Managing the Sustainable Business Model of a Heavy Vehicle Manufacturer through Life Cycle Thinking

A Case Study of Road Freight Transport Supply Chains

Veronika Pereseina
Acknowledgements

I dedicate my work to my mom and my dad, as everything I am and I have I owe to them.

It feels as this part of my manuscript is the most important part of my work as it is to show how grateful I am to everyone who supported me on my way to becoming a PhD.

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Abstract

Recent global events show increased awareness of general sustainability challenges (for example, the climate change forum in Paris in 2015 and the 17 Sustainable Development Goals promulgated by the United Nations). The influence of business on the environmental and social aspects of sustainability has also been emphasized. However, discussions about these concerns have been ongoing for some time. Hence, there are diverse ways for businesses to tackle sustainability goals, and the approach of a particular business may depend on the industry. The transportation industry has received significant attention regarding its environmental and social impacts. The road transport business in particular has been the focus of substantial attention due to its environmental burden; as this segment continues to grow, its environmental burden is projected to increase.

The sustainability challenges of the road transport industry can be addressed in many ways. An increasing number of theoretical and practical discussions note the importance of supply chain-level decisions and espouse a holistic view of the problems. Life cycle thinking (with total cost discussions) is not new to the industry, but the manner in which it can help to make road transport supply chains more sustainable remains unclear. Specifically, the question of how life cycle thinking can help to develop a sustainable business model for this particular industry has scarcely been researched.

Therefore, the purpose of this thesis is to explore how life cycle thinking can be applied to road freight transport supply chains and to explain certain important matters in the management of sustainable business models for heavy vehicle manufacturers. This study is largely the result of an international research project. It is a single case study that uses several supply chains as units of analysis. Several additional cases were analysed in the final research paper of this thesis. The abductive nature of this study allowed for going back and forth between the theoretical and empirical parts of the study. Data collection was conducted mainly through interviews and workshops, with certain secondary data collected from companies’ websites and printed materials. The countries represented in this thesis are Sweden, Poland, China and Australia.

This is a compilation thesis that comprises a kappa and five research papers. The contributions of this study are both theoretical and practical. The application of system theory and social network theory as external and internal lenses contributes to the theoretical development of the sustainable supply chain management field. The growing conceptualization of the sustainable business model is also addressed in this thesis. The practical importance of the thesis lies in the empirical example of the adoption of life cycle thinking in the context of road freight transport supply chains.
General public blog entry

Addressing the challenges of the road freight transport industry from a sustainable supply chain business model perspective

There are many challenges that affect the road freight transportation industry, including the increasing environmental and social impacts of the industry, the mounting business responsibilities derived from pressure exerted by diverse stakeholders, and continually changing market requirements. Although several approaches for addressing these challenges exist, a sustainable supply chain business model is rarely discussed for this industry. The main components of such a model are as follows: a business solution that includes a product designed in accord with life cycle performance thinking, services that improve the environmental and social performances of the actors involved via value co-creation processes, the calculation of costs and revenues throughout the product life cycle, and long-term relationships based on trust. The most important principle of such a model is increased product-in-use value, which in the road freight transport industry can mean an increase in transport equipment utilization. Other principles include the integration of sustainability into core values and strategies along the supply chain, transparency in operations and goals, and enhanced learning and information sharing, which may occur via IT innovations.

Relationships are known to be very important in supply chain management to achieve increased efficiency, enhanced collaboration, and integration. They are even more important in the growing field of sustainable supply chain management because sustainable businesses must adhere to the longevity principle through the co-creation of long-term value. In the road freight transport industry, this aspect has been shown to be an important feature of business relationships among actors in the industry: transport equipment manufacturers, dealers/sales representatives and transport companies, that are involved in collaboration based on trust, transparency, and information sharing to co-create value. When the manufacturer has business knowledge from both its customers and the customers’ customers, the co-creation of value may lead to a more sustainable business model with increased value-in-use.

Another aspect of the longevity principle may be an extension of value-in-use. The concept of product life extension, which in the case of the road freight transport industry refers to improved vehicle utilization, is one way to achieve more sustainable transport and supply chain systems in general. This can be achieved through product service systems that lead to a more sustainable business model while delivering functionality and experience and even emphasize the performance of the product rather than its ownership. In the case of road freight transport supply chains, increased product-in-use can be influenced by specific added services, such as driver training and coaching and maintenance. Further, performance-based solutions (i.e., addressing a service-dominant logic with improved heavy vehicle utilization) can be achieved through performance cost allocation (e.g., business solutions based on rental of the transport equipment,
total integrated transport solutions, or ‘Uber for trucks’). Increased use of such business solutions can extend overall product usage and lead to a more sustainable approach. For this approach to succeed, actors within the road freight transport supply chain must integrate sustainability into their core values and strategies and enhance information sharing and transparency through collaboration. Diverse IT systems (for example, fleet management systems) can facilitate transparency in operations.

Another component of the sustainable supply chain business model is the method by which costs are calculated. The value of the product increases when the cost is calculated based on the use of the product and services over its lifetime and considers relevant external costs and benefits. However, this method increases the complexity of calculating costs. From the transport company perspective, a product’s lifetime cost includes not only the acquisition cost (when transport equipment is purchased) but also costs incurred while the product is in use (in addition to added services). Further, the life cycle of the product must be considered. Processes used for production and reuse/remanufacture of the product are also considered in the product life cycle. These elements can create specific challenges but also offer long term opportunities. Thus, the road freight transport industry must focus on environmentally, socially and economically viable business models that are designed for road freight transport supply chains and address diverse stakeholder needs.
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1 Introduction

The introductory chapter aims to describe the motivation for this study and the overall problem, purpose and main research questions of the study. The empirical and theoretical gaps and an overview of the case industry are presented. The process through which this study was conducted is also summarized herein. In addition, the thesis structure, its limitations and potential contributions are described in this chapter.

1.1 Background

The background of this thesis begins with the very broad topic of sustainability and sustainable development, which has been a very important matter for several decades. The discussion then proceeds into the main area of this thesis, which is sustainability in business via sustainable supply chain management in the context of the case industry.

Awareness of sustainability and its meaning in our modern society is growing. Many sustainable development actions have occurred at the global level, including the climate change forum in Paris in 2015, where countries agreed to take sustainability seriously, with a focus on the environmental issue of emissions. In September 2015, the United Nations announced its 17 Sustainable Development Goals, which unifies the goals of numerous countries regarding societal and environmental problems on our planet. Sweden has elected to be in the forefront of this movement with Agenda 2030, which strives to achieve the environmental goals by the year 2030. There are numerous activities and new initiatives on many levels that potentially can contribute to the overall goal of sustainable development, including expanding trends such as sustainable procurement, sustainable consumerism, innovative projects to clean the oceans, the fight against poverty and injustice, and the fight for gender equality. Businesses are being forced to adopt new business practices, change their business models and design their supply chains in a more sustainable manner because market changes seem inevitable.

Sustainability challenges have been acknowledged for several decades (Elkington, 1997). Environmental and social concerns have been discussed on the supply chain level due to the increased globalization of businesses (Sarkis and Talluri, 2002; Srivastava, 2007; Morali and Searcy, 2013), which led to many issues regarding unsustainable production and use of resources in supply chains, as well as transportation and logistics concerns (Pagell and Wu, 2009; Matthews et al., 2016). Consideration of product life cycle from a sustainable perspective, from the initial processing of raw materials to customer delivery and beyond, has stimulated the development of the sustainable supply chain management field.
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(Linton et al., 2007; van Hoek and Johnson, 2010; Carter and Easton, 2011), which focuses primarily on stakeholders rather than shareholders and promotes strategic transparent management of supply chains while considering the triple bottom line (Carter and Rogers, 2008). There is also a growing discussion on more efficient and sustainable transportation methods and sophisticated logistics processes (Tavasszy and Thissen, 2003; Piecyk and McKinnon, 2010; McKinnon, 2016). Supply chain managers have an opportunity to impact the environmental and social performance of their respective organizations and the entire supply chain through supplier selection and development, transport selection, logistics, locational decisions, and packaging choices (Carter and Easton, 2011; Eng-Larsson and Norrman, 2014). The discussion about sustainability in the supply chain field highlights the differences in how strategies are established, business models are designed, and collaborations and relationships are formed (Touboulic and Walker, 2015; Lüdeke-Freund et al., 2016).

Long-term partnerships based on trust with new and existing suppliers and customers (particularly in the business-to-business setting) are emphasized (Handfield and Bechtel, 2004; Chakkol et al., 2014). Embedding the notion of life cycles in the business process, with a life cycle cost focus, is also discussed in terms of regulatory compliance and as a business strategy and operational focus (Linton et al., 2007; ISO., 2015). Discussion in the connected field of sustainable business models focuses on the extended use of products in combination with services, as well as value co-creation (Grönroos and Ravald, 2011; Boons and Lüdeke-Freund, 2013). Several industries have already tried to implement more sustainable business models based on product/service systems, product life extensions, solutions, and performance sales (e.g., healthcare, construction, aerospace, defence industries, city transport) (Howard et al., 2014; Essig et al., 2016). However, many industries are still perceived as traditional, and road freight transport is one of those industries. Therefore, the focus of this study is to explore how road freight transport supply chains can become more sustainable from the perspective of the heavy vehicle manufacturer. Adopting the perspective of the heavy vehicle manufacturer is important for many reasons. For instance, the truck industry can be characterized as having a traditional product mindset, with a lack of focus on services associated with the product (Chakkol et al., 2014). Compared to the numerous small players in this industry (i.e., small transport companies) (Eng-Larsson and Norrman, 2014), the large manufacturer possesses sufficient resources and can take more responsibility for research on and implementation of sustainable business models, and indeed some premium heavy vehicle manufacturers are focusing on these issues today.

In general, transportation is one of several industries that has generated increasing sustainability concerns due to economic growth, the length of global supply chains and the resulting environmental and social footprint. The negative influence of the transport sector, particularly in terms of air pollution and safety, has resulted in slower progress compared to other industries (emissions increased by 29% from 1990 until 2007 in the EU, although there was a short-term decrease of 2.7% from 2000 to 2012). The environmental influence of other sectors is
decreasing faster (Aronsson and Huge Brodin, 2006); Eurostat, 2016; European Commission Report, 2016 see the figure below).

Figure 1-1. Greenhouse gas emissions from diverse industries (European Commission Report, 2016)

This figure shows the global challenge facing the industry and requires changes along supply chains based on long-term sustainability criteria (Roth and Kåberger, 2002; McKinnon, 2016). Stakeholders including governments and customers are putting more pressure on the logistics and transport industries to follow environmental initiatives and reduce emissions generated by their operations, but the development of such initiatives in this industry is described in the literature as in its infancy (Isaksson, 2012). There is significant emphasis on smart city or urban logistics (Behrends, 2011), although long-haul road freight transportation is also in flux (Piecyk and McKinnon, 2010). Regarding the transportation sector, the road freight sector is changing not only in terms of new technologies in production and logistics efficiency but also in terms of how its supply chains are designed. The effect of these changes can go beyond the road freight industry because they will be included in the systems of numerous supply chains (e.g., manufacturing, retail, and construction), both downstream and/or upstream, as well as in traffic considerations. The road freight transport supply chain as a part of the transport sector has received less attention despite its detrimental impact on sustainable development goals due to the substantial demand and growth of long-haul deliveries. Due to the growth of greenhouse emissions (usually referred to as carbon dioxide (CO2) emissions, which is the main greenhouse gas (IPCC, 2014) across the globe), the urgency of this issue is
dramatic (e.g., in Europe, goods delivered by road account for almost 50% of all deliveries) (European Commission report, 2016).

The amount of freight delivered by trucks worldwide remains massive; therefore, the challenge for the transport sector is to make this process as efficient and sustainable as possible. One way to reduce the environmental impact of freight transportation is to reduce the impact of each transport mode (Björklund, 2005; Santen, 2016). Hence, technology and logistics development are very important (Piecyk and McKinnon, 2010). However, business management in this sector and best methods for making the entire transport supply chain work in a more sustainable way are lacking in terms of theoretical and empirical evidence (e.g., Chakkol et al., 2014; McKinnon, 2016).

1.2 Identifying the problem and revealing the gap

This discussion reveals the theoretical and empirical gap and explains the motivation for the specific focus of this thesis by answering the questions ‘so what?’ and ‘who cares?’

The importance of the road freight transport industry for economic growth and sustainability is undeniable. In terms of transport volumes and performance, road freight transport is by far the most important mode of transportation. For many reasons, including dense road networks, flexibility, and speed, road transport is unavoidable and cannot be replaced by other transport modes (Léonardi and Baumgartner, 2004; Fürst and Oberhofer, 2012). Hence, this sector is the focus of many decision makers worldwide as emissions continue to grow (Jaegler and Gondran (2014); European Commission Report, 2016).

Figure 1-2. Greenhouse gas emissions by transport by mode in 2014 (left), Share of transport energy demand by mode in 2014 (right) (%) – European Commission Climate Action, 2016).
Many governments have formulated strategies to reduce emissions from the road freight transport sector due to the focus on road transport stemming from its dominance in freight movement within many countries (IPCC, 2014). There are ambitions to decrease CO\(_2\) emissions from road freight transport by 60% by 2050 (from 1990 levels) (European Commission White paper, 2011b). Road transport was responsible for approximately 70% of CO\(_2\) emissions in 2012, whereas railways accounted for only 0.6% (Reducing emissions from transport, 2016; Liimatainen and Pöllänen, 2013). There are many ways to tackle these challenges, including the use of alternative fuel vehicles and reduced energy consumption (Steenberghen and Lopez, 2008). Even marginal improvements can help to reach long-term sustainable goals (Roth and Kåberger, 2002). Three general approaches to reduce the environmental impact of freight transport activities include reducing the environmental impact of each transport mode, using environmentally friendlier transport modes and decreasing the need for transport (Santen, 2016). All three approaches are important; examples of such approaches include improving the intermodal transport system and increasing railway deliveries. However, recognizing that road transportation remains the largest provider of long-haul deliveries in many countries and that it is continuing to grow despite all attempts to change the structure of the sector, it is important to focus on the first approach, namely, reducing the environmental impact of each mode, which here is road transport. Improved vehicle utilization is one way for the sector to improve, including through the use of diverse IT systems, enhanced information sharing within road freight transport supply chains, improved load factors, strategic routing and scheduling, and driver training (Schmidt, 2001; Piecyk and McKinnon, 2010; Demir et al., 2014).

Although the focus is on the environmental sustainability of the sector, social sustainability remains as important. The growing focus on safety can be credited to economic development; however, traffic density is increasing, particularly in global metropolises, where the risk of accidents has also increased (Ruger et al., 2014). The key for improvement in industry sustainable performance can also be viewed as the shared responsibility of all involved stakeholders (Schmidt, 2001). For example, both government and industry can support the development of sustainability standardization in transportation (Zhu and Sarkis, 2006). Stakeholders’ groups such as industry associations, policy makers, the media, competitors and suppliers influence the companies in this sector (Kovács, 2008; Dey et al., 2011). Another important goal is to increase knowledge about the connection between decision-making in transportation and environmental impacts; this knowledge can be spread through education and training. In this case, technology and governments may generate possibilities but firms must transform those possibilities into reality (Gold et al., 2010).

Important actors in the road freight transport industry include transport service or logistics companies (Björklund and Forslund, 2016). In the last decade, environmental sustainability issues, together with transport solutions and mode selection (in addition to improved logistics operations), have been increasingly addressed by transport companies (Zhu and Sarkis, 2006; Hoen et al., 2010; Lieb
and Lieb, 2010; Neubert et al., 2011; Dekker et al., 2012; Björklund and Forslund, 2013). There are many studies on the importance of technology and production of heavy vehicles, as well as logistics activities, for more sustainable freight transport (IPCC, 2014). However, few business studies have considered the implications of sustainable performance in the heavy vehicle industry from the perspective of the manufacturer’s downstream network. Bankvall et al. (2013b) examined diverse business models in the truck industry from the perspective of heavy vehicle and transport companies. Usually, reduction of the environmental impact of transport modes is related to technical advances in transport, such as sustainable fuels, energy-efficient engines or clean vehicle technologies (European Commission White Paper, 2011b; Wismans et al., 2016). However, relying on technical advances for industry improvements is not enough (Johansson et al., 2016). Rather, behavioural changes in the way business is conducted in the industry are also important. Specifically, a strategic focus on making supply chains and business models more sustainable is vital (Stefan Schaltegger et al., 2014; Lüdeke-Freund et al., 2016). The focus on business transformation through sustainable business models and sustainable supply chain management is an important means of facilitating the operationalization of sustainability goals (Gold et al., 2013; Lüdeke-Freund et al., 2016).

The recent focus of premium heavy vehicle manufacturers has yielded sustainable transport solutions for their customers (for example, the announcements from the biggest players in the road freight transport industry in Sweden in 2014 (Scania and Volvo Truck webpages)). Hence, the markets in Sweden and Europe have provided opportunities to develop solutions for road transportation by focusing on the concept of total cost and on offering extended service (Deloitte report, 2014; PWC report, 2014; Scania, Volvo, Volkswagen, Daimler webpages). Hence, the application of the life cycle notion in this specific sector is thought-provoking due to its emphasis on the entire network of the road freight transport sector and its consideration of the many actors involved in the supply chain (Chakkol et al., 2014; Maisam et al., 2016).

Academia is calling for studies in the transport industry that involve multiple actors to achieve a more empirical application of sustainable supply chain management (Carter and Easton, 2011; Abbasi and Nilsson, 2016). A specific focus on the downstream supply chain is also rare; leading to calls for more research related to supplier-customer interaction on sustainability initiatives (Winter and Kneumeyer, 2013). Hence, this PhD thesis focuses on the sustainable business model in the road freight transport sector, particularly the downstream supply chain of premium heavy vehicle manufacturers (road freight transport industry – illustration in Figure 3-2). The application of life cycle thinking in the road freight transport sector and the role of life cycle thinking in sustainable supply chain management from the supply chain perspective are the theoretical and practical gaps addressed in this study.
1.3 The overall purpose and main research questions of the PhD study

This subchapter reflects on the discussion above and presents the overall purpose and main research questions of this PhD study, in addition to introducing the working conceptual framework.

Building on the previous discussion, the purpose of this study is to explore how road freight transport supply chains can move towards being more sustainable from the perspective of a heavy vehicle manufacturer.

To fulfil the purpose of the study, two main research questions (RQs) are addressed:

RQ1: What is the role of life-cycle thinking in developing more sustainable road freight transport supply chains?

RQ2: How can life cycle thinking be applied in sustainable business models in road freight transport supply chains?

RQ1 aims to understand the role of life cycle thinking in developing more sustainable road freight transport supply chains. Because there are many diverse ways to increase the sustainability of the industry, the focus of this study is on the supply chain (which is the unit of analysis) and on the role of life cycle thinking in improving sustainable industry performance in road freight transport supply chains. To understand these issues, the second research question focuses on the application of life cycle thinking in a sustainable business model for the downstream supply chains of heavy vehicle manufacturers.

The figure below is a working conceptual framework illustrating the interrelationships among the researched concepts with a specific focus on the road freight transportation industry. In figure 1-3, the main interconnections are seen as the facilitation of sustainable business model development by life cycle thinking in the studied industry through sustainable supply chain management practices.
1.4 The research process

Every PhD process is a unique case; hence, the context of the research process for this thesis is explained in this chapter.

This study is largely based on empirical data obtained from an international research project rooted in the road freight transport industry (more information about the project is provided in Chapter 3.4). The motivation for the specific focus of the PhD thesis was a feature of the project focus. The project, called Value to Business (V2B), was an international collaborative project involving scholars and road freight transport industry representatives from several countries. Several areas of research grounded in supply chain management were covered by the project. The main purposes of this project were to focus strategically on road freight transport supply chains and to compare several markets. One goal was to enhance the discussion about environmental and social challenges and opportunities in this sector at the international level. This specific goal of the project motivated the overall purpose of this study (more information on the project and my role in it is provided in Chapter 3).

Because V2B was also based on ongoing discussions in academia regarding the identified challenges and opportunities, the theoretical gap addressed by this thesis was supported by the practical relevance of the project. Increasing awareness of sustainability issues in this specific industry was an additional motivation for the purpose of this thesis. Going back and forth within the research
process – between data collection (interviews and workshops), literature reviews, general literature readings, conferences, etc. - allowed for an abductive research method and facilitated finding support for this study. Most data for this thesis were collected throughout the project, which entailed the in-depth single case study of several supply chains in three different markets (resulting in Research Papers 1, 2 and 4 of this compilation thesis). However, to broaden the empirical scope of this study and tackle certain limitations of the single case study method, the decision was made to go beyond the case company’s supply chains and collect more data from another premium truck manufacturer in another market (more information on the multiple case study is provided in 3.4.1). Case study 2, which focused on two markets and covered several supply chains, was completed after Case study 1 had been completed (Figure 1-4).

Figure 1-4. Research process timeline

1.5 Intended contributions and limitations of the study

The discussion herein is about the intended theoretical and practical contributions and implications of this study, as well as what this study does not address, including the limitations of the study.

This dissertation intends to contribute to the discussions in the supply chain management discipline – particularly with respect to sustainable supply chain management – as well as to discussions on sustainable business models and life cycle thinking. The practical relevance is evinced by the case study of road freight transport supply chains. By focusing on current discussions in the mentioned areas and the interrelationships among them, the goal of this thesis is to explore the context of road freight transport supply chains and the ongoing sustainable business challenges in this industry. Addressing theoretical and practical gaps in this dissertation will allow policy makers and diverse industry stakeholders to tackle the challenges and take advantage of the opportunities of business
management in the road freight transport industry in terms of environmental influence, traffic safety and economic gains (more information on the theoretical and practical implications is provided in 6.2 and 6.3). The ability of the industry to design sustainable business models should help to fulfill the rapidly growing needs of modern society, particularly in the challenging road freight transport industry, which in turn can influence other industries and groups, such as upstream industries (manufacturing) and downstream entities (consumers), as well as the traffic situation in general.

There are many alternative ways to tackle the overall problem addressed in this study; however, this study has a specific focus and certain limitations within that focus. Hence, it is important to set the boundaries and explain the context of the study. The context of the study is its attachment to the Centre of Logistics and Supply Chain Management at Jönköping International Business School. This thesis is rooted in the supply chain management discipline and thus it is not an operational study (i.e., it is not performed in the tradition of operations research). In the tradition of supply chain management research (with a focus on triads), the system boundaries for this study are placed around the downstream supply chains of the heavy vehicle manufacturer; the upper part of the supply chain is excluded from the main focus (i.e., the study does not focus on the production of heavy vehicles or on their recycling). Although certain sustainable road transportation technologies and green logistics strategies are discussed in this study, it does not focus on different modes or combinations of modes of road transportation or road transport technologies (i.e., the study does not focus on the analysis of new transport technologies in the sector, e.g., new vehicles, electric motors, IT technologies, etc.). The business focus of this study in the context of the discussion of sustainable business models for heavy vehicle manufacturers places this thesis in the sustainable supply chain management field and not in the environmental/green logistics field. One reason for this positioning is the consideration of social aspects of sustainability rather than focusing only on environmental issues.

The farthest boundaries include the first-leg customers of the heavy vehicle downstream supply chain. The second-hand market is not explored in this study. The study is also limited to four markets (empirical findings are obtained from Sweden, China, Poland and Australia). The author investigates three supply chains of the case company in China, Poland and Sweden to provide examples from three diverse markets with different levels of market development. The farthest supporting study, which was performed with other heavy vehicle manufacturers in Swedish and Australian markets, was added to broaden the scope of the single case study and to include other premium heavy vehicle manufacturers in the analysis. The strength of the single case study lies in its ability to achieve a deeper understanding of the phenomenon (more information on the strengths and limitations of the single case study is provided in 3.2 and 3.7), whereas the multiple case study can help to test the results of the research.

The next limitation relates to sustainability metrics. This study does not attempt to cover all aspects of sustainability in the studied sector. The
environmental and social dimensions of sustainability in the context of the industry can be mainly represented by pollution, resource depletion, land use, inefficiency and social damage (Santen, 2016). In the context of this study, the environmental and social issues are reflected by CO2 emissions (environmental), safety on the roads and working conditions (social) and life cycle costing (economic).

Table 1 Summary of intended contributions and limitations of the study

<table>
<thead>
<tr>
<th>Outside the scope of this study</th>
<th>Intended contributions of the study focus</th>
<th>Study limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not an operational study</td>
<td>Sustainable business model in the context of road freight transport supply chains</td>
<td>Supply chain focus – three actors</td>
</tr>
<tr>
<td>Not a study on green or IT technologies</td>
<td>System theory and social network theory as lenses</td>
<td>Does not include the second-hand market</td>
</tr>
<tr>
<td>Not a study on environmental/green logistics</td>
<td>Other connected industries (upstream and downstream) can be influenced as well</td>
<td>Four markets – Sweden, Poland, China and Australia</td>
</tr>
<tr>
<td>Not a study on intermodal transport or other sustainable transport approaches</td>
<td>Practice and industry implications via discussions in the managerial context</td>
<td>Sustainability in the industry mainly via emissions, safety and cost factors</td>
</tr>
</tbody>
</table>

1.6 Definitions of main study concepts

The chosen definitions for core and peripheral concepts of this thesis are presented in Table 2.

This study concentrates on the application of life cycle thinking in the road freight transport industry through sustainable business models in the context of sustainable supply chain management. Certain core and peripheral concepts related to this focus that are used in this thesis are presented in Table 2 and elaborated in the Theoretical Background.
<table>
<thead>
<tr>
<th>Core concepts</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainability</td>
<td>The consideration of economic, environmental and social matters (Elkington, 1997)</td>
</tr>
<tr>
<td>Sustainable Supply Chain Management</td>
<td>The strategic and transparent integration and achievement of an organization’s environmental, social and economic goals through the systematic coordination of key inter-organizational business processes (Carter and Rogers, 2008, p. 368)</td>
</tr>
<tr>
<td>Sustainable Business model</td>
<td>…where a triple bottom line approach is incorporated and a wide range of stakeholder interests, including environmental and social interests, are considered (Bocken et al., 2014)</td>
</tr>
<tr>
<td>Life Cycle Thinking</td>
<td>Life cycle thinking is the application of holistic logic to the assessment of product/service life cycles using the tools of life cycle assessment and life cycle costing (Heiskanen, 2002; Finnveden et al., 2007)</td>
</tr>
<tr>
<td>Road Freight Transport Supply Chain</td>
<td>The actors in the road freight transport industry, namely, heavy vehicle manufacturers, sales representatives, and transport companies (Chakkol et al., 2014)</td>
</tr>
<tr>
<td>System Theory</td>
<td>Refers to the hard core of supply chain management and describes the complexity of supply chains and the perspective of cost totality (Defee et al., 2010).</td>
</tr>
<tr>
<td>Social Network Theory</td>
<td>Refers to the interrelation of nodes (actors) in the supply chain based on trust (Borgatti and Li, 2009)</td>
</tr>
<tr>
<td>Peripheral concepts</td>
<td></td>
</tr>
<tr>
<td>Challenges</td>
<td>Refer to difficulties in implementing actions</td>
</tr>
<tr>
<td>Drivers</td>
<td>Refer to forces that facilitate actions</td>
</tr>
<tr>
<td>Barriers</td>
<td>Refer to the boundaries of action implementation</td>
</tr>
<tr>
<td>Interaction patterns</td>
<td>Forms of the business interaction process (e.g., supplier -customer) (i.e., Ford et al., 2002; Grönroos and Ravald, 2011)</td>
</tr>
</tbody>
</table>
### Introduction

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Competencies, abilities and skills in the business context (i.e., Ford et al., 2002; Salonen, 2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product service systems</td>
<td>The combination of product(s) and services in the value proposition (Orsato and Wells, 2007; Bocken et al., 2014)</td>
</tr>
<tr>
<td>Value co-creation</td>
<td>Customer value fulfilment via supplier-customer interactions (Grönroos and Ravald, 2011)</td>
</tr>
<tr>
<td>Long-term relationship</td>
<td>Business cooperation with a long term focus based on trust (Carter and Rogers, 2008; Beske et al., 2011)</td>
</tr>
<tr>
<td>Trust</td>
<td>‘Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another.’ Rousseau et al. (1998, p. 395) Trust is largely based on a common set of shared values and is a core concept of supply chain collaboration (Skjoett-Larsen et al., 2003; Tatham and Kovács, 2010)</td>
</tr>
<tr>
<td>Sustainability in the road freight transport industry</td>
<td>CO2 emissions – greenhouse gases (Chapman, 2007), safety (Plowden and Buchan, 1995), and cost (Eng-Larsson and Norrman, 2014)</td>
</tr>
</tbody>
</table>

### 1.7 Thesis structure

*This part of the introduction presents the thesis structure, the author’s contributions to each part of the thesis, and a description of how the research papers are positioned within the working conceptual framework.*

This thesis is a compilation of research papers. The first part of the thesis is the kappa. The goal of the kappa is to summarize and discuss the results of all five research papers. The kappa includes the general introduction to the theoretical and practical problem, the literature overview, the motivation for the selection of theories, a description of the methods used, and the results discussion with the conclusions. The second part of this thesis is the compilation of 5 research papers, wherein the research questions are answered.
The included research papers are the result of both individual and joint efforts. Research papers 1, 2 and 4 are based on empirical data from the project. Research Paper 3 is a theoretical article. Research paper 5 is based mainly on data collected by the author. The author’s contributions to each research paper are as follows:

Assumed the main role in planning the paper and led the writing process. Paper is based on empirical data from the project collected through joint efforts (First author).

Research Paper 2.
Took part in planning the paper and in the writing process. Paper is based on empirical data from the project collected through joint efforts (Third author).
Research Paper 3.  
Systematic literature review (theoretical). Assumed the main role in planning the paper and led the writing process (First author).

Assumed the main role in planning and writing the paper. Paper is based on empirical data from the project collected through joint efforts (Single-author paper).

Research Paper 5  
Assumed the main role in planning and writing the paper. Paper is mainly based on empirical data collected by the author (Single-author paper).

Figure 1-6 Research paper timeline

Research paper 1 is rooted in sustainable supply chain management and discusses sustainability challenges and conflicts in the case industry. Research Paper 2 discusses certain important managerial issues (namely, interaction patterns and capabilities) related to various business models in the road freight transport industry. Research Paper 3 is a theoretical paper based on a comparative analysis of life cycle thinking and sustainable supply chain management. Research Paper 4 examines the application of life cycle thinking in the road freight transport industry from the system theory perspective. Research paper 5 focuses on a discussion about sustainable business models in the studied industry from a social network theory perspective (more information on these theories is provided in 2.4).
2 Theoretical Background

This chapter presents the theoretical background of the discussion on increasing the sustainability of road freight transport supply chains. It is grounded in sustainability-focused literature, specifically, literature on sustainable supply chain management, life cycle thinking and sustainable business models in the context of the road freight transport industry. Certain managerial issues and general challenges and conflicts presented by sustainable business models in road freight transport supply chains are also discussed. The main concepts and definitions are discussed at the beginning of the chapter. The industry focus is presented next, followed by the arguments for the chosen support theories. Then, certain important managerial issues are discussed. The chapter concludes with a summary, concept map and development of sub-research questions.

2.1 Sustainability, sustainable development and sustainable business

The following discussion addresses sustainability and sustainable development in general and sustainability in business in particular.

The concepts of sustainability and sustainable development have existed for several decades. The World Commission on Environment and Development (WCED) brought the concept of sustainability to global prominence in Our Common Future (Brundtland, 1987), defining the concept as sustainable development that meets “the needs of the present without compromising the ability of future generations to meet their needs” (Kleindorfer et al., 2005, p. 484). This definition highlights the fundamental components of sustainable development: economic growth, social equity for today’s generation, and environmental protection for today’s generation and for future generations (Brundtland, 1987). The concept is complex and its definition differs across disciplines, however, the fundamentals of sustainability are manifested in the triple bottom line, or the balance of economics, environment and society (Elkington, 1997; Seuring and Müller, 2008). The terms sustainable development and sustainability are often used interchangeably (Aras and Crowther, 2009).

According to the economic approach, the aim of sustainable development is to maintain a certain level of consumption or welfare per capita for future generations (Klaassen and Opschoor, 1991). Classical economists also addressed the issue of sustainability. Thomas Robert Malthus (1766–1834) was the first economist to predict limits on economic growth due to resource scarcity. Although his views fit into the classic economics tradition and he accepted the
principles laid down by Smith (1776), Malthus diverged from certain basic
principles by virtue of his pessimistic assessment of the economic future
who fundamentally agreed with the danger of overpopulation, Malthus presented
his “environmental limits thinking”, which notes the limited supply of good
quality agricultural land and the consequential diminishing returns of agricultural
fiercely disagreed with each other’s economic views on almost every issue except
one — the population theory. Ricardo’s more complex economic model predicted
economic decline in the long run due to a scarcity of natural resources. Thus, the
Malthusian theory of environmental limits may be considered an originator of the
concept of sustainable development (Mebratu, 1998).

In “The Limits of Growth” by Meadows et al. (1972), the discussion about the
state of the world in terms of population growth, pollution, resource depletion and
poverty led the authors to conclude that the world economy would collapse. Even
then, scientists were stressing limits on the Earth’s capacity to support further
human development if no changes were made (Thomas et al., 2004). This report
influenced emerging green movements and international policy makers. However,
the updated version of this report, “Beyond the Limits”, acknowledges the
limitation caused by its failure to account for future discoveries in natural
resources. Nonetheless, even considering all future natural resource discoveries,
the authors conclude that the limits will eventually be reached unless international
policy makers take action (Meadows et al., 1972; Thomas et al., 2004).

Today, we can observe actions taken by many international policy makers in
recognition of the sustainable development problem. The United Nations Climate
Change Summit in 2015 in Paris resulted in the Paris Climate Agreement, a
universal pact among 195 countries to combat climate change. The primary
sources of global warming are believed to be the increased volumes of carbon
dioxide and other greenhouse gas emissions generated by burning fossil fuels,
land clearing, agriculture, and other human activities during the last 50 years (UN
Climate Change Conference, 2016). The two biggest polluters in the world (China
and the USA, with 20.09% and 17.89% of total global greenhouse emissions)
ratified the agreement in September 2016, ushering in a ‘new era in global efforts
to address climate change’ (The Guardian, 2016)1. ‘The Paris Agreement on
climate change remains a momentous diplomatic success, universally supported
by all countries when it was adopted in 2015 at a United Nations conference, and
as of today, it has been ratified by 141 nations, surpassing the threshold for its
entry into force.’ (UNFCCC Executive Secretary, March 2017). Furthermore, the
United Nations announced sustainable development goals to end poverty, protect
the planet and ensure prosperity for all. The goals were accepted by 193 UN
member states in September 2015 with specific targets for the next 15 years (UN
Sustainable Development Goals). The Swedish government, for example, has

1 However, there could be potential challenges regarding environmental policies worldwide
established Agenda 2030, which focuses generally on decreasing emissions and has a specific focus on renewable resources and transportation.

Although the proposed goals place enormous pressure on many stakeholders worldwide, including organizations and businesses, not enough is being done (Montabon et al., 2016). The discussion about sustainability in the business context was facilitated by Elkington (1997), whose essential principle of the triple bottom line is widely used in sustainability-related sciences and practices. The author advocated a new, responsible approach for companies operating today and in the future and emphasized transparency and shaping stakeholder value through such initiatives as the Global Reporting Initiative or the Dow Jones Sustainability Index (Bercovics, 2010). His main point is that international institutions must take responsibility for their actions by focusing on soft value and on their obligations to numerous stakeholders (Elkington, 1997).

Furthermore, stakeholder pressure and sustainability reporting require transparency of companies’ operations and strategies, which is facilitated by IT developments. The focus on the life cycles of products and services facilitates cooperation and the development of partnerships, and trust is becoming a crucial basis for economic relationships. In addition, the importance of cooperation among governments, industry and non-governmental organizations (NGOs) is increasing. Hence, a long-term focus and business eco-systems are important aspects of sustainable business strategies (Elkington, 1997). One example of a well-known symbiosis is the Natural Step. Originating in Sweden, the international NGO for strategic sustainable development (Natural Step) helps companies to understand how to move towards sustainability in a systematic way (Holmberg and Robert, 2000). It focuses on planning for the future (back-casting) and complex and systemic thinking according to sustainability principles. According to Robèrt et al. (2002), the general model of essential elements for sustainable development comprises the creation of a comprehensive view on sustainable development, the design of action programmes, the selection of tools, the transformation of tax systems and the implementation of planning designed to avoid ecological collapse.

The operationalization of sustainable goals in diverse business areas remains unclear, however (Linton et al., 2007). Some researchers have tried to translate sustainability into corporate language, defining it as ‘meeting the needs of a firm’s direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities, etc.), without compromising its ability to meet the needs of future stakeholders as well’ (Dyllick and Hockerts, 2002, p. 131; Morali and Searcy, 2013). The integration of environmental and social issues with economic concerns in corporate sustainability has become increasingly important for managerial decision making in general and for supply chain management (SCM) (Carter and Rogers, 2008) and operations management (Kleindorfer et al., 2005; Brandenburg et al., 2014) in particular, because supply chain management affects the sustainable development of organizations (Carter and Rogers, 2008; van Hoek and Johnson, 2010). A focus on supply chains is considered a step towards sustainability because the supply chain contemplates the product from...
initial processing of raw materials to delivery of the final product to the end customer (Linton et al., 2007; Seuring and Müller, 2008).

The application of sustainability in business, including sustainable supply chain management and sustainable business models, is discussed in diverse scientific communities. These concepts are overarching and interlinked, because supply chain management and business models are important for companies engaged in sustainability management. Thinking outside of the organization’s boundaries motivates research and practice when addressing sustainable supply chains (SSCs) and sustainable business models (SBMs). These concepts originate from different backgrounds but are highly interrelated both theoretically and practically, with ‘one building in part on the other often without recognition by scholars and practitioners in both fields’ (Lüdeke-Freund et al., 2016, p. 2). Because most organizations are part of at least one supply chain in the global market, where supply chains compete with each other, the sustainable management of supply chains is highly relevant for both economic development and responsible business practices at all stages of the supply chain (Ashby et al., 2012). Supply chain management can present many challenges for the actors involved when sustainability is becoming embedded in the chain. Interaction patterns between the actors differ from those in traditional supply chain management, and the capabilities of companies offering sustainable business models can vary as well, both of which create challenges for the actors. However, it is important to understand what drives or prevents the development of more sustainable supply chains. The general context of this PhD thesis is rooted in sustainable supply chain management and in part in life cycle thinking and sustainable business model literature. The combination of the Business School focus and the Centre of Logistics and Supply Chain Management environment motivated and facilitated the general focus of this PhD thesis.

2.2 Sustainable Supply Chain Management (SSCM), Sustainable Business Models (SBM) and Life-Cycle Thinking (LCT)

The first three parts of this subchapter focus on the key discussion in each area (and on the intersection among them): SSCM, SBM and LCT. The most common definitions of SSCM and LCT can be found in the systematic literature review in Research Paper 3. The definitions of SBM are presented in this subchapter.

2.2.1 Sustainable Supply Chain Management

What is supply chain management? The definition promulgated by the Council of Supply Chain Management Professionals (CSCMP) states as follows: ‘Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management
activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies.’ (CSCMP). A frequently cited and very inclusive definition of SCM states that SCM is “a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances and/or information from a source to a customer” (Mentzer et al., 2001, p. 4). Both definitions stress the network of actors involved in managing and organizing the life cycle of the products/services and related activities. After the WCED defined sustainable development, environmental and social factors became additional drivers of SCM, and the sustainable supply chain management field has started to evolve rapidly (Ashby et al., 2012). Pagell and Wu (2009, p. 38) developed an extended definition of SCM by adding two dimensions of sustainability: ‘a sustainable supply chain is one that performs well based on traditional measures of profit and loss and on an expanded conceptualization of performance that includes social and natural dimensions’.

One approach for assessing the incorporation of sustainability into supply chains is proposed by Seuring and Müller (2008), who discuss three aspects of this process: triggers for sustainable supply chain management, supplier management of risks and performance, and supply chain management of sustainable products. According to their literature review, external triggers (pressures as well as incentives) are put forward and exerted on focal companies by governing agencies, customers and other stakeholders. Based on these triggers and certain identified barriers (higher costs, coordination complexity/effort, and insufficient/absent communication) in the supply chain, two strategies are identified – supplier management of risks and performance and supply chain management for sustainable products. One major fear of companies that follow the strategy of supplier management of risks and performance is a loss of reputation. Therefore, economic supplier evaluations are complemented by additional environmental and social criteria. The second strategy, supply chain management for sustainable products, requires the definition of life cycle-based standards for the environmental and social performance of products, which are then implemented throughout the supply chain (Seuring and Müller, 2008).

The widely used framework for sustainable supply chain management was introduced by Carter and Rogers (2008). This framework addresses the trade-offs between all three pillars of sustainability – economic, social and environmental – as well as the domains influenced by the integration of sustainability into supply chain management, which include strategic planning, risk management, organizational culture and transparency (Figure 4).
However, the application of life cycle standards that are not only economic but also environmental and social throughout the supply chain is not the focus of Carter and Roger’s framework (Seuring and Muller, 2008).

The latest analysis of definitions of sustainable supply chain management and green supply chain management (GSCM) used in the literature, which was conducted by Ahi and Searcy (2013), identified 22 definitions for GSCM and 12 definitions for SSCM. Their analysis showed that definitions of GSCM focused more specifically on environmental aspects compared with definitions of SSCM. The authors argued that although there was significant overlap between GSCM and SSCM definitions, SSCM is essentially an extension of GSCM (Ahi and Searcy, 2013). Hence, the focus of this thesis is in line with the triple bottom line approach in the SSCM field. Next, it is important to acknowledge another field related to sustainable supply chain management, namely, closed-loop supply chain management (CLSCM). CLSCM gives substantial attention to reverse logistics. Reverse and forward supply chains form a closed loop that is managed in a coordinated way to achieve the common goal of maximizing profits (Kleindorfer et al., 2005; Srivastava, 2007). Because companies are increasingly expected (and sometimes legally required) to take responsibility for their products throughout the product life cycle (including proper recycling and disposal), reverse logistics or reverse supply chains make a significant contribution to sustainable thinking (Dowlatshahi, 2005; Hoen et al., 2010). The practice of reverse logistics furthers the concept of SSCM by extending it to a ‘cradle to
cradle’ approach. Focusing on the environmental burden at the end of the product/service life cycle and on its prevention/control is the best way to tackle supply chain environmental problems while achieving economic savings and enhanced competitiveness (Rao and Holt, 2005; Ashby et al., 2012). The definitions of SSCM-related concepts are presented in Research Paper 3.

Table 3 Growing awareness and parallel discussions within SSCM (by author)

<table>
<thead>
<tr>
<th>Development of discussion in SSCM</th>
<th>Beginning of 2000s</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major focus</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsible supply chain management, corporate social responsibility, business ethics, supplier codes</td>
<td>Sustainable supply chains (focus on both environmental and social aspects) in parallel with green/environmental logistics/SCM and closed-loop SCM</td>
<td>Truly sustainable supply chains</td>
</tr>
<tr>
<td><strong>Main authors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carter and Jennings (2002); Murphy and Poist (2002)</td>
<td>Carter and Rogers, 2008; Seuring and Muller, 2008; Sarkis et al. (2011); Wells and Seitz, (2005)</td>
<td>Pagel and Wu (2009); Pagell and Schevchenko (2014)</td>
</tr>
<tr>
<td><strong>Main Contributions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorporating CSR and business ethics into SCM</td>
<td>Focus on the environmental and social aspects in addition to the economic aspects (primary focus) in a more strategic way</td>
<td>All supply chains must be truly sustainable (do not cause net harm to the environment and society)</td>
</tr>
</tbody>
</table>

Sustainability concerns in the field of supply chain management have influenced the strategy, design and operation of conventional supply chains (Halldórsson et al., 2009) and are still perceived as a challenge (Seuring and Müller, 2008). Discussions on sustainable supply chains (including environmental, social and economic considerations) in the XX century have developed in parallel with discussions on responsible supply chain management, the implementation of business ethics and corporate social responsibility (Carter and Jennings, 2002; Murphy and Poist, 2002), and further development of supplier codes (for example, Andersen and Skjoett-Larsen (2009). Part of the environmental discussion developed in the green/environmental logistics/supply chain field (Sarkis et al., 2011; Wells and Seitz, 2005). The consideration of net harm to the environment and society provides increasing motivation for further discussions on sustainable
supply chains (Pagel and Wu, 2009; Pagell and Schevchenko, 2014). Similar to the general discussion on sustainability, academics and practitioners question whether enough has been done. In the future, truly sustainable supply chains shall be designed according to the closed-loop, cradle-to-cradle, life cycle framework (Wells and Seitz, 2005; Kumar and Putnam, 2008).

2.2.2 Sustainable Business Models

There is a clear intersection between sustainable business models and sustainable supply chain management, and conceptualization within these two subfields will increase (Lüdeke-Freund et al., 2016). Although some initial discussions on the V2B project focused on business models, there is a clearer need for this thesis to consider sustainable business model literature in order to better understand this phenomenon.

The business model as a concept can be viewed as a background for theoretical discussions about sustainable business models and encompasses the notions of values, functions, profits, relationships (systems) and resources (Chesbrough, 2010; Zott et al., 2011; Achtenhagen et al., 2013). Determining the value for the customer and capturing value while doing so are key issues in designing a business model. It is becoming obvious that customers want more than just products; they want solutions to their perceived needs through the value offered by the enterprise. Thus, value creation combined with a delivery and capture mechanism are facets of the business model that are either explicitly or implicitly employed by newly established business enterprises (Teece, 2010). Grönroos and Ravald (2011) note the difference between value co-creation and value facilitation and describe value co-creation as the joint creation of value by the supplier and its customers during interactions between them (the supplier is also a value facilitator). This process, together with the effective use of supplier-customer interactions, enables the co-creation of value. According to Upward and Jones (2015), business model ontology has not been critically assessed in terms of its applicability to successful sustainable businesses in the peer-reviewed management literature. The authors suggest evaluating the relationships and concepts in the foundation ontology in order to define the feasibility of the business model through natural and social sciences while contributing to sustainable outcomes (Upward and Jones, 2015). The similar interdisciplinarity of the business model concept and sustainability management is mentioned by Schaltegger et al. (2015). In summary, pressures from resources and stakeholders (i.e., resource scarcity and stakeholder demands for sustainability) facilitate the creation of new business models that consider all three dimensions of sustainability (economic, environmental and social). Examples of sustainable business models in research and practice include closed-loop or sustainable supply chain management, social entrepreneurship, product-service systems, life-cycle models, strategies for sustainable products, solution businesses, etc. (Pagell and Wu, 2009; Zahra et al., 2009; Boons and Lüdeke-Freund, 2013; Storbacka et al., 2013).
Hence, the SSCM field has a significant connection to the growing SBM discussion. In the literature review conducted by Boons and Lüdeke-Freund (2013), the normative requirement of a business model is that its value proposition should provide both economic and social/ecological value through products and services. According to Gronroos and Ravald (2011), firms are increasingly competing on the basis of services rather than physical products. Industries are being transformed into customer- and service-oriented firms that do not depend on the products and services (product service systems, PSS) they sell but rather focus on the notion of value co-creation and a larger role for customer-supplier interaction. The focus on the service aspects of the product-service mix offered by manufacturing companies provides an opportunity to gain a sustainable competitive advantage. The notion of PSS is also part of a well-known work on service dominant logic (SDL) by Vargo and Lusch (Vargo and Lusch, 2004, 2008). While moving from a marketing-dominant logic based on embedded value, transactions and tangible resources, Vargo and Lusch propose a school of thought that builds on service provision as an economic exchange instead of the usual goods exchange. The core of their proposal is the service-centred model of exchange that includes relationships, value and customer orientation, and a long-term focus.

The logistics industry provides an example of a developing service-based industry that is transitioning from the business concept of transportation to a concept that serves more customer logistics needs (Chapman et al., 2003). Storbacka et al. (2013) maintain that in the industrial context, specific tools and guidelines already exist for a solution business model based on products/services logic. Due to the increased complexity of a solution business, it is possible that operational costs will increase more than the additional revenue generated by solutions (Storbacka et al., 2013). For logistics firms, there is a need to reassess the extent of their functions, systems, and processes within the entire supply chain and to synchronize the activities of the partners in the network through application of new technologies. Thinking for their customers and meeting customer needs through new knowledge enable these companies to recognize opportunities outside of traditional business models. Ceschin (2013) offers insights from innovation studies regarding eco-efficient product-service systems (PSS) that companies can adopt to enhance sustainability. However, he also argues that the implementation of eco-efficient PSS is not easily achieved through changes to the company’s business model alone. Hence, companies that implement eco-efficient PSS must understand not only eco-efficient PSS concepts but also contextual conditions development strategies (Ceschin, 2013).

In his introduction to the BMfS special issue, Lüdeke-Freund (2013) argues that the phenomenological, theoretical and methodical approaches to discovering and understanding sustainable business models remain in their infancy. However, discussions around specific examples of business models that can be considered more sustainable (for example, product/service systems (PSS), solutions and performance sales, performance-based contracting, and sustainable supply chain management) have been ongoing for quite some time. The conceptualization of
sustainable business models requires a new understanding of value and a reconfigured business purpose that considers economic, social and environmental goals (Elkington, 1997; Roome and Louche, 2016). The table below presents the most commonly used definitions of SBM.

Table 4. Definitions of sustainable business model-related concepts

<table>
<thead>
<tr>
<th>Concept/Authors</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business model (Osterwalder and Pigneur, 2010, p. 14)</td>
<td>‘A business model describes the rationale of how an organization creates, delivers, and captures value’</td>
</tr>
</tbody>
</table>
| Sustainable Business Model (Stubbs and Cocklin, 2008, p. 123; Boons and Lüdeke-Freund, 2013) | ‘An organization adopting an SBM develops internal structural and cultural capabilities to achieve firm-level sustainability and collaborates with key stakeholders to achieve sustainability for the system that the organization is part of.’  
“We define a sustainable business model as the rationale of how an organization creates, delivers and captures economic, environmental and social forms of value simultaneously.” |
| Business Model for Sustainability (Schaltegger et al., 2016, p. 4)            | ‘A business model for sustainability helps describing, analysing, managing, and communicating (i) a company’s sustainable value proposition to its customers and all other stakeholders, (ii) how it creates and delivers this value, and (iii) how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries.’ |
| Product Service System Centre for Sustainable Design (UK) (Wong, 2004)       | ‘A pre-designed system of products, supporting infrastructure and necessary networks that fulfil a user’s needs, have a smaller environmental impact than separate products and services with the same function fulfilment and are self-learning’.  
‘Product Service-Systems (PSS) may be defined as a solution offered for sale that involves both a product and a service element to deliver the required functionality’. |
| Performance-based contracting (Kim et al., 2007, p. 1843)                     | This model ‘involves reshaping service support supply chains in capital-intensive industries [...] and aims to replace traditionally used fixed-price and cost-plus contracts to improve product availability and reduce the cost of ownership by tying a supplier’s compensation to the output value of the product generated by the customer.’ |
2.2.3 **Life Cycle Thinking (Life cycle Management, Life cycle Assessment, Life Cycle Costing)**

Life-cycle approaches that entail the holistic identification and assessment of the environmental impacts of products and services can vary from qualitative decision support concepts and screening methods to detailed inventory-based life cycle assessments (Hunkeler and Rebitzer, 2005; Lofgren *et al.*, 2011). Life-cycle thinking includes the both life-cycle assessment (LCA) and life-cycle costing (LCC), and there is growing discussion regarding social life cycle assessment, environmental life cycle assessment and life cycle sustainability assessment (SLCA, ELCA and LSCM). Although the use of LCA when measuring the environmental dimension of sustainability is reasonably widespread, similar approaches for the social and economic dimensions of sustainability still have limited application worldwide. It is crucial that LCSA, which combines environmental, social and economic LCAs (LCSA=ELCA+SLCA+LCC), be developed further because it allows for the emergence of life-cycle based sustainability assessment (Ciroth *et al.*, 2011; Klöpffer and Ciroth, 2011) in UNEP/SETAC Life Cycle Initiative, 2011). Life-cycle assessment considers the manufacture (or purchase), usage, maintenance, and end-of-life treatment of the product, whereas life-cycle costing refers to the costs associated with the product’s life cycle (Finnveden *et al*., 2009; Kwak and Kim, 2013).

‘LCT has also been defined as incorporating the basic approach of LCA without the need for a detailed assessment of each process, instead using a range of reference data sources to identify trends in results and conclusions that are considered representative’ (Lazarevic *et al.*, 2012, p. 199). The review of GSCM quantitative models by Seuring (2013) indicates that life cycle thinking is related to a product perspective but also considers value chain cooperation between companies, although life cycle based approaches and impact criteria clearly dominate. The importance of obtaining a complete picture is highlighted, along with the elimination of trade-offs and inefficient activities between partners in the value chain.

In the introduction to life cycle management by Rebitzer (2015), life cycle thinking is considered an approach that uses related tools, such as life cycle management and life cycle assessment, to help governments and industries (especially in fast growing economies) to develop new policies for the prevention of environmental degradation through strategic and innovative technology choices based on these approaches, which is similar to the views of de Larderel (2006). Life cycle thinking helps actors to recognize the influence of individual choices on events at each stage of the product life cycle point, which in turn should encourage trade-offs to positively impact the economy, the environment, and society. Life cycle thinking helps to avoid actions that solve one environmental problem but create others; in this way, life cycle thinking improves entire systems. According to Pelletier, (2015), researchers have recognized the importance of incorporating life cycle-based measures of socio-economic performance in product assessment (particularly food product assessment) in order to move...
towards true life cycle sustainability assessment. The tools and standards for social and economic LCAs seem substantially less developed than those used for life cycle costing. Life cycle costing provides a basis for economic considerations along product supply chains through the distribution of costs, including private, public and external costs, among diverse actors in the supply chain (Pelletier, 2015).

Life cycle cost is a component of product sustainability performance from the economic perspective (Kwak and Kim, 2013). It is the aggregation of all costs that are related to a product over its entire life-cycle – from resource extraction through the supply chain to use and disposal – including external relevant costs and benefits (Ciroth et al., 2011). It precedes LCA, and there have been diverse conceptual foundations and methodological approaches that can be traced to its developmental roots in economics and systems engineering (Finnveden et al., 2009).

The main definitions of life-cycle thinking and related concepts are presented in Research Paper 3.

### 2.2.4 Intersection and overlaps among discussed areas

![Diagram of intersections and overlaps among SSCM, SBM, and LCT](image)

Overlaps among the discussed concepts are summarized in the respective text boxes in Figure 2-2. Gaps in the intersections of these areas include the following:

1) SSCM pursues many actors’ goals, material and other elements (e.g., information, cost, revenues) flow forward and backward, and risk is managed,
whereas SBM focuses on the goals of a single organization while increasingly thinking outside of the organizational boundaries. Another specific example of SBM is social entrepreneurship, which is less complex than sustainable supply chain management. 2) Although the holistic approach is used in both concepts, SSCM as a subfield of SCM is more developed compared with LCT discussions. The focus on environmental performance is also richer than the focus on social performance. Whereas life cycle thinking has specific well-developed tools such as life cycle assessment and life cycle costing, some of the literature on SSCM proposes using the latter as a tool for SSCM assessment. 3) The focus of SCM is on specific business models that place increased emphasis on stakeholders, whereas the background of life cycle thinking is the life cycle (circularity); hence, the focus on stakeholders is also increasing in LCT discussions.

2.3  SSCM, SBM and LCT in the road freight transport industry context

This subchapter presents the application of all three subfields in the context of the road freight transport industry.

Focusing on the supply chain can be perceived as a step towards a more sustainable approach because the supply chain perspective considers the life-cycle of the product. Several authors have discussed alternatives ways to address the environmental and social performance of products (and services) through the implementation of sustainable solutions that employ the life-cycle concept throughout the supply chain (Kleindofer et al., 2005, Linton et al., 2007, Kwak and Kim, 2013). In a study on the automotive industry (including road freight), Schmidt (2001) advocates three main strategic areas for sustainable development: technology (sustainable innovations in technology), life cycle, and service. In his example, the leaders set sustainable product and service goals that focus on the achievement of environmental economies of scale through life cycle and service strategies rather than product strategies. For example, improved driver training can lead to a substantial reduction in fuel consumption (Schmidt, 2001). In addition, certain actions that lie beyond the core of supply chain management should be implemented, including product life extension. Product life extension increases the value of an individual product (Linton et al., 2007) and is one of the three objectives of more sustainable transport systems (i.e., improved vehicle utilization) (in addition to other strategies focused on efficient logistics) (European Transport Policy, 2010; Aronson and Brodin, 2006; van Hoek and Johnson, 2011).

Although the product-service system (PSS) is discussed quite extensively in certain industries, it has not received as much attention in the heavy vehicle industry (Bankvall et al., 2013b). PSS is described as an example of a more
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sustainable business model (Orsato and Wells, 2007; Bocken et al., 2014). In the industrial context, PSS can refer to an integrated solution with more services that can help to reduce the number of products entering the market and to increase the use of products by adding value (Hedvall, 2016). Furthermore, the notion of lifecycle thinking is important because it encompasses the exploitation of resources, material production, component/product manufacturing, maintenance, and recovery/disposal. It is also critical that responsibility is shared among all stakeholders in the product life cycle (Schmidt, 2001). This criticality highlights the importance of transparency and shared information among all members as time and common resources are invested (Bankvall et al., 2013a). Thus, the combination of these strategies (life-cycle thinking, technological improvements and a focus on services) is an efficient and effective method for achieving positive environmental effects (Schmidt, 2001; Bocken et al, 2014). In the logistics sector (including the transportation industry), the maintenance of vehicles is another major environmental issue and thus proper maintenance programmes are necessary to maintain vehicles in safe and efficient working condition. The integrated solution in the industrial context can be described as a sustainable system of products and services that addresses customer needs and sustainability issues (Wu and Dunn, 1995; Coley and Lemon, 2009).

Another example of the movement towards more sustainable business models of a PSS nature is the focus on delivery of functionality and experience rather than product ownership (Bocken et al., 2014). The conceptualization of sustainable business models requires a new understanding of value and a reconfigured business purpose (Roome and Louche, 2015). ‘Service innovation occurs when a firm is able to focus all of its energies on thinking on behalf of the customer and thereby produces an outcome that surpasses customers’ present expectations of superior value’ (Chapman et al., 2003, p.13). The focus on service aspects of the product-service mix offered by manufacturing companies provides an opportunity to gain a sustainable competitive advantage. For example, the logistics industry is a developing service-based industry that transitioned from the business concept of transportation to a concept that serves more customer logistics needs (Chapman et al., 2003). The value in use can be the focus here. In the road freight transportation industry, vehicle utilization represents the value that customers can obtain from the truck.

A trend towards focusing on performance (a contractual approach) can be observed in manufacturing and service industries, as noted in the literature review conducted by Selviaridis and Wynstra (2015). The environmental and societal outcomes of this business strategy are not negligible; indeed, performance specifications and incentives in the transportation sector may contribute to the reduction of environmental pollution and road congestion, improved safety and service, and the achievement of efficiency goals (Khalumba et al. 2014; Collins and Maille 2011). The captured value of the customer is emphasized in performance-based business models as a contractual outcome, which is reflected in the logic of value co-creation and based on trust building through collaboration,
effective communication and teamwork, and information sharing within the supply chain (Randall et al., 2011; Selviaridis and Wynstra, 2015).

Hence, value co-creation plays an important role. Supplier-customer interactions and customer value fulfilment foster value co-creation (Gronroos and Ravald, 2011). The challenge for the provider of the product is to develop value propositions that allow customers to capture more of the product/service value. For example, in a study of a truck manufacturer and its downstream supply chain in the UK, Chakkol et al. (2014) provided an empirical example of solution sales and value co-creation through service-dominant logic to explain different network configurations. To achieve these goals within truck supply chains, the actors within the network should understand the flows (of resources) amongst actors as well as the complexity of solution sales. Customer service is then tailored to customer needs through improved communication channels, collaboration and training. Hence, as products and services become more integrated, long-term relationships will become more common. The network (supply chain) becomes more critical and the role of dealers increases, leading to the need for increased information sharing and coordination in customer support. When adding integrative IT services (telematics) and trainings courses to the offered product/service mix, shifting to the ‘service mindset’ is necessary, along with a higher degree of interaction within the supply chain (Chakkol et al., 2014). The improved quality and optimization of processes not only increase the value perceived by the customer but also bring value to several actors in the supply chain (Finnveden, 2009; Chakkol et al., 2014).

From the logistics service provider perspective, vertical and horizontal collaborations are also important factors in the environmental sustainability of freight transport, as found in the study by Abbasi and Nilsson (2012). IT systems, compliance with legislation and standards, efficient utilization of transport infrastructure and vehicle utilization were also important for environmental sustainability. Eco-driving and sustainable procurement are components of the proposed design of environmentally sustainable freight transport (including road transport), whereas innovation and research, energy efficiency and increased awareness are the primary activities found in the LSP study. The discussion on supplier collaboration highlights cooperation with vehicle manufacturers, which can create the managerial complexities (e.g., assessment difficulties, insufficient information flow, sub-optimal resource utilization, etc.) (Wolf and Seuring, 2010; Abbasi and Nilsson, 2012). Unisen (2014) also examined the environmental activities of LSPs and their downstream supply chains, including transport management, vehicle technology, environmental management systems, emissions reduction, modal combinations and logistics system design. In his studies on the road freight market, Eng Larsson (2014) mentions the economic side of more environmentally friendly freight transport, discussing the overall cost. Although the upfront (initial) cost of low-carbon transport can be higher, the economies of scale are greater; hence, the operating costs and fuel consumption are lower. Employing the holistic approach to the greatest extent possible is very important for the entire network (McKinnon, 2010; Eng Larsson, 2014)
2.4 Managing SSCs: Challenges, Drivers, Barriers, Interaction patterns and Capabilities

The chapter describes certain specific aspects of managing sustainable supply chains based on SSCM and SBM literature.

2.4.1 Challenges, drivers and barriers

Managing sustainable supply chains or business models in any industry can bring challenges, and understanding the challenges that influence the road freight transport industry is important. Companies that adopt changes and integrate sustainability into their supply chains encounter challenges during this process, as well drivers and barriers. Important challenges discussed in the SSCM literature include a lack of understanding of the interrelations among the three pillars of sustainability and the effect of sustainability on the economic bottom line. The lack of knowledge and training in this area prevents the diffusion of knowledge and the development of sustainability awareness in corporate cultures. Other challenges relate to capital commitments (e.g., large investments and other financial concerns); risk management and supplier monitoring; measurement and accounting methods; overall transparency of information and knowledge (including inter-departmental co-operation and communication in addition to communication among different stakeholders, which entails overcoming different backgrounds and perspectives); and alignment of corporate strategy with SSCM initiatives (Morali and Cearcy, 2013; Mathiyazhagan et al, 2013; Matos and Silvestre, 2013).
Boundaries or barriers also exist on several levels outside the organization and include political boundaries (lack of government support and regulation) and industry-specific barriers (Walker et al., 2008; Sarkis, 2012; Mathiyazhagan et al., 2013). Several discussions address the complexity of new technologies and innovation implementation (Ceschin, 2013; Mathiyazhagan et al., 2013). A lack of technical expertise and designs suitable for reusing or recycling, as well as locked-in infrastructures and supply chain dependencies, reflect resistance to change and a lack of information, which can differ greatly between the B2B and consumer markets (Mathiyazhagan et al., 2013; Ramirez et al., 2014; Bocken et al., 2014; Schaltegger et al., 2015). These issues can be expected in the road transport industry; change is particularly slow in this very traditional market. Communication and the alignment of suppliers’ actions are other important factors in overcoming adoption barriers (Ramirez et al., 2014). In the trucking industry, strategic partnerships with larger customers should also be considered, because larger manufacturers often have more resources and knowledge (Chakkol et al., 2014). In their study on the automotive industry in China, Zhu and Sarkis (2007) emphasize regulatory and global market pressures regarding sustainability issues. Their suggestions for future research include applied studies to assess whether the social aspect of sustainability is in line with the environmental aspect; they also call for more sustainability-based industry studies in general (Sarkis, 2012, Winter, 2013). The analysis of various boundaries (barriers) can be a tool for researchers and practitioners to better understand how to address environmental issues in the business world. For example, governments and policy makers might comprehend the importance of political boundaries subject to their oversight, whereas cultural boundaries might be more important for non-governmental organizations or cultural institutions. In short, boundaries may be mapped according to diverse stakeholder responsibilities. A lack of customer awareness (even slowly increasing awareness) is a major influence on the sustainable performance of companies and their supply chains; conversely, customer awareness can be a major driver of sustainability (Walker, 2008; Diabat and Govindan, 2011; Mathiyazhagan et al., 2013).

Several researchers have reported the positive influence of the incorporation of sustainability practices into supply chain management (Tavasszy et al, 2003). When incorporating social and environmental issues into a company’s corporate behaviour, organizational capabilities develop, which in turn present potential sources of competitive advantage due to their imperfect imitability by competitors (Gold et al., 2010). Industry competition – particularly in the highly competitive road freight transport industry – can influence and shape the focus of the companies involved, because the adoption of sustainable operations might someday be essential to staying in business (referring to the proposition of Montabon et al. (2016) regarding making sustainability sustainable). Hutchins and Sutherland (2008) mention safety and quality as endpoints of higher order needs for companies that wish to be sustainable and emphasize the need to focus on the social aspect of sustainability. Purchasing and distribution have a vital role in improving the sustainability of a firm; therefore, an awareness of the influence
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of strategic and tactical decisions on operational outcomes is necessary to make more sustainable decisions. However, strategic decisions have a greater impact than operative decisions on aspects such as emissions (Aronsson and Brodin 2006).

The financial performance of companies in the supply chain can be positively affected by improvements in environmental performance, in several ways: minimization of waste, reduced use of resources, reduced operating cost, improved productivity, creation of marketing advantages (the increase in a company’s brand value and reputation is a business case for sustainability), increased market share and new market opportunities (Rao and Holt, 2005; Schaltegger et al, 2012). Additionally, according to Schaltegger et al, (2012), the main drivers of sustainable business models include their direct and indirect influences on economic performance, with cost being the most direct link between them. Cost reduction, through energy savings, reduced material flows or cleaner production, is often mentioned as a driver. Another driver of sustainable management relates to risk reduction (technical, political, societal or market). Other drivers, such as market development or market entry, can also be considered, depending on a company’s strategies. In addition to the rather direct economic impacts, indirect drivers of corporate sustainability include attractiveness as an employer due to recruiting, selection and induction and development programmes; innovation capabilities; and a greater diversity of sources (Rao and Holt, 2005; Schaltegger et al, 2012). In terms of reverse logistics, Guide et al. (2003) argue that increased global competition, shorter life cycles, broader environmental regulations and commercial returns for resellers, together with decreasing profit margins, will increase the reverse flow. Decreasing profit margins is the main issue in the road transport industry. He et al. (2005) show the important role of the government in improving the environmental status of the road transport industry. The growth of road transportation gives rise to many difficult questions regarding sustainable transport solutions and sustainable supply chains (Nielsen et al, 2003). Hence, the management of these types of solutions require specific interaction patterns and capabilities within industry networks.

2.4.2 Interaction patterns and capabilities

Other management issues for sustainable supply chains include the capabilities required for more sustainable solutions and the interaction patterns within the network of involved actors. The road freight transport industry lacks research in this area; hence, existing literature in the industrial context is analysed. Actors in the supply chain must have capabilities not only to design and implement value-creating solutions but also to enable new forms of customer interaction and interaction patterns (Gremyr et al., 2010; Hartmann et al., 2014; Salonen, 2011; Storbacka, 2011; Ulaga and Reinartz, 2011; Ulaga and Loveland, 2014). Different value propositions place different requirements on customer-supplier interaction. In addition, differences in customers’ employment of services are reflected
through the customer-supplier interaction process and have implications for both customer and supplier capabilities (van der Valk and Wynstra, 2014). For example, Grönroos (2011b) argues that close customer-supplier interaction is often necessary to develop service offerings for customer processes and Tuli et al. (2007) confirms that solutions (in the form of customized and integrated combinations of goods and services) can only be understood through customer-supplier relational processes. ‘Understanding the nature of suppliers’ opportunities to co-create value and the customer’s role in this process requires an in-depth understanding of the interaction concept and the role of interactions in value creation’ (Grönroos and Ravald, 2011, p. 11).

Dimensions and characterizations of interaction processes are proposed in the industrial marketing literature (Ford et al., 2002). One characteristic relates to formal and informal relationship processes; formal processes occur at prescribed intervals at assigned places, whereas, informal processes take place more often and are influenced by social factors (Gremyr et al., 2010). Other characteristics relate to the level of the people involved (top management, operative management, etc.) and whether the interactions are strategic or operative in nature (the former requires the development of long-term relationships, whereas the latter involves day-to-day issues and tasks) (Agndal and Axelsson, 2012). Interaction processes vary widely in structure, involve people at different levels of management and address different functions and actors in the supply chain depending on the nature of the value proposition (Ford and Mouzas, 2013; Storbacka 2011; Storbacka and Nenonen, 2015), as exemplified in the trucking industry by network configuration specifications (Chakkol et al., 2014).

In Storbacka’s (2011) extensive review of provider capabilities in the solution business, the main commercialization capabilities include understanding, generating, quantifying, and verifying value and the main industrialization capabilities include developing, configuring, and delivering solutions for customers. Other capabilities are needed to support these processes, including strategic planning, the creation of managerial systems and structures, infrastructure support and human resource management. An imbalance in the customer-supplier relationship is possible depending on the strength of the relationship, the firms’ respective positions in the network, and the impacts of the solution on existing internal activities and on customers’ core processes (Windahl and Lakemond, 2006). Moreover, customer willingness to be involved in a solution business can depend on its maturity and understanding of the required capabilities (Spring and Araujo, 2009), as well as its awareness of the value co-creation process (Gronroos, 2011b). Additionally, customer learning can be an important factor in preparedness for the value co-creation process between the customer and the provider (Komulainen, 2014). Selling complex value propositions (such as hybrid offerings or product life-cycle services) requires capabilities related to data interpretation, risk assessment and design-to-service capabilities (Ulaga and Reinartz, 2011; Hartmann et al., 2014). In addition, the sale of highly integrated solutions (such as performance-based value propositions) requires intensive integration and a profound understanding of the customer’s
value creating processes (Ng et al., 2009; Randall et al., 2010). Sustainability capabilities can be developed when complex bundles of human and non-human resources are oriented towards shared values, sustainability goals and norms (Gold et al., 2010; Dao et al., 2011). Sustainability capabilities may also relate to innovation; in this area, stakeholder involvement, relationships with external stakeholders, high-order learning, international experience and political management capabilities can contribute to the definition of sustainability-related strategies (Peters et al., 2011). Hence, capabilities in supply chains should be developed with an eye towards value fulfilment (Abbasi, 2014).

2.5 Systems theory and social network theory

This subchapter is presents the theories that were used to better understand and explain the phenomenon explored in this thesis. Short backgrounds on the theories and critiques are also discussed.

The theoretical lenses of the supply chain management field include a wide variety of theories from a large number of disciplines, including the business model field. The most frequently used theories in SCM are the resource-based view, transaction cost economics, social network theory, contingency theory, information processing theory, resource-advantage theory, organizational learning, and resource-dependency theory (Carter et al., 2015). In addition, systems theory is used as a base for supply chain management research (Randall et al., 2009); some scholars even argue that it is the core of the logistics and supply chain management field (Halldórsson and Arlbjörn, 2005; Lindskog, 2012b). For example, it is argued that systems theory (consideration of resources) helps to explain how application of the resource-based view benefits the firm and supply chain. The subfield of sustainable supply chain management also draws on several theories, but the theoretical background for the SSCM field remains in its infancy (Moraly and Searcy, 2012). One highly cited theoretical overview of SSCM theories highlights nine organizational theories used for SSCM: complexity theory, ecological modernization theory, information theory, institutional theory, resource-based view (RBV), resource dependency theory (RDT), social network theory, stakeholder theory, and transaction cost economics (Sarkis et al., 2011). One of the most frequently discussed theories in SSCM research is stakeholder theory (Varsei et al., 2014; Carter and Easton, 2011). The major contributions of this theory are the analysis of stakeholder influence on the adoption of sustainability practices across the supply chain and its explanation of stakeholder commitment as a driver and enabler of SSCM (Matos and Hall, 2007; De Brito et al., 2008; Sarkis et al., 2010; Varsei et al., 2014). Another theory used to explain the importance of stakeholders in networks comprising multiple organizations is social network theory, the primary focus of which, according to Rowley (1997), is the interdependence of actors and their positions in networks. Density and centrality are the two key elements of social network theory (Rowley, 1997;
Sarkis et al, 2011). Following their systematic review of theoretical lenses used in sustainable supply chain management, Touboulic and Walker (2015) suggest that in addition to those commonly used theories (which include the (natural) resource-based view, stakeholder theory, institutional theory and transaction cost theory), other approaches drawn from the SSCM literature could be used to investigate the evolution of business practices. According to their systematic literature review, there are few articles (including three articles that used system theory and one article that used social network theory) in SSCM research (Toubulic and Walker, 2015). The authors refer to SSCM as a field and conclude that this field is becoming more mature in terms of theories application. After considering the relevance of the above-mentioned theories to the explanation of the phenomenon addressed in this thesis, systems theory and social network theory were chosen to provide a better understanding of the phenomenon of road freight transport supply chain sustainability (Figure 2-4, Figure 1-3). Considering the background of the supply chain (or its core), the systems theory seems to offer an explanation of the holistic focus. The move from the single firm perspective to one that involves an entire supply chain or network comprising many systems actors involved is allowed by systems theory (Mele et al, 2010). Systems theory also enables the application of boundaries that can be helpful in analysing the complex supply chain context. However, it is difficult to ignore the importance of network theory in the supply chain management field (Hertz, 2001). In sustainable supply chains in particular, it seems even more important to look through the lens of social network theory, because the context of sustainability generates more complexity in network interactions and emphasizes social influence.

Therefore, the main theories that are used in this thesis to better explain the phenomenon (as specifically discussed in Research Paper 4 and Research Paper 5) are systems theory and social network theory. The focus on these two theories allows the use of both internal and external lenses on road freight transport supply chains and helps to explain how and why business interactions transpire. Systems theory helps to explain the importance of the holistic approach and the calculation of total cost throughout the life-cycle of the products/services of the road freight transport supply chains (as advised by McKinnon, 2010). Systems theory also suggests the possibility of placing boundaries (in this case, on the market phase) in order to explain the phase of product-in-use. The social network theory helps to demonstrate why trust can be the key issue in building sustainable relations in road freight transport supply chains. The combination of these theoretical lenses supports an improved analysis of the issues involved in the implementation of sustainable practices in road freight transport supply chains and draws richer insights from the empirical results.
2.5.1 Systems Theory

‘Current discussions in both the resilience research world and the global development community have turned to complex systems thinking.’ - Stockholm Resilience Center (2017)

Systems theory can sometimes be described by other terms, such as systems thinking or systems approach. It generally means any approach to research on enterprises with a holistic ambition (Lindskog, 2012).

Background and connection to SSCM. Generally, the application of systems theory to management and marketing evinces a focus on knowledge, value, quality, environment, relationships, adaptation and complexity (Mele et al., 2010). The ‘knowledge aspect’ refers to the view of the firm as a learning system that employs the skills needed to produce its own knowledge through continuous learning processes. Systems theory and the associated notion of holism is the base for supply chain management (New, 1997; Randall and Farris, 2009). Systems
theory is also a dominant ontological and epistemological position within the field of SCM (Johannessen, 2005). The application of system thinking to management has referred to the importance of social-technical systems, that is, the need for organizations to adapt to an open-systems environment where social and technical components are optimized together simultaneously; otherwise, crisis may result if the solutions do not fit together systemically (Emery and Thorsrud, 1976).

According to this view, to achieve the full potential of systems thinking, the relationships within the sustainable development system are extremely important (Meadows et al., 1992). Hence, relationships constitute a major issue in, for example, the industrial networks (Hakansson and Johanson, 2002) and supply chain integration (Cui and Hertz, 2011) fields. Similarly, the role of long-term relationships based on trust is emphasized in sustainable supply chain management (Carter and Rogers, 2008; Beske et al., 2011). Although the firm operates within the supply chain, value creation results from a process of intervening factors, such as quality management, R&D activities, internal auditing and cooperation logics, and asset improvement.

Several basic assumptions should be considered while analysing the application of the defining aspects of systems theory to management (Mele et al., 2010). The importance of relationship management (e.g., establishing communication channels, organizing the flow of information, managing functions and developing external relationships) is referred to as competitive behaviour. For organizations, it is crucial to consider both static and dynamic aspects of relationships and to improve the compatibility of the systemic actors and their harmonic interactions. The employment of systems theory can facilitate research on management, marketing and service due to its holistic approach to the observed phenomenon and reductionist view (boundaries) of the specific components under the arch of complexities, which is generally based on three parameters: variety (the possibility of the phenomenon being presented to the observer), variability (variety over time) and indeterminacy (the ability to fully understand the phenomenon) (Mele et al., 2010). The importance of holism is also reflected in sustainability-focused research (Lüdeke-Freund et al., 2016; Toubulic and Walker, 2015). Systems theory has been employed as a research approach in SCM (Pathak et al., 2007; Lindskog, 2012a), environmental science (Whiteman et al., 2013), social theory, and service-dominant logic, where economic and normative values for sustainability are enabled (Vargo and Lusch, 2011; Alexander and Walker, 2013). Although systems theory has been extensively applied in the SCM field, SSCM has rarely adopted this approach. The relevance of systems theory can be argued based on the coalescing perspectives of the three above-mentioned fields. Moreover, systems theory has practical relevance for SSCM practitioners due to the notions of shared value and values. In addition, to understand SSCM, a wide and unifying view of theory should be adopted (Alexander and Walker, 2013). Checkland (1983) refers to systems theory at an epistemological level rather than an ontological one, presenting a method for viewing things rather than directly measuring them and considering the whole rather than analysing the components.
Another important aspect that can be explained by systems theory is the focus on cost totality. The notion of total cost was introduced in the 50s in the study by Lewis et al. (1956) on air freight (Lindskog, 2012). In supply chain management research, total costs are considered the main indicator of system efficiency (along with the interaction among activities and functions). Hence, the unit of analysis is the flow (Stentoft Arlbjørn and Halldorsson, 2002) and the universal feature is the focus on total cost, which engages in a trade-off relationship with supply chain performance (Lindskog, 2012). Hence, calculation of life cycle cost is one way to assess the overall cost assigned to the product from a systems perspective. The calculation of cost based on the use of products and services over the life-time of the product provides the opposite perception of product value relative to the acquisition cost. The long-term focus is crucial in this regard because it provides an opportunity to account for life cycle cost. Hence, life cycle costing can yield perceived benefits in terms of helping decision-making processes and prompting the collection of all necessary data to perform LCC, which is a systemic and complex issue (Gluch and Baumann, 2004).

The conceptual framework of life cycle costing differentiates between internal (all costs within the economic system) and external costs (costs that include natural and social system measures). In economics, the external costs usually refer to externalities and represent environmental and social effects that are not directly assigned to the firm (Rebitzer and Hunkeler, 2003). Hence, in sustainability research on the prevention of burden shifting, the totality notion can be reflected through life cycle costing as a part of life cycle sustainability assessment (Schau et al, 2011). Life cycle costing supports sustainability research by stressing the costs incurred in the product life cycle and reflects a broader approach compared to conventional costing systems. The advantage of this logic is that it takes a future-oriented perspective of time, in addition to indicating which aspects to consider (Gluch and Baumann, 2004). In the industrial context, particularly in the automotive, electronics and primary materials sectors, life cycle costing can be seen as an opportunity to manage supply chain cost flows while considering the environment and reflecting on the economic pillar of sustainability (Rebitzer et al, 2003). Hence, the system approach refers to the generation and predetermination of costs and environmental impacts in a product life cycle. The totality of cost has also been adopted in the transport industry, albeit not explicitly.

**Criticism of Systems Theory.** The major challenge to the systems approach (according to Kast and Rosenzweig (1972)) is its complexity. The second criticism or impression regarding systems thinking is its extraordinary diversity, i.e., the diverse fields of its application (Midgley, 2003). An overview of the research potential and obstacles of general systems theory (GST) was presented by Troncale (1985) and later by Midgley (2003). Both authors discussed obstacles in the field of systems science and in GST in particular and offered directions for future progress in the field. The first major obstacle to progress in this field is the lack of consensus on general terms and their inconsistent use. For instance, systems science can refer to systems analysis, systems theory and general theory of systems, because all of these fields focus on a ‘system’ level of reality. Systems
thinking is the most inclusive term and attempts to emphasize the similarities among the phenomena. The second obstacle relates to the need to transcend internal conflicts regarding the opposing concepts of holism and reductionism, which in fact are equally useful and complementary. A lack of motivation or a mechanism to synthesize the literature findings across the field is another problem; finally, there is a need to share the results of isolated investigators (Troncale, 1985).

Within the systems theory, life cycle costing has its limitations as well. One criticism of LCC refers to a heavily debated question about the ownership of costs: ‘Are the costs of the user/consumer, of the producer, or the waste management operator, to give some examples, the relevant ones?’ (Rebitzer and Hunkeler, 2003, p.255) The impetus for this question is the added value and margins, which are not accounted for in LCC. Hence, the cost for one actor can be the revenue for another actor, which influences the necessary level of detail. The notion of value added requires consideration of both costs and revenues at each stage, which increases the complexity of calculations (Rebitzer and Hunkeler, 2003). It is also perceived that LCC can fail when addressing decisions under uncertainty or irreversible decisions. Other reported problems include the over-simplification of future environmental costs and its potential dependence on the decision maker’s personal values (Gluch and Baumann, 2004)

Another critique of the overall field of systems theory is that in its more formalized configurations, it has evolved in a different direction than logistics management. This essence of this criticism is that the field shifted towards the use of its own language and its own version of systems thinking rather than acknowledging that the theory was not employed (Rebitzer and Hunkeler, 2003). Moreover, there are several ways to understand systems theory in terms of open and closed systems. Hence, by taking a holistic view of a specific system, one can assess closed systems through the placement of certain boundaries while acknowledging the notion of open systems as well. This technique was used for Research Paper 4, where systems theory was applied to the market phase of the road freight transport supply chains.

### 2.5.2 Social Network Theory

Social network theory helps to explain the relationships among the actors within sustainable supply chains. The notion of trust and the underpinning propositions of this theory help to describe the need for long term relationships among the actors within road freight transport supply chains to achieve a more sustainable business model.

‘Connectivity, or having strong networks, for example, in human systems that connect individuals and organisations, helps us to build trust and resilience.’

Stockholm Resilience Center (2017)
Theoretical Background

As a prerequisite for social network theory, it is important to acknowledge its connection to the network and industrial network approaches to supply chain management research and to sustainable supply chain management in particular. Supply chains can be viewed as interrelated organizations that perform within the social network (Varsei et al., 2014). Hence, the network approach is closer to social exchange theory because it portrays firms as social units. The basic assumption underlying the network approach is a firm’s dependency on resources controlled by other firms and the ability to access those resources due to its position in the network (Håkansson and Snehota, 2002; Cui and Hertz, 2011). However, the industrial network approach emphasizes the relationships within the networks and the indirect connections between those relationships (Windahl and Lakemond, 2006). The concepts of trust and uncertainty are linked to the network approach (Håkansson and Snehota, 2002). Trust is an important characteristic of actors’ relationships, whereas uncertainty is viewed as a lack of information in network relationships (Galaskiewicz, 2011). The development of trust within a network can resolve the uncertainty issue because trust is rooted in the exchange of information. The success of organizations involved in the network can be explained by the systematic integration of business processes and the combined performance of the supply chain network (Varsei et al., 2014). This explanation leads to the main assumption of industrial network theory: firms’ interdependencies in the business environment. Therefore, the focus should be on the network of which the firm is a part (Håkansson and Johanson, 2002). Further, successful information exchange within that network is an importance aspect of the implementation of sustainability practices (Varsei et al., 2014).

Early studies on the difficulties of gaining trust in the context of supply chains can be found as early as the 1960s (e.g., Macaulay, 1963), although the majority arrive in the 1980s, e.g., Granovetter (1985), who explained the role of social networks in facilitating interaction beyond organizational boundaries. Other studies from that period emphasize interpersonal ties and trust not only for business partners but also for the entire industry (e.g., the diamond industry in Coleman, 1988) (Galaskiewicz, 2011). Employing the social network theory in a sustainability-related study can help to investigate ‘how organizations adapt and respond to the sustainability challenges through their social relationships and the development of social capital’ (Toubulic and Walker, 2015, p. 34). Similarly, Gold et al. (2010) suggest that social network theory can be used as a tool to explain mutual organizational learning or the development of trust-based interdependencies within supply chains. Moreover, because trust is central in most theories of social network effectiveness, it is also central in supply chain networks (Galaskiewicz, 2011). Trust is becoming even more important in the relations among actors in supply chains with sustainability goals. Hence, in the road transport industry, the emphasis on networks is critical, because there are a great number of actors, such as small transport or logistics companies, who rely heavily on their networks and relationships.

The main concepts in social network theory refer to the interrelation of nodes (or actors) with a diversity of ties. Ties can be of many types and levels (e.g.,
countries, companies, etc.). Other dimensions of ties can be implied, such as friendship, competition, duration or frequency. The same dimensions can be applied to a firm’s ties, although there are certain challenges related to interactions and flows (Borgatti and Li, 2009). In traditional industries such as road transportation, ties are very important to the development of business along the supply chain.

Academics who support the use of social network theory argue that it can help to understand the interdependent relationships among network actors and the need for trust and collaboration among them. The resulting network governance model reflects the uncertainty and complexity within the network, as well as its connectedness and the resultant need to facilitate information flows (Vuuro et al., 2010). Hence, the road transport network should facilitate the development of relationships within the network, especially those that focus on product service systems or a solutions business (Chakkol et al., 2014). Social network theory can guide an examination of the connections between actors within the network, which in a business-to-business context means that exchanges are not examined as discrete transactions but rather as business relationships (Tokman et al., 2011). This point is emphasized by Bernardes (2010), who suggests that the central tenet of social network theory is that social capital affects economic transactions in such a way that behaviour is predicated on social relations.

According to Quarshie et al. (2015), social network theory can be used to bridge the gaps between two streams of literature: business ethics and sustainable supply chain management. In this regard, social network theory facilitates an understanding of how sustainability can be aligned with other strategies, objectives and metrics; how diverse actors within companies and across supply chains (including downstream supply chains, which encompass customers and consumers) engage with each other; and how to tackle conflicts and collaboration with non-traditional supply chain partners. Similarly, Connelly et al. (2011) argue that sustainability research can be explained by social network theory because strategic initiatives in an organization may be diffused through organizational networks. For example, a firm with good sustainability practices may influence other firms in its network by providing information and reducing uncertainty. Thus, social network theory can be particularly important for managers who seek to identify and evaluate sustainable practices (Connelly et al., 2011). In the heavy-vehicle industry, this process could be undertaken by large manufacturers, which may have greater knowledge and more investment opportunities in sustainability research compared with the many small transport companies in the industry. As explained by Vuuro et al. (2009), a focal company can actually benefit from its central position while facilitating and monitoring sustainability initiatives via economic and ‘softer’ types of relationships (Borgatti and Li, 2009). Hence, in reviewing the design of supply chains, an extended focus on advance information sharing tools shall occur. Advanced information sharing tools can increase supply chain density and the ability to take sustainability actions (Stefan Schaltegger et al., 2014). In this way, social networks enable effective implementation of
sustainability practices and validate the necessity of collaborative practices within supply chains (Sarkis et al., 2011)

**Criticism of Social Network Theory.** Starik and Kanashiro (2013) question the ability of social network theory to address the relationship between humans and the natural environment, even assuming it can help the understanding of how sustainability issues affect individual interactions and inter-relationships. Galaskiewicz (2011) proposes that trust issues account for the length and complexity of supply chains through a small world network structure. Shorter global paths connected by random bridges do not make this solution overly simplistic, because supply chains are usually complex systems with many source channels merging with other channels and forming new channels. Hence, according to Galaskiewicz (2011), trust-based relationships may not be the most appropriate approach for every supply chain. Another issue is the ‘locality’ of social network theory. Supply chains are usually lengthy, which generates problems beyond the triad; hence, the applicability of social network theory to supply chains may be limited (Bernardes, 2010; Galaskiewicz, 2011)

2.6 Summary of the Theoretical Overview and Development of Sub-Research Questions

2.6.1 Summary and concept map

Given the extension of the business model definition under the systems approach and the inclusion of diverse stakeholders and actors in the supply chain environment, the logic for an organization’s existence can be stated as follows: ‘who it does it for, to and with; what it does now and in the future; how, where and with what does it do it; and how it defines and measures its success’ (Upward and Jones, 2015, p.10). Moreover, important issues to consider in sustainable supply chain management include how sustainability can be integrated into strategy among the actors involved via long term relationships. It is also crucial to acknowledge the complexities of managing increasingly sustainable supply chains, which include specific interaction patterns and capabilities, managerial and general challenges, and contextual drivers and barriers. Examples of sustainable business models discussed in practice and research include closed-loop production/supply systems with a cradle-to-cradle approach (Winkler 2011; Dekker et al., 2012; Kumar and Putnam, 2008); sustainable supply chains (Carter and Easton, 2001); and product service systems with a focus on servitization and on eco-innovations with life-cycle approaches (Bocken et al., 2014; Schmidt, 2001). Road freight transport supply chains (as part of the transport industry) should consider implementing specific business models that focus on sustainability. Such models may involve life cycle thinking and long term partnerships; consideration of environmental and social issues via product service systems; increased information sharing and collaboration; and strategic
sustainability considerations. The discussion for this industry in terms of sustainability involves several important issues, however, the most frequent consideration today is pollution via CO2 emissions. Safety issues (safety on the roads) and cost (Khalumba et al. 2014; Collins and Maille 2011; Eng Larsson, 2014) represent the social and economic aspects of sustainability in the industry. However, the social aspect is sometimes overlooked (Ruger et al, 2014).

The systems theory is often used in supply chain management because it allows a holistic perspective. Holism is very important in sustainable supply chain management and can help to explain the importance of life cycle thinking by considering each step instead of simply transferring the burden from one step to another. Social network theory provides support for building long-term relationships to achieve a more sustainable business model through social ties based on trust (Figure 2-3).

Figure 2-5. Summary of the theoretical overview and concept map based on the previous research incorporated into the core and peripheral concepts of the thesis and working conceptual framework with theoretical lenses (by author)

2.6.2 Development of sub-research questions

While addressing the purpose of this study, to explore how road freight transport supply chains can become more sustainable from the perspective of a heavy vehicle manufacturer, two main research questions are elaborated. To answer the first research question (RQ1: What is the role of life-cycle thinking in developing more sustainable road freight transport supply chains?), two sub-questions are developed.
First, to understand the overlap and differences between LCT and SSCM, sub-question 1a is addressed by the systematic literature review in Research Paper 3:

1a What is the interconnection between life cycle thinking and sustainable supply chain management?

An understanding of the interconnection between life cycle thinking and sustainable supply chain management can contribute to an investigation of the interrelationship and differences between these two concepts.

The second sub-question refers to the employment of life cycle thinking in the context of the studied industry:

1b What is LCT in the context of road freight transport supply chains?

Research Paper 4 answers this sub-question by using the system theory to apply the concept of life cycle cost to business partnerships in road freight supply chains.

To answer the second research question (RQ2: How can life cycle thinking be applied in sustainable business models in road freight transport supply chains?) two sub-research questions are developed. The first sub-question refers to sustainable business models in road freight transport supply chains:

2a What is a sustainable business model of a heavy vehicle manufacturer in road freight transport supply chains?

This question aims to understand and define the main aspects of sustainable business models in this particular industry. Research papers 4 and 5 contribute to answering this question.

The second sub-question refers specifically to managing a sustainable business model in road freight transport supply chains:

2b What are important managerial challenges for more sustainable supply chain business models?

This question aims to understand specific challenges of managing business models and supply chains that incorporate sustainability approaches. Research Papers 1 and 2 address this question.

To answer the research questions of this study, each Research Paper addressed a specific set of questions related to the general purpose. The figure below shows which subRQs and main RQs are addressed by each Research Paper (Figure 2-6).
Figure 2-6. Study research questions addressed by the Research Papers

Research Question I
What is the role of life-cycle thinking in developing more sustainable road freight transport supply chains?

Research Question II
How can life-cycle thinking be applied in sustainable business model of road freight transport supply chains?

RQ1a
What is the overlap between LCT and SSCM?

RQ1b
What is LCT in the context of road freight transport supply chains?

RQIIa
What is a sustainable business model of HVM in road freight transport supply chains?

RQIIb
What are some managerial challenges for more sustainable business models?
3 Research Methodology

The following parts of the chapter on research methodology chapter discuss the epistemology and chosen philosophical approach, the role of the researcher, and the research design and study methods. The data collection and analysis and literature review processes are also described. The conclusion of this chapter considers the quality of the study. In addition, the international project that played a significant role in the entire PhD study process is presented in this section.

3.1 Epistemological stance and Philosophical approach – Critical Realism and Abduction

The discussion in this sub-chapter explains the decision regarding the epistemological and ontological stance of this thesis and describes the abductive study approach

There are numerous theories about how reality is constructed and ‘what exists’ (ontology) and about how we construct knowledge about what exists (epistemology). Thus, the clarification of epistemology in research is an important issue for academics (Gioia and Pitre, 1990; Huff, 2008; Alvesson and Sköldberg, 2009). Although the researcher’s stance can depend on the discipline, research questions, research goals, context and other factors, the role played by the researcher in the research process is unneglectable (Darlaston-Jones, 2007). Morgan and Smircich (1980) suggest that all approaches to social science are based on interconnected sets of assumptions regarding ontology, human nature, and epistemology and therefore researchers should not ‘remain as external observers, measuring what they see; they must move to investigate from within the subject of study’ (p. 498). It is also important that the relationship between epistemology and methods is understood and advocated in one’s thesis (Morgan and Smircich, 1980; Darlaston-Jones, 2007). Thus, epistemology is an important issue for me because the nature and scope of the interpretation of the study results depend on my acknowledgement of the defined research philosophy, which is my epistemological stance for this study and for research in general.

The nature of reality, in my opinion (which is in line with Alvesson and Sköldberg (2009), as well as Astrup and Haldorsson (2008)), is objective but interpreted through social conditioning, which is a stance of critical realists (CR). The knowledge of reality cannot be understood apart from the social actors involved in the process of obtaining knowledge, and we only see one part of the bigger picture (Saunders et al, 2009). Critical realism can be seen as an alternative view of social constructionism (or extension) and seeks to identify mechanisms for the generation of empirical phenomena (Astrup and Haldorsson, 2008).
Critical realists see relations as complex and causality as existing on different levels (Alvesson and Sköldberg, 2009). On the ontological level, critical realists see phenomena as creating perceptions that are open to misinterpretation; thus, critical realism focuses on explaining within a context or contexts (Leplin, 1984). This stance helps me to argue for the chosen research method and the manner in which the study results are interpreted. CR allows for an abductive philosophical approach in case study research (Dubois and Gadde, 2002; Van de Ven, 2007), which was applied in this study.

This study follows the abductive approach. Abductive logic (or systematic combining) is a process whereby the theoretical framework, empirical fieldwork, and case analysis develop simultaneously (Dubois and Gadde, 2002), which appeared to be the case in this specific study. Kovács and Spens (2005) define the abductive approach as not following the patterns of pure induction or deduction but reasoning from effects to causes or explanations. However, the abductive approach has characteristics of both induction and deduction (Alvesson and Sköldberg, 2009). The figure below depicts a framework of these three approaches, which depend on the starting point of the research process, the aim of the research, the point of the suggested hypotheses/propositions (H/P) and the reasoning that supports or justifies the conclusions (Spens and Kovacs, 2005; Alvesson and Sköldberg, 2009).

Abductive reasoning is used in many case study-based research processes and can contribute to the logistics literature by overcoming the limitations of inductive and deductive approaches, both of which are restricted to established relations between known constructs (Alvesson and Sköldberg, 2009; Spens and Kovacs, 2005). Van De Ven (2007) also proposes the use of abductive logic in engaged scholarship thinking. The author defines abduction as a creative form of reasoning.
that aims to address the research question (about a surprising observation or experience) and culminates with plausible or coherent solution that might resolve the question (Van de Ven, 2007). During the process of this study, I went back and forth between theory and practice while the phenomena were observed. The nature and structure of the project facilitated constant analysis combined with simultaneous empirical data collection and theory reviews while involving the project members at various stages. Van de Ven (2007) describes this process as engaged scholarship, which is a participative form of research used to find the views of major stakeholders to understand a complex problem in its specific context. ‘By exploiting differences in the viewpoints of these key stakeholders, engaged scholarship produces knowledge that is more penetrating and insightful than when researchers work alone.’ (Van de Ven, 2011, p. 190). This benefit is also reflected in the diverse papers written on the method. Several perspectives appeared to be useful for further analysis during the various steps of this study. Engagement with industry was achieved through workshops, interviews, and discussions with academic and non-academic project members. Hence, I moved between theoretical and practical stances while analysing the observed phenomenon.

Abductive logic can be successfully applied in qualitative case studies (Dubois and Gadde, 2014). An integrative approach is required to understand the characteristics and consequences of case studies based on abductive logic due to the main difficulty of case studies, which is managing the interrelatedness among the different elements in the research work. By constantly going ‘back and forth’ from one type of research activity to another and moving between empirical observations and theory, the researcher can expand his/her understanding of both theory and empirical phenomena through non-positivistic logic (Dubois and Gadde, 2002, 2014).

3.2 Research methods – qualitative case study and unit of analysis

The motivation for a qualitative case study is presented here. Several critiques are also discussed.

Qualitative research is gaining acceptance for knowledge advancement in logistics and supply chain management (Halldórsson and Arlbjörn, 2005; Borgström, 2012). This type of research applied an abductive approach (Spens and Kovács, 2006) through which understanding is generated for the field. Qualitative SCM research addresses a dynamic and complex reality, which makes refined conceptualization important (Borgström, 2012).

The strength of qualitative research lies in its deep focus on the studied situation, which entails delving into social complexities to truly investigate and understand the meaning of the situation for a participant and the contexts of the actions taken within the situation (Maxwell, 2005; O’Leary, 2010). Qualitative
methods help to identify and compare ‘qualities’ or characteristics of empirical evidence (Huff, 2008). Thus, the typical goals of qualitative research are to explain how and why things happen; bring more detail and depth to theoretic explanations; connect ideas to practical experience; and exploration (Huff, 2008; Yin, 2009). In this study, the main goal of qualitative research is to address the question of how (Research Question I) and to explore and describe the phenomenon and its facets by investigating the case company’s downstream supply chains. Explorative research can adopt a flexible design to include interesting insights and facilitate constant examination of the problem (Borgstrom, 2012). Easton (2010) argues for critical realism in case study research:

‘Case research which would wish to lay claim to a realist epistemology must be carried out in a different way; to be inquisitive, to look for the roots of things, to disentangle complexities and to conceptualise and reconceptualise, test and retest, to be both rigorous and creative and above all to seek the underlying reality through the thick veil which hides it.’

(Easton, 2010, p. 212)

Case study research in supply chain management can help to generate SCM theories (Halldórsson et al., 2015). Supply chain management (as well as logistics) research can benefit from case study research as a method for theory building, ‘best practices’ explanations and in-depth understanding of gathered data (Ellram, 1996; Haldorsson and Arlbjorn, 2005). Case study research is a form of social research and qualitative study and is preferred when answering what, why and how questions through investigation of a contemporary phenomenon in its real-world context (Ellram, 1996; Näslund and Jasmand, 2012). One of the fundamental issues in the case study is to define the number of cases and the units of analysis within the case. Hence, single case study is suitable when a critical case presents an opportunity to test theory or reveal previously inaccessible phenomena, such as extreme or unique cases; a representative case would inform and reveal theory and allow researchers to observe and analyse a phenomenon previously inaccessible to social science inquiry (Ellram, 1996; Yin, 2009). The rationale for single case study can depend on the specific case and research purpose (Yin, 2009).

An in-depth case study was chosen as the main research method for this PhD thesis. The case can be considered unique and revelatory because the usual research setting in this industry is more technical than strategic. Hence, analysing an example of a more sustainable business model in this industry is rare. In a critical realist approach to case research, the research questions emphasize the causes of the occurring events (Easton, 2010). The phenomenon of this study was questioned using similar means while attempting to understand certain managerial issues and backgrounds for the sustainable business model in road freight transport supply chains and the adoption of life cycle thinking. Furthermore, the
criticality of this case can help to extend existing theoretical propositions (as in Yin, 2009; Dubois and Gadde, 2014).

Even recognizing the strengths of an in-depth single case study, it is important to acknowledge the perceived limitations of this type of method (Flyvbjerg, 2006). There are several general misunderstandings of the single case study approach (Flyvbjerg, 2006; Easton, 2010). As opposed to multiple case studies or hypothesis testing, the single case study in the social science field may be described by some researchers as subjective and not generalizable (Flyvbjerg, 2006). However, the manner in which knowledge is created through a case study in a context-dependent (practical) manner makes a contribution to the scientific development that is as important as other methods in social science research. Hence, the generalization is analytical rather than statistical and revolves around theory-data connection (Dubois and Araujo, 2007). Another criticism relates to the rigor of case study research (da Mota Pedrosa et al., 2012). The importance of appropriate research questions, research protocols and well-designed instruments (for example, interview guidelines) can help to overcome deficiencies in the case methodology (Eisenhardt and Graebner, 2007) (more information on the quality of this specific case study process is provided in sub-chapter 3.7). Moreover, a causal explanation obtained from a case study may be particularly relevant for the critical realist stance on causal explanations. Hence, the case study is considered a more legitimate method in the critical realism realm (Aastrup and Halldorson, 2008). Limitations on the single case study could be mitigated by following up with a quantitative or multiple case study; however, the questions and results could not be extended as much as they could in a single case study. Nevertheless, to build on the single case study, a multiple case study (Research Paper 5) was added to this thesis, representing an attempt to replicate and extend the single case study by exploring other cases of premium heavy vehicle manufacturers’ downstream supply chains.

The single case study performed and described by research papers 1, 2 and 4 and the multiple case study in research paper 5 are based on the same unit of analysis, namely, a supply chain of a company in diverse contexts (countries) (Figure 3-2). Identifying the unit of analysis can be a key aspect of rigorous research design in a case study (Naslund et al, 2010). The heavy vehicle industry, or trucking industry, mainly includes the heavy-vehicle manufacturers and their connected networks (Chakkol et al, 2014), whereas the transport service industry includes the transport service companies and their respective networks (Unisen, 2014). The intersection of these two industries is the road freight transport industry, which includes the network of heavy vehicle manufacturers, dealers/salespeople and transport companies that buy heavy vehicles. In the studies of this thesis, the triadic relationship in road freight transport supply chains includes heavy vehicle manufacturer, dealers/salespeople, and customers (transport companies).
The context of diverse markets (countries) allows for cross-case assumptions in the single case study (embedded single case as one of four basic types of case study design, Yin, 2009) – Figure 3-3. The diversity of the supply chains contexts in the three countries allows exploration of the critical phenomenon (Yin, 2009). The rationale for choosing the embedded single case study is as follows: First, the design includes contextual conditions related to the case. Second, multiple units of analysis (three in the study) can provide opportunities for intensive analysis, thereby enhancing the insights of the single case study. The single case study can contribute to knowledge and theory by confirming, challenging or extending theory (Yin, 2009), as well as by providing conceptual contributions or additional justifications for the theoretical argument (Siggelkow, 2007). In this study, the rigor entails the collection of rich and meaningful data in the supply chain context for explorative and descriptive purposes in the real-life context (da Mota Pedrosa et al., 2012).
The multiple case study in research paper 5 is based on embedded (multiple) units of analysis in the contexts of several cases (Figure 12 – right bottom corner). The main task of this study is to identify similarities and differences by applying a multiple case study logic, as opposed to a ‘statistical’ logic (Dubois and Araujo, 2007), using a study setting similar to that used in the single case study but with more units of analysis (road freight transport supply chains).

3.3 Research strategy and design

The description of the research strategy and design of this thesis is explained in this sub-chapter.

The chosen philosophical approach and methods help to prescribe the research strategy and study design. A qualitative study that focuses on a single case is a strategy that emphasizes data collection within limited contexts to conduct an in-
depth investigation of a phenomenon. Maxwell’s (2005) interactive model was used to explain the design of such a qualitative study. The coherence of the study is addressed by five sets of issues: goals – the purpose of the study and its intended contributions (i.e., so what? who cares?); conceptual framework – what theories, literature, prior research and personal experiences influence the study?; research questions – what specific questions do I want to answer?; methods – which methods help me to answer the questions and implement the research strategy?; and validity or the quality of the study – what are the limitations on the results and trustworthiness of the study? (Maxwell, 2005). The connections among these sets of issues are important, whereas the dashed lines indicate more flexible connections (Figure 3-4). In addition, according to Maxwell (2005), many contextual factors influence research design (including personal goals, participants’ concerns, funding, ethical standards, research setting and skills, research paradigm, perceived problems, etc.), and such factors have influenced this study design at various points in the process. In this study, “The Project” played the major role; however, the personal goals and skills of the researcher (me) and the experience (in terms of qualitative study methods) in the traditions of this environment also facilitated the design of this study.

The conceptual framework and goals of the study were primarily influenced by the practical and theoretical problem (Chapter 1). The lack of extensive prior research in this area in this specific context influenced the goals and methods of this study (as well as The Project study). The abductive approach and the adoption of critical realism as an epistemological stance facilitated the formulation of goals and research questions. The ethical standards (as discussed in relation to the quality of the study) should be (Maxwell, 2005; Oliver, 2003) and are important and were involved in every aspect of this qualitative study design.

The conceptual framework is based on Figure 1-3 (in the Introduction) and on the theoretical framework discussed in Chapter 2. The methods incorporate qualitative study with a number of data collection tools, including interviews, workshops, and the review of secondary data. The quality of the study is analysed based on trustworthiness evaluation criteria, such as credibility, transferability, dependability and confirmability (Huff, 2008). The research questions derived from the purpose of the study reflect the two main goals: the focus of the study and how it is conducted (Maxwell, 2005; Yin, 2009).
The research strategy and design for the multiple case study in research paper 5 was based on the research design model adopted from Maxwell (2005), which was used as a background for the multiple case study. Thus, the goals, conceptual framework, methods and questions were adapted to the multiple case study according to a similar quality logic (more information on the process and quality of the study is provided in subchapters 3.4.2 and 3.7).

3.4 Description of The Project and Data Collection

This subchapter discusses the role of The Project (V2B) in this thesis and provides details on the data collection from the project.

The idea for The Project Value To Business (V2B) was developed jointly by academia and industry at least one year before it commenced, and The Project
lasted for three years (2012-2015). My PhD process started with The Project in 2012 and was greatly influenced by The Project process. V2B was funded by VINNOVA, a Swedish organization for innovation (Sweden’s Innovation Agency) and the case company (in kind). The case company contributed two key participants who were deeply involved in the project (from the company side) and in research meetings and discussions; numerous company employees in diverse markets who helped the research team throughout the project; and access to data and empirical knowledge. The case company is one of the major Swedish heavy vehicle manufacturers (henceforth, the case company is called Truckia), and the focus within the company was on long-haul trucks and the associated services. The Project was positioned at a strategic and international level and initially was focused on 4 diverse markets: Sweden, China, Poland and Taiwan. The logic of focusing on these four countries (markets) in the project was a result of several factors. First, the knowledge and competence of the case company was in the home country, Sweden, where considerations regarding environmental and social issues throughout the entire supply chain are developed. Additionally, the business models based on customer knowledge, value co-creation, product/service systems, and performance had already been introduced in the Swedish market. Similarly, the Polish market had already introduced several of the mentioned business models, but under different market development conditions. The Chinese market offered an example of a growing market where these types of business models had not yet been introduced, which provided opportunities for context analysis. In addition, considerations of environmental and social challenges in the industry was an important justification for a cross-country discussion because all of the selected markets faced certain changes and challenges in these areas. The strategic focus on challenges facing the premium heavy vehicle manufacturer was one of the backgrounds for the proposed project focus.

For this thesis, only three markets are examined, because I was mainly involved in the study of these three markets due to data collection concerns. From the academic sector, 7 researchers were involved in V2B: 5 from Swedish universities and 2 from Asian universities. The overall goal of The Project was to tackle current issues in the downstream supply chain of Truckia, including the emergence of a new business model that involved the transition towards service- and performance-based offerings for customers and growing problems in the industry, namely, environmental considerations related to emissions and social considerations related to safety on the road and drivers’ working conditions. The principles of engaged scholarship were used in this project and were represented as follows: the relationship was seen as a collaboration for the purpose of producing mutual learning involving negotiations and mutual respect while studying complex problems with and/or for practitioners and other stakeholders (Van de Ven, 2007). In this case, the other stakeholders were the customers’ customers and industry experts (more information about other stakeholders is provided below).
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The downstream supply chain of Truckia included the dealers (company units or independent companies responsible for sales of company offerings) and customers (logistics firms that purchase the company’s offerings). Other actors involved in the downstream supply chain include the customers’ customers and other industry representatives (e.g., authorities, industry experts, the media, etc.), which were not the focus of The Project. The main purpose of V2B was to generate a greater understanding of the acceptance and adoption of extended offerings in different markets at different stages of maturity. Data collection was performed mainly through interviews and workshops, as well as secondary data collection (reports, magazines, protocols from internal meetings, and information from websites). Details regarding data collection methods used for this thesis are presented in Table 6. The interviews were conducted with Truckia representatives from the business units based in Sweden, Poland and mainland China; dealers and sales units of the company; and logistics and transport firms (both end-users and wholesalers also in these three countries).

The interviews were based on semi-structured logic (Eisenhardt, 1989) and covered diverse groups of topics in order to obtain in-depth knowledge (Ritchie and Lewis, 2003). Because qualitative data collection does not require pre-structured questions, the topic guides were outlined rather than questions (Ritchie et al., 2013). However (in line with Ritchie and Lewis, 2003), a high degree of planning is necessary and the structure of the interview guides was discussed and prepared in advance and then updated during the process (Appendix 1). The topics and semi-structured questions used in V2B were modified depending on the interviewee (there were different interview guides for Truckia representatives, dealers and transport companies – see Appendices 2, 3 and 4).

Table 5 Examples of typical interview questions by respondent

<table>
<thead>
<tr>
<th>General business-/market-related questions</th>
<th>Truck Manufacturer</th>
<th>Dealer/Sales</th>
<th>Transport companies/customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background and key issues for each market/retailer/dealer network/service organization; history of the market</td>
<td>Background/Sales process/aftermarket/types of customers/Relations with service providers/truck manufacturers</td>
<td>Development of the market/Market (customer) structure/Customers’ customers and suppliers (transportation network)/Main challenges faced by customers</td>
<td></td>
</tr>
<tr>
<td>Value propositions/oferings</td>
<td>Value proposition/practices and perceptions of product/service and performance</td>
<td>Customer value/relations/truck life cycle/cost calculation offerings/components of</td>
<td>Main features/principles and main components of sustainable solution/services/cost calculation/vehicle afterlife/second-hand</td>
</tr>
</tbody>
</table>
The initial interviews focused more on the main elements of Truckia value propositions, understanding the context of the road freight transport industry (e.g., main actors, relationships), and market developments (due to the contexts of different countries). Later in the process, the focus shifted to purchasing motives, relationships and value co-creation among the actors in RFTSCs. Questions regarding various sustainability issues (managerial, business and general sustainability questions) varied depending on the respondent (Table 5, see also Appendices 1-4). For example, when talking to the Vehicle Definition Research and Development Unit, the questions were related to the vehicle rather than to business models or services.

All interviews were recorded, structurally organized, transcribed verbatim and then analysed. At least two researchers were present at each interview (as prescribed by Benbasat et al., 1987). The workshops were also recorded for transcription. Five workshops (intensive half-day workshops) were conducted at various stages of The Project. During workshops, the topics and findings of The Project were discussed with transport and logistics companies, Truckia representatives, researchers, and industry intermediaries (such as media and industry experts). The workshops were semi-structured in advance with roundtable presentations and open discussions. Secondary data collection was based on material collected from the Truckia head office, dealers, and customers (transport and logistics companies). Secondary material included information on meeting protocols; company and regulatory reports; external and internal promotional material from actors in the supply chain; and sustainability reports (also in Abbasi and Nilsson (2016)). Secondary data were organized in a manner that facilitated analysis of the primary data. There were many initial, interim and post-project meetings of the research group (including two main Truckia representatives), where issues related to planning, processes and the dissemination of results were discussed. Interviewees were usually from top and middle management within the organizations; sales managers and CEOs of the dealerships; and company owners at customer sites (i.e., transport and logistics companies). The mutual trust between the research team and the interviewees was a result of the level of access allowed due to The Project process and ethical
framework discussions conducted during the initial planning of The Project (as in Avison et al, 1999; Naslund et al, 2010).

Table 6. Empirical data collection

<table>
<thead>
<tr>
<th>Description (in Sweden, Poland and China)</th>
<th>No. of interviews</th>
<th>No. of participants</th>
<th>Approx. length (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews with Truckia representatives (top management at head office and sales and service units)</td>
<td>39</td>
<td>27</td>
<td>56</td>
</tr>
<tr>
<td>Interviews with dealers (managers and salespeople)</td>
<td>7</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Interviews with logistics and transport companies (customers)</td>
<td>18</td>
<td>18</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>52</td>
<td>97</td>
</tr>
<tr>
<td>Workshops with Truckia representatives, customers and intermediaries</td>
<td>n/a</td>
<td>10-25</td>
<td>15</td>
</tr>
</tbody>
</table>

Several representatives of the case company participated in multiple interviews, including employees at the head office and representatives in different countries. These interviews were conducted to clarify the received data and to obtain more data on issues that emerged within The Project topics. Hence, this process was also facilitated by the abductive logic approach to the research (Kovács and Spens, 2005).

3.4.1 My role in The Project

A description of my role in the project.

I started my PhD process at the same time The Project officially launched. I had several roles in the Project, including as a project research team member and project assistant. Some of my project responsibilities included helping to organize and structure data, because rigorous documentation is important in case study research (Naslund et al, 2010). I was also present at most interviews and participated in the workshops. Research papers 1, 2 and 4 were written during the process of The Project. Research paper 5 was written outside of the project but was closely related to it. The embeddedness of my study in the project illustrates the engaged scholarship process described by van de Ven (2007), wherein the abductive strategy allows for a significant interaction between research and practice and movement from theory review to data collection to analysis and back again. Moreover, the research activities, including research conferences, industry conferences and workshops, continuously shaped and developed the theoretical and empirical discussions.
Siggelkow (2007) suggests that going back and forth between data and theory over time allows researchers to better grasp the theoretical constructs grounded in the underlying forces of the phenomenon. The Project allowed me to adopt this approach and even facilitated the process. In addition, the main focus of The Project was on certain sustainability issues (such as service-related offerings; life cycle costing; pollution and safety issues; supply chain improvements; etc.). This focus shaped the focus of my PhD study. Moreover, I received support from my supervisors and project members. In summary, the importance and relevance of this specific study focus was confirmed by numerous strategic and operational issues in the case company and by Truckia’s announcement that it wanted to provide sustainable transport solutions to their customers (company website, personal communication with strategic manager (2014)).

3.4.2 Beyond the project

The details and context of data collection for Research Paper 5 are described herein.

Almost simultaneously, another major heavy vehicle manufacturer in Sweden announced a focus on sustainable business solutions. The next seemingly logical step was to collect more data outside of the project from other actors in the industry with the same focus as the single case study. The motivation to collect more data came from a willingness to compare and either confirm or disprove the research phenomenon (which is tied to abduction logic). This effort was also encouraged by the project team and my supervisors. Table 7 presents details regarding data collection from the study for Research Paper 5. The decision was made to collect more data from another premium heavy vehicle manufacturer (herein called Trucko) that also focused on the long-haul road transport sector along its downstream supply chain (including dealers and customers) and had a similar sustainability strategy. However, the dealers involved in the initial project, V2B, often sold several truck brands; thus, a decision was made to focus on Trucko representatives and customers. More data was collected in Sweden and Australia and hence another market was added – Australia. Access to data in both markets was made possible by industry experts’ contacts (in Sweden, the industry conference contact referred me to Trucko representatives who had knowledge in this area, who in turn suggested specific customers (transport companies); in Australia, the industry experts provided suitable contacts at manufacturers and transport companies. Access and trust in case study research is an important issue (Naslund et al., 2010). In The Project V2B, access – ‘a right of entry to information and data about the phenomenon being studied’ (Naslund et al., 2010, p. 336) – was a long-term planned process involving numerous discussions within the research team. The relation was based on mutual trust and open access to data. In my individual project, it was possible to reach a similar level of access through the snowballed contacts, although the process was not as simple as that in The Project.
Table 7. Additional fieldwork (individual project – Research Paper 5)

<table>
<thead>
<tr>
<th>Description</th>
<th>No. of interviews</th>
<th>No. of participants</th>
<th>Approx. Length (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews with Trucko representatives (top management at the head office)</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Interviews with logistics and transport companies (customers)</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Interviews with Truckia representatives</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

3.5 Literature reviews

Literature review plays a different role in theory generation based on abduction or systematic combining. The objective of such research is to discover new experiences (other relationships and variables). However, even new phenomena should be considered under the shadow of a theoretical framework, where they can be viewed as an emergent condition (Dubois and Gadde, 2002; Sandberg and Tsoukas, 2011). Hence, theory is developed over time, but it is important to enter a study with a theoretical background (or literature survey and systematic review) (Corbin and Strauss, 1990; Huff, 2008). In abductive logic, ‘the researcher could not even identify ‘all literature’ because the empirical fieldwork parallels the theoretical conceptualization; hence, the ‘need’ for theory is created in the process’ (Dubois and Gadde, 2002, p. 559). Huff (2008) maintains that literature review is an important part of scholarly activity for all researchers because it allows them to appreciate and critically appraise previous publications by others. There are different ways of performing the literature reviews – survey, critical, systematic, meta-analysis and supportive (Huff, 2008). In this study, I focus mainly on critical, systematic and supportive literature reviews.

My study started with an ongoing overview of the subject domain and critical reading of the key literature. The supportive reviews (in Papers 1 and 2) helped me to resolve specific problems in the field of supply chain management and logistics (and partly industrial marketing) and supported the ideas I developed during the initial part of my research process. In Paper 1, the focus was on challenges and conflicts in sustainable supply chain management; therefore, the study was initially positioned in the logistics and supply chain management field. To answer the research questions in Paper 2, the focus shifted to the industrial marketing field (which intersects with the logistics and supply chain management field). The critical overview of subfields such as solution sales, performance-based contracting and service transition supported the understanding of certain important managerial issues (namely, capabilities and interaction patterns) that emerge in a number of value propositions in a value co-creation process that is
moving towards performance-based solutions. Because the abductive approach was used, supportive reviews allowed for modifications to the theoretical base.

In a systematic review, the scholar usually begins with a focused question and conducts a multidisciplinary search for evidence to inform further research about what is and is not known (Huff, 2008; Denyer and Tranfield, 2009). A systematic review ensures that the current work does not duplicate previous research. Research paper 3 followed the logic of a systematic literature review. It entailed extensive consideration of appropriate interdisciplinary literature, mostly of which was rooted in the sustainable supply chain management and life cycle thinking fields, as well as the intersection between them. An approach similar to a systematic review by Touboulic and Walker (2015) on theories in SSCM was used by me through the similar review structure allowing a comparison of ideas and approaches. According to the abductive approach, returning to the literature reviews and analysis at different stages of my PhD research was a natural and logical process. Due to the timing of the V2B project, the systematic literature review occurred near the middle of the entire PhD process; therefore, it is positioned as Research Paper 3 in the chronological collection of papers.

Key elements of a critical review include the choice of vocabulary, selection of a field that contributes to the area of interest, and identification of inconsistencies and gaps (Huff, 2008). The primary focus of the critical reviews in Research Papers 4 and 5 was on the identification of key concepts and arguments in the field that helped to answer my research questions, which in turn allowed me to break the arguments down into my own framework (as also in Huff, 2008). Research Paper 4 presented a discussion of the literature on life cycle thinking and sustainable solutions in the road transport sector. Research Paper 5 examined the intersection between the sustainable business model and sustainable supply chain management fields to identify interesting works and key arguments, which would enable me to join the ongoing discussions.

Acknowledging the boundaries of the various chosen literature review strategies is important. However, the goal was to adopt the review strategy that best suited the focus and goal of the research. Because I entered the overarching field of sustainable supply chain management, the challenge was to acknowledge and scrutinize many related and interconnected subfields. However, the selection of the most appropriate subfields was made based on the general problem and purpose of this study and the contextual industry.

3.6 Data analysis

This subchapter describes how data analysis was conducted for The Project and for each Research Paper in this compilation thesis.

The aim of data analysis is to generate knowledge by transforming data into findings via organization, categorization and connection. However, there are different ways to achieve these aims (Reeves, 1996, Patton, 2002; Maxwell,
Methods of analysing qualitative data include thematic and narrative analysis. A narrative analysis was mainly used to review empirical material for information regarding the issues in the project study (V2B) (Czarniawska, 2014; Bryman and Bell, 2015). The main focus of narrative analysis is making sense of what occurred and to what effect. The use of abductive logic to ask different questions was useful to clarify the themes/topic at issue in the project. The main topics related to questions in the semi-structured interviews and were agreed upon by the project group in the course of numerous discussions and meetings. The abductive approach and joint reflections were employed in The Project. By taking time for reflection and analysis before implementing new action, thoughts and ideas were shared among the case participants (in The Project - during the workshops, presentations and discussions). This approach can benefit case study research (as in Naslund et al., 2010; Gummensson, 2004) through the integrative process of acquiring knowledge on ‘what’ and ‘why’ in order to interpret the knowledge through dialogue between research and practice (Research Papers 1 and 2).

The analysis for Research Paper 3 (the theoretical literature review) was based on coding via categories (Table 5 in Research Paper 3). The underlying themes were identified through qualitative content analysis. This approach helped to explore the underlying themes of the reviewed articles in a systematic manner.

Research Papers 4 and 5 were also based on the narrative logic of data collection and analysis. Thematic analysis of transcripts was also added to identify repetitive themes related to the specific focus of each paper, because repetition is one of the most common criteria for establishing theme patterns (Bryman and Bell, 2015). Theme identification not only provided guidance on matters raised by the research questions but also enabled a meaningful qualitative data analysis (Bryman and Bell, 2015). The decisions regarding themes development were based on literature and data; hence, the data analysis in the various papers include several diverse interactions between theory and empirical data (Eisenhardt, 1989; Dubois and Gadde, 2002).

The data collection and analysis conducted for each Research Paper are summarized in Table 8.
Table 8. Data collection and analysis (Research Papers 1-5).

<table>
<thead>
<tr>
<th>Research Paper</th>
<th>Data collection</th>
<th>Data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Challenges of sustainable supply chain management - literature review</td>
<td>Analysing the challenges under the framework from the literature review</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identifying conflicts by analysing data and literature review results</td>
</tr>
<tr>
<td></td>
<td>Challenges of SSCM in practice (in road freight transport supply chains) – data collection: interviews and workshops (Sweden and China)</td>
<td>Considering the context of two countries – Sweden and China</td>
</tr>
<tr>
<td>2</td>
<td>Identifying and discussing capabilities and interaction patterns of diverse value propositions – literature review</td>
<td>Identifying specific interaction patterns and capabilities for case value propositions (three levels)</td>
</tr>
<tr>
<td></td>
<td>Diverse value propositions of the case company – data collection via interviews and workshops (Sweden, Poland and China)</td>
<td>Analysing the data from the interviews and workshops of three countries – Sweden, Poland and China</td>
</tr>
<tr>
<td>3</td>
<td>Systematic literature review – data collection: 121 articles in the Sustainable Supply Chain Management and Life Cycle Thinking fields</td>
<td>Analysing data using coding categories (type and method, main theme, definition, industry, stage of material flow and criteria of comparison). Criteria of comparison: system boundaries, actor network, time frame, level (strategic or operational). Subject areas: sustainability dimensions, interconnection of approaches, consideration of stakeholders</td>
</tr>
<tr>
<td>4</td>
<td>Life cycle thinking under systems theory – literature review</td>
<td>Analysing themes found in the literature and in the empirical data</td>
</tr>
<tr>
<td></td>
<td>Empirical data from Swedish and Polish markets – specific focus on the ecosolution value proposition and its context in the case supply chains</td>
<td>Identifying themes in LCT and SSCM in light of the empirical example of a value proposition in the context of road freight transport supply chains</td>
</tr>
</tbody>
</table>
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| 5 | Sustainable business models from the social network perspective, specifically in the context of road freight transport supply chains – literature review | Analysing themes in sustainability practices, relationship context and the composition of sustainable business models in the literature and the empirical context of the industry |
|   | Empirical data from Swedish and Australian markets – specific focus on the principles, components and architecture of SBM in road freight transport supply chains | Identifying principles, components and architecture of sustainable business models in road freight transport supply chains |

In Research Paper 1, the challenges and conflicts of managing sustainable supply chains in the case study were compared to those identified in the literature. The comparison was based on the country context, because two markets were included: Sweden and China (more information is provided in Research Paper 1).

Research Paper 2 focused on interaction patterns and capabilities involved in managing different sets of value propositions, including the integrated solution (which focused on sustainable performance) of the case company’s downstream supply chains. The empirical data were from interviews conducted in China, Sweden and Poland, as well as secondary data sources and workshops. A constant comparative analysis (Czarniawska, 2014) was employed in this paper, which allowed the analysis to occur in teams that included practitioners and facilitated the categorization of the data (which were also confirmed through the workshops) (more information is provided in Research Paper 2).

Research Paper 3 followed the systematic literature review process of Toubulic and Walker (2015) and Seuring (2004b), which involved the selection and modification of code categories based on the specific research questions of the paper. Qualitative content analysis in this paper included a systematic and analytical exploration of the underlying issues in the analysed materials (Cullinane and Toy, 2000; Bryman and Bell, 2007). The selected criteria for analysis included sustainability criteria (social, environmental and economic); consideration of stakeholders (company level, supply chain level and broader stakeholder level); and the interconnection of concepts as synonyms related to tools/methods, strategy/management, or strategic or operational focus (more information is provided in Research Paper 3).

Research Paper 4 adopted the theoretical conceptual model and analysed the sustainable solution from the case study in two contexts, namely, the Swedish and Polish market-based empirical results. The data were analysed based on themes found in theory and specific research questions (more information is provided in Research Paper 4).

Research Paper 5 used the three main theme categories for data analysis. First, sustainability practices relating to the supply chain (both upstream and downstream) and to general industry; second, customer needs and value and
relationships; third, the components and features of a sustainable business model (more information is provided in Research Paper 5).

3.7 Evaluating the quality of the qualitative case study

Ethical issues in the research process must be considered at all the steps of the research (Maxwell, 2005). For qualitative case research (in the common ground of action research), ethics and values are important at many levels: between the scholars and the environment that lies beyond our research setting, to the academic institutions we work in, to the communities we live in, and even on a global scale. The key ethical principles include respect for people and knowledge; beneficence and justice; belief in the possibility of positive social change; and commitment to action (Brydon-Miller, 2008). Regarding the project, in the earlier stages of the V2B, common values and goals were clarified through open dialogue and discussions. Because discussions for the project took quite some time, access to the data was based on cooperation and transparency. Similarly, data collection for the multiple case study (Research Paper 5) was based on transparent cooperation with the industry achieved through open discussions regarding the goals and context of the research. Other considerations included the anonymity of the participants (if willing); the right of the respondents to terminate their involvement in the single case and multiple case study; and the principle of informed consent (i.e., describing the goals of the project to each interviewee and during each workshop). Agreements regarding the process to be followed if any ethical issues arose during the research were in place (as in Oliver, 2003).

Assessing the quality of the qualitative case study can be tricky because traditionally, qualitative research has used the vocabulary of quantitative study quality evaluations. For example, the external validity of qualitative studies should be softened with terms such as transferability and contextualization (Halldorsson and Aastrup, 2003) as opposed to generalization. According to the critical realist perspective, case studies should be assessed based on their complementarity to extensive studies (Tsoukas, 1990). Learning from an in-depth single case study should be considered a strength rather than a weakness because it enables a comprehensive understanding of the interaction between a phenomenon and its context, provides a unique means of developing theory, and can serve as a very powerful example (Dubois and Gadde, 2002; Siggelkow, 2007; Dubois and Gadde, 2014). Systematic combining (or the abductive approach) can help in non-positivistic and non-linear case study strategies to ensure rigor and relevant research (Naslund et al, 2010; Dubois and Gadde, 2014). However, there are several aspects of quality that should be considered. I decided to base my quality evaluation on the trustworthiness criteria of Lincoln and Guba (1985) (and was also informed by Huff (2008), Naslund et al (2010) and Bryman and Bell (2015)): credibility, transferability, dependability and confirmability.
In quantitative terms, credibility refers to ‘internal validity’ (Huff, 2007; Naslund et al, 2010). Credibility aims to ensure that the researcher has adequately captured the views of the respondents (respondent validation) and has accurately related those views to reality (Halldórsson and Aastrup, 2003; Bryman and Bell, 2015). To increase the credibility of this study, throughout the entire process, any uncertainty regarding the investigated issues was constantly addressed by the research team within the project by project and workshop participants. Although the results and work-in-progress were presented in different scientific and practitioner-oriented conferences, PhD consortiums, and research seminars, co-authoring the scientific articles with members of the research team in The Project enhanced the credibility of the research. In addition, the draft reports were sent to the key interviewees. Moreover, respondents were given the opportunity to participate anonymously to ensure ethical considerations were addressed (i.e., assuring that no names of willing participants will be mentioned in printed material). Furthermore, to minimize information bias, the data were triangulated by complementing the interviews with secondary data collection and analysis as well as organized workshops. The number of interviewees was also increased based on their diverse roles and to confirm the responses previously obtained. Investigator triangulation (Oppermann, 2000) addressed attitudinal and behavioural issues and reduced researcher bias (Eisenhardt, 1989; Yin, 2009). In addition, 3 researchers were usually present at the interviews conducted during The Project. The team-based approach is actually encouraged in action-based research because different researchers can provide various strengths to the project (Naslund et al, 2010). In V2B, researchers came from different cultural and research backgrounds and had different levels and types of experience (assistant professors, professors and young researchers from Sweden, Norway and China), which enhanced the analytical practices and provided excellent opportunities for a less experienced researcher (me) to develop and learn specific skills (as in Naslund, 2010).

Transferability refers to the extent to which the study results can be applied to other cases (Seuring, 2008; Bryman and Bell, 2015); in the quantitative terms, transferability refers to external validity. This criterion makes the description of the context very important; hence, in this study, both the industry and market contexts were described in detail. Claims from case study research – especially single case studies – are often questioned due to their lack of generalizability. The question is how a complex situation researched at the case study level can be convincingly presented as representative and generalizable. Per Yin (2003) and Easton (2010), the generalizability of case studies refers to theoretical propositions, not to populations or universes, meaning that case studies expand theories through analytical generalization (‘based on replication logic comparable to the prediction/deductive logic of the experiment’), not statistical generalization. Making general claims in logistics has also traditionally been considered important. According to critical realism, this kind of reasoning has a role in extensive research (Sayer, 2000). From a critical realism perspective, a causal justification in an in-depth case study must be rooted in theory and organized in
terms of a critical realist causal explanation (Easton, 2010). According to Aastrup and Haldorsson (2008), when accepting the realist view, one case study can be sufficient for generalization because it can create and/or test a theory by disclosing reality (Easton, 2001; Flyvberg, 2006). According to Yin (2009), analytical generalization is possible when the case is perceived to be critical (compared to theory), revelatory, extreme or unique (compared to other cases). Hence, this study may be classified as introducing a unique and critical case (compared to existing theory), because sustainable supply chain management research in the road freight transport supply chain context with a specific focus on the analysis of sustainable business solutions is limited. To reiterate, the relationship with existing theory is important (Easton, 2010). ‘More generally, a pragmatic approach can be adopted. If the objective is to advance theory, then one should be able to say which theoretical aspects one wishes to address and how will that be served by undertaking one case study compared with many’ (p. 127). However, I agree with Aastrup and Haldorsson (2008) that use of the term generalization is problematic in qualitative research. Instead, it is better to refer to possibility of transferability, which is a qualitative term. Hence, in this case study, the in-depth and interactive nature of The Project allows for analytical transferability, as demonstrated in Papers 1, 2 and 4.

**Dependability** (reliability in quantitative terms) requires presentation of the study process in a logical, well-documented and easily observable way. There are two principles for establishing the reliability of a case study: the creation of a case study database and the maintenance of a chain of evidence (Ellram, 1996; Yin, 2009). The chain of evidence is this case was maintained as follows: Purpose and RQs – case study protocol (interview protocol) – case study database. Because abductive logic allows the researcher to return and revise the research questions, the fact that the interview protocol (questions) were semi-structured allowed some flexibility and room for adjustment. A case study data base was created for this study (both The Project and the general PhD study). The researchers on The Project used a common database stored in several data clouds, where the data were structurally and meaningfully arranged according to the country (context) and to respondents’ roles in the supply chain and in the companies (e.g., company representatives, dealers, customers, other stakeholders). The data (and transcriptions) were divided by the country of study (Sweden, China, Poland (RPs 1, 2, 4). The data from the workshops and secondary data were organized accordingly. All raw data (notes, documents, tables, brochures) were saved separately from the researcher’s reports, which increases the dependability of the study. The general PhD study database contains not only organized data from the Project but also literature reviews, theme frameworks, data analysis procedures, timelines and notes. The details of the systematic literature review (Research Paper 3) are also stored in a well-documented manner.

**Confirmability** (objectivity) refers to the ability to ensure the good faith of the researcher; that is, to ensure that no personal values or theoretical inclinations may have noticeably influenced the way the research was performed or the findings were derived (Bryman and Bell, 2015). The involvement of a team of researchers
Research Methodology

enhanced objectivity of this study (investigator triangulation – Naslund et al., 2010). Team members could provide complementary insights, adding to the richness and novel interpretations of the data. By using multiple researchers with different academic backgrounds, areas of interest, research experience, etc., it was possible to arrive at a consensus interpretation of the case rather than one biased by the personal characteristics of the individual researcher (Eisenhardt, 1989). The team of researchers involved in the project included seven academics. Discussions within the team as well as with other academics assured the potential confirmability of the case study. Nevertheless, complete objectivity is impossible to achieve in case studies due to the close interaction between the phenomenon and the researcher (Hirschman, 1986) and thus this was not the goal of this study. Hence, the emphasis in case studies, and in this case study in particular, is on using the in-depth narrative about the specific context to elaborate theory (Ketokivi & Choi, 2014). For Research Paper 3, the processes of data collection and data analysis were thoroughly documented and described (including an explanation of the coding and comparison analysis criteria) and were discussed among the team of researchers.

The quality of the individual study in research paper 5 can also be analysed based on trustworthiness criteria (Bryman and Bell, 2015). The credibility of this multiple case study with embedded units of analysis was increased by confirming the issues addressed and analysed with my supervisors and industry experts. The transferability of the study was increased due to the number of cases, but the same logic of analytical transferability (Aastrup and Halldórsson, 2008) was applied for this study. The dependability of this study was addressed using logic similar to that used for the single case study process (RPs 1, 2 and 4). The processes of data collection and analysis were based on the case study protocol of the single case study and adapted to the multi-case context. These processes were also discussed with my supervisors and industry experts. The interviews were recorded, transcribed and structured for data analysis. Abductive logic was used, which allowed for the adoption of semi-structured questions for the interviews. Data collection was performed via interviews and secondary data collection of additional printed and online materials. The database was organized by respondent according to the same logic used for actors in the unit of analysis: company, dealers/sales representatives, and customers. The confirmability of the multiple case study was ensured through discussions with other researchers and industry members in the course of supervision, workshops and conference presentations.
Table 9 Summary of the components of study quality

<table>
<thead>
<tr>
<th>Study</th>
<th>Credibility</th>
<th>Transferability</th>
<th>Dependability</th>
<th>Confirmability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research papers 1, 2, 4</td>
<td>Investigator triangulation, data triangulation</td>
<td>Context (industry) description, analytical transferability of in-depth single case study</td>
<td>Data collection and analysis are well-documented and described</td>
<td>Team of researchers, conference presentations</td>
</tr>
<tr>
<td>Research paper 3</td>
<td>N/A</td>
<td>N/A</td>
<td>Data collection and analysis are well-documented and described</td>
<td>Team of researchers, conference presentation</td>
</tr>
<tr>
<td>Research paper 5</td>
<td>Data triangulation</td>
<td>Description of different contexts, analytical transferability of several case studies</td>
<td>Data collection and analysis are well-documented and described</td>
<td>Workshop and conference presentation, industry experts</td>
</tr>
</tbody>
</table>

3.8 Dissemination of results

*In this sub-chapter, the manners of dissemination of the thesis results are presented.*

In engaged scholarship – and in academia in general – the communication of results or works-in-progress to the interested groups and general public is very important (Huff, 2008, van de Ven, 2007). This communication not only contributes to the ongoing discussion but also, especially in an abductive study, helps to find secondary sources of suggestions and affirmation. The next table summarizes the occasions and locations where the research papers and parts of kappa were presented and/or submitted/published.
Table 10. Dissemination of PhD thesis results

<table>
<thead>
<tr>
<th>Dissemination channel</th>
<th>Research paper</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Conferences</td>
<td>Research Paper 1</td>
<td>Presented at international scientific conference NOFOMA (Nordic Logistics Research Network)</td>
</tr>
<tr>
<td></td>
<td>Research Paper 2</td>
<td>Presented at international scientific conference on Service Forum</td>
</tr>
<tr>
<td></td>
<td>Research Paper 3</td>
<td>Presented at international scientific conference on Business Ethics; discussed at technology- and practitioner-oriented conference on Life Cycle Management</td>
</tr>
<tr>
<td></td>
<td>Research Paper 4</td>
<td>Presented at international scientific conference NOFOMA, international scientific and practitioner conference HVTT (Heavy Vehicle Transport and Technology)</td>
</tr>
<tr>
<td></td>
<td>Research Paper 5</td>
<td>Presented at international scientific conference NOFOMA, scientific and practitioner conference HVTT</td>
</tr>
<tr>
<td>Seminars, workshops, other platforms</td>
<td>Research Paper 2</td>
<td>Discussed at Research Project V2B workshops</td>
</tr>
<tr>
<td></td>
<td>Research Paper 3</td>
<td>Presented and discussed at CEMS research seminar</td>
</tr>
<tr>
<td></td>
<td>Research Paper 5</td>
<td>Presented and discussed at Linköping University Nordic Sustainable Logistics Winter (SLOW) symposium and Jönköping University workshop on sustainable business models</td>
</tr>
<tr>
<td></td>
<td>Parts of Kappa</td>
<td>Presented at doctoral workshops connected to NOFOMA (NORDLOG) and IPSERA (International Purchasing &amp; Supply Education &amp; Research Association) conferences, blog entry on Vertikals platform</td>
</tr>
<tr>
<td>Scientific journals (submission status)</td>
<td>Research Paper 1</td>
<td>Published in Supply Chain Forum: An International Journal</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Research Paper 4</td>
<td>Submitted to International Journal of Logistics Application and Research</td>
<td></td>
</tr>
<tr>
<td>Research Paper 5</td>
<td>Submitted to the Journal Organization and Environment</td>
<td></td>
</tr>
</tbody>
</table>
4 Findings from the Research Papers and Industry Context

This chapter presents the context of the studied industry in four different markets (countries), together with the results from five research papers. The chapter concludes with a general discussion of the results.

4.1 The context of the industry and all markets in the study

The global truck market is expected to grow at 3.1% by 2024, although growth is not global but regional (with India having the largest share, 9%). New growth markets will be seen in Eastern Europe (7%) and Russia (5%). Growth in large existing markets will occur in countries such as Germany, Brazil, India and China. Sales increases will result from developments in the trucks themselves and in their operations (for example, the use of telematics; total cost of ownership; fuel optimization; solutions for customers; and value-based pricing) that will generate value for the industry network (Deloitte trucks study, 2014). Hence, growth in road deliveries will also continue to increase unless governments implement drastic solutions to cause a modal shift (Figueroa et al, 2014). In their report on energy used for transport, Figueroa et al. (2014) compare several scenarios published by diverse organizations. Figure 4-1 depicts the energy used historically by various transport modes and shows that road transportation accounts for the largest share of final energy use. According to Figueroa’s (2014) comparison of different scenarios, truck travel distances will increase further by at least 34%.
This PhD Thesis includes studies on the context of four different markets: Sweden, Poland, China and Australia. These markets exhibit certain similarities and certain differences in the sector of interest. Although the increase in road freight transport (as part of transportation) depends in large part on economic development (Eng-Larsson et al., 2012; Wang and Lu, 2014), its energy use and emissions can be strongly influenced by other factors (for example, new regulations) (Eng-Larsson, 2012; Liimatainen et al., 2014). Hence, the studies of road freight transport in the Polish and Chinese contexts exemplify the challenges presented by economic development for road freight transport in terms of emissions and safety. The studies of the Swedish and Australian contexts offer examples in contexts with slower economic growth and different sustainability strategies (in terms of the historical and overall situations of the sector). Therefore, the structures of the following subchapters on different markets consider specific issues in each market.

Nonetheless, trucking industry problems around the world are very similar in terms of the numerous small actors in the industry (such as transport companies – High Level Group Report, 2012); ageing truck drivers and the challenge of attracting next-generation drivers; gender diversity in the sector; safety; cabotage (especially in Europe); etc. According to a Deloitte study (2014), changes in business models are feasible in the near future, with a particular focus on vehicle life-cycle (improved quality), value-added services, dealer support, warehouse/distribution consolidation, driver safety, pricing evolution from cost-based to value-based pricing, improved total cost of ownership, telematics, etc. (Deloitte truck study, 2014). Factors influencing the global truck market include sustainable business models and brand strategy development; cyclicality; demand shift to growth regions; total cost of ownership; and overcoming environmental challenges (KPMG, 2011).
4.1.1 Swedish market

The analysis from Statistics Sweden provides detailed information and statistics about Swedish road freight transport. One general trend observed in Sweden is a move towards larger vehicles with greater load capacities. Hence, there is a growing emphasis on the importance of infrastructure (because vehicle types correspond to the situation on the roads). Progress in infrastructure systems has been high in Sweden but has declined steadily in recent years. The country has made increasing investments in road systems and their operation and maintenance (similar investments have been made in neighbouring countries) (Transport analysis report, 2014). The Swedish truck market is perceived as stable. In the last 40 years, two Swedish truck manufacturers (Scania and Volvo) have dominated the market, with each having about 50% market share. The maturity of buyers in the market is increasing. Service and maintenance contracts are often used in the Swedish market, although occasionally customers will prefer to conduct these activities in-house. There are many small transport companies (usually family businesses); however, large transport companies are growing in size. Hence, some customers are more conservative and are not looking for new solutions-based offers, whereas the ‘new generation’ of truck buyers is different and open to the innovative business solutions promoted by dealers (V2B project results).

Companies in the road freight transport sectors exemplify their position at the forefront of sustainability by focusing on diverse sustainability strategies. For example, at the end of 2016, Scania launched a new generation of sustainable vehicles and solutions. ‘The new truck line is the result of ten years of development work and project costs of more than 2 billion euros. With this line, Scania extends its offerings and, thanks to its unique modular system, can offer more performance steps, connectivity and a comprehensive palette of productivity-enhancing services and provide sustainable transport solutions that are precisely customized for each type of customer in the highly competitive transportation industry.’ (Scania’s website, accessed 2016-10-22). Similarly, Volvo has placed a significant emphasis on their sustainable values: ‘Protecting the environment is the biggest challenge we face. With new technologies, increased social momentum and industry collaboration, we can turn this challenge into our greatest achievement’ (Lars Martensson, Director of Environment and Innovation, Volvo Trucks website)

The specifics of the market include difficulties presented by foreign competition; Swedish transport companies’ share of the international long-haulage industry has dramatically decreased due to operators’ headquarters in low-wage countries (cabotage), which places pressure on profitability in an industry with already low margins. Hence, increasing specialization for types of goods and customer categories is evident. The emphasis on higher standards in terms of codes of conduct for drivers and environmental pressures from both regulatory schemes and transport customers are shaping the industry.
4.1.2 Polish market

In the European context, the Polish market can be considered quite special due to its position and substantial international logistics (Poland accounts for 15% of all EU transport). In terms of ton-kilometres (which is a unit of measure representing the transport of one ton of goods per kilometre), Poland is the second largest transport country in Europe, behind only Germany. Polish hauliers perform well as third parties in international flows and are the most represented nationality in the international long-haul industry (Eurostat, 2015).

In terms of the barriers to the effective functioning of road transport companies, the most prominent are the high costs of providing haulage services (combined with the low prices of the services) and significant competition from domestic and international carriers (Balke, 2013). In the V2B Project, the market situation was described in terms of significant opportunities after entering the EU and unprofessional competition based on very low pricing for transport services. However, low-cost labour is one reason why Polish hauliers are competitive in the EU road freight transport market. In terms of safety, Poland had the highest rate of people killed in road accidents (in terms of overall number of inhabitants) in 2013 (most people killed in road accidents were drivers) (Eurostat report, 2015). Hence, the quality of the drivers must be taken seriously and services such as driver training are quite popular among this specific group of customers (Poland – Truckia Head of Training and Research centre). Lower fuel consumption (in the EcoSolution offering, for example) was one benefit of driver training, and coaching has proved to be an efficient method of cutting costs. In addition, such solutions could facilitate social and cultural conditions, for example, involving the drivers in the business in the long term. The service network is gaining increased importance in the Polish market among a specific group of customers.

Problems include pirate workshops that are used outside of maintenance contracts. Moreover, several respondents describe the Polish market as volatile and less stable than that in Sweden. There is also a large market for second-hand trucks. The largest market share in Poland belongs to DAF (23-24%). Other heavy vehicle manufacturers include Mercedes, MAN and Volvo, which each account for 15-17%, and Renault and Iveco, which each have shares of less than 10%. Poland has strong environmental regulations, but implementation of these regulations lags far behind the regulations themselves (Truckia Polish office).

4.1.3 Chinese market

In China, road freight transport is a dominant part of the transportation system (He et al, 2005) and continues to grow (Freight Trucking Market Research Report, 2016). Road transport contributes the greatest proportion to overall GHG emissions, which highlights the crucial role played by road transport in decreasing emissions from the general freight transport sector (Hao et al, 2015). In the future, the Chinese truck market will see the greatest consolidation opportunities in terms
of partnerships with drivers, which will facilitate access to advanced technology, economies of scale, relocation of production, and long term growth (Deloitte truck study 2014). As in the Swedish, Polish and Australian markets, costs in the Chinese transport industry are a major issue. The prices for transport services are not high enough, which puts pressure on transport companies (Liu et al, 2013). The selection of transport service providers increasingly depends on service quality, reliability, flexibility and the range of product offerings. There is also increased focus in the transport market on supply chains and on the reliability and security of the road freight transport sector (Liu et al, 2013). The general situation in China is quite challenging (The Project V2B results). With many small transport firms, which may soon be consolidated, there is poor performance and low customer satisfaction. Gas/oil accounts for 30% of the overall cost (as in Poland). Hence, there will be increased focus on how the trucks are driven.

The major advantage of road transportation is its flexibility, whereas its many disadvantages include emissions and weight limitations (this sector is responsible for a considerable portion of China’s total CO2 emissions) (Liu et al, 2013). Whilst China’s 12th 5-Year Plan contains much discussion of the importance of efficient logistic systems and the need to decrease the environmental impact of the industry, implementation of appropriate regulations clearly remains a challenge (China’s 12th 5-year plan). The market is still eliminating unauthorized types of vehicles, and the importance of services and service networks is growing. Mature groups of customers have realized the benefits of truck value (as opposed to cost), and this awareness will slowly grow, although the lack of long-term orientation persists (Liu et al, 2013).

The heavy vehicle market in China is dominated by Chinese brands, although the market share of foreign brands has been increasing. The major Chinese brands are Dong Feng, Jie Fang, and Foton. The major foreign brands in the Chinese market include Scania, Volvo, Mercedes, MAN and DAF.

4.1.4 Australian market

In Australia, road transport is the main mode of transport for most commodities (BITRE, 2014). According to the study conducted for Research Paper 5, over 60% of freight in Australia is carried by heavy vehicles. In capital cities, road freight accounted for 20% of total road freight in 2011–12, whereas in urban areas outside capital cities it accounted for 10%. Intercapital road freight accounts for approximately 18–19% of total road freight movement. The freight transported between capital cities and regional areas and other inter- and intrastate freight accounts for approximately 50% of total road freight. Over 95% of Australia’s road freight is carried by heavy vehicles (i.e., vehicles weighing 4.5 tons or more). B-double heavy vehicle combinations (also called road trains, which include two or more trailers) are becoming the most significant road freight vehicle combination, accounting for approximately 40% of total road freight in 2011–12 (BITRE, 2014). As indicated in the NTI report (2015), these trucks are causing fewer accidents on the road while delivering larger amounts of freight.
Additionally, according to the RP5 study results, the increase in road trains (or multicombination trucks) is only going to increase (a similar trend is occurring in the USA and several European countries). Despite their major contribution to the road freight task, freight vehicles account for less than 8% of total road use, whereas light vehicles represent 92% of vehicles on the road (BITRE, 2014).

Future projections indicate that both the freight task in general and the use of road freight transport will increase (NTI report, 2015). The latter is estimated to grow by 80% between 2010 and 2030. Environmental pressures could cause many problems in this sector (and indeed already are), and government and community concerns about these issues are increasing (BITRE, 2014). One way to tackle this issue (according to the RP5 study) is by using longer combinations on the road and increasing PBS (performance-based standard) combinations. The challenges of the truck market in Australia are exacerbated by differences in existing regulations across different states. Hence, certain truck combinations may not be allowed in neighbouring states, which creates problems for transport companies (National Truck Accident Research Centre, Australia).

The largest market shares in Australia belong to Mercedes, Daimler and Kenworth (the last being the only brand with production based in Australia). Other European brands include Volvo, Scania and Iveco. In addition, the influence of firms from Asian markets (especially Korea and Japan) is growing.

4.2 The results of the Research Papers

This subchapter will present a summary of each paper, focusing on the purpose/research questions, theoretical framework and main contributions and results.

4.2.1 Research Paper 1 - Challenges and Conflicts in Sustainable Supply Chain Management: Evidence from the heavy vehicle industry

4.2.1.1 Purpose and research questions

Paper 1 was written in the middle of The Project V2B together with my supervisors (research team members). The main portion of the empirical data came from interviews and workshops in Sweden and China. The overall aim of the paper was to explore the challenges and conflicts in sustainable supply chain management in the context of the case industry. By understanding the contextual conflicts and challenges under the umbrella of sustainable supply chain management in two diverse markets, managerial practices could arguably be improved. Hence, the following purpose was formulated:

The purpose of Paper 1 is to increase understanding of the challenges and to explore the conflicts in SSCM through the empirical examples of the case supply
chains in Sweden and China. The analysis of these countries allowed for exemplification of quite different market development levels and sustainability practices, which arguably creates an opportunity for interesting results.

By discussing the challenges and conflicts in sustainable supply chain management (the theoretical framework), as well as considering existing studies about sustainability trade-offs for multiple stakeholders in the specific industry in these two countries, the authors developed three research questions:

1 RQ: What are the conflicts and challenges for sustainable supply chain management in the heavy vehicle industry?

2 RQ: How does the perception of sustainability issues differ for diverse actors in the heavy vehicle industry in diverse markets?

3 RQ: How can a life-cycle cost-based solution help to achieve sustainable supply chain goals?

The third research question referred to the business solution offered by the heavy vehicle manufacturer. The solution was based on the notion of life cycle costing, and the analysis described how it could influence all three pillars of sustainability in a manner that works for the industry.

4.2.1.2 Main results and contributions

Although the contextual situations in the studied markets showed some similarities, there were many very significant contrasts as well. The challenges and conflicts in sustainable supply chain management included the short-term focus on cost in the Chinese supply chains of the heavy vehicle manufacturer, as well as the operationalization of regulations. Hence, although safety and environmental issues were regulated quite heavily, exerting control over these regulations in the supply chains was difficult. Negligence on the part of nearly all stakeholders increased the challenges, because the knowledge and strategies needed to tackle possible sustainability challenges were not in place. The complexity of the problems also had an impact. The primary conflict was that between short- and long-term focus, which may explain why most of the pressure on the companies came from the authorities and end-consumers. These two stakeholders are increasingly worried about the development and substantial environmental impact of the transportation sector and by implication, the heavy vehicle industry. Although the government is already focusing on improving the sustainable performance of the industry, the complexity lies in the measurement as well as enforcement.

In the Swedish context, there were challenges to further improving the sustainability of supply chain after the low hanging fruit (in terms of cleaner fuel and better engines) had been picked. The government is highly aware of sustainability issues and is increasingly seeking voluntary changes. Hence, the interviewees discussed the possibility of modifying the taxation system to
promote sustainability issues in supply chains. However, a significant conflict remains between environmental and economic factors, because with the existence of other European competitors (specifically truck drivers), decreasing social costs can create higher local unemployment rates as well as an imbalance in sustainability goals.

Regarding the overall strategy for supply chain business models in the industry, the use of life cycle cost-based solutions might be one way for companies in both countries to address the trade-offs between economic, social and environmental goals. The focus on premium vehicles, extended services (including driver training and coaching) and total cost can generate safety and efficiency benefits for the firms in the explored supply chains. This focus can also create benefits for society in terms of lower emissions, reduced environmental impact and improved traffic safety, as well as improve the profitability of supply chain actors (through decreases in fuel consumption and repair and maintenance costs).

The heavy vehicle manufacturer in road freight transport supply chains has several options in terms of business solutions. However, operating internationally can cause additional challenges in this regard. Hence, understanding the specificities of interaction patterns and capabilities in the context of diverse business solutions is crucial.

4.2.2 Research Paper 2 – The evolution of heavy vehicle value propositions: Service modules, integrated solutions and performance

4.2.2.1 Purpose and research questions

Paper 2 was written with two V2B project research team members and focuses on interaction patterns and capabilities related to the management of diverse value propositions from the perspective of the case heavy vehicle manufacturer. The focus is also on managing these value propositions simultaneously and understanding more developed integrated and performance-based value propositions. The different value propositions discussed in this paper are modular solutions based on add-on services, integrated solutions (which are co-developed for the customer’s specific problem and include a focus on the life-cycle cost and life-cycle utilization of the vehicle, as well as ecological and social concerns), and performance-based solutions. The empirical data include studies from The V2B in three country contexts: Sweden, Poland and China. The theoretical framework was based on the value proposition and interaction patterns/capabilities.

Two research questions were formulated: (1) How and why do interaction patterns change with new value propositions? (2) How do capabilities relate to different value propositions?
4.2.2.2 Main results and contributions

The content and sales process of value propositions are briefly described in the table below (hence, in this summary, the focus is on integrated and performance solutions).

Table 11. Integrated and performance solutions (from Research Paper 2).

<table>
<thead>
<tr>
<th>Content of value proposition based on a) object of exchange, b) payment model, and c) degree of customizatio n</th>
<th>Integrated solution</th>
<th>Performance Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck incl. maintenance/repair contract and other services as a customized solution. Customer pays basic price for truck and monthly charge for contracted service. If at end of contract service needs were lower than predicted, customer gets refund. Joint development of solution to suit customer’s needs</td>
<td>Uptime, driven kilometres, or tons transported per km. Customer pays according to service level agreement. Joint development of solution as basis for partnership</td>
<td></td>
</tr>
<tr>
<td>Sales process</td>
<td>A solution is created to address a problem faced by the customer. Problems include accidents, unplanned stops and repairs needed during transport operations, among others. Service support, on-road assistance, and training available from the truck manufacturer’s organization are needed to solve the problem. The buyer’s organization is not engaged on a wider basis, although its relationship with the supplier has the potential to be a long term one.</td>
<td>Many simultaneous interaction processes among different functions. The parties organize as if they belong to the same organization and serve the same customer (i.e., the customer’s customer). The truck manufacturer becomes a function in the buyer’s organization, interacting with top management on strategic directives and coordinating with other functions.</td>
</tr>
<tr>
<td>The interaction process(es) result in capability</td>
<td>Low cost and differentiator capabilities are sustained. Capabilities depend on the function/business process involved in collaboration with the truck manufacturer.</td>
<td>Innovation in terms of the development of the customer’s resources to better suit the customer’s customer</td>
</tr>
</tbody>
</table>

For an integrated solution, close interaction with the customer and a long-term relationship are required. Thus, the capability to analyse and understand the customer’s business is important, in addition to the capability to assist the customer to become more mature through support for life cycle cost drivers and revenue generation analysis. Trust is the basis of this kind of relationships.
Industrialization capabilities, including the systematic collection, analysis and diffusion of information, are also vital. Thus, the development of such capabilities in solution sales is a challenge. In performance-based solution sales, capabilities at the top of the integrated solution include analysis of the customer’s and the customers’ customer’s businesses and risk management. Pricing transparency might also be a crucial aspect.

The capability to manage a portfolio of diverse solutions is a challenge in the service transition strategy and requires changes in managerial mindsets and organizational structures. These capabilities are developed based on previously developed value proposition capabilities, because there is strong inter-dependence among the different value propositions. These empirical examples showed that all value propositions can be available simultaneously from one manufacturer (and its sales personnel or dealers). Thus, the portfolio of diverse value propositions depends on the ability to capture and diffuse experiences of integrated and performance solutions for modular solutions and vice-versa. Inter-organizational problem solving capabilities are also important factors in the decision regarding which type of value proposition yields the greatest revenue enhancement.

This paper draws on industrial marketing, service transitions and integrated solution literature and conducts an empirical discussion on how different value propositions can co-exist within a company and on how capabilities and interaction patterns relate to each value propositions and to each other. Strategic processes and management focus, along with organizational learning and change, are needed to balance the diverse value propositions involving performance-based and integrated solutions.

4.2.3 Research Paper 3 - Understanding the Overlap Between Life-Cycle Thinking and Sustainable Supply Chain Management: Beyond A Systematic Literature Review.

4.2.3.1 Purpose and Research Method
Paper 3 was developed as a systematic literature review to facilitate a discussion of the overlap between SSCM and LCT. The paper was written with two supervisors from Griffith University (while on a research exchange programme). The purpose of this literature review was to merge the literature streams on SSCM and LCT and to investigate the status of their interrelationship and the differences between them. To achieve this end, the qualitative content analysis method was applied to the SSCM and LCT literature.

4.2.3.2 Main results and contributions
The main result is a conceptual model and a discussion of the main intersection points (below). The concepts were compared in terms of system boundaries, actor
network, time frame and distinctive features. The different levels (operational and strategic) were analysed.

Figure 4-2. Conceptual model: application of and interconnection between LCT and SSCM (based in part on Carter and Rogers, 2008).

The interrelation of SSCM and LCT through integration and adaptation represents the underlying logic of LCT as a base for SSCM, with LCT-related tools helping SSCM in terms of the measurement and operationalization of sustainability. The managerial and strategic complexity of SSCM includes issues of organizational culture, transparency, risk management and sustainability strategy. However, there are many intersection points between LCT and SSCM that are discussed in the literature. Both concepts focus on tools for measuring environmental, social and economic impacts throughout the life cycles of products and services and share a strategic focus on products and services from
the resource extraction stage to their re-use and re-manufacture. The holistic managerial approach needed to operationalize sustainability into business refers to both life cycle management and SSCM. In both cases, great importance is placed on the involvement of diverse stakeholders in decision-making and the supply chain structure.

4.2.4 Research Paper 4 – Life cycle thinking in the road freight transport supply chain – a systems perspective.

4.2.4.1 Purpose and research questions

Paper 4 is based on the empirical studies of Sweden and Poland. The paper focuses specifically on the value proposition of the heavy vehicle manufacturer that includes a focus on the truck in use and on ways in which costs can be allocated in the market phase. The aim of this paper is to improve the understanding of life cycle thinking (LCT) in the context of road freight transport supply chains within the boundaries of the truck market phase. System theory is used as the lens to understand the adoption of LCT within the boundaries of road freight transport supply chains. Hence, the aim of the paper is captured in the following research question: How can the adoption of LCT impact the sustainable performance of road freight transport supply chains?

4.2.4.2 Main results and contributions

As another way to achieve a more sustainable business, life-cycle thinking allows companies to establish the logic for the decision-making process regarding business partnerships and to efficiently address the trade-offs among economic, social and environmental requirements. LCT can create benefits for diverse stakeholders in the road transport supply chain in terms of reduced environmental impact, improved traffic safety and economic gains, as shown by the empirical example in this paper. The social issues of sustainability, which are the least researched sustainability issues in this specific industry, are addressed in this study in terms of improvements to working conditions and increased safety on the roads through the added services included in the sales package from the heavy vehicle manufacturer.

The results of the paper also demonstrate that maintaining a focus on total cost allocation, which is underpinned by long-term relationships within the unit of analysis, can contribute not only to economic savings but also to a reduction of emissions (environmental burden) and social implications (improved driver working conditions and increased safety on the road).
Within road freight transport supply chains, the product can be seen as the truck in use. In the proposed business model EcoSolution, the services included in the package (such as maintenance and driver training/coaching) add to the value of truck in terms of economic value (cost savings), environmental value (decreased pollution) and social value (increased safety and working conditions). The long-term relationships within the triadic relationship (heavy vehicle manufacturer, dealers/sales people, and transport companies) allow the complex solution to reflect customers’ expectations. Long-term relationships also help to improve information sharing among the actors and contribute to the formation of trust-based relationships. The economic performance of sustainability based on the totality of cost within the boundaries of the solution represents life-cycle costing as a component of sustainable performance.
4.2.5 Research Paper 5 - A sustainable business model in the road freight transport supply chain: Experience from the Swedish and Australian trucking industries from a social network perspective

4.2.5.1 Purpose and research questions

Paper 5 was developed outside of the main project as a means to collect additional data from within the same industry. The method for this paper is a multiple case study with the same unit of analysis – the triadic relationship that exists within the road freight transport supply chain: heavy vehicle manufacturer, dealers/sales representatives, and transport companies. The data were collected by the author in the context of the Australian and Swedish markets. The research questions that are answered in this paper are: *What is a sustainable business model in road freight transport supply chains? What are such a model’s main components and principles?*

4.2.5.2 Main results and contributions

Drawing on social network theory, the sustainable business model and sustainable supply chain literature, the paper proposes the principles, architecture and components of a sustainable business model for road freight transport supply chains.

![Figure 4-4. Sustainable business model principles and components in road freight transport supply chains (by author, based on Wells’ (2014) framework)]
According to this study, the main principles of a sustainable business model include resource efficiency, a focus on long-term business, and the integration of sustainability into core values and strategy. The main components of the model refer to the life cycle of the vehicle in use: the premium heavy vehicle, product service system, a closed loop (which leads to the possibility of reuse and recycling), and efficient involvement of IT and ICT (e.g., fleet management systems, driver training programmes). The architecture should focus on value co-creation in the supply chain, where trust and transparency are the underlying logic for building sustainable partnerships. A common trend in the Swedish and Australian contexts is the development of larger trucks, with Australia being ahead in this respect. However, in terms of the focus on business solutions, the Swedish market has created greater opportunities for the prevailing logic of sustainable business models, whereas in Australia, compliance with legislation remains the main focus of actors in road freight transport supply chains.

4.3 Summary of the results and connection to general purpose and RQs

See table below for the summary of the results and connection to general purpose and RQs.
<table>
<thead>
<tr>
<th>Title</th>
<th>Research Purpose</th>
<th>Theoretical Framework</th>
<th>Methods</th>
<th>Main Findings and Contributions</th>
<th>Connection to main purpose and RQs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Paper 1. Challenges and Conflicts in Sustainable Supply Chain Management: Evidence from the heavy vehicle industry</td>
<td>To increase understanding of the challenges and explore the conflicts in SSCM using empirical examples of the case supply chains in Sweden and China</td>
<td>Sustainable Supply Chain Management, with a focus on its challenges</td>
<td>In-depth case study (markets: Sweden and China)</td>
<td>The challenges of short-term focus, operationalization of sustainability practices, stakeholder importance, trade-offs between economic/environmental aspects, opportunity to address three pillars of sustainability through focus on safety, emissions and life cycle cost.</td>
<td>RPI helps to answer RQII through RQ1b and RQ 2b while shedding light on certain challenges in road freight transport supply chain management and discussing value propositions of the HVM for more sustainable business in the industry</td>
</tr>
<tr>
<td>Research Paper 2. From product through service and solution to performance: Value propositions, interaction patterns and capabilities</td>
<td>To explore how interaction patterns vary with performance-based and other value propositions and assess which capabilities are associated with these interaction patterns and management of parallel value propositions</td>
<td>Service transition literature on industrial marketing, performance-based and other complex solutions, and interaction patterns and capabilities to manage those</td>
<td>In-depth case study (Sweden, China and Poland)</td>
<td>The capability to manage a portfolio of diverse solutions is a challenge of service transition strategy that requires changes in managerial mindsets and organizational structures. Capabilities are developed based on previous solution capabilities because there is strong inter-dependence between the different value propositions. The portfolio of diverse value propositions depends on the capability to capture and diffuse experiences of integrated and performance solutions for modular solutions and vice versa.</td>
<td>RP 2 contributes to answering RQII by understanding the interaction patterns and capabilities of more sustainable business models in the road freight transport industry.</td>
</tr>
<tr>
<td>Research Paper 3. Understanding the Overlap Between Life-Cycle Thinking and Sustainable Supply Chain Management: Beyond A Systematic Literature Review.</td>
<td>To bring together the literature streams on SSCM and LCT and to investigate the status of the interrelationship and differences between these two concepts.</td>
<td>Sustainable Supply Chain Management and Life Cycle Thinking-related literature and the interaction between them</td>
<td>Systematic literature review</td>
<td>The interrelation between SSCM and LCT through integration and adaptation reflect the underlying logic of LCT within SSCM, with LCT-related tools helping SSCM in terms of measuring and operationalizing sustainability. Both concepts focus on tools for measuring environmental, social and economic impacts throughout product and service life-cycles, with a strategic focus on products and services from the resource extraction stage to their re-use and re-manufacture. The holistic managerial approach needed to operationalize sustainability into business refers to both Life Cycle Management and SSCM.</td>
<td>RP3 answers RQ1a while investigating the interrelationships and differences between SSCM and LCT. Further, RP3 provides a background on the role LCT can play within sustainable supply chain management.</td>
</tr>
<tr>
<td>Research Paper 4. Life cycle thinking in road freight transport supply chains – a system perspective</td>
<td>To understand how life-cycle thinking can be used in a sustainable solution in road freight transport supply chains.</td>
<td>Life cycle costing in the truck market phase (within the boundaries, based on system theory)</td>
<td>In-depth case study (Sweden and Poland)</td>
<td>As a way to achieve more sustainable businesses, life-cycle thinking via cost totality within the boundaries of the truck market phase can frame the logic for decision making regarding long-term business partnerships.</td>
<td>RP4 helps to answer RQIa, RQIba and RQIIa in a sustainable business model context in the industry within the boundaries of the market phase. Life cycle thinking based on life cycle cost and revenues under system theory offers an explanation of LCT in the context of road freight transport supply chains. The study shows that the social issues of sustainability in the sector are under-researched and shows how sustainability can be applied in RFTSCs.</td>
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<tr>
<td>Research Paper 5. Sustainable business model in road freight transport supply chains – Experience from the Swedish and Australian trucking industries. Social network perspective</td>
<td>To explore the main components and principles of a sustainable business model in road freight transport supply chains</td>
<td>Sustainable Business Models and Sustainable Supply Chain Management</td>
<td>Multiple-case study (Sweden and Australia)</td>
<td>The main principles of a sustainable business model include resource efficiency, a focus on long-term business and the integration of sustainability into core values and strategy. The main components refer to the life cycle of the vehicle in use: the premium heavy vehicle, product service system, closed loop (which lead to the possibility of reuse and recycling), and the efficient involvement of IT and ICT. The architecture should focus on value co-creation in the supply chain, where trust and transparency are the underlying logic for building sustainable partnerships.</td>
<td>RP 5 contributes to answering RQII via the exploration of sustainable business model principles and components in road freight transport supply chains.</td>
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5 Concluding analysis and discussion

This chapter discusses the results from all of the research papers and presents the concluding analysis and development of the conceptual model.

5.1 The interconnections among the Research Papers

The Research Papers are interconnected and build upon each other in several ways:

- The overall purpose of the thesis and its connection to the projects (timeline)
- The motivation and ideas for the focus of successive research papers
- Contributions to the thesis research questions

The purpose of this thesis is to explore how road freight transport supply chains can become more sustainable from the perspective of the heavy vehicle manufacturer. Research Paper 1 provides a context of challenges and conflicts in the industry in Swedish and Chinese markets, referring to the specific value propositions of Truckia and to certain conflicts related to triple bottom line considerations in the context of the two national markets that are the focus of this paper. The proposed trade-off among triple bottom line considerations was linked to the solution offered by the road freight transport supply chain from the perspective of the heavy vehicle manufacturer. The focus on safety, emissions reduction and totality of cost was offered as a product/service combination in long-term relationships within downstream supply chains. This is one of the solution packages offered by Truckia in diverse markets. The transition from ‘simple’ heavy vehicle sales to the sales of product/service packages (including EcoSolution) and further to performances sales was partially analysed in Research Paper 2. The identification of several challenges in the management of these diverse value propositions, particularly with respect to capabilities and interaction patterns, was the main contribution of this paper. The paper focused on three markets within V2B: Sweden, China and Poland. The empirical analysis in the following paper (Research Paper 4) also relied on data from these three markets but focused on a single Truckia value proposition: EcoSolution. The Project involving Truckia gave rise to the idea to address limitations of single case study research and motivated the collection of more empirical data regarding road freight transport supply chains. Research Paper 5 explores the issues related to
EcoSolution and focuses on the components and principles of sustainable business models in Swedish and Australian markets based on several road freight transport supply chains of Truckia and Trucko.

The interconnections between the diverse papers may be described as follows: the theoretical discussion in Research Paper 1 is grounded in sustainable supply chain management literature, and the challenges/barriers discussed were drawn from propositions in the literature, for example, Walker et al. (2008); Abbasi (2014). Life cycle thinking was found to be ingrained in SSCM literature in several ways. The enquiry into the integration of and interrelationship between SSCM and LCT was the basis for Research Paper 3. This paper conducted a theoretical review of two literature streams and formed the background and motivation for the theoretical focus of Research Paper 4. Whereas Research Paper 2 focused on various value propositions, including one based on the product/service system and value co-creation, as well as on long-term partnerships, the focus of research paper 5 was on further understanding the principles and components of a particular value proposition and employed the theoretical framework of the sustainable business model. The empirical setting for Research Paper 5 was the downstream supply chains of heavy vehicle manufacturers, and several additional supply chains were included in the analysis.

The contributions from Research Paper 1 highlight the challenges and conflicts inherent in managing supply chains in the road freight industry in a more sustainable way (RQ2b). This paper provides a context to understand how road freight transport supply chains can become more sustainable. The perspective of a heavy vehicle manufacturer is adopted by focusing on downstream supply chains of Truckia. Considerations of life cycle thinking in road freight transport supply chains were exemplified by one of the value propositions from the heavy vehicle manufacturer, which was shown to offer benefits to industry actors in terms of safety, lower emissions and long-term profitability in the Swedish and Chinese contexts, which in turn illustrated the role of life cycle thinking in the development of more sustainable road freight transport supply chains (RQ1). The systemic literature review conducted in Research Paper 3 offered a theoretical discussion on how life cycle thinking and sustainable supply chain management are interconnected and contributed to an understanding of how life cycle thinking can be applied in sustainable supply chain management (RQ2). The interconnections between SSCM and LCT are seen through the measurement of environmental, economic and (less represented) social impacts; the focus on the life cycle (strategic and operational); the holistic approach; and the importance of diverse stakeholders for the management of supply chains. These results help to understand the overlap between SSCM and LCT (RQ1a). Research Paper 4 builds upon this discussion by exemplifying how LCC (one of the LCT tools) can be applied in road freight transport supply chains. This discussion contributes to answering RQ1b. It also provides background for the discussion in Research Paper 5, because the product/service system, longevity principles and value co-creation are major elements in sustainable business model literature. The contributions from Research Paper 5 include the introduction of sustainable
business model principles, architecture and components in road freight transport supply chains, thereby clarifying the sustainable business model of a heavy vehicle manufacturer in road freight transport supply chains (RQ2a) and demonstrating how life cycle thinking can be applied in a sustainable business model of road freight transport supply chains (RQ2). The results from Research Paper 2 help to elucidate the specific context in terms of the interaction patterns and capabilities involved in the management of diverse value propositions offered by the heavy vehicle manufacturer, including integrated value propositions based on product/services systems, long-term partnerships and sustainability considerations. The specification of challenges in managing these kinds of value propositions in Research Paper 2 allow us to understand important managerial challenges presented by a more sustainable supply chain business model (RQ2b).

5.2 Development of the conceptual model

This thesis is positioned in sustainable supply chain management literature where it intersects with other areas, such as life cycle thinking and sustainable business models. The system theory and social network theory were helpful in understanding the context of the phenomenon when applying the theoretical frameworks of sustainable supply chain management, life cycle thinking and sustainable business models to the specific industry context, namely, road freight transport supply chains (the upper part of the conceptual model).

). From the perspective of the heavy vehicle manufacturer, there are several crucial issues to consider when endeavouring to make road freight transport supply chains more sustainable, including contextual, managerial and content-related issues. The contextual issues include the diverse drivers and barriers that impact sustainability in road freight transport supply chains. Managerial issues include specific interaction patterns and capabilities entailed in the management of sustainable business models for a heavy vehicle manufacturer. The content of sustainable business models in road freight transport supply chains comprise the principles, architecture and components.

The content structure refers to the integration and network of the actors and hence the importance of long-term partnerships based on trust; the focus on life cycle costing and increasing product-in-use value; value co-creation processes; the role of diverse services in the product-service system embodied in the complex solution; transparency in operations and goals; and improved learning. The following analysis is organized based on the flow of these findings (the lower part of the conceptual model, Figure 5-1)

The relationship in supply chain management has long been known to be very important for increased efficiency, enhanced collaboration and integration, and sustainable business. Hence, it is even more important in terms of sustainable supply chain management; in Rogers and Carter (2008), Seuring and Muller (2008) and other key references, the notion of long-term business is emphasized. Nonetheless, many businesses today continue to pursue short-term profit
maximization, which presents a challenge for sustainable supply chain management (Abbasi and Nilsson, 2013). In the sustainable business model literature, longevity is the underlying principle. Longevity can refer to business longevity achieved through long term value creation (for example, family businesses) and product longevity (e.g., extension of product-in-use) (Wells, 2016). In life cycle thinking, another important consideration is how to increase the value of the product throughout its life cycle while eliminating sustainability trade-offs and inefficiencies between partners in the supply chain (Seuring, 2013).

An analogous logic exists in the road freight transport supply chain of the premium truck manufacturer that was the focus of this study (Case study 1). As many respondents argued, long-term partnerships are the basis for sustainable relationships and value co-creation in product-service based value propositions. The co-creation of value requires the manufacturer to be involved in the businesses of its customer’s and the customer’s customers. This involvement requires specific capabilities on both sides, and interaction patterns in performance sales are even closer and more long-term oriented. The case study shows that from the customer side, increased learning capabilities and closer interaction with dealers are needed. Chakkol et al. (2014) studied road freight supply chains in the UK, and the results show that long-term relationships are more common in and vital for value co-creation. As the network becomes more critical as a result of increased coordination and collaboration demands, the need for integrative IT systems and training courses increases as well (Chakkol et al., 2014). Hence, the case study results show that IT-related tools are extremely important for efficiency and transparency between the customer and the manufacturer. Furthermore, as mentioned by one of the transport companies, there should be a greater focus on assistance with IT systems from (developed by) the manufacturer, because these systems not only support analyses of driver behaviour and truck performance (fleet management systems) but also contribute to increased truck-in-use life.

The concept of product life extension, which also refers to improved vehicle utilization, describes one way to move towards more sustainable logistics and transport systems (Linton et al., 2007; Schmidt, 2001; European transport Policy, 2010; Aronson and Brodin, 2006). This shift can be achieved through product-service systems that lead towards more sustainable business models (Wells, 2004; Bocken et al., 2014). In product-service systems, the focus is on delivering functionality, experience and product performance rather than product ownership (Bocken et al., 2014). In the case study, performance-based solutions had not yet been communicated to the majority of customers; although such solutions already demonstrated benefits in terms of improved vehicle utilization, they created more risk for the manufacturer. However, service-dominant logic (Gronroos, 2011), is gaining more acceptance in the road freight transport industry, because, according to the study (Research Paper 2), other benefits of this logic are foreseen. Those benefits relate to overall product usage extension and hence to a more sustainable approach (Research Paper 5). Another important component is the manner in which costs are calculated.
Cost allocation in the various value propositions differs from that in traditional product sales (ownership sales), and life cycle costing can be viewed as an economic component of product sustainability (Kwak and Kim, 2013). In a systems theory view, the value of the product increases when cost is calculated based on the use of the product and services over the life-time of the product, albeit within certain boundaries (market phase – Research Paper 4). However, life cycle costing can also increase complexity (Gluch and Baumann, 2004). The allocation of cost over the product life cycle, including relevant external costs and benefits, is referred to as life-cycle costing (Ciroth et al., 2011). From the transport company perspective, the consideration of a truck’s life-time cost refers not only to the acquisition cost (when the truck is purchased) but to the costs incurred while the truck is in use. This type of cost allocation refers to solution sales, whereby the truck is complemented by services such as maintenance and repair, driver training and coaching, and financial and other services tailored to the customer’s needs. In performance-based value propositions, cost calculations are adjusted towards a focus on uptime (refer to Paper 2 for more details). Hence the content of the value proposition is uptime or carbon footprints, or tons per km, whereas the cost is allocated according to the service level agreement. According to the study results (Research Paper 2), forming a relationship with customers through sales of integrated solutions can help to enhance the long-term relationship and transparency between the actors.

Hence, the network of actors, which is based on transparency in the supply chain, can represent an opportunity for the development of sustainable business relations, although these can be hard to achieve. Resistance to transparency and the alignment of strategic and operational actions and the lack of knowledge and training can damage the potential for sustainable supply chains (Morali and Cearcy, 2013; Matos and Silvestre, 2013). Such challenges and barriers exist in the road freight transport industry, where (according to the study in Research Paper 1), even more challenges exist, such as regulatory schemes and their operationalization. The drivers of sustainability are seen in most markets and include industry-specific drivers (e.g., governmental regulations on minimum engine performance), recognition of the triple bottom line concept, and the influence of diverse stakeholders (e.g., customers, competitors, suppliers, media, NGOs, etc.). According to most transport company interviews in the study, the primary drivers of sustainability are customer requirements and governmental regulation. A similar explanation was heard in interviews with dealers and certain representatives of Truckia and Trucko top management. In the road freight transport sector, the network of actors is extensive (i.e., numerous small transport companies). Hence, in terms of sustainability, the role of the manufacturer can be considered very important. Transparency and trust-based relationships in networks demonstrate responses to sustainability challenges through the development of social capital (Toubulic and Walker, 2015). Additionally, the application of social network theory in the road freight transport industry helps to explain the inter-dependence among the many actors in the network, where trust and collaboration provide a background for sustainable supply chain
management. Hence, a flawless information flow is required (Vuuro et al., 2010). The importance of information flow increases with the sale of solutions and product-service systems (Chakkol et al., 2014), as demonstrated in the case study, particularly in the Swedish market context.

Figure 5-1 illustrates the above discussion based on development of the working conceptual framework presented in Chapters 1 and 2 through the lenses of two theories. Following the interconnection among life cycle thinking, sustainable supply chain management and sustainable business model in the context of the triadic relationship in road freight transport supply chains, the main part of the overall conceptual model was developed. The model in the ‘basket’ shows that from the perspective of the heavy vehicle manufacturer, life cycle thinking affects the content of sustainable business models in road freight transport supply chains in several ways. The mediator role is played by contextual issues that influence the content of SBM. The moderator is represented by specific managerial issues that are important factors in the content of SBMs in RFTSCs.

The contributions of the conceptual model can be seen at three levels of the hot air balloon: first, the theoretical working conceptual model level; second, the application of the theoretical working conceptual framework to the supply chain in the road freight industry; and third, the resulting relationship among the main constructs of the conceptual model in the basket.
Figure 5-1. Conceptual model (Hot air balloon – by author)
6 Conclusions, contributions, implications and future research

This chapter concludes the overall discussion of this thesis by revisiting the research questions raised in the introduction of this study based on Table 13. The theoretical and managerial contributions, as well as future research recommendations, are discussed here as well.

6.1 Concluding remarks – revisiting research questions

Returning to the main research purpose of this study, which is to explore how road freight transport supply chains can become more sustainable from the perspective of the heavy vehicle manufacturer, the set of research questions developed for each paper in this thesis contributed to answering the overarching RQs (Table 13).

With respect to RQ1a, What is the role of life-cycle thinking in developing more sustainable road freight transport supply chains? the answers are provided by Research Papers 3 and 4. Research Paper 3 focuses on the theoretical contribution of the study by analysing the interconnection between and application of SSCM and LCT. Clearly, both streams of literature can benefit from each other, although the concepts that underpin the subfield of SSCM are more developed. The framework of Carter and Rogers (2008), which is one of the most widely used SSCM frameworks, offers a solid background for development of this subfield. The important facets (Figure 2-1) of SSCM include risk management, which in road freight transport supply chains can be enhanced by the development of sustainable value propositions, as shown by the results of Research Paper 4. Another facet is transparency, which is also shown to be important for managing sustainable business models in the industry. Although the emphasis is on operational activities, better transparency can be achieved via IT systems (for example, FMS). Embedding sustainability in culture and strategy presents many challenges but can be achieved through the development of social networks and information sharing within supply chains.

The role of life cycle thinking can be described in several ways. Although LCT-supporting methodologies can clearly assist in measuring performance of sustainable supply chains (Seuring, 2004a) via LCA and LCC, the main role of
LCT can be described in terms of holistic thinking in SSCM and consideration of cost totality in road freight transport supply chains. The system theory also enhances understanding of how challenges and conflicts might be resolved when assessing the life cycle of products/services systems. Specifically, the assessment should include several steps (*i.e.*, actors in the road freight transport supply chain). This approach can help to avoid misjudging the overall picture as each step is considered. The focus on life cycle costs, albeit limited to the costs incurred while the truck is in use (*i.e.*, the market phase), can help to increase the value of the product/service system over time (Research Paper 4).

To answer RQ2 (*How can life cycle thinking be applied in sustainable business model of road freight transport supply chains?*), Research Papers 4 and 5 describe sustainable business models of heavy vehicle manufacturers in the context of road freight transport supply chains as the means to develop a more sustainable industry sector. Hence, sustainability awareness in this specific industry creates many drivers (as well as barriers, especially in diverse markets), involves many different stakeholders, and suggests many possible strategies to achieve more sustainable supply chains. Within the boundaries of this study, the role of life cycle thinking in the sustainable business model of heavy vehicle manufacturers demonstrates the need for specific interaction patterns as well as the capabilities to manage those interactions. The EcoSolution example in this study showed how the triple bottom line can be assessed based on the way a business is organized in a supply chain. The necessary features of a sustainable business model, within the boundaries of the performed study, include a focus on premium trucks that are developed to meet customers’ needs and specifications; a long-term focus on relationships and increased truck utilization; the totality of cost approach, which considers profitability on both sides of the transaction; value co-creation through truck servicing and driver training and coaching; and transparency and increased information sharing.

Research Papers 1 and 2 helped to answer the second subquestion on the managerial challenges of more sustainable business models through their discussion on key managerial issues and the challenges and conflicts that exist in road freight transport supply chains. Challenges include changing mindsets, addressing sustainability trade-offs, increasing stakeholder influence and the managing the implications of required capabilities and interaction patterns. The importance of understanding these challenges when managing multiple value propositions was revealed in Research Paper 2. The industry context was also shown to create challenges. Specifically, due to the multiplicity of actors involved, the role of heavy vehicle manufacturers in enhancing sustainability is quite significant in this industry. Moreover, due to the environmental and social impacts of this industry, heavy vehicle manufacturers face pressure from diverse stakeholders.
### Table 13. Research questions revised

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Themes from literature / theory</th>
<th>Interview questions</th>
<th>Themes from literature confirmed</th>
<th>New themes</th>
<th>How themes from literature were confirmed/ not found</th>
<th>New theoretical contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQIa: What is the connection between LCT and SSCM?</td>
<td>Holism, stakeholder influence acknowledgement, management</td>
<td>Content analysis</td>
<td>Life cycle approach, holism, system thinking</td>
<td>Stakeholder importance</td>
<td>By analysing the intersection of two streams of literature, the overlap between LCT and SSCM was confirmed</td>
<td>Conceptual model – theory building. Overlap between SSCM and LCT</td>
</tr>
<tr>
<td>RQIb: What is LCT in the context of road freight transport supply chains?</td>
<td>Life cycle cost, system thinking, long-term relationship</td>
<td>How are cost and revenues calculated? Long-term focus?</td>
<td>Total cost, long-term relationship, life cycle thinking</td>
<td>Total cost and revenue calculation for market phase</td>
<td>Increased product value-in-use via life cycle thinking, with total cost calculations</td>
<td>Confirm themes from system theory – totality of cost, holism, boundaries</td>
</tr>
<tr>
<td>RQIIa: What is a sustainable business model for HVMs in road freight transport supply chains?</td>
<td>Product service systems, life cycle (circular approach), value co-creation, consideration of three pillars, long term</td>
<td>What is a sustainable business model in the industry? What are the main components and principles?</td>
<td>PSS, total cost, long-term relationship</td>
<td>Extended value-in-use, environmental social and economic trade-offs</td>
<td>The analysis of sustainable business model components and principles in the context of road freight transport supply chains</td>
<td>Confirm themes from social network theory – trust in relationships</td>
</tr>
<tr>
<td>RQIIb: What are some managerial challenges presented by more sustainable business models?</td>
<td>Challenges include increased cost, operationalization of sustainable development, changing cultures and mindsets, difficulty of controlling and managing uncertainties and trade-offs, and the complexity of problems. Conflicts due to stakeholder influence, trade-offs between three pillars. Interaction patterns: long term, transparent, knowledge sharing. Capabilities: close mgmt. of interaction, business knowledge about customer’s customer</td>
<td>What are the issues related to sustainability? Where do the pressures come from? What are your perceived challenges?</td>
<td>Challenges include operationalization, mindset change, cost/environmental trade-offs, stakeholder influence, sustainability trade-offs</td>
<td>Managing multiple value propositions</td>
<td>Road freight transport supply chains represent an industry with multiple actors, low margins and cost focus. The example of premium HVM’s sustainable value proposition shows it is possible to manage SCs in diverse markets in a more sustainable way</td>
<td>Proposed trade-offs between three pillars of sustainability in the value proposition of road freight transport supply chains</td>
</tr>
</tbody>
</table>
6.2 Theoretical contributions

The main theoretical contributions of this study are illustrated in the conceptual model (Figure 5-1).

The first contribution relates to knowledge about sustainable business models in road freight transport supply chains. An analysis of the principles, architecture and features of sustainable business models in this sector reveals the merit of value co-creation processes; the importance of long-term relationships; interaction patterns; and specific measurements and strategies. All of these discoveries indicate the potential for the industry improvement. In addition, this empirical example contributes to SBM and SSCM literature, as has been called for in these literature streams (Carter and Easton, 2011; Ludeke-Freund, 2015).

One way that firms recognize the importance of sustainable business models is through their supply chains (Meixell and Luoma, 2015). In the road freight transport industry in particular, social considerations, as distinct from environmental considerations, have largely gone unaddressed. Addressing these social considerations has also been called for in the research (for instance, by Abbasi and Nilsson, 2016), because social sustainability in the transportation industry is under-researched. Hence, the EcoSolution example contributes to the thinking on all three sustainability pillars (economic, environmental and social) within the boundaries of the sustainability measures adopted for this industry (totality of cost, CO2 emissions, and safety considerations).

Another theoretical contribution relates to diverse value propositions (such as PSS, solutions and performance-based sales) in road freight transport supply chains and to the capabilities and interaction patterns of such propositions. Empirical evidence in the SSCM, SBM and LCT literature regarding how these value propositions can work in road freight transport supply chains remains limited (as in Chakkol et al., 2014). In this context, it is observed that the use of solutions and performance value propositions are expected to increase in the freight transport industry.

The fourth theoretical contribution refers to the application of system theory and social network theory to explain the logic behind sustainable supply chain business models. The holistic approach, life cycle costing, assessment of products and services over their lifetimes, and consideration of the complexities involved allows businesses to satisfy the environmental and economic facets of sustainability. This contribution highlights the necessity of transparent and trust-based supply chains and hence presents an opportunity for mutual learning and increased transparency (Gold et al., 2011). The application of the combination of these theories in the study of supply chains in the road freight transport industry is a theoretical contribution to the sustainable supply chain management field.

The overarching contribution of this thesis is to the topic of sustainable business and, hopefully, to sustainable development. The intention is to emphasize the importance influence of businesses on sustainable development and to show how different stakeholders can work together to shape a more sustainable industry.
6.3 Managerial and policy implications

As demonstrated in this thesis, management of sustainable business models involves significant challenges and conflicts for the network of actors. This study finds that moving towards more sustainable supply chain management requires consideration of many issues. Premium truck manufacturers (exemplified in this thesis) are involved in the development of product-service systems-based value propositions as part of an effort to adopt a more sustainable business model that considers environmental, social and economic bottom lines. The triple bottom line is represented by increased safety on the roads, decreased fuel usage (and hence decreased CO2 emissions), and long-term cost reduction. The research presented in this thesis suggests that heavy vehicle manufacturers and transport companies should also consider the business aspects of sustainable road freight transportation.

Going one step further to performance-based solutions, where cost allocation is performed in a non-traditional way, can further enhance truck utilization and performance. However, the percentage of customers that require and are aware of these diverse solutions is quite low (based on Swedish, Polish, Chinese and Australian study results – Research Papers 2 and 5). The maturity of the market can play a big role in this regard. However, as demonstrated in the Polish market, efforts to improve knowledge about the overall benefits of sustainable business models (such as EcoSolution) can be successful in developing trucking markets. Nonetheless, consideration of the surrounding context is also very important.

Challenges from the customer (transport company) side include the need for increased operational analysis and more frequent and long-term interaction patterns (e.g., more formal and informal meetings with dealers or manufacturer representatives – as shown in Research Paper 4). More means and policies to promote communication might be necessary, because trust and transparency should provide the background for these relationships. Organizational learning (on the manufacturer’s side) should address the challenges of transitioning towards more sustainable business models because, as shown in the study case, most value propositions can exist and be offered simultaneously, which in turn requires the capability to manage and sell them simultaneously (through the same salespeople or dealers) (see Research Paper 2 results).

Thus, organizational learning can be a key capability for the promotion of sustainable business solutions, because several traditional dealer motivators – such as bonuses based on truck sales – do not apply to the sales of extended services or solutions and performance-based value propositions.

Specific implications for the manufacturers may include increased focus on value-in-use (i.e., transport equipment utilization) to achieve more sustainable performance. Another implication, for many reasons, is the importance of risk evaluation when offering sustainable business models or performance-based solutions (Research Papers 2 and 4). Because supply chain relationships can become very strong and persist over the long term, it becomes extremely important to analyse actors and perhaps even customers in advance. Hence, for
the sustainable business model, risk management (Selviaridis and Wynstra, 2014; Essig et al., 2016) becomes one of the most important issues, in addition to incentives, performance specifications and valuation. Therefore, a well-designed contract should consider the pre-existing trust in the relationship and correctly calculate the value proposition.

Dealers/sales representatives may also realize the importance of managing the menu of diverse value propositions. Hence, the industry should experience trust-based long-term relationships and increasing logic based on life cycle cost calculations. Moreover, social network theory contributes to an understanding of how the supply chain can become more sustainable by helping dealers to recognize the significance of social ties in their networks.

From the customer (transport company) side, challenges may include the need for more frequent and long-term interaction patterns (more formal and informal meetings with dealers or manufacturer representatives, for example – as shown in Research Paper 4). Hence, means and policies designed to increase communication might be necessary, because trust and transparency should provide the background for these relationships.

### 6.4 Recommendations for future research

The areas of sustainable supply chain management, life cycle thinking and sustainable business models are growing both theoretically and practically; however, there are several related areas that cover similar issues (for example, integrated supply chain management, industrial ecology, closed-loop supply chain management, circular economy, etc.). This case could probably be positioned in these areas as well, albeit the research purpose and questions would be different. For example, in the tradition of industrial ecology, the usual question is how the industrial network interacts with the biosphere (Ny, 2007). In the field of life cycle assessment, calculations of the truck-in-use life cycle (including manufacturing and reuse/recycling) might be performed. These questions could be explored in future research that uses the contributions of this thesis as a stepping stone.

In this study, a high-quality premium truck is considered a necessary feature of sustainable business models. However, the meaning assigned to this product in the future could differ substantially from its meaning today (for example, studies on hybrid trucks, alternative fuel-based trucks, electric trucks, etc., have already produced valuable results – see, e.g., Yang et al., 2009; Liimatainen et al., 2014; Figueroa, 2014). Moreover, fuel consumption, which is recognized as a major cause of the environmental footprint, can be influenced not only by driving habits but also by numerous logistics issues, such as freight density, vehicle capacity, structure and technological issues (such as chassis, brakes or aerodynamics, etc.) (e.g., Akerman and Hojer, 2006; Piecyk and McKinnon, 2010). A sustainable business model such as EcoSolution can be modified if the industry shifts to other types of vehicles. However, even if the industry switched to electric vehicles, it is possible that from a life cycle perspective, traditional fuel-based vehicles might
have a smaller environmental footprint depending largely on the sources of energy used to produce electricity, the production processes or problems with battery recycling. Hence, road freight transport studies that focus on technology or logistics systems could provide even more inspiration for business studies in this area. Similarly, the development of sustainable supply chains could become extremely interesting if 3D printing becomes more popular or the internet of things and platooning (automated driving) become more widespread.

Further research on sustainable business models in terms of resources and investigations relating to required capabilities should be undertaken and applied in other industries. In the studied industry, the costing system can reshape the nature of the partnerships; hence, costing systems constitute an important area of research, for instance, in the context of various business networks (Essig et al., 2016). Service-dominant logic as a theoretical framework (as in Chakkol et al., 2014) can also be further explored in longitudinal empirical studies of networks.

Going one step further, the growing discussion on truly sustainable supply chains or truly sustainable business models may influence the focus of research in general (please refer to Pagell and Shevchenko (2014) and Montabon et al. (2016). If and/or when supply chains are designed in a manner that produces no negative impact on the planet and people, then ‘business as usual’ or even ‘sustainable business as usual’ models would change dramatically.

In summary, the diverse methods of operationalizing sustainability and sustainable development goals require significant attention, maybe more so than any other type of research focus (Markman and Krause, 2016). With the implementation of more sustainable technologies, businesses must make the necessary changes to adopt the ‘right’ strategy for the market and to use more sustainable business models under sustainable supply chain management.
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Appendices

Appendix 1. Key issues to consider for each market

1. Size and share of market (as deemed relevant in the particular case)
   a. Total market size new vehicles (units/sales value)
   b. Market share per manufacturer new vehicles (units/sales value)
   c. Total market size used vehicles (units/sales value)
   d. Market share per manufacturer used vehicles (units/sales value)
   e. Growth of a-d
   f. The market’s main customer application and industry

2. Market (customer) structure
   a. Main alternatives for truck buyers (used vehicles, other brands…)
   b. Main customer categories (new/used vehicles); trucking firms, manufacturers etc. (who uses the trucks)
   c. Differences between Truckia and other truck manufacturers
   d. Size of sales per customer category (units/value); for Truckia and other manufacturers
   e. Customers’ customers (what does the transportation “network” look like); differences between Truckia and other truck manufacturers
   f. Intermediaries and specialists in the system
   g. Main challenges faced by customers

3. Truckia retailers/dealers
   a. Development and current organization of dealer network
   b. Number of dealers per ownership form/structure
   c. Approaches adopted by retailers/dealers in truck sales
   d. Main challenges faced by dealers/retailers

4. Service organization
   a. The development and current organization of the service network
   b. Density/quality of the service network
   c. Ownership structure of service organization for different customer segments
   d. Differences between Truckia and other truck manufacturers in regard to service organization
   e. Alternatives to Truckia’s own service organization
   f. Main challenges faced by the service organization

5. Truckia’s offering
   a. Product categories on the particular market (i.e. different types of trucks sold)/which models are sold
   b. Share of market per category
c. Degree and form of adaptation to (country) market (physical product, warranties etc.)
d. Which services that are sold and their shares of sales value (vs. physical trucks)
e. Warranties and other responsibilities towards customers

6. Truckia history on the market
   a. Key events and developments
   b. Development of sales
   c. Profitability (new vehicles, used vehicles, services)

7. Truckia image on the market (compared to other manufacturers)
   a. quality/reliability
   b. service
   c. resale
   d. green and social (sustainable)

8. Perceptions and practices on the market regarding extended services
   a. Dealers/retailers’ perceptions
   b. Customer perceptions
   c. Market maturity (derived from some of the above issues)

9. Environmental regulations
   a. Current (CO2 emissions, engines, …)
   b. Perspective

10. Social issues
   a. Safety

11. Shortly describe the total operating economy concept (TOE) in terms of its development and constituent parts
   a. For each customer segment (as above). Are there significant differences between offers directed at different customer segments?
   b. Breakdown into components (e.g. insurance, training, maintenance both preventive and when needed)
   c. Can individual components be bought or only specific bundles
   d. Which are the main component bundles
   e. Are there significant differences between offers directed at different (country) markets? Do service components play different roles on different markets (e.g. comparing Asian and Western markets)? Does TOE mean different things?
   f. What does the (sales) reporting system look in regard to components?

12. For each customer segment, how is customer value generated
   a. What is YOUR perception of customer value?
   b. How does TOE add value for customers (relating to its various components such as environmental issues, fuel economy, road safety, maintenance, uptime, etc.)?
   c. (How) do you consider how TOE helps the customer adds value to ITS customer

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d. Are there significant differences for different segments?

e. Are there significant differences in value generation for/on different (country) markets? (e.g. Asia vs. Western markets)?

13. Customer purchasing behaviour
   a. Which are the main parameters that customers consider?
   b. Are there differences between different segments?
   c. Are there differences between different markets (e.g. how do Asian customers think when they may purchases compared to western buyers?)

14. The (continuous) design process for TOE
   a. Who comes up with ideas for services? What does the typical “innovation process” look like?
   b. Inspiration from other firms/industries
   c. Customer involvement (workshops, feedback, specific customer requirements)
   d. Intra-firm collaboration (marketing and sales units, “physical” product development, etc.)

15. Promotional activities (i.e. market development) for each customer segment
   a. How is TOE communicated to customers? Changed over time?
   b. Which main arguments are used to “convince” customers? Changed over time?
   c. Forms of indirect promotion (target customers’ customers)? Changed over time?
   d. Are there differences between segments and (country) markets?
   e. Inter-firm collaboration (Truckia-independent retailers-users (trucking firms, 3PL, private fleets)-etc.)

16. How are environmental, sustainable issues considered when developing TOE?
   a. Are they mentioned in promotional activities?
   b. Which part of value of the whole TOE concept do these issues have, for customers and Truckia?
   c. How are they developed in the continuous TOE design process?

17. TOE in numbers (when relevant)
   a. Share of service sales vs. “physical” component
   b. D: o, developments over time (historical and predicted)
   c. How many customer just buy trucks and how many buy (different “levels” of) TOE (in different countries
   d. D: o, developments over time (historical and predicted)

18. Share of different TOE components in sales and their profitability
   a. Profiability of service sales vs. “physical” component
   b. D: o, developments over time (historical and predicted)

19. Challenges
a. Which are the main challenges encountered in relation to business development especially services in relation to the TOE concept
b. Which are the main challenges encountered when trying to gain customer acceptance of the TOE concept

20. Are there other people in (and outside) Truckia you think we should talk to about these issues?

Appendix 2. Interview guide for sales staff

1) General information about respondent (education, tenure with Truckia, positions)
2) Organization of the unit where the respondent works and how it related to other units
3) Which are the main customer segments; how are segments defined by Truckia?
   a) Trucken firms
   b) 3PL
   c) Etc.
4) Sales process for a truck
   a) Typical process
   b) Differences between customer segments?
   c) Which Truckia actors are involved in a typical sales process except the sales staff?
   d) Which customer actors are involved?
   e) What does the (sales) reporting system look in regard to components?
5) In which ways does a sale involve analyzing and understanding the customer’s business?
   a) Customer value
   b) How is customer’s customer ‘s business considered?
   c) How has Truckia “solution business” ambitions influenced operative sales?
6) How are components to a purchase structured? I.e. truck vs. services?
   a) Are there typical or main bundles?
   b) In which ways are purchases customized/standardized?
   c) Are there significant differences between customer categories?
7) How is the sales function supported by Truckia centrally?
   a) Marketing materials, promotional activities etc.
   b) Process descriptions
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c) Feedback to operative sales?

8) What does the feedback system from operative sales staff to Truckia look like?
   a) Feedback to marketing and business planning
   b) Feedback to product development
   c) Feedback to service development
   d) Are suggestions from operative sales staff given weight by Truckia centrally?

9) Thoughts on customer purchasing behavior
   a) Which are the main parameters that customers consider or emphasize (vs. what Truckia salespeople emphasize)?
   b) Are there differences between different segments?
   c) Is it difficult to gain acceptance among customers for concepts like “TOE” or “uptime”? Which are the main objections? Which are the main reasons perceived by customers in favour of such concepts? Does acceptance vary between segments?
   d) To what extent and in what ways do customers consider environmental, sustainability and social issues when making truck purchases
   e) To what extent and in what ways are “emotional” aspects important in truck purchased? Differences between segments?

10) Remuneration of sales staff
    a) How are commissions determined? Truck vs. services?

11) Are there other people in (and outside) Truckia you think we should talk to about these issues?
Appendix 3. Interview guide for dealers

1. Background
   a. Position in the company
   b. The dealer situation, such as challenges etc

2. Customers
   a. Different types
   b. Standard / unusual
   c. Important now and in the future
   d. Development over time

3. Relationships with
   a. Customers
   b. Marketing companies
   c. Service companies
   d. Headquarters
   e. The others?

4. How is the customer value created? How has this changed over the years?

5. To what extent are your sales based on the purchase price and the total operating cost of the truck?

6. Why do customers choose to buy or not to buy trucks based on the total operating cost?

7. How do the dealers/customers work with the truck and related services?

8. What is the relationship between the dealer and the customer during the truck's life cycle?

9. What does your offer mean as an environmental solution and solution in terms of safety aspects for the customer?

10. Are there any customers we can talk to in order to better understand these kinds of solutions?
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Appendix 4. Interview guide for customers (transport companies)

1. Introduction questions
   a. Your background
   b. Your role in the organization
2. Market related questions
   a. The development of the market
   b. Market (customer) structure
3. Main alternatives for trucks (used vehicles, other brands, other modes)
4. Customers’ customers and suppliers (what does the transportation “network” look like)
5. Intermediaries and specialists in the system
6. Main challenges faced by your customers
7. Environmental and social concerns:
   a. Company’s stand and image in regard to sustainability concerns
   b. How sustainability can be integrated in transportation?
   c. Where comes the requirement for sustainability?
   d. How do you disseminate sustainability culture in your organization and beyond?
   e. Regulations
8. Sustainable solutions - Truck manufacturers are talking about sustainable solutions, what is it for you?
   a. What are the main features of sustainable solution?
   b. What should be included in the sustainable solution?
   c. What services should be included?
   d. How should the costs be calculated?
   e. What happens when you stop using the vehicles?
   f. What about the second-hand market?
9. Life-cycle thinking
   a. What is the life-cycle of the vehicle?
   b. How can you assess the life-cycle of the services