack of infrastructure</td>
<td></td>
<td>• Product related risks</td>
</tr>
<tr>
<td>• Lack of metrics</td>
<td></td>
<td>(e.g. product quality, economies of scale)</td>
</tr>
<tr>
<td>• Losing partners</td>
<td></td>
<td>• Customer requirements</td>
</tr>
<tr>
<td>• Lack of resources</td>
<td></td>
<td>(e.g. delivery frequency, quality, convenience, customer demand)</td>
</tr>
<tr>
<td>• Lack of support from management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Lack of support from suppliers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Unsuitable legislation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measurement and Metrics</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ecological KPIs</td>
<td>• Measure environmental impact</td>
<td>• Measure cost</td>
</tr>
<tr>
<td>• Ecological reporting</td>
<td></td>
<td>• Measure environmental impact</td>
</tr>
<tr>
<td>• Footprint calculation software</td>
<td></td>
<td>• Trade-off between inventory level and customer service constant</td>
</tr>
<tr>
<td>• Greening performance relativity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• ISO 14001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Measure emissions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Measure land use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Measure noise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Measure total energy consumption</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 3.5 Gaps identification

The authors have identified several topics that have not been researched or presented by academic researchers, so called theoretical gaps that should be bridged by this thesis using
empirical evidence. For the empirical study, the authors focus on two theoretical gaps out of three identified.

First, regarding the connection of GSCM/green logistics and intermodal transportation, the theory has not presented or verified any framework relating both topics with regard to benefits, drivers, challenges and measurement/metrics. Therefore, as the authors presented a new built model in section 3.4.3, the interviews with experts intend to discuss this model and also extend it with the input given by the interviewees if applicable.

Second, in the current theory, there are no practical examples of companies using an intermodal transportation network design as a solution to follow a GSCM/green logistics approach. Thus, a further research possibility is to present examples of companies/industries applying this method. For this thesis, the interviewees will be asked to share their experiences and describe how intermodal transportation networks can be used and should be applied.

Third, the literature review revealed that no academic paper has looked at the social impact of intermodal transportation in detail. Despite collecting some data about this topic in the empirical part, the authors focus their analysis on the model, so a detailed analysis of social impact is subject to further research.
4. Results

This chapter depicts the data, which was collected during eight expert interviews in a purely descriptive way. Ten hours of empirical material was collected between the 2\textsuperscript{nd} of April and 19\textsuperscript{th} of April 2018. First, general information about the interviewees as well as a short summary of each of the interviews are presented. Afterwards, the main findings of the interviews are described and classified based on the research gaps.

4.1 Interview summaries

In total eight expert interviews were conducted. Table 10 provides a high-level overview about the conducted interviews. While most of the interviews were conducted in English, the interviewers made use of their mother tongues i.e. French and German, too. The interviewees have an average of 17 years of working experience with a standard deviation of 13 years. The interviews were conducted with experts from five European countries i.e. France, Germany, the Netherlands, Sweden and Switzerland.

<table>
<thead>
<tr>
<th>INTERVIEW NUMBER</th>
<th>WORKING AREA / INDUSTRY OF EXPERT</th>
<th>EXPERIENCE IN YEARS</th>
<th>LANGUAGE OF INTERVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCM Consulting</td>
<td>36</td>
<td>French</td>
</tr>
<tr>
<td>2</td>
<td>Furniture</td>
<td>4</td>
<td>German &amp; English</td>
</tr>
<tr>
<td>3</td>
<td>Consulting</td>
<td>10</td>
<td>German</td>
</tr>
<tr>
<td>4</td>
<td>Third-Party Logistics</td>
<td>15</td>
<td>English</td>
</tr>
<tr>
<td>5</td>
<td>Furniture</td>
<td>6</td>
<td>English</td>
</tr>
<tr>
<td>6</td>
<td>Sea freight</td>
<td>20</td>
<td>English</td>
</tr>
<tr>
<td>7</td>
<td>SCM Consulting</td>
<td>38</td>
<td>French</td>
</tr>
<tr>
<td>8</td>
<td>Consulting</td>
<td>8</td>
<td>German</td>
</tr>
</tbody>
</table>

\textit{Interview 1}

This interview was conducted with an expert who is currently Consultant and expert within the French subsidiary of a North American consultancy in SCM and has 36 years of experience in this field.
Interview 2
Interviewee 2 works in the need and transportation planning department of a Swedish furniture company. The person has been working with this company for approximately two years and has additional two years of experience in SCM related positions in different European countries.

Interview 3
This person has ten years of working experience in consultancy for various projects in the SCM and logistics area of many industries. Currently, the interviewee is working as a Project Manager for two different projects (one in the automotive industry in Germany and the second one for an automobile importer in Switzerland).

Interview 4
The interviewed expert for this interview has 15 years of experience in SCM/logistics after having worked for LSPs.

Interview 5
This expert has been working as a Transport Business Developer for a large multinational Swedish company. In the current position, the interviewee is responsible to organize and coordinate transportation activities on both – the inbound and outbound side. In total, the expert has more than ten years professional working experience. The interviewee is very interested in the topic and asked to receive the final thesis once it is submitted.

Interview 6
For this interview, an expert in sea freight logistics was interviewed. This expert has been working for 20 years in the SCM/logistics industry. At the moment of the interview, the expert was Business Manager in Logistics with a focus on intermodal solutions. Unfortunately, due to time constraints of the expert, the model in Table 9 was not discussed. Instead, the interviewer focused on collecting information about the relationship between GSCM/green logistics and intermodal, examples of the use of intermodal transportation in the context of GSCM/green logistics as well as examples of the social impact of the intermodal freight transportation.
Interview 7
Interviewee 7 was contacted based on the suggestion of interviewee 1. In total, this expert has 38 years of working experience in SCM. The interviewee worked in the paper production industry and was involved in different SCM industry associations to elaborate standards and promote SCM and logistics initiatives. At the time of the interview, the expert has been working as a Trainer and Consultant in SCM for two years.

Interview 8
This interview was conducted with an expert that was referred by interviewee 3. This expert has been working for eight years in the consulting industry with a focus on the transportation and travel industry. Due to time constraints, during the 50 minutes interview, not all areas of the interview topic guide were covered. A focus was set on the model as well as on the social impact of intermodal transportation.

4.2 Interviewees’ understanding of the key definitions
In each interview, the interviewees were asked for their understanding of the covered topics. This included explicitly asking for the experts' definition of GSCM/green logistics as well as intermodal transportation. In contrast to the other results, the interviewers here directly quote the experts' statements, as they consider this to be relevant for the part about definitions; for the remainder of the interview, paraphrased statements from memory protocols were used.

While for some interviewees the topics of GSCM and green logistics were used interchangeably, for others there was a clear distinction between the topics. All eight experts claimed environmental considerations to be part of GSCM/green logistics. When asked for the understanding of intermodal transportation, the answers varied from a very abstract definition (Interviewee 3) up to really detailed answers which in some cases included mentioning a percentage of how much of transportation distance needs to be covered by other modes than road to speak off intermodal transportation. What all interviewees agreed upon is the benefit of aligning the interviewers and interviewees understanding of the topic before continuing with subsequent questions. Table 11 provides an overview about the experts understanding of the topics.
Table 11: Interviewees’ understanding of the key definitions

<table>
<thead>
<tr>
<th>INTERVIEWEE</th>
<th>UNDERSTANDING OF GSCM/GREEN LOGISTICS</th>
<th>UNDERSTANDING OF INTERMODAL TRANSPORTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GSCM: &quot;Is a supply chain that found an equilibrium between environmentally friendly, economic and social factors.&quot;</td>
<td>&quot;Is a shipment that changes the mode of transportation via a hub. […] Can also refer to changing the fuel used by a mode of transport such as electric power for the last mile.&quot;</td>
</tr>
<tr>
<td>2</td>
<td>&quot;GSCM is to pursue logistic activities that consider the environment and impact of logistics on its surrounding.&quot;</td>
<td>&quot;Intermodal transportation describes transportation that is happening with different modes such as air, rail or truck.&quot;</td>
</tr>
<tr>
<td>3</td>
<td>&quot;GSCM is SCM that focuses on triple bottom line when conducting business.&quot;</td>
<td>&quot;Is a combination of transport modes.&quot;</td>
</tr>
<tr>
<td>4</td>
<td>&quot;Green logistics is a sustainable logistics chain which uses the most optimal solution while considering the impact on economy, environment and society. It implies the emphasis on social responsibility.&quot;</td>
<td>&quot;Is the combination of two or more modes for one transportation, whereby the load content is not touched.&quot;</td>
</tr>
<tr>
<td>5</td>
<td>&quot;GSCM considers the impact of SCM or transportation on the environment and the people.&quot;</td>
<td>&quot;Is transport with more than one transport mode. At [name of the company] intermodality means, that on a given route, half of the distance is covered by other modes than road.&quot;</td>
</tr>
<tr>
<td>6</td>
<td>&quot;Green logistics tries to reduce the footprint in logistics by increasing the efficiency.&quot;</td>
<td>&quot;Intermodal transportation is a combination of rail and road transportation.&quot;</td>
</tr>
<tr>
<td>7</td>
<td>&quot;GSCM/green logistics describes the application of environmental aspects on SCM and logistics.&quot;</td>
<td>Intermodal transportation is &quot;[t]he use of different contracts between each mode of transport used.&quot;</td>
</tr>
<tr>
<td>8</td>
<td>&quot;GSCM is SCM that serves the needs of today without neglecting the needs of future generations.&quot;</td>
<td>&quot;Intermodal transportation is a combination of two or more modes of transportation.&quot;</td>
</tr>
</tbody>
</table>

4.3 Feedback about the model

In the first section of the interview, the interviewees were asked to give feedback about the model that was built as a result of the literature review to show the common points of GSCM/green logistics and intermodal transportation with regard to four categories: Benefits,
drivers, challenges and measurement/metrics. In general, the interviewees agree to the presented model as they also see “clear” (Interviewee 2) or “obvious” (Interviewee 5) connections between GSCM/green logistics and intermodal transportation. Nonetheless, the theoretical focus of the model is also highlighted as interviewee 3 claims that the connection presented in the model is not that clear in the business environment.

Benefits
Starting with the benefits, interviewee 4 was the only expert to fully agree with the content of this category shown in Table 9. On the contrary, interviewee 1, 2, 3 and 8 did not fully agree. Interviewee 1 claimed that the benefit of GSCM/green logistics is not to lose existing market shares rather than to access new markets. Furthermore, the benefit of GSCM/green logistics is not to increase financial and economic performance since this depends a lot on the context of a company, nor is it to increase the market share. If a company follows what others already have implemented, a company is probably not going to increase its market share. Moreover, implementing GSCM/green logistics does not reduce the costs on a short term as it often represents additional costs for companies.

Interviewee 2 partly agreed to the model presented; the major criticism about the model affects the benefits of GSCM. The expert did not see reducing costs as the most relevant benefit of GSCM. Additionally, increased economic and financial performance is not considered among the main benefits of GSCM. Regarding common aspects, the interviewee's opinion converges with the created model. In connection with the benefits of intermodal transportation, according to the expert, accessibility enables a company to use intermodal transportation thus, it was suggested to add this element to the model.

Interviewee 3 agreed partly to the benefits described in the model, whereas the experts highlighted the discrepancy between theoretical strategies/papers/concepts and the implementation in real projects several times. Especially with the experience gained from numerous consulting projects in the transportation industry, the interviewee claimed that still many projects are scoped around increasing efficiency and reducing costs, but not around getting more sustainable transportation solutions.

Interviewee 8 mostly agreed to the benefits portrayed by the model. Nonetheless, the expert did not agree with the following points: Emissions are not always reduced by intermodal
transportation where the example of an air/road intermodal solution is mentioned as an example. Additionally, neither is the benefit of GSCM to reduce costs nor is efficiency primarily achieved by GSCM.

Finally, interviewee 7 agreed with the content of the benefits. However, the expert was surprised that only few benefits for intermodal transportation were formulated. In fact, the expert said that one of the benefits of intermodal transportation is to reduce and overcome the congestion problems on some highways or in cities.

Drivers
For the list of drivers, interviewees 4, 7 and 8 are the only experts that agreed completely with those drivers. Nevertheless, interviewee 7 suggested that this section should be put before the measurement/metrics as metrics and drivers are, from the interviewee’s point of view, related. Moreover, interviewee 4 mentioned that premium truck manufacturers also look at the social impact of transportation and not only at price when choosing transportation solution for their goods, which is an aspect missing in the list of drivers for this interviewee.

Interviewee 1 did not agree with a generalization of the drivers. In fact, the expert said that the drivers need to be defined specifically for a company within its context. Moreover, the influence of the drivers need to be measurable to determine their effective impact. Additionally, this expert suggested that the social factors such as the impact on health and the positive opinion that the society has on GSCM/green logistics need to be added to the list.

Interviewee 2 and 3 partly agreed with the content. On the one hand, interviewee 2 agreed with the drivers of intermodal transportation as well as the common aspects. On the other hand, the expert strongly disagreed with the content regarding GSCM. Especially, the aspect that speed is one driver of GSCM was opposed by the interviewee. Moreover, this expert claimed that information technology software is primarily used to increase efficiency but less to become more sustainable. Interviewee 3 claimed, that costs do only partly drive GSCM. A focus of the experts' reply to that answer was the perception that primarily the end-user can drive GSCM initiatives. The expert went further by pointing out that many end-customers are not aware of their consumer behavior when it comes to same-day-delivery and other customer-oriented services, which usually implies to neglect GSCM considerations. With that being stated, it is highlighted that the education of the end-user has the potential to affect and drive GSCM.
Additionally, with regard to cost drivers, interviewee 5 agreed with the cost considerations described in the model, but also explained situations in which a road-rail intermodal transportation solution may have a higher per-unit cost than pure road transportation.

Challenges

Interviewee 1, 4 and 8 agreed with the challenges of the model in Table 9. However, three interviewees (2, 3, 5 and 7) suggested some changes to this part. Interviewee 2 added several points regarding the challenges illustrated by the model. Among the most relevant factors for GSCM, this expert saw the top-management support for GSCM initiatives. With this support, GSCM strategies either become successful or remain irrelevant. Furthermore, neither did the expert see coordination as a major challenge for GSCM nor did the expert support the statement of "unsuitable legislation" since the government will not hinder companies to implement GSCM or intermodal transportation solutions. Interviewee 3 agreed to the challenges presented by the model in almost all of the points. Nonetheless, communication and tracking issues need to be added to the challenges for intermodal transportation. Moreover, interviewee 5 agreed on the points in the model but also mentioned that is has become increasingly challenging for the company the expert is working for to find truck drivers. The interviewee tried to explain this by the bad working conditions amongst other potential reasons. Interviewee 7 also agreed with the content of this section but suggested that the “complexity of intermodal transportation” should be added as an extra challenge of intermodal transportation.

Measurement and metrics

All experts agreed with the content of the metrics section of Table 9. Nonetheless, some experts had additional comments with regard to this category. For instance, did interviewee 3 claim that it is challenging to measure the quality of life or health. In this context, the expert was also not aware of a framework that tries to include those metrics. Interviewee 5 provided an insight into the company’s culture, claiming that the company the expert is working for intends to contribute to the global warming goal by having implemented a company-wide program for CO₂ savings, which also affects transportation decisions. On the one hand, interviewee 8 agreed to the metrics mentioned in the model; on the other hand, did the expert state that a weighting of different Key Performance Indicators (KPIs) might be beneficial for a practical usage of the framework.
General comments

Some comments from the interviewees were general and do not fit into any of the previous categories. For instance, interviewee 1 commented on the model by saying that the content of each category may depend on the geographical, cultural and political context. Moreover, interviewee 4 suggested that the wording in the common points column should match the formulation used within the left and the right column so that the reader clearly identifies the common points. Additionally, interviewee 8 saw the model more as a spider chart where different factors are traded-off among each other and mentioned that intermodal transportation is just one of many solutions to achieve more sustainable transportation.

4.4 Social impact of intermodal freight transportation

In the last part of the interview, the interviewees were asked to give examples of how intermodal transportation impacts the society.

Interviewee 1 said that the social impact of an intermodal freight transportation network design will depend or depends on the way its sustainable impact is communicated. This means that social impact depends on the perception by the society/community of the intermodal solution. Moreover, the expert said that if the communication/marketing around the intermodal solution generates a positive image about its economic and sustainable aspects then, the impact on the society will be more positive. For example, people will be more interested in working within the intermodal network (companies using it and companies responsible for e.g. airports, ports and hubs), customer will use the solution and the community will accept the solution.

Interviewee 2 stated that the company this person is working for tries to consider also social aspects in their daily business, what the experts saw as part of the companies’ vision of making a better everyday life for people. According to the interviewee, this results in the employees being conscious about acting green and the company treating people in a fair way (including the external transportation provider). The interviewee suspected that the awareness with regards to sustainability in Scandinavian countries causes most of the previously mentioned actions.

For interviewee 3, two aspects were relevant with regard to the social impact of intermodal transportation. First, this expert recommended that customer awareness needs to be promoted
to achieve a long-run positive social impact of intermodal transportation. Especially in an environment where customers become increasingly demanding with regard to fast logistic solutions. Second, the limitations of fossil fuel were for the interviewee seen as one point, where intermodal transportation might have an impact on society.

For interviewee 4, the impact on the society was discussed using an example of the trucking industry. The interviewee mentioned the situation of some truck drivers having to drive far from their homes to deliver shipments especially in Europe. For the interviewee, using the intermodal transportation reduces the need for long distances by truck. Thus, this lowers the number of drivers having to drive far from home. Moreover, the expert described the fact that by using less long-distance road transport solutions, companies tend to increase their use of local road transport performed by local transporters. For this expert, local businesses tend to apply society's ethical and social rules to a larger extent than if the transport is performed by a third long distance transporter which is under much less control. To conclude, the expert gave following factors that would determine the social impact of intermodal transportation use based on the example of the trucking industry: Distance (from home) that the driver (e.g. truck) needs to drive, driver’s (e.g. truck) salary, management decisions/strategy to select the drivers and the mode of transportation, degree to which you can control the third-party transporters if they follow local social rules e.g. salary, working hours and finally, local regulations and laws.

During interview 6, the expert claimed that one positive impact of railroad transportation on the society is fewer air pollution as well as a decreased noise level in urban areas which increases the living conditions of people in this area (Interviewee 6).

In interview 7, the experts said that intermodal transportation has imposed norms to the society such as the container size. Moreover, due to the complexity of the intermodal freight transportation network design, there is a need for companies/communities that support companies to organize their intermodal transportation. This generates a need for positions within organizations in the logistics and SCM. As a result, this could generate more jobs within the field. Finally, the expert said, such as the interviewee 4, that due to the increased use of intermodal freight transportation e.g. use of rail and truck, less truck drivers have to travel far from home as rail is used for the longer distances. Therefore, there is a positive impact for the drivers that can come home more regularly than if they would need to travel for longer distance to deliver directly. To sum up, following factors were identified during this interview: The
container size, the complexity of the intermodal freight transportation network, the evolution of the transportation flows and the level of demand for intermodal solutions as well as the distance from home for truck drivers / ability to drive home more regularly (Interviewee 7).

With interviewee 8, a detailed discussion about the social impact was conducted, which revealed several points. First, the expert claimed that less accidents and fewer health problems might be a result of a shift towards more sustainable oriented transportation solutions. Nonetheless, according to the interviewee, transportation is just one part of a SCM network, which can have a social impact. The expert suggested to cover social impact holistically, not only to focus on the transport of finished goods, but also include sourcing with regard to the implementation of intermodal transportation solutions. Last, the interviewee stated that intermodal transportation can also have a negative social effect, since intermodal transportation does not necessarily describe a switch in transport mode from road to rail but can also refer to an increasing road to air transportation switch, which then is contradicting to the connection of intermodal transportation within green logistics.

4.5 Relation between GSCM/green logistics and intermodal transportation

A further objective of the interviews was to ask the experts if GSCM/green logistics and intermodal transportation are related. The collected opinions regarding the convergences between those topics from the different interviews are presented in Table 12. The most often, the interviewees mentioned that intermodal transportation supports GSCM/green logistic goals such as to reduce economic, environmental and social costs. Additionally, three interviewees claimed that intermodal transportation is one solution to achieve green logistics key performance indicators such as the carbon footprint, which is in the interest of management. Moreover, three interviewees claimed that intermodal transportation is pushed by green logistics and GSCM initiatives. Last, two experts agreed that green logistics and GSCM build a framework of criteria which can be applied to select a transportation solution that is sustainable.
Table 12: Convergences of the topics

<table>
<thead>
<tr>
<th>CONVERGENCES OF GSCM/GREEN LOGISTICS AND INTERMODAL TRANSPORTATION</th>
<th>INTERVIEWEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermodal transportation supports green logistic goals such as to reduce economic, environmental and social costs.</td>
<td>1, 2, 4, 5, 7, 8</td>
</tr>
<tr>
<td>Intermodal transportation is one solution to achieve green logistics key performance indicators.</td>
<td>1, 2, 6</td>
</tr>
<tr>
<td>Intermodal transportation can be pushed by green logistics and GSCM.</td>
<td>2, 6, 8</td>
</tr>
<tr>
<td>GSCM/green logistics build a framework of criteria to select a transportation solution.</td>
<td>1, 8</td>
</tr>
</tbody>
</table>

4.6 Application of intermodal transportation in a GSCM/green logistics context

To get a better idea how GSCM/green logistics approaches using intermodal transportation are applied in industries, the interviewees were asked to describe business examples based on their professional working experience. Those examples are listed in Table 13.

Additionally, the experts were asked to give advices to companies planning to use intermodal transportation for GSCM/green logistics purposes. Not every interviewee gave an answer to this question.

To start, interviewee 1 found it challenging to provide a general answer to how to advice a company regarding this topic because for the expert you first need to look at the context of a company to develop different selection criteria for a transportation solution. However, the expert said that a company first needs to list its sustainable criteria and the impacts of the intermodal solution. Then, the company needs to look at the priorities of the stakeholders. Finally, according to interviewee 1, companies should look at the long-term aspect which tends to be challenging.
### Table 13: Intermodal transportation examples

<table>
<thead>
<tr>
<th>INDUSTRY</th>
<th>EXAMPLE</th>
<th>INTERVIEWEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk goods</td>
<td>Often barges/ships are also used to replace road for products which do not need a fast transportation e.g. sand.</td>
<td>7</td>
</tr>
<tr>
<td>Infrastructure building</td>
<td>The railroad connection between China and Duisburg in Germany helps to reduce emissions and enables growth along the railroad network.</td>
<td>8</td>
</tr>
<tr>
<td>LSP</td>
<td>A logistics service provider in Sweden uses intermodal transportation for approximately 10-15% of its transportations within Sweden for the North-South-North transports.</td>
<td>4</td>
</tr>
<tr>
<td>LSP</td>
<td>A tool has been developed by a major port in Europe for shippers or forwarders to see what possibilities to and from this port exist using the intermodal network in Europe.</td>
<td>6</td>
</tr>
<tr>
<td>LSP</td>
<td>An extension of this tool is currently developed but for a worldwide application by adding the deep-sea schedules as well as a CO2 calculator in order to show the fastest option and the most ecofriendly one.</td>
<td>6</td>
</tr>
<tr>
<td>LSP</td>
<td>The utilization of rail to replace road for distances greater than 400-500km (e.g. a great amount of transportation companies book space on freight trains for example on the track Rennes-Valence or Dourges-Lyon-Valence-Marseille).</td>
<td>7</td>
</tr>
<tr>
<td>Retail</td>
<td>A food delivery company uses electric trucks for little supermarkets deliveries (last mile).</td>
<td>1</td>
</tr>
<tr>
<td>Retail</td>
<td>A supermarket chain uses barges on rivers to transport products from their main hub to the closest harbor next to the cities where their supermarkets are located and then delivers the supermarkets using electric trucks.</td>
<td>1</td>
</tr>
</tbody>
</table>

For interviewee 3, a company should look at legislative support and taxation benefits before considering intermodal transportation. Interviewee 4 for instance suggested that a company should think about what impact the intermodal transportation solution has (on time, on the flexibility etc.) Additionally, a company needs to define what type of goods it wants to ship via an intermodal transportation network. The expert here recommended using an intermodal solution for non-customized goods and to use other transportation designs for customized goods, as this will help to shorten the lead time.
During the interview with interviewee 5, the interviewee mentioned that organizations should use multi-step approval processes in order to approve emergency transportation by air to prevent the use of those less sustainable transportation solutions.

For interviewee 7, a company needs first to develop a corporate social responsibility (CSR) approach for its business and its logistics. Therefore, the company would better understand the complexity. This in turn would enable a company to understand intermodal transportation. Moreover, developing a CSR approach might also bring the company to see intermodal transportation as a solution to become more sustainable. The expert also suggested, such as interview 1 did, that a company needs to identify the demand from its stakeholders before finally looking at the different transportation flows it has to find the most appropriate solution for each of those.
5. Empirical analysis

As a final step of the content analysis, this chapter discusses the results of the empirical study with regard to the research questions and the outcome of the systematic literature review. For a solid foundation, the difference in the understanding of the key definitions are summarized briefly. Based on this, the first research question is enriched by expert statements with regard to the created model. Next, the use of intermodal freight transportation in a GSCM/green logistics context is analyzed to provide a profound answer to research question two. Last, the findings are reviewed in a critical way, to determine the contribution of this thesis as well as potential further research.

5.1 Differences in understanding of key definitions

For a common discussion baseline, it is the objective of the authors to identify the experts understanding of intermodal transportation and GSCM and/or green logistics. There are two reasons for this. First, in case the interviewees were not able to answer that questions, they might not have been suitable from a content perspective to conduct the expert interview with them. Second, since there is no standardized definition about the topics, it is important to identify how the experts defined the key terms to put that into relation to their following statements and to avoid any misunderstanding.

An analysis of the expert's understanding reveals, that in three out of eight interviews the experts see environmental aspects to be associated with GSCM and/or green logistics (Interviewee 2, 5 & 7). In contrast to the definition which was applied in the theoretical part of this thesis, social and economic factors are just taken into consideration by the interviewee when being actively mentioned by the interviewer. On the one hand, this reveals how closely the term "green" and "sustainable" are associated with a pure environmental oriented perspective. This in turn confirms the debate about the definition of “green” mentioned by Ahi and Searcy (2013) and Pereseina (2017). On the other hand, this implies the following: First, almost all of the sample interviewees do not associate economic considerations with GSCM/green logistics and as a part of neglecting economic considerations they do not see costs to be relevant in this regard. This is a critical finding especially when it is connected to the model, where costs play a central role. Second, three out of eight interviewees also do not immediately draw a connection between GSCM/green logistics and the social part of the triple-
bottom line approach. This stands in contrast to the findings of section 4.4., where many interviewees connect the topic when specifically asked for it.

5.2 Feedback about the model

After presenting the experts’ disagreement with the model, the points of agreement are discussed. Then, the connection of the topics is analyzed, and the model is adapted based on the feedback from the experts.

5.2.1 Experts’ disagreement with the model

As the expert interviews revealed, the interviewees did not agree to the model about the connection of intermodal transportation and GSCM/green logistics in all of the four predefined categories. While in general, most experts agreed to the connections, some interviewees’ statements revealed additional concerns. Hereby, a major focus of the interviewees' feedback can be assigned to the topic of costs as well as the topic of demanding end-customers.

With regard to cost, interviewee 3 claimed that in the business consulting world, still many projects rather scope efficiency increases and cost reduction instead of achieving a greater sustainability in the companies’ logistics or supply chain operations. This matches the academic statements, where Eng-Larsson and Norrman (2014) describe costs as the key decision-variable for transport activities. Moreover, Van den Berg and De Langen (2017) refer to studies revealing that the willingness to pay a higher price for increased environmental performance of a shipment is low. The issue that customers are not willing to share costs (Tacken et al., 2014) may worsen this situation. This verifies the key common challenges of costs, which was already included into the first draft of the model. In general, cost considerations can be split into internal costs, where companies show a great sensitivity regrading costs and external costs, where customer show a low willingness to pay for additional costs. In relation to internal costs, it is contradicting that on the one side, the interviewees claimed costs to be an important challenge for intermodal transportation in the context of GSCM/green logistics but on the other side, they did not consider economic considerations as part of the GSCM definition (as illustrated in section 5.1). This leaves room for further studies to explore this. In relation to external costs, this thesis did neither analyze reasons for the low willingness to pay of end-user for increased environmental performance, nor did the thesis aim to find out the influences of customers willingness to pay. As a logical next step to this thesis, the authors consider it to be important to create awareness among the businesses for which
sustainable transportation solutions and environmental logistic services the customers are willing to pay for.

Second, interviewee 3 also claimed that intermodal transportation solutions are not meeting the latest logistics and SCM requirements, where the most critical aspect is the time component. As customers get increasingly demanding in terms of faster delivery, the intermodal solution to focus on rail instead of road transportation does not fit this demand according to the interviewee’s perspective. This argument is not mentioned in existing academic literature; instead Eng-Larsson and Kohn (2012) suggested to reduce the environmental impact of transportation with the shift of transport modes, from faster, more polluting modes such as road and air transport to slower and less polluting modes such as rail or maritime transport without considering the factor of high-demanding customers. As interviewee 3 was the only expert coming up with this argumentation, this contradicts the reviewed literature and thus needs to be further researched and validated potentially with quantitative studies. A quantitative study may also provide answers to the question if reality really looks as described by interviewee 3 and why customers are becoming increasingly demanding. Additional research in this area could cover topics such as how to nudge demanding customers to change their consuming behavior thereby potentially contributing to more sustainable transportation solutions. A potential idea might be a delivery mode, where the customer selects an environmentally friendly transportation solution, thereby paying a discounted price but receiving the products a few days later due to a relatively slower but more sustainable transportation solution.

The major finding of the interviewees' disagreement with the model does not affect the model itself but provides a more holistic perspective and argumentation on this topic. The end-user is identified as a central element to influence the application of GSCM/green logistic approaches. Of course, this can be seen as an alternative solution where SCM experts shift their responsibility to another stakeholder group. The authors are aware that literature on this is rare and nonetheless, they claim to analyze those interrelations and connections in further studies. Additionally, according to the interviewees, it is challenging in a business environment to balance the three characteristics of the triple-bottom-line approach. This statement stands in contrast to the experts initial understanding of GSCM/green logistics and the triple-bottom-line. Despite that, many interviewees claimed that adhering to the triple-bottom line should be the ultimate long-term objective of firms hereby being the same opinion as Lo and Shiah.
(2016), who state that in the long-term perspective, the consideration of sustainable aspects improves a firm’s profitability due to better customer satisfaction and loyalty.

5.2.2 Agreement with the model from a business perspective

Despite the individual disagreement with the model of single experts, an analysis of the expert interviews revealed that most of the interviewees agreed on the connection between the topics. While some experts consider this connection to be "clear" (Interviewee 2) or "obvious" (Interviewee 5), others describe a connection of GSCM/green logistics and intermodal transportation in the business environment but mention that this one is not as clear as in the academia world. Overall, the interviews indicate that arguments brought up in the literature, such as environmental and economic performance, are improved if GSCM implementation works properly (Xie & Breen, 2012) and intermodal transport is one of the key elements towards a sustainable freight transport policy (Limbourg & Jourquin, 2009) or, that a larger share of intermodal transport generally is better from an environmental perspective (Eng-Larsson & Norrman, 2014; European Commission, 2001) are confirmed from the practical perspective, where according to interviewee 1, 2, 4, 5, 7 and 8 intermodal transportation supports green logistic goals such as the reduction of economic, environmental and social costs. The authors consider those findings as a valid first starting point, where sample interviewees confirmed the theory-based model; nonetheless it is obvious, that this needs to be further verified and confirmed by quantitative research.

5.2.3 Analysis of the connection from a business perspective

The content analysis of the conducted interviews, based on a coding approach, confirmed two major areas. First, it is confirmed, as illustrated in the literature, that intermodal transportation is one solution within GSCM/green logistics approaches. Second, it is revealed that when looking at the transportation from a sustainable perspective, the triple-bottom line needs to be considered. Within regard to the triple-bottom-line, the analysis of the topic is split into the three areas. Initially, codes about the consideration of environmental impacts of the transportation mode selection are studied. Afterwards, economic aspects are taken into consideration, and as a last part, the social impact is analyzed.
Based on the interviewees' statements, intermodal transportation is one among other solutions to support a GSCM/green logistics approach. From the business perspective, this approach works vice versa where GSCM/green logistics should be one criteria when selecting transportation modes and intermodal transportation approaches should be one solution to more sustainable transportation. As environmental KPIs such as the carbon footprint of one product are in high management focus, for transportation planning it is possible to achieve those KPIs by using intermodal transportation solutions. Those findings do match the arguments from the measurements and metrics category of the model. The authors consider it to be problematic to provide a deeper analysis on this topic, as this thesis left mathematic optimization models out-of-scope. This is not seen as room for further research, but just to set a different focus when selecting literature by including different journals and articles. Nonetheless, the findings of this thesis can be included for mathematical approaches by defining variables for different sustainable transportation solutions as well as social costs into the model.

Furthermore, when looking at the transportation from a sustainable perspective, the triple-bottom line needs to be considered. The interviewees state that by optimizing cost through intermodal transportation also environmental and social aspects are considered. While this matches Carter and Rogers (2008) opinion, that firms which strategically undertake GSCM will achieve higher financial performance than firms that pursue only one or two of the three components of the triple bottom line; it is not consistent to the initial definition given by three of the eight interviewees who do not see all three elements to be equally important.

Focusing on the economic perspective of the triple bottom line, costs and efficiency aspects can be highlighted. With regard to internal costs, the interviewees stated that e.g. the kilometer price for rail transport may be lower but caused by the loading/unloading costs, the final transportation costs of an intermodal transport solution are higher. This contradicts the findings of Eng-Larsson and Kohn (2012) that in general, costs are perceived to be lower with an intermodal solution. As only one expert stated this, interpretation for the statement can be versatile. Therefore, it is suggested to review additional literature and reports to empirically confirm the findings of Eng-Larsson and Kohn (2012) or disprove those.

Focusing on the environmental perspective of the triple bottom line, interviewees state, that some companies do already adhere to programs intending to save CO₂ hereby on the one hand, contributing to the global goal to reduce global warming to a maximum of two degrees and on
the other hand, avoiding paying fees for pollution that can be directly transferred to monetary value. Among those programs, academic research by Dekker et al. (2012) or Van den Berg and De Langen (2017) are confirmed by the experts that see the fuel type used in intermodal transportation as one element that obviously has an impact on the environment.

Focusing on the social perspective of the triple bottom line, several considerations were brought up by the interviewees. For each of the four categories mentioned by the interviewees (image of intermodal transportation, firms’ responsibility for sustainable solutions, demand for intermodal transportation and “further social benefits”), the connection to the literature review is drawn.

To start with, experts claimed that the image of intermodal transportation and the perception of it can influence the thematic in a positive way. By creating the appropriate image and awareness of intermodal transportation, this can have a positive influence on the social image. For example, interviewee 1 claimed that if people will be interested in working in the intermodal networks (companies using it and companies responsible for e.g. airports, ports and hubs), customer will use the solution and the community will accept the solution. This statement matches the aspect brought up by interviewee 3 about the relevance of the end-users and the society in general, where according to the authors awareness for sustainable transportation solutions needs to be creates.

Moreover, as revealed by the experts, a company’s strategy has a deep impact on social aspects of the triple bottom line. By adhering to responsibility standards, including the consideration of working conditions – not only internally, but also the working conditions of contractors – a company has the power to influence the social component of transportation solutions. This includes exemplarily, that through intermodal transportation solutions, it can be avoided and/or reduced to have truck-drivers working long-distances far away from their place of residence. In a broader context, this might mitigate the identified challenges of several companies, that it is becoming increasingly demanding to find enough truck-drivers. As an intermodal rail transportation solution is more independent with regard to the number of drivers, intermodal transportation is seen as a solution which also considers social aspects according to the interviewees. Academic researchers such as Baykasoğlu and Subulan (2016) agree on that opinion.
Besides that, the demand for intermodal transportation creates a change in the job-market. Since the experts of the study have contradicting opinions if that change causes job-creation or job-shifts, this is an additional point for further research.

Last, intermodal transportation – seen from the social perspective – provides the chance to positively influence the quality of life for many people. The interviewed experts did not only agree that intermodal transportation solutions decrease the amount of traffic on roads, but also claim that it might decrease accident rates and noise levels. From a theoretical perspective, those benefits include saving thousands of truck kilometers in congestion-sensitive areas (Dekker et al., 2012). When putting this finding together with results of the previous analysis, this might be a starting point of how to create society awareness and influence customer to demand more sustainable intermodal transportation solutions.

5.2.4 Outcome: Adapted model

Based on the content analysis described previously (which includes the experts’ statements as well as the connection to the reviewed literature), the draft of the initial model was adapted. While in the following, only the major adjustments to the model are described, the complete model can be found in Table 14. In this context, the authors kept those attributes of the model, which were not opposed by the experts, and changed the ones, where the interviewees provided additional information/insights. Generally speaking, the model represents a strong focus on academic findings from the systematic literature review; nonetheless, the expert interviews proved to be a first step to contribute to applied research hereby partly closing one of the identified gaps. The authors suggest to use the built model as a starting point for further verification with hypothesis.

First, for the category of benefits in the model and based on the experts’ feedback, reducing costs is not applicable for GSCM/green logistics. While the experts had clearly agreed on that, it was also revealed that some companies might see cost-reduction as a long-term benefit. However, from a current perspective, this category does not fit into the benefit category of GSCM/green logistics. While, improving SCM efficiency is no benefit of GSCM according to the interviewees, who see efficiency primarily from an economic, but not environmental perspective (Interviewsee 8). Therefore, the same holds true for an increased economic performance, which according to interviewee 3, 5 and 8, is not primarily achieved by GSCM.
Based on this, the common points of GSCM/green logistics and intermodal transportation were adapted by erasing the aspects of “cost reduction” and “improving economic performance” from the original model. However, as the experts’ view contradicts with the theory, the actual cost reduction possibilities would need to be proven in further research to determine if this can be generalized.

Table 14: Convergences of GSCM/green logistics and intermodal transportation – Final model

<table>
<thead>
<tr>
<th>GSCM AND GREEN LOGISTICS</th>
<th>COMMON POINTS</th>
<th>INTERMODAL TRANSPORTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ability to influence shaping future regulations</td>
<td>• Reduce environmental impact</td>
<td>• Economies of scale</td>
</tr>
<tr>
<td>• Be ahead of competitors/legislations</td>
<td></td>
<td>• Reduce environmental impact</td>
</tr>
<tr>
<td>• Better reaction to stakeholder request for green activities</td>
<td></td>
<td>• Decrease congestion in urban areas</td>
</tr>
<tr>
<td>• Decrease the environmental risk</td>
<td></td>
<td></td>
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<tr>
<td>• Improve the image of a firm</td>
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<td></td>
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<tr>
<td>• Increase the employee motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drivers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Environmental (external) drivers (e.g. collaboration, communication &amp; transparency, supply uncertainty)</td>
<td>• Costs</td>
<td>• Cost</td>
</tr>
<tr>
<td>• Organizational (internal) drivers (e.g. company size, reputation)</td>
<td>• Regulations &amp; policy intervention</td>
<td>• Regulations &amp; policy intervention</td>
</tr>
<tr>
<td>• Technological factors (e.g. complexity of innovation)</td>
<td>• Organizational support</td>
<td>• Contracts between firms (collaboration)</td>
</tr>
<tr>
<td></td>
<td>• Collaboration</td>
<td>• Organizational support</td>
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<tr>
<td></td>
<td></td>
<td>• Price and profit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Truck drivers’ working conditions</td>
</tr>
<tr>
<td>Challenges</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cost</td>
<td>• Coordination</td>
<td>• Emissions (e.g. reduction, carrier performance)</td>
</tr>
<tr>
<td>• Effort for the implementation of measurement systems, coordination</td>
<td>• Cost</td>
<td>• Dependencies (e.g. contradicting contract objectives, inventory issues, capacity constraints)</td>
</tr>
<tr>
<td>• Lack of cross-functional relations</td>
<td>• Capacity constraints</td>
<td>• Product related risks (e.g. product quality, economies of scale)</td>
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<tr>
<td>• Lack of information</td>
<td></td>
<td>• Customer requirements (e.g. delivery frequency, quality, convenience, customer demand)</td>
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<td>• Lack of infrastructure</td>
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<tr>
<td>• Lack of metrics</td>
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<tr>
<td>• Losing partners</td>
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<tr>
<td>• Lack of resources</td>
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<tr>
<td>• Lack of support from management</td>
<td></td>
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<tr>
<td>• Lack of support from suppliers</td>
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<td></td>
</tr>
<tr>
<td>• Unsuitable legislation and different standards</td>
<td></td>
<td></td>
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<tr>
<td>Measurement and Metrics</td>
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<td></td>
</tr>
<tr>
<td>• Measure environmental impact (e.g. emissions, land use, noise, energy consumption)</td>
<td>• Measure environmental impact</td>
<td>• Measure environmental impact</td>
</tr>
<tr>
<td>• Measure social impact</td>
<td></td>
<td>• Measure cost</td>
</tr>
<tr>
<td>• Ecological reporting including environmental KPIs</td>
<td></td>
<td>• Trade-off between inventory level and customer service constant</td>
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<tr>
<td>• Footprint calculation software</td>
<td></td>
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<tr>
<td>• Greening performance relativity</td>
<td></td>
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</tr>
<tr>
<td>• ISO 14001</td>
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</tbody>
</table>

Second, with regard to the drivers of intermodal transportation and GSCM/green logistics, the only adaption of the model in this section is adding the category “truck drivers’ working
conditions” as one final aspect of the adapted model as this was the only criticism that was mentioned by the interviewees. For this category, it is remarkable that not much content in the reviewed articles was assigned to social considerations herby leaving the open questions about reasons for this.

Third, based on the feedback and analysis of the “challenges” category, unsuitable legislation and differences in standards in the area of GSCM/green logistics was combined into one aspect now called “unsuitable legislation and different standards” as during the interviews, those topics were closely related by interviewee 2, 3 and 5.

Fourth, in terms of measurement and metrics, the analysis revealed that different metrics are commonly used to measure the environmental impact of GSCM/green logistics or intermodal transportation solutions. No criticism regarding those aspects was formulated by the experts. Therefore, no adaptation of this part is needed from the view of the authors. Last, with regard to social implications, the key-term “measure social impact” was added as one metric of GSCM/green logistics. This example includes, considering additional indirect costs such as air pollution, congestion, noise, global warming and accidents. As already identified in a previous part, social considerations, besides economic and environmental ones, are mentioned by all interviewees. The authors see this as one indicator for the relevance of this topic, that nonetheless needs to be validated in a quantitative way.

To sum up the considerations regarding the validation of the model, it can be claimed that the model in general was confirmed by the interviewed experts. Besides criticism of some points, which either was considered to adapt the model or disproved based on academic literature, some points were additionally added to the model to provide a verified model as result of the content analysis.

5.3 Usage of intermodal freight transportation in a GSCM/green logistics context

The second analysis round intends to answer research question two. Therefore, the authors identified which examples the experts gave for the application of intermodal freight transportation in a sustainable context by following GSCM and/or green logistics purposes. Moreover, the authors also tried to understand the meaning of the advices that interviewees were asked to give to companies in order to introduce intermodal transportation to fulfill the
GSCM/green logistics objectives. The analysis is presented based on the codes and categories identified through the content analysis.

5.3.1 Practical examples of intermodal transportation in GSCM/green logistics

The practical examples given by the interviewees can be classified into four different industries, namely bulks goods industry, retail, infrastructure building (which in this context is not seen as a real industry, but more as an additional example case mentioned in one of the interviews) and LSP.

First, the example of the bulk goods industry given by the interviewee 7 revealed the use of barges/ships to replace road to transport goods such as sand which do not need a fast transportation. This validates the fact that not every product is suitable to intermodal transportation such as perishables as Eng-Larsson and Kohn (2012) claim. In this situation, sand is seen as non-critical and non-perishable good. The use of barges is presented by the expert as a greener transportation solution. However, the expert did not present any empirical evidence about the exact social or economic impact of this solution. Therefore, the verification of this argument needs to be further researched.

Second, interviewee 1 gave an example of the retail industry to illustrate the use of intermodal transportation in a GSCM/green logistics context. In this example, the expert reveals the use of barges by supermarket chains to bring their goods from their main hub to the closest port next to their supermarkets. Those goods are then transported to the shops using electric trucks. This can be connected to the concept of pre-, long- and end-haulage presented by Baykasoğlu and Subulan (2016), whereby short distances are done by trucks and longer distances by exemplarily ships. However, using barges, which is a slower solution than trucks, can be seen as a slight opposition to the statement by Eng-Larsson and Kohn (2012) that perishables are not adapted for being transported via an intermodal transportation network. This provides opportunities for further research by analyzing how this particular case handles perishables in the intermodal transportation network to verify or oppose the theory presented by Eng-Larsson and Kohn (2012). Additionally, the real sustainable impact of this solution would need to be proven, such as the one before, as the focus here seems to be more on reducing emissions and lowering the costs for the long-distance shipments than on trying to lower the social impact. However, due to the fact that the use of barges helps to avoid the use of road transportation,
this solution may contribute to the reduction of truck traffic and avoid traffic jams on main roads. This result (if verified empirically) can be seen as a positive impact on the society. Nevertheless, this social impact would still require empirical evidence to present this solution as more sustainable.

As a third example, interviewee 8 mentioned the railroad connection between China and Duisburg in Germany as a positive example to reduce emissions and enable economic growth along this railroad network. This goes hand-in-hand with the most common mode combination presented in the literature, meaning the usage of a railroad combination for intermodal transportation. Nevertheless, the way the expert presents this solution as sustainable can be criticized, as the social impact is not clearly discussed and underpinned by empirical evidences. This example in addition with the previously discussed ones, strengthen the lack of consideration or proofs of the social impact by some experts when presenting the examples.

Finally, as a fourth industry, different examples of the LSP industry were presented such as the use of computer tools to plan intermodal transportation routings and to calculate CO₂ emissions mentioned by interviewee 6. Even if mathematical route optimization was out of scope for this thesis, this example has been mentioned hereby illustrating that those tools are not only used theoretically but are also applied in practice by a major port in Europe to identify the environmental impact of each routing option based on the emissions calculator. Nevertheless, it can be criticized that the social impacts seem not to be considered in those tools so far making this tool only looking at two out of three sides of the sustainability concept by Carter and Rogers (2008). In contrast, the Scandinavian company interviewee 5 is working for, additionally considers economic factors in a combination with environmental KPIs thereby illustrating again the advanced way of thinking in Scandinavian companies regarding sustainable business. Furthermore, as interviewee 5 claimed, this company continuously tries to improve its transportation cost calculations by quantifying and including externalities. The solution presented by interviewee 6 is according to the definition of Carter and Rogers (2008) not a sustainable solution as it only considers the environmental and economic impact. Additionally, the development of such tools supports the statement made by interviewee 7, who claimed that intermodal transportation is a complex topic and that companies would need to be supported in their understanding of such systems. This tool, from the authors’ perspective, present the characteristics of a platform that could help forwarders to provide them with a
simple solution calculated by a complex process, however, not considering every element of sustainability.

Another example, from the same industry, presented by interviewee 4 and 7 was the use of this network design to transport goods on long distances (longer than 400-500 kilometers) for economic and environmental reasons. This example can be linked to the concept of pre-, long- and end-haulage presented by Baykasoğlu and Subulan (2016). Furthermore, this statement such as the example from the infrastructure building industry support why most often the literature mentions railroad transportation as an intermodal solution example, as this solution seems to be regularly applied in practice. Finally, this example confirms the benefit of intermodal transportation which is to reduce emissions. However, the recurrent issue discussed earlier is the lack of evidence regarding the social impact of such solutions. Nonetheless, using the data collected regarding the social impact of intermodal transportation, the answers provided by interviewees 4 and 7 can be related to this example. The interviewees argued that using less trucks but more trains on longer distances reduces the need for the truck drivers to travel far from their homes. This is turn presents a positive impact on the society. This view from the interviewees is seen as narrowminded for the authors, as the social impact that such change may have on the train drivers and the people living close to the train tracks is not considered. As a result of this example, the authors see a dilemma and trade-off with regard to the social impact. While one decision may have a negative effect on somebody, it might have additional positive outcomes on another. This needs to be considered in both, business decisions as well as theoretical articles. As one cannot achieve all aims, this situation matches one interviewees' statement that the model could also be presented as a data spider, where various arguments are traded-off among each other, hereby highlighting that a perfect solution will not be feasible. Therefore, this solution cannot be seen from the authors perspective as being more sustainable at least when considering this example from a more holistic perspective.

To sum up, this part of the analysis revealed that the true sustainable impact of the given examples still need to be assessed using different metrics to prove a real improvement of the economic, environmental and social impact of those solutions presented as greener solutions. Nevertheless, this collection of examples that experts from SCM/logistics see as sustainable is a first step towards filling the gap about the lack of practical examples in the literature for the application of intermodal transportation in the context of GSCM/green logistics. However, this
gap is not completely bridged as additional examples need to be collected and those examples need to be assessed.

5.3.2 Experts’ advices how to apply sustainable intermodal transportation

The advices given by the experts how to apply sustainable intermodal transportation can be summarized into eight main advices which can be translated into criteria and divided into three different phases, where each phase represents a stage of the implementation process: pre-implementation, implementation and post-implementation phase (see Table 15).

A first advice is the idea brought by interviewee 1. This expert suggested that a company needs to understand the context in which it operates to apply the solution in order to identify the required selection criteria for its mode selections. For the authors, the context of a company is referred to as the micro and macro environment. From the authors view, this advice is related to the pre-implementation phase, as the expert claimed that this needs to be done before selecting and implementing the solution.

Furthermore, for interviewee 1, there is a need to look at the long-term aspect of transportation decisions. This statement is related to the fact that for instance advantages for intermodal transportation will only appear on a long-term regarding Narayanan and Raman (2004). This also confirms the need for metrics considering long-term measures in ESPMS as raised by Searcy (2016). This, for the authors, mainly relates to the post-implantation phase when the long-term assessment of the chosen solution is done. In fact, some benefits will probably appear years after implementation. However, the points on which this decision should be taken were not brought by the interviewee, leaving this open for further research to try collect long-term decision criteria and their metrics. From a critical viewpoint, the sustainable long-term orientation mentioned in this paragraph contradicts the short-term orientation of business in terms of costs and end-users in terms of an increased demand for same-day-deliveries as mentioned by interviewee 3.

The next advice, which was illustrated by interviewee 4, is to look at the type of goods that need to be transported via an intermodal transportation network design whereby the expert claimed that not every type of product can use this solution and suggested that customer specific goods would need faster transportation than non-customer specific goods. This for the
authors, belongs to a decision that has to be taken in the pre-implementation phase to implement the adapted solution to the transported goods later on. Moreover, during the interview with interviewee 4, the expert recommended to look at the global impact that the intermodal transportation solution will have on the supply chain regarding time and flexibility. This shows that decisions should be made by considering not only the transportation itself but also the whole supply chain. This advice not only concerns the pre-implementation but also the post-implementation as the global impact will have to be assessed after implementation to see if the planned impact in the pre-implementation phase occurred.

Next, interviewee 5 explained that an organization should build a multi-step approval process to get emergency transportation shipped by air. Therefore, more sustainable transportation solution would need to be considered as a standard process. This system can be linked to the fact that organizational internal driver such as organizational support drives the use of intermodal transportation as mentioned by Huang et al. (2017), Kim and Han (2012), Lin and Ho (2011), Lo (2013), Lo and Shah (2016) and Wolf (2011). This need for organizational support as a driver of GSCM/green logistics and intermodal transportation is also stressed by the advice of interviewee 2 which is the need for presenting the reliability of a sustainable intermodal solution using for instance a business case to get the needed support and approval by the top management. For the authors, this advice should be used during the implementation of the solution as this needs to be applied for operational decisions if the intermodal solution is the most adapted for a particular shipment.

Another advice given by the interviewee 7 is that in order to think about using intermodal transportation as a solution to become more sustainable, a company first needs to develop a CSR approach. As a result of this approach, a company might discover intermodal transportation as a solution to become more sustainable but also understand the complexity of such a network design. This advice supports the fact that the firms’ strategic orientation and culture drives GSCM/green logistics as presented in the literature review and the analysis of the model. This point given by interviewee 7 is for the authors also an advice that belongs to the pre-implementation as the CSR approach needs to be constructed before the intermodal solution.

A final advice communicated by three different experts was the necessity to include the stakeholders’ requirements into the decision process. Interviewee 1 and 7 agreed on looking at
stakeholder priorities. Additionally, interviewee 2 mentioned that one driver for the decision might be legislations and taxes advantages. This advice confirms stakeholder to be a common driver of intermodal transportation and GSCM/green logistics as presented in the updated model in Table 14. This advice refers back to the need for companies to identify what the different stakeholder wish when using intermodal transportation e.g. selling a greener product with a greener solution. For the authors, this advice belongs to the pre-implementation and post-implementation as requirements will need to be assessed before and after the implementation to ensure that there are not changing. As it is advised to include stakeholder into the decision-making process, it can be also suggested to influence/educate those. This needs to be further validated by empirical research.

To sum up, it can be said that most of the advices are related to the need for organizational drivers or processes to create a favorable context for the implementation of intermodal transportation as a sustainable transportation solution. As a result of this analysis, the authors summarized in Table 15 the different advises depending on which stage of the implementation process these can be related to. However, the true applicability and value-adding of those advices need to be proven in further research. This means that the gap that the answer to RQ2 tried to bridge is not completely closed by this empirical study and needs further research.

Table 15: Criteria for implementing intermodal transportation in a sustainable context

<table>
<thead>
<tr>
<th>PHASE</th>
<th>CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-implementation</td>
<td>• Company’s context (micro and macro environment) is considered when determining the selection criteria for transportation solutions</td>
</tr>
<tr>
<td></td>
<td>• Product type characteristics are considered for shipping within the intermodal transportation network</td>
</tr>
<tr>
<td></td>
<td>• Impact of transportation solution on the supply chain is considered</td>
</tr>
<tr>
<td></td>
<td>• Company follows a CSR approach</td>
</tr>
<tr>
<td></td>
<td>• Stakeholder requirements are gathered, evaluated and considered</td>
</tr>
<tr>
<td>Implementation</td>
<td>• Multi-step approval process for transportation selection exists</td>
</tr>
<tr>
<td>Post-implementation</td>
<td>• Long-term as well as global impact of the solution needs to be assessed</td>
</tr>
<tr>
<td></td>
<td>• Stakeholder requirements are assessed regularly</td>
</tr>
</tbody>
</table>
5.4 Critical assessment of findings

With regard to research question one and the created model, the authors see three main issues with their model. First, the model has a strong European focus. The fact that two articles out of 53, describe the connection of GSCM/green logistics and intermodal transportation in great detail, are from Swedish researchers represents the interviewees opinion, who claimed that the perception of GSCM/green logistics depends a lot on the geographic, cultural and political context, where according to the interviewees, Scandinavian countries tend to be advanced when it comes to the topic of sustainability. This finding is also mentioned in the literature, where the cultural context builds a major pre-requisite for coercive, normative and socio-cultural pressure that is applied in the organizations norms and values (Hsu et al., 2013). With regard to the model, the authors suggest, that the model is primarily applicable to the European application of intermodal freight transportation, as both – a majority of the authors of the reviewed articles as well as all the experts come from Europe. Second, as mentioned previously, the model has a strong theoretical focus, hereby probably not being applicable to every potential business situations. A comparison of the theoretical information and the interviewees’ comments revealed that the experts from the business side see more positive points that the ones which are mentioned in the reviewed literature. Hereby, the expert’s statements contributed to answer research question one but leaving some open gaps, where further empirical research is required to close those. Third, from the authors' perspective, the final model is a descriptive summary of the key findings based on the literature review as well as on the empirical findings. Therefore, no recommendations to the reader or to supply chain managers were formulated.

With regard to research question two and the usage of intermodal freight transportation in a GSCM/green logistics context there is additional information which can be assed critically. To start with, only few academic materials are available on the topic of how companies use intermodal transportation linked with GSCM and green logistics purposes and what companies need to consider when implementing intermodal transportation solutions in a context of sustainability, making the foundation of a theoretical base to answer this question challenging. Although answers to this question could be collected during the empirical study, only eight expert opinions were considered to get a first insight into business considerations about the topic. The claimed advises by the interviewees need to be further verified by additional examples. Additionally, it might be argued that not only expert interviews provide an insight into the usage of intermodal transportation from a GSCM/green logistics perspective, but also
in-depth case studies of "lighthouse projects" can contribute to add further value from the practical perspective.
6. Conclusion

To conclude, the theoretical and practical findings and implications of this thesis are summarized. Moreover, the main limitations of this thesis – covering limitations of the approach as well as limitations of the findings – are given and further research areas are suggested.

6.1 General conclusion

The purpose of this study was to analyze the connection of intermodal transportation and GSCM/green logistics. Two research questions were raised to close existing gaps. Based on the conducted theoretical literature review and the empirical study, this thesis provides an answer to the two research questions.

RQ 1. How are GSCM/green logistics and intermodal transportation connected?

According to a systematic literature review based on peer-reviewed articles from the last ten years at the intersection of the topics, GSCM/green logistics and intermodal transportation are connected. A categorization into four different characteristics (benefits, drivers, challenges, measurement/metrics) of both topics identified several converging elements. This accounts to the academic side as well as the business side, which was additionally considered by conducting qualitative expert interviews with experts from five different European countries. For the benefit category, reducing the environmental impact is the key converging element between GSCM/green logistics and intermodal transportation. With regard to drivers, costs, regulations and policy interventions as well as collaboration elements are determined as the key common driving factors of both topic categories. The identified key challenges, that apply to both topic categories are coordination, costs and capacity constraints. For measurements, metrics, which measure the environmental impact, are seen as the interface between the topics. In order to summarize the main findings for this research question, a model has been constructed (see Table 14).
RQ 2. How can companies use intermodal freight transportation in relation to GSCM/green logistics?

The second question explicitly intended to gather information about the practical application of intermodal transportation in a sustainable context. According to the findings, it can be said that various industries, such as bulk goods, infrastructure, LSP and retail industry, already use intermodal freight transportation in relation to GSCM and/or green logistics strategies in many different ways. Those findings strengthen the fact that intermodal transportation and GSCM/green logistics are not only theoretically but also practically related in daily operations. Moreover, different advices for the use or application of intermodal freight transportation for GSCM/green logistics purposes were given by the experts. Those given advices, given by the interviewed experts from the SCM and logistics industry, were summarized by the authors into three different criteria categories, namely the pre-implementation phase, the implementation phase and the post-implementation phase (see Table 15). The main advices given by the experts were for companies to analyze their supply chain and their stakeholders’ demand from a holistic view but also to build organizational drivers or processes to create a favorable context for the implementation of intermodal freight transportation as a sustainable transportation solution. One example was to start with a CSR approach to generate sustainable thinking and understanding for complex concepts.

6.2 Contribution of findings

The conducted research intended to add significant value on both side – the theoretical and applied one. With the dual approach followed by this thesis, the authors built a solid foundation from the academic perspective for further research and a solid jump-off basis regarding the collection of practical examples and practical implementation criteria for intermodal freight transportation in the context of GSCM/green logistics.

With regard to the academic contribution, previous research built the basis for the research conducted in this thesis. Since previously there was no existing model at the intersection of GSCM/green logistics and intermodal transportation, this paper bridges this gap and may help further researchers in this area. While previous research is not only presented in a structured way, earlier findings are also extended by including the applied business perspective into this research. Therefore, a main contribution for theory is the model presented in Table 14.
For managerial contribution, the authors believe the results of this thesis can be used by SCM/logistics managers looking for practical examples for the use of intermodal modal transportation or searching for experts’ advices about how to implement this kind of transportation network design. Nonetheless, single expert statements should not be considered as examples that can be applied in every situation. With regard to the practical contributions of this thesis, the interviewees' information did not fully close the existing research gap and allow further research. Influenced by time-constraints for this thesis, the authors are aware of the remaining open gap from a practical perspective, but consider it to be of higher importance to fill the theoretical gaps before completely closing applied gaps.

6.3 Limitations and further research

The authors identify two main areas of limitations to their thesis, regarding the methodology and the findings.

First, the limitations of the selected approach include limited time to conduct a more complex analysis with experts from the business side. Moreover, the interviews were conducted via Skype or telephone due to geographical distance and time constraints of the interviewees. A personal setting would have allowed to better manage/steer the interviewee and better adapt to the time constraints of the interviewee (Easterby-Smith et al., 2015). Even if the authors were able to conduct interviews with a sufficient length to gather all the relevant data, it needs to be mentioned that only eight expert interviews were conducted and that employees of smaller transport companies are generally very engaged in their daily operations and have limited time to participate in such studies. Last, in terms of snowball sampling, this may have contributed to similar opinions among the interviewees (caused by a similar academic and professional background), which could have been avoided by having more time to conduct the empirical study.

Furthermore, as stated in chapter 5, experts sometimes are subjective caused by their environment which influences their opinion. For the application of the model in other areas, further verification by local experts in a qualitative or quantitative way is suggested. This finding fits other researchers’ awareness, who see the lack of non-Western, non-Asian researchers as problematic due to the fact that SCM is globalized. Therefore, the authors suggest to only apply the model in a European context, since all expert interviews were conducted in this geographical area and to extend the number of countries where the connection
of GSCM/green logistics and intermodal transportation is investigated. Furthermore, the statements of the experts regarding the examples and advices for the application of intermodal freight transportation would need to be underpinned by empirical data to prove the real sustainability of the cases and the applicability of the advices for implementing intermodal freight transportation in a GSCM/green logistics context. All in all, this thesis and its findings need quantitative validation to be seen as a proven theory.

Based on those limitations, further research should be conducted by collecting data through personal interviews with experts from all over the world during a longer period of time. Furthermore, further research should try to focus even more on trying to provide additional recommendation to SCM managers in the application of intermodal freight transportation in relation to GSCM/green logistics. Moreover, additional empirical data to prove the real sustainability of the examples given by the experts as well as to prove if the advices can help companies to implement intermodal freight transportation would need to be collected. Also, the findings of this thesis need to be validated through using a quantitative study design. Additionally, as the social impacts were not intensively studied in this thesis, further research could be done to first qualitatively identify impacts that should then be then quantitatively assessed. Finally, to provide more insights into how intermodal freight transportation and GSCM/green logistics are related and applied together, further research based on the case study method should be used to bridge the various open gaps that this research left, e.g. testing the applicability of the model in Table 14 in different business areas.
7. Reference list


Duriau, V. J., Reger, R. K., & Pfarrer, M. D. (2007). A Content Analysis of the Content Analysis Literature in Organization Studies: Research Themes, Data Sources, and


Appendix 1: Theme blocks GSCM/green logistics and intermodal transportation

<table>
<thead>
<tr>
<th>GRAPHICAL OVERVIEW</th>
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<td>Green Supply Chain Management</td>
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<td>Intermodal Transportation</td>
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</tr>
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</table>
Appendix 2: Interview topic guide

Section 1: Opening questions

- What is your current position? *
  - Can you describe what your company does? Can you describe the business model of your company?
  - What are your responsibilities?
- How long have you been working in the supply chain management and/or logistics field? *
  - Can you describe your background (education, job experience, international experience)?
- How old are you?
- How would you define Green Supply Chain Management and Green Logistics?
- How would you define Intermodal Transportation?

Section 2: Questions about Green Supply Chain Management/Green Logistics and Intermodal Transportation

Bridging 1st gap: Relation between GSCM/Green Logistics and Intermodal Transportation

- Do you think that the concepts of Green Supply Chain Management/Green Logistics and Intermodal Transportation are related? *
- How do you think those topics are related? *
  - What are the common points between those topics?
  - Do you see aspects where the topics cannot be connected?
- Based on the model that has been sent to you before the interview, what is your feedback regarding this model? *
  - Do you agree with this model and why?
  - What common points regarding benefits, drivers, challenges and metrics would you add and why?
  - What common points regarding benefits, drivers, challenges and metrics would you remove and why?
Bridging 2nd gap: Practical examples of companies using Intermodal Transportation within a GSCM/Green Logistics approach

- Do you know examples of companies using Intermodal Transportation within a Green Supply Chain Management/Green Logistics approach and could you give some examples? *
  - Do you know companies which use Intermodal Transportation?
  - Could you please explain how Intermodal Transportation is applied while considering the economic, environmental and social impact of a company’s supply chain?
  - Could you imagine any reasons why intermodal transportation within a GSCM/Green Logistics approach is not commonly used? Where are the problems? Would needs for Intermodal Transportation have to be given to apply Intermodal Transportation for a GSCM/Green Logistics approach?
- How do you think a company needs to apply Intermodal Transportation in order to become more sustainable? *
  - What would you do as a manager to improve the sustainability of the transportation used by your company?

Bridging 3rd gap: Factors influencing the social impact of Intermodal Freight Transportation

- How do you think does the use of Intermodal Freight Transportation impact the society? *
  - Does Intermodal Freight Transportation impact the society and how? (give examples)
  - How does Freight Transportation impact the society? (give examples)
  - What are the negative/positive impacts that Intermodal Freight Transportation can have on society? How can this impact be influenced/changed?
- What are the factors that influence the social impact that Intermodal Freight Transportation has? *
  - What influences the social impact of Intermodal Freight Transportation?
  - What are types of factors that can influence the social impact of a transportation network?
Section 3: Closing questions

• How do you see the future of those three concepts? *
  o How do you think the three topics will develop in the future and why?
  o Do you think that those three topics will remain important and why?
• Can you think of another transportation network design that is sustainable and explain why?
  (e.g. automated trucks as competition to rail transport) *
• What else would you like to add to this interview? *
  o Do you know other experts that we could interview?
  o Is there a topic that you see as important and which was not discussed during this interview?

Questions that are marked with * are seen as the most important/relevant for the authors. Therefore, the authors tried to have most of those answered during the interviews.
Dear [NAME],

As discussed earlier [per mail/per LinkedIn/on the telephone], we would like to invite you to an interview about the relation between Intermodal Transportation and Green Supply Chain Management/Green Logistics and which impact the use of Intermodal Freight Transportation has on the society.

The interview will take place via [Skype/telephone] on the [DATE] at [TIME] and will be conducted by [both of us/Kevin/Florian]. It will probably last about one hour.

How to prepare for this interview:

- Please read the enclosed file with the model.
- Please read the informed consent enclosed. If you agree to participate to the interview, you agree with the conditions written in this consent.
- Please send us your [Skype username/phone number] as soon as possible, as we will contact you via [Skype/telephone] at the indicate time above.

We would like to thank you in advance for your time and support in the process of our Master Thesis.

If you have any questions regarding the documents, the process of the interview or regarding other issues please do not hesitate to contact us.

Best regards,

Florian and Kevin
Appendix 4: Informed consent

Informed consent* for the Master Thesis of Kiy and Scanvic conducted in April 2018

1. I, the interviewee, have read and understood the informed consent provided.
2. I have been given the opportunity to ask questions about the Study.
3. I understand that taking part in the Study will include being interviewed and audio recorded.
4. I have been given adequate time to consider my decision and I agree to take part in the Study.
5. I understand that my personal details such as name and employer name will not be revealed to anyone besides the authors.
6. I understand that my words may be quoted in publications, reports, web pages, and other research outputs, but my name will not be used.
7. I understand that I can withdraw from the Study at any time and I will not be asked any questions about why I no longer want to take part.

* Based on an example version from Bryman and Bell (2011).
### Appendix 5: Interview process

<table>
<thead>
<tr>
<th>What:</th>
<th>Contacting potential interviewee</th>
</tr>
</thead>
<tbody>
<tr>
<td>How:</td>
<td>Via mail, telephone or LinkedIn</td>
</tr>
<tr>
<td>When:</td>
<td>Beginning of week 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What:</th>
<th>Preparation of experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>How:</td>
<td>If interviewee agrees on participating, the interview invitation including the summary of the thesis as well as the informed consent was sent to that expert.</td>
</tr>
<tr>
<td>When:</td>
<td>As soon as possible (usually beginning week 2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What:</th>
<th>Conduct the interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>How:</td>
<td>If interviewee agrees on participating, the interview was conducted on phone or Skype using the interview topic guide</td>
</tr>
<tr>
<td>When:</td>
<td>Week 2-3</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>What:</th>
<th>Follow-up and request for approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>How:</td>
<td>Sending the interview memory protocol to interviewee for approval</td>
</tr>
<tr>
<td>When:</td>
<td>Week 3-4</td>
</tr>
</tbody>
</table>