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Exploring Themes and Challenges in Developing Sustainable Supply Chains

A Complexity Theory Perspective

Maisam Abbasi



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DOCTORAL DISSERTATION

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Department of Operations Management, Copenhagen Business School, Denmark

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Abstract <p>To develop sustainable supply chains in a way that their negative environmental and social effects are minimized, short- and long-term targets should be set. The transformation of supply chains towards these targets calls for the development of innovative strategies and the need to continuously identify, classify, and tackle the challenges that can hinder the execution of such strategies. To develop innovative strategies, the patterns of current trends and themes need to be learned and the missing ones need to be identified.</p> <p>The purpose of this research was to explore themes and challenges in developing sustainable supply chain activities from theoretical and empirical perspectives. Six research studies (RS) were designed and carried out. Two explored the patterns of the themes and challenges in making supply chains environmentally and socially sustainable in general (RS1, RS2). One explored freight transport (RS3), one, urban freight distribution (RS4), and one, logistical services (RS5) in particular. RS6 explored a complexity theory perspective (CTP) on managing, governing, and developing sustainable supply chains activities. A CTP was chosen because of its applicability and ability to provide an understanding of the complex phenomena that sustainable development and supply chains represent.</p> <p>During and after the design of each research study, data were collected from a variety of sources and then analyzed by different researchers on some occasions and by different methods. Thus, the research design, data collection, and data analysis were mixed and overlapping, because they were not completely sequentially carried out. The aim of the analysis was to generate knowledge by (re)organizing and categorizing the data collected, by exploring the meaning of the data (i.e., generating information), and identifying their patterns of associations. After assessing the quality of the synthesized knowledge, the results were communicated to several target groups through several communication channels.</p> <p>In RS1, five major themes and challenges were identified in making supply chains environmentally sustainable. RS5 led to a deeper understanding of the insights of logistics service providers (LSPs) about the challenges identified in RS1. RS2 led to the identification of five major themes and eight major challenges in making supply chains socially sustainable. In the context of freight transport in RS3, fifteen major themes and five major challenges emerged. In the context of urban freight distribution in RS4, these numbers were eight major themes and seven major challenges. However, the results (i.e., the generated knowledge) about the themes and challenges were subjective: They were influenced by my interpretation of what had been said, observed, or scientifically written. The results were also relative (related to what had been said, observed, or scientifically written), and influenced by the different methods for collection and analysis of data.</p> <p>By combining the thirty-three identified themes in the research studies and classifying them based on their similarities and overlap, four central themes in making supply chains sustainable emerged out: <i>sustainability in goods and services</i>, <i>sustainability in resources</i>, <i>sustainability in corporation</i>, and <i>sustainability in management and/or governance</i>. Similarly, by combining the twenty-four identified challenges in the research studies and classifying them based on their similarities and overlap, five central challenges in making supply chains sustainable emerged out: <i>shifting the values</i>, <i>difficulties of operationalization</i>, <i>dealing with complexity</i>, <i>difficulties of corporate governance</i>, and <i>SMEs difficulties</i>. Taking a CTP was beneficial in understanding the complexity involved in the central themes of making supply chains sustainable. It also led to further propositions for tackling the challenges.</p>		
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14 April 2014, Lund, Sweden
Maisam Abbasi

Abstract

To develop sustainable supply chains in a way that their negative environmental and social effects are minimized, short- and long-term targets should be set. The transformation of supply chains towards these targets calls for the development of innovative strategies and the need to continuously identify, classify, and tackle the challenges that can hinder the execution of such strategies. To develop innovative strategies, the patterns of current trends and themes need to be learned and the missing ones need to be identified.

The purpose of this research was to explore themes and challenges in developing sustainable supply chain activities from theoretical and empirical perspectives. Six research studies (RS) were designed and carried out. Two explored the patterns of the themes and challenges in making supply chains environmentally and socially sustainable in general (RS1, RS2). One explored freight transport (RS3), one, urban freight distribution (RS4), and one, logistical services (RS5) in particular. RS6 explored a complexity theory perspective (CTP) on managing, governing, and developing sustainable supply chains activities. A CTP was chosen because of its applicability and ability to provide an understanding of the complex phenomena that sustainable development and supply chains represent.

During and after the design of each research study, data were collected from a variety of sources and then analyzed by different researchers on some occasions and by different methods. Thus, the research design, data collection, and data analysis were mixed and overlapping, because they were not completely sequentially carried out. The aim of the analysis was to generate knowledge by (re)organizing and categorizing the data collected, by exploring the meaning of the data (i.e., generating information), and identifying their patterns of associations. After assessing the quality of the synthesized knowledge, the results were communicated to several target groups through several communication channels.

In RS1, five major themes and challenges were identified in making supply chains environmentally sustainable. RS5 led to a deeper understanding of the insights of logistics service providers (LSPs) about the challenges identified in RS1. RS2 led to the identification of five major themes and eight major challenges in making supply chains socially sustainable. In the context of freight transport in RS3, fifteen major themes and five major challenges emerged. In the context of urban freight distribution in RS4, these numbers were eight major themes and seven major challenges. However, the results (i.e., the generated knowledge) about the themes and challenges were subjective: They were influenced by my interpretation of what had been said, observed, or scientifically written. The results were also relative (related to what had been said, observed, or scientifically written), and influenced by the different methods for collection and analysis of data.

By combining the thirty-three identified themes in the research studies and classifying them based on their similarities and overlap, four central themes in making supply chains sustainable emerged out: *sustainability in goods and services*, *sustainability in resources*, *sustainability in corporation*, and *sustainability in management and/or governance*. Similarly, by combining the twenty-four identified challenges in the research studies and classifying them based on their similarities and overlap, five central challenges in making supply chains sustainable emerged out: *shifting the values*, *difficulties of operationalization*, *dealing with complexity*, *difficulties of corporate governance*, and *SMEs difficulties*. Taking a CTP was beneficial in understanding the complexity involved in the central themes of making supply chains sustainable. It also led to further propositions for tackling the challenges.

Popular Science Summary

If you wonder about the journey of goods and services before they reach you and the effects that journey has on the natural environment and the society, this dissertation is for you. In order to deliver goods and services from raw materials to you, the customer/consumer, several organizations and individuals interact with each other. They source the materials, manufacture or produce the products, pack and handle them, transport and distribute them, and ultimately sell them. These interactions and activities make up the supply chain (SC). Supply chain management (SCM) involves the management and integration of these interactions and activities. Numerous evidence-based studies show that SCM can increase your satisfaction as a customer and consumer, meet your demands, and reduce costs and conflicts for the organizations, businesses and individuals involved.

Businesses are beginning to realize that SCs have several negative effects on their surrounding natural environment and societies that should be minimized. Examples of these are that SCs are still dependent on fossil fuels and nonrenewable natural resources. They give rise to atmospheric, land, water, noise, air pollution; lead to waste, congestion, injuries, and accidents; produce/manufacture and trade goods and services according to unethical laws and standards; and abuse human as well as employees' rights. If remedies for mitigating the negative effects are not found soon, the costs will be too high for future generations to cope with the effects. It might also be too late for them to find and implement long-term solutions to keep our planet a sustainable place to live and our businesses sustainable to operate.

The purpose of this research was to explore themes (topics, activities) in developing sustainable SCs so that the negative effects can be minimized. It also explored challenges (difficulties, obstacles, or dilemmas) that can hinder sustainable development of SCs. In-depth studies of logistical services and activities were carried out because they have not been well examined with a sustainability lens.

The results revealed a pattern of themes in developing sustainable SCs. The first theme originated from the direct characteristics of sustainable goods and services. Goods and services can be sustainable if they are effective and efficient with minimized pollution, if they are sourced from renewable raw materials and natural resources, and are recyclable, safe, healthy, secure, and transparently traceable. This means that appropriate steps should be taken to generate goods and services sustainably so that all sorts of waste, emissions, toxicants, noise and air pollution are minimized. The second theme was related to sustainability in the resources necessary for generating goods and services, including the physical, financial, human, and intangible ones. Among the aspects discussed are: effectiveness and efficiency (appropriate resources, rightly utilized) with minimized pollution; recyclability; safety; security; respecting the rights of employees; developing a learning context; exploring and exploiting innovation; fostering diversity; employee development; protecting trust, brand, and reputation; maintaining and continuing business relationships; dealing with risks; as well as resistance and resilience.

Sustainability does not emerge in just the goods, services, and resources of SCs, though. The third theme sheds light on inter-processes and interrelationships in sustainable SCs including the flows of goods and services from suppliers to consumers and vice versa that should be integrated. All the businesses involved should take and share responsibilities in following the ethical norms and minimum standards and requirements. They should also be responsible and collaborative in their relationships with others. Businesses also have responsibilities in developing their societies such as social investment, supporting public services, and

philanthropy. Finally, the fourth theme underlined managerial and governmental activities in developing SCs.

The results also revealed the pattern of the challenges in developing sustainable SCs. The first challenge was to shift the values in the supply chains in a way that the two non-economic pillars of sustainable development (environmental and social friendliness) are equally weighted with the economic pillar. This can hinder sustainable development of SCs when short-term costs are in focus or when customers prioritize financial criteria such as delivery time, price, functionality, and service-rate ahead of environmental and social criteria such as recyclability, emissions, and working conditions or rights of employees. The second challenge was related to the difficulties of operationalization due to asymmetric knowledge in the interpretation of criteria for sustainable development in different parts of SCs; difficulties in changing the resistant, reluctant, disregarding, or short-term mind-sets and behaviors; and uncertainties about short- and long-term changes that might affect SCs.

The third challenge was dealing with the increasing complexity associated with the sustainable development of SCs. The first dimension that contributes to this complexity is the difficulty in evaluating SC sustainability. This is due to the subjectivity in defining the changing SC boundaries, the organizations and individuals involved, as well as the multiple ways that SC activities affect or are affected by their surrounding societies and environments. The second dimension relates to leakage/spillovers in open SCs because of the shift of emissions from one sector to another (from transport to production of electricity, for example) or from one country to another. Leakage may also occur when a stakeholder evades its responsibilities or externalizes its social and environmental degradation costs by transferring to or sourcing from places or stakeholders with looser regulations and standards. The third dimension involves several trade-offs that exist in the sustainable development of SCs, where making one part sustainable leads to unsustainability in another. There are also several conflicts of a paradoxical character that simultaneously exist in the managing and governing of sustainable SCs.

The fourth challenge was related to the difficulties in corporate governance of sustainable SCs due to the large scale of interactions and activities. There are several contexts where supply chains operate, ranging from local to urban areas, regions, and different countries. Different rules, laws, standards, certificates, labels, norms, bureaucracies, and administration processes exist. There is considerable heterogeneity regarding sustainability practices between and within industries, and a reluctance of businesses to accept legislation or to participate in initiatives. There are also concerns over transparency, accountability, and the credibility of standards, norms, and third party or external auditors and certifiers. Finally, the fifth challenge was related to the difficulties of small and medium sized enterprises, as they may be uncertain about the benefits of upgrading to new sustainability standards and codes of conduct. They may also lack the knowledge, skills, time, money and human resources to respond to the social and environmental requirements of global buyers and SCs.

The conclusion is that taking a complexity theory perspective (CTP) on sustainable SCs is beneficial to better understand, manage, and govern gradual and radical changes in them. A CTP takes into account changes in the themes and challenges and is helpful in dealings with the challenges, such as changing customers' priorities; changing short-term mind-sets and behaviors; uncertainties; subjectivity in embodying SCs; dealing with leakage/spillovers, trade-offs, and paradoxes; and heterogeneity regarding sustainability practices between and within industries.

List of appended papers

Paper I

Title: Themes and Challenges in Making Supply Chains Environmentally Sustainable

Authors: Maisam Abbasi and Fredrik Nilsson

Published in: *Supply Chain Management: An International Journal*

Presented at: NOFOMA 2010 Conference, Kolding, Denmark

The paper is available at: <http://www.emeraldinsight.com/journals.htm?articleid=17047205>. An earlier version of the paper was presented at the NOFOMA 2010 Conference, Kolding, Denmark. Both authors contributed equally to the paper. The first author was responsible for collecting, analyzing, and writing first draft of the paper. The second author contributed in the data analysis phase as well as writing the final draft and editing the whole paper.

Paper II

Title: Themes and Challenges in Making Supply Chains Socially Sustainable

Author: Maisam Abbasi

Published in: *NOFOMA 2014 Conference Proceeding*

Presented at: NOFOMA 2014 Conference, Copenhagen, Denmark

The revised paper has been accepted for publication in the NOFOMA 2014 Conference Proceeding. The author solely contributed to the paper.

Paper III

Title: Themes and Challenges in Making Freight Transportation Environmentally Sustainable – A logistics service provider perspective

Authors: Maisam Abbasi and Fredrik Nilsson

Submitted to: *Transportation Research – Part D: Transport and Environment*

Published in: *Transportation Research Forum 2012 Conference Proceeding*, Florida, USA

Presented at: NOFOMA 2011 Conference, Harstad, Norway

The paper is available at: <http://www.trforum.org/forum/viewabstract.php?id=424>. An earlier version of the paper was presented at the NOFOMA 2011 Conference, Harstad, Norway. A new version of the paper is under review in *Transportation Research – Part D: Transport and Environment*. The first author contributed to 60% of the paper by collecting and analyzing data and ultimately writing the synthesis of the analyzed data. The second author contributed in the data collection and analysis phases as well as writing parts of the second and fifth sections and editing the whole paper.

Paper IV

Title: Themes and Challenges in Making Urban Freight Distribution Sustainable

Authors: Maisam Abbasi and Mats Johnsson

Published in: *Rethinking Transport in the Øresund Region: Policies, Strategies and Behaviours*, 2012

Published in: *NOFOMA 2012 Conference Proceeding*

Accepted for publication in: *Journal of Traffic and Transportation Engineering*

Presented at: NOFOMA 2012 Conference, Turku, Finland

This paper was published in the *NOFOMA 2012 Conference Proceeding*. A new version of the paper has been accepted for publication in *Journal of Traffic and Transportation Engineering*. An earlier version was published as a chapter in the Øresund Ecomobility Project book, *Rethinking Transport in the Øresund Region: Policies, Strategies and Behaviours*. The book is also available online as a PDF at <http://lup.lub.lu.se/luur/download?func=downloadFile&recordOID=2429902&fileOID=2429926>. The first author contributed to 80% of the paper. The first author was responsible for collecting, analyzing, and writing final draft of the paper. The second author contributed in writing parts of the first and second sections and editing the whole paper.

Paper V

Title: Who Controls the Logistics Emissions? Challenges in Making Fragmented Supply Chains Environmentally Sustainable from Logistics Service Providers' Perspective

Authors: Maisam Abbasi, Henrik Sternberg, Fredrik Nilsson

Published in: *NOFOMA 2014 Conference Proceeding*

Presented at: NOFOMA 2014 Conference, Copenhagen, Denmark

The revised paper has been accepted for publication in the NOFOMA 2014 Conference Proceeding. The authors contributed equally to this paper.

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Appended Papers

Paper I: Themes and Challenges in Making Supply Chains Environmentally Sustainable

Paper II: Themes and Challenges in Making Supply Chains Socially Sustainable

Paper III: Themes and Challenges in Making Freight Transportation Environmentally Sustainable –
A logistics service provider perspective

Paper IV: Themes and Challenges in Making Urban Freight Distribution Sustainable

Paper V: Who Controls the Logistics Emissions? Challenges in Making Fragmented Supply Chains
Environmentally Sustainable from Logistics Service Providers' Perspective

Appendices

Interview Guide of the Research Study 2

Codification of the Central Challenges

1. INTRODUCTION

No one can stop the future but everyone can change how it comes.

This chapter provides a holistic view of the background and framework of the research by elaborating on the problems that have motivated the formulation of the research purpose and questions and a summary of the research studies.

1.1 Background

Fulfilling the demand for goods and services makes internal and external processes of an organization dependent on those of other organizations or individuals (stakeholders). Interactions among an organization and its interdependent upstream and downstream stakeholders create a supply chain or network.

Supply chain processes involve activities in delivering a product or service from raw material to the customer/consumer including: purchasing and procurement, manufacturing/production, packaging and handling, transportation, marketing and selling, physical distribution across all channels, and information sharing. Organizations have realized that by managing the interactions and integrating the processes in their supply chains, they can increase the efficiency and effectiveness of their operations; optimize utilization of resources; facilitate access to emerging inter-firm scarce resources, capabilities, information, skills, experiences, innovations, and technologies; reduce transactional and total costs; align their strategies; fulfill their networks' values; better match supply with demand; increase customer/consumer satisfaction; minimize risks and conflicts; design competitive business models; and achieve sustainable competitive advantage.

Organizations may also have realized that their sustainable development goes hand in hand with their stakeholders across their supply chains. Sustainable development encompasses all the interdependent and mutually reinforcing pillars of economic development (Profit), social development (People), and environmental protection (Planet) (Elkington, 1997; United Nations, 2005). How can an organization become environmentally sustainable if its supplier delivers non-recyclable units or a carrier of its products emits too much carbon dioxide (CO₂)? How can it reduce its transactional and total costs, minimize wastes, increase its performance, or protect its reputation and brand without considering its interactions with other stakeholders? How can it become socially sustainable if its logistics service provider does not pay attention to safety and security standards or a distributor of its products tends to corruption?

Supply chain activities have several positive socio-economic effects as demand and need for goods and services are fulfilled; innovative goods and services are introduced; infrastructures are constructed; new jobs are created; poverty, hunger and crimes are lowered; and humans and nations become wealthy. Although supply chains activities are associated with a cascade of socio-economic benefits, they may have several negative effects on their surrounding (natural) environment and societies that should be minimized. Supply chains are still dependent on fossil fuels and nonrenewable natural resources. They produce non-recyclable goods; have negative effects on residents' health and safety; give rise to atmospheric, land, water, noise, and visual pollution (McKinnon *et al.*, 2010); lead to degradation of ecosystem services (Hester and Harrison, 2010), congestion, intimidation, vibration, injuries, and

accidents (McKinnon *et al.*, 2010); deteriorate the cultural carrying capacity (Hardin, 1991); destroy cultural monuments; produce/manufacture and trade goods and services according to unethical laws and standards; and abuse human as well as labor rights.

On the other hand, the (natural) environment and society can have negative effects on supply chain activities such as natural disasters (floods, earthquakes, volcanic eruptions, tornados), rust, corrosion, sudden temperature changes, shock, stress, cargo theft, smuggling of goods, hijacking, corruption, and violating intellectual property rights.

In a closer examination of atmospheric pollution, the *Stern Review: The Economics of Climate Change* (2006) reports that agriculture, industrial production, and transport (three significant parts of a supply chain) together account for 40% of the total emission of greenhouse gases in the world. Atmospheric pollution can also lead to water pollution. 20-25 million tons of carbon dioxide are added to the oceans each day (Gandhi *et al.*, 2006), resulting in triggers for climate change and global warming (United Nations, 2004). Deforestation is another problem as it can destroy the natural carbon capture and storage mechanisms. In the forest industry, it is estimated that the amount of wood taken from forests and plantations per year could triple by 2050 due to rising population, demand, and use of wood for bioenergy (WWF Living Forests Report, 2011). It is also estimated that by 2050, annual wood demand for energy could reach 6-8 billion m³, which would require more than twice the wood cut down for all uses today.

In a recent investigation, NASA (National Aeronautics and Space Administration) in the USA reported that the mean temperature for land and ocean has increased more than 1°C since the mid-20th century. With the current amount of root causes of global warming, it is forecasted that the mean temperature for land and ocean will increase more than 4°C until the end of the 21th century (knowledge.allianz.com). Such an increase will reduce crop yields, affect water resources, melt the ice sheet tremendously, raise sea levels, and alter marine ecosystems (metoffice.gov.uk). The Intergovernmental Panel on Climate Change (IPCC, 2013) concludes that most of the observed temperature increase is caused by increasing concentrations of greenhouse gases from human activities such as fossil fuel burning and deforestation. According to the Kyoto Protocol, greenhouse gases are natural (carbon dioxide, nitrous oxide, and methane) and industrial (perfluorocarbons, hydrofluorocarbons and sulphur hexafluorides). Carbon dioxide accounts for by far the largest proportion (approximately 85%) of GHGs in the atmosphere, which is why there is so much attention focused on this particular gas (McKinnon *et al.*, 2010).

On the basis of current climate modeling, it is estimated that global greenhouse gas emissions will have to be reduced from 48 billion tons of CO₂ in 2007 to 24-28 billion tons in 2050 to keep the increase in average temperature within 2°C (McKinnon, 2010). The logistics sector in the EU still depends on oil and oil products for 96% of its energy needs (European Union, 2011). In this regard, the EU (including Sweden) has set targets to limit climate change below 2°C by drastically reducing GHG emissions – from all sectors of the economy – by 80-90% below the 1990 levels by 2050. It is also estimated that a reduction of at least 60% of GHGs by 2050 with respect to 1990 is required from the logistics sector. The European Union (2011, p. 9) also has the goal to “*halve the use of ‘conventionally-fuelled’ cars in urban transport by 2030; phase them out in cities by 2050; and achieve essentially CO₂-free city logistics in major urban centers by 2030.*”

In order to minimize the negative environmental and social effects of supply chain activities, similar short- and long-term targets need to be set as well as necessary actions need to be taken immediately. Setting targets may facilitate the design of innovative strategies, the creation of sustainability norms, and the adaptation of acceptable solutions.

At the same time, sustainable development is a gradual evolution rather than an overnight one. It calls for long-term targets and perspectives as, for example, it takes time to educate future generations, increase awareness, change stakeholders' behavior, construct/ reconstruct/ equip the infrastructures, redesign supply chains, redefine business models, develop innovative clean technologies, identify challenges, and adapt to new legislation/ regulations/ laws/ policies. Consequently, in order for the necessary changes to take place, it is imperative that it starts immediately.

1.2 Transition towards sustainability targets

By setting sustainability targets, supply chains activities need to be transitioned towards the targets. Transition can be defined as the “continuous process of change where the structural character of a society (or a complex subsystem of society) transforms” (Rotmans *et al.*, 2001, p. 16). The transition of supply chains towards the long-term (2050) targets is complex as it includes socio-economic and technical changes with different time scales and is governed by the decision-making of a variety of actors. Furthermore, the transition path is and will continue to be different for different types of supply chains as well as supply chain actors, as they may be in different stages of development and influenced by different types of social structures, natural resources, geographic location, and technical knowledge (Meza and Dijkema, 2009). This transition calls for designing new strategies and continuously identifying and tackling the challenges that can hinder execution of such strategies.

To understand and deal with the multidimensional, dynamic and complex characteristics of transitions of supply chains activities, a theoretical perspective that encompasses the complexity is necessary. Complexity theory provides an interesting perspective when dealing with complex issues such as the sustainable development of supply chains activities (Choi *et al.*, 2001; Ellram *et al.*, 2007; Boons, 2008; Wycisk *et al.*, 2008; Varga *et al.*, 2009; Birkin and Polesie, 2011; Nilsson and Gammelgaard, 2012).

The concepts of teleology are found beneficial to better understand the processes of change in supply chains as well as the different understandings of future states of supply chains from a complexity perspective (Nilsson, 2005; Svensson, 2010). “*The aim of teleology is to explain phenomena by the purpose they serve rather than by postulated causes*” (Oxford Dictionaries). Stacey *et al.* (2000, p. 14-15) refer to teleology as discussion about two things: *the kind of movement into the future that is being assumed* and *the reason for the movement into the future*. In regards to the first, a key distinction will be whether the movement towards the future is assumed to be towards a known state or an unknown state. In regards to the second, a key distinction will be whether it is assumed that a phenomenon moves towards the future in order to realize some optimal arrangement, a chosen target, a mature form of itself, or continuity and transformation of its identity.

Stacey *et al.* (2000) suggest five notions of teleology that relate to the above discussion in different ways: Secular Natural Law Teleology, Rationalist Teleology, Formative Teleology, Transformative Teleology, and Adaptionist Teleology. Nilsson (2005) uses the notion of teleology in logistics and concludes that three of these are applicable to the context of

logistics and supply chains management (SCM), namely rationalist, formative and transformative. Transformative teleology is the most prominent in modern complexity theory (Nilsson, 2005) while the other teleological notions can be found in some of its applications (Stacey *et al.*, 2000).

Setting optimally agreed upon long-term targets makes the future of supply chains and their agents barely recognizable – they have to become sustainable and develop sustainably by fulfilling the targets – but the strategies and challenges are subject to change and to being driven by self-organizing processes. The new strategies and challenges are influenced by the previous ones; they might be replication of the past but with the potential for transformation.

Transformative teleology is well matched with the reality of supply chains when both freedom and conflicting constraints and paradoxes arise in the spontaneity and diversity of micro interactions (i.e., interactions among supply chains agents). As Nilsson (2005, p. 46) states: *“In these paradoxical change processes cooperation and competition, conflict and agreement, control and the inability of it, order and disorder, etc., are present simultaneously and are needed for future development”*.

By understanding the complexity of supply chains, interactions among their agents, and creativity as well as novel changes inside them is enabled with a perspective of transformative teleology. The patterns of current trends and themes as well as the missing ones need to be identified in the process of recreating strategies that matter for a sustainable society and the planet. Equally important is the execution and operationalization of the strategies. It is in the daily interactions among supply chain agents that the required actions will take place. Furthermore, in these transformative processes, the understanding of current trends and themes will influence the absorptive capacity (Todorova and Durisin, 2007; Gao *et al.*, 2008; Fabrizio, 2009) of organizations and governments. Radical suggestions may hinder instead of help the changes needed to transit towards the targets set because the agents will not act upon them, but only debate or even ignore them. The innovative strategies needed to obtain sustainable development can also be improved by learning from the past ones.

Achieving the global and EU targets appears to be tremendously challenging. It is obvious that with current business-as-usual approaches, the goals cannot be reached (European Union, 2011, p. 4-5). Instead new strategies with innovative solutions are required. Breaking the current approaches, ways of thinking, and patterns of behavior is fairly complex, costly, and time-consuming. Although innovation can be radical, adaptation of new technologies as well as change of behavior are incremental (Rogers, 2003). In order to transform supply chains activities towards targets, the pattern of challenges need to be identified and classified and the challenges' influence on sustainability assessed. Finally, the challenges need to be tackled and continually reassessed. In order to transform supply chains towards sustainability targets and to create and recreate sustainability-oriented strategies, the trends that can influence sustainable development of supply chains activities in the short and long term should be continuously explored and reassessed.

1.3 Research purpose and questions

The purpose of this research was to explore themes and challenges in developing sustainable supply chain activities from theoretical and empirical perspectives.

To achieve this purpose, it was first necessary to take a more holistic view of the pattern of currently discussed themes and challenges reflected in the research literature. Insights could thus be gained on: sustainability-oriented topics that are discussed; sustainability-oriented activities that are carried out by different supply chain stakeholders; how sustainability is materialized in the supply chain; and the most discussed difficulties, obstacles, or dilemmas that can hinder sustainable development of supply chain activities.

Being more holistic also facilitated the understanding of similarities and differences in the research literature and empowered suggestions of closed-to-reality propositions for tackling the challenges. Themes and challenges of sustainable development were then explored more in-depth in different empirical settings, namely transport, logistical services, and urban freight distribution. These represent areas that are critical while challenging for sustainable development of supply chains (Wu and Dunn, 1995; McKinnon *et al.*, 2010).

Complexity theory was the theoretical perspective chosen due to its applicability and ability to provide an understanding of the complex phenomena that both sustainable development and supply chains represent. Consequently, the following research questions emerged during the research process:

RQ1. What are themes and challenges in making supply chains environmentally sustainable?

In the early phases of the research process, it became clear that holistic perspectives on environmental issues were lacking and little attention had been paid to challenges, i.e., difficulties, obstacles, or dilemmas in developing environmentally sustainable supply chains (Richey *et al.*, 2010). As a result, RQ1 was set.

RQ2. What are themes and challenges in making supply chains socially sustainable?

In the later phases of the research process, it became clear that social aspects of sustainable supply chains had not been as well-discussed as environmental ones in practice or in theory (Hutchins and Sutherland, 2008; Abbasi and Nilsson, 2012; Seuring, 2013). During several research projects, conferences, seminars, workshops, and meetings it also became clear that different supply chains stakeholders had inadequate knowledge and were uncertain about their social responsibilities in practice. These stakeholders included practitioners/supply chains actors, decision and policy makers, NGOs, consumers, along with researchers and consultants. In addition, as some previous literature (Gimenez *et al.*, 2012) claims, the published literature in the field is trans-disciplinary and fragmented.

RQ2 was set in order to take a more holistic view on the existing literature in this field and explore what may challenge or hinder social sustainability of sustainable chains.

RQ3. What are themes and challenges in making freight transport environmentally sustainable?

“Traditional supply chain management focuses primarily on market and manufacturing issues, and transport has typically been considered as a rather marginal activity” (McKinnon *et al.*, 2010, p. 119), although freight transport is considered to be the key element in modern supply chains (Cetinkaya *et al.*, 2011, p. 4; Sternberg, 2011).

However, the majority of negative (environmental) impacts of logistical activities emanate from freight transport (Wu and Dunn, 1995). Freight transport leads to atmospheric pollution

(global in the form of GHG emissions, regional in the form of acid rain and photochemical smog, local concerning health and air quality) (McKinnon *et al.*, 2010), noise pollution, accidents, injuries, congestion, visual intrusion, vibration, land take, and more.

According to the International Energy Agency, transport accounts for 13% of all global GHG emissions and 23% of global carbon dioxide emissions. Fatalities from transport account for 1.27 million yearly and more than 80% of air pollution in developing countries can be attributed to the transport sector (UNEP, 2012). Over the past decade, transport GHG emissions have increased at a faster rate than any other energy using sector (IPCC, 2007; Cetinkaya *et al.*, 2011) and still represent the fastest growing in the future (Browne, 2005). Transportation activities are expected to grow robustly over the next decades. As a result, in a business-as-usual scenario, it is predicted that there will be an annual increase of world transportation energy use of 2%, and an 80% higher total transportation energy use and carbon emissions in 2030 compared to the 2004 levels (IPCC, 2007).

Freight transport has grown even more rapidly than passenger transport and is expected to continue to do so (World Business Council for Sustainable Development, 2004). In the EU, for example, the demand for freight transportation is expected to grow on average by 2.7% per year. Globally, freight transportation is expected to grow from approximately 15 trillion ton-kilometers in 2000 to around 45 trillion ton-kilometers in 2050 (World Business Council for Sustainable Development, 2004).

In Sweden, 40% of the CO₂ emissions are from the transport sector (Swedish Energy Agency, 2010). Depending on where the systems boundaries are set, freight (goods) transport accounts for between 25% (just domestic transport) and 40% (both domestic and overseas transport) of CO₂ emissions (Swedish Energy Agency, 2010). As a result, 10-16% of CO₂ emissions in Sweden are due to freight transport. National freight transport is increasing in line with growth of the GDP and it is expected to double by 2050 (LETS-rapport, 2013).

In the research process, it was determined that themes and challenges would be explored from the logistics service providers' (LSPs) perspective. This was because of the increase in outsourcing of logistical/supply chain services to LSPs (Rao and Young, 1994; Gripsrud *et al.*, 2006; Stefansson, 2006; McKinnon *et al.*, 2010, p. 116) as well as less research on sustainability promotion and policies (Wigan and Southworth, 2004; Himanen *et al.*, 2004; Lieb and Lieb, 2010; Colicchia *et al.*, 2013). Lin and Ho (2008) argue that despite the great environmental impact of logistical activities, the logistics industry is still in its infancy when it comes to environmental issues. According to Wolf and Seuring (2010), the transport activities of LSPs are the single largest source of environmental hazards and CO₂ emissions in the logistics industry. Lack of research dealing with sustainability issues out of the LSPs' perspective promoted the formulation of RQ3.

RQ4. What are themes and challenges in making urban freight distribution sustainable?

It is expected that the number of residents in cities will grow from what is currently half of the world's population (approximately 3.6 billion) to more than 80% of humanity in 2050 (approximately 7.7 billion) (UNEP, 2012). Cities are becoming increasingly important from a sustainable development perspective on supply chain activities as they drive economic growth and play a significant role in employment, production, trade, consumption of materials and energy, the production of waste, and GHG emissions (UNEP, 2012).

As a result of rapid expansion of the planet’s urban population, urban areas continue to grow at a faster rate than any other land use type. In Europe, approximately 80% of the citizens live in urban environments (McKinnon *et al.*, 2010). On the same continent, 85% of the gross domestic product (GDP) is generated in cities (European Union, 2009). Freight distribution in urban environments has an array of challenges as a multidisciplinary field (Dablanc, 2007).

Until relatively recently, researchers and policy makers have paid little attention to urban freight (Álvarez and de la Calle, 2011). The scenario becomes even worse when it comes to awareness of, and attention to, sustainable urban freight distribution as “*the problems experienced by those performing freight transport and logistics operations in urban areas are far less well understood*” (McKinnon *et al.*, 2010, p. 286). More than a quarter of the total CO₂ released by urban traffic is due to freight distribution, the fastest growing source of total CO₂ emissions in the urban environment (Dablanc, 2008). In the European Union (EU), urban transport is responsible for about a quarter of CO₂ emissions from transport, and 69% of road accidents occur in cities (European Union, 2011). Lack of research in both theory and practice motivated formulation of RQ4, in line with interests of the research projects’ stakeholders.

1.4 Research scope and demarcations

In total, six research studies (RS) were designed and carried out to answer the research questions and provide further discussion about management, governance, and development of sustainable supply chains activities.

The scope of the second study was on the social pillar of sustainable development. The scope of the other studies was on the environmental pillar. However, due to the integrated nature of sustainable development, interactions/interrelations of all its triple pillars/bottom lines were also taken into account. The scope of the first and second research studies (RS1 and RS2) was a more holistic view on supply chain activities in general.

The third study (RS3) was limited to freight transport and the fourth study (RS4) to urban freight distribution activities of supply chains. The fifth study (RS5) was designed based on results of the first and third studies. In RS5, the interviewed logistics service providers (LSPs) in RS3 were surveyed about the challenges identified in RS1. As a result, RS5 was limited to LSPs and their triadic relationships with shippers (consignors and consignees) (Figures 1.1.a and 1.1.b).

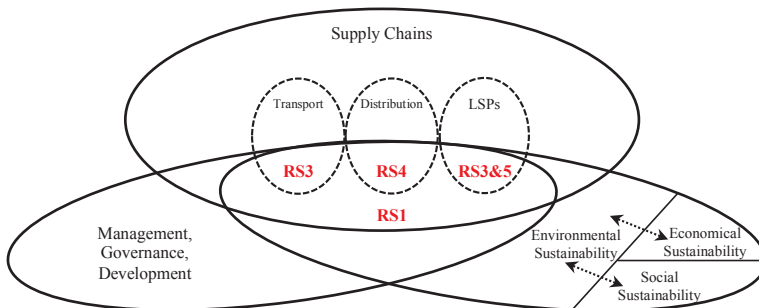


Figure 1.1.a. Focus and demarcation of the research studies 1, 3, 4, 5 (RS1, RS3, RS4, RS5)

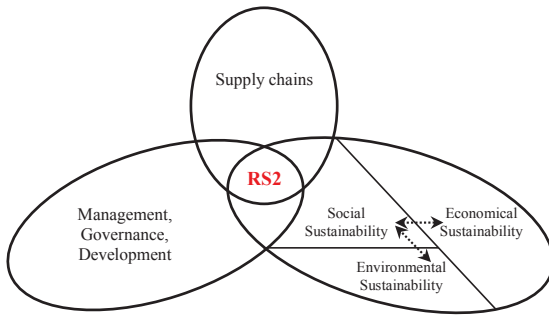


Figure 1.1.b. Focus and demarcation of the research study 2 (RS2)

The whole research process (see chapter 2) was based on a complexity theory perspective (CTP). Taking this perspective, RS6 led to a discussion about management, governance, and the development of sustainable supply chains activities in chapter 4, as well as reflective discussion about the emerged central themes and challenges in making supply chains sustainable in chapter 6 (Figure 1.1.c).

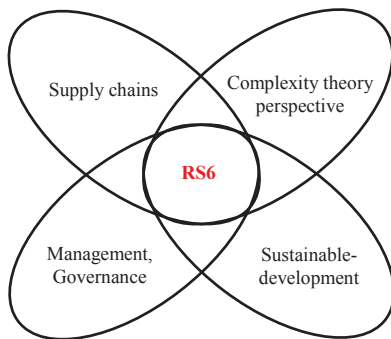


Figure 1.1.c. Focus and demarcation of the research study 6 (RS6)

1.5 Readers' guidance

The main target groups of this dissertation are researchers, students, and practitioners in the disciplines of supply chains, logistics, and sustainability studies. Study of the dissertation is also recommended for managers, decision and policy makers as it can be beneficial when they approach sustainable supply chains and logistics management, governance, development, strategies, and challenges.

Chapter 2 describes the research and learning processes. Chapter 3 presents the theoretical frame of reference and definitions. Chapter 4 reports on the exploration of a complexity theory perspective in managing, governing, and developing sustainable supply chains. Chapter 5 goes into the results of the research studies. Chapter 6 offers complementary discussions, and chapter 7, closing remarks. Researchers and students are recommended to read all the chapters sequentially. Other readers, including practitioners, managers, as well as decision and policy makers, are recommended to read (at least) chapters 4 and 6 sequentially.

2. CRAFT OF RESEARCH

Noting but knowledge and wisdom are infinite powers.

This chapter provides an overview of the research and learning processes during the doctoral program. It elaborates on how knowledge was produced, communicated, and accumulated; and on how learning was strengthened by doing, experimenting, and being involved.

2.1 Harnessing wisdom

The ultimate aim of the doctoral program was to scientifically harness wisdom, that is, “the ability or result of an ability to think and act utilizing knowledge, experience, understanding, common sense, and insight” (Dictionary.com) (Figure 2.1). According to Reeves (1996), wisdom encompasses the three dimensions of cognition, conation and affection. Cognition is in-depth knowledge of basics, experience, the limits of certainty, and the dialectical or reflective use of acquired knowledge. Conation is the degree of impulsiveness or cautiousness. Affection is the influence of emotion on the generation of effective alternatives.

In order to increase the cognitive wisdom, knowledge was scientifically generated, communicated, and used (section 2.2) to find trustworthy and authentic answers to the research questions as well as further discussion. Repeating and linking these processes led to deep leaning of the accumulated knowledge (Biggs and Tang, 2007; Reeves, 1996). With regard to this, I tried to: a) take a broad view on the different parts of supply chains and relate their sustainability-oriented themes and challenges to find patterns of associations; b) relate the results of the research studies to each other as well as the previously accumulated knowledge before starting the doctoral program; c) understand the meaning of the collected data by analyzing, synthesizing and interpreting them (section 2.2.8); d) send the accumulated knowledge to my long-term memory by repeated reading, writing, listening, and speaking about different processes of the research (section 2.2); e) make use of evidence in the research studies by referring to what had been said, observed, or scientifically written; f) make use of inquiry by asking others, such as experts, practitioners, scholars, and decision-makers in cases of misunderstandings and obscurities; g) relate concepts to everyday experience; h) interact vigorously with the content during the research process; and i) keep myself motivated.

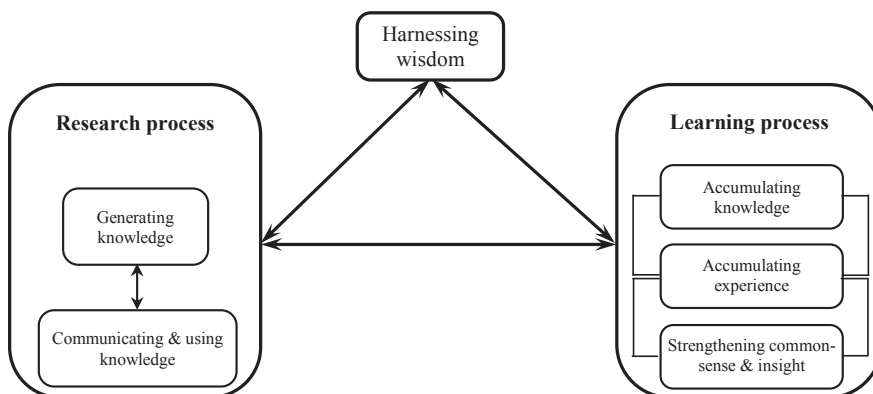


Figure 2.1. Harnessing wisdom during the doctoral program

Accumulating experience (by engaging me in the research projects and working context) and strengthening understanding through common sense and insight (by accumulating my observations and learning from my intuitions) increased my cognitive, conative, and affective wisdom. Harnessing wisdom was a dynamic process that dynamically developed during the entire program.

2.2 Research process

The aim of the research process was to scientifically generate, communicate, and use knowledge (Figure 2.2). This was accomplished by finding trustworthy and authentic answers to the research questions and by means of the discussions in chapters 4 and 6 of how to manage, govern, and develop sustainable supply chains, tackle the challenges, and solve practical and research problems.

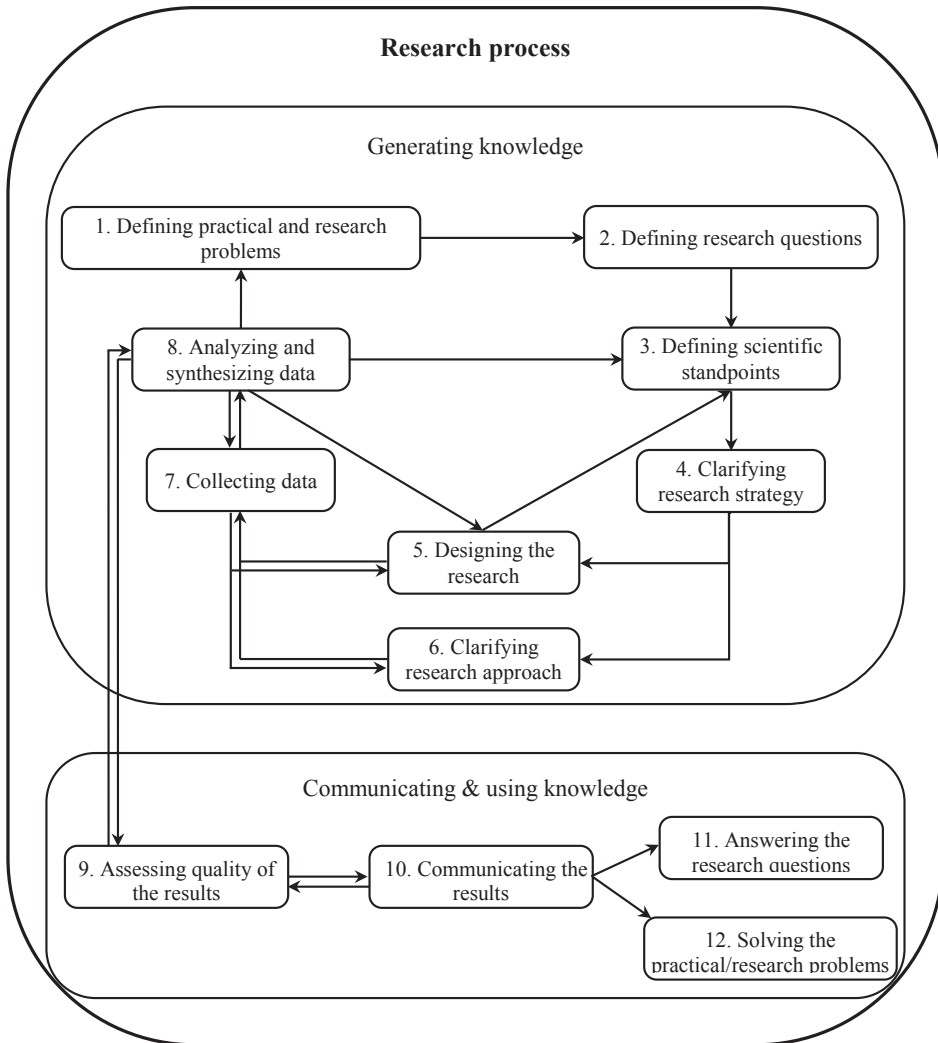


Figure 2.2. Producing and communicating knowledge in the research process

As illustrated in Figure 2.2, the scientific research process started by identifying practical and research problems in developing sustainable supply chains. This motivated the research questions, mentioned in the previous chapter. During the research process, my scientific standpoints were clarified (section 2.2.3). My ontological, epistemological, teleological, and theoretical stances remained aligned, but the axiological one was redefined. It was redefined based on the scope of each research study and what was considered valuable/ important/ interesting to investigate at the time. Clarifying the scientific standpoints was important as they influenced the data that were to be collected, how they were to be collected, how they were to be analyzed, the theories and assumptions to be considered, and the types of perspectives, views and paradigms that were required.

Based on the scientific standpoints, a research strategy for dealing with the research questions was clarified. From the research strategy, which was transformative by nature, the six research studies emerged and the approaches were clarified. In this transformative process, in discussions with colleagues and supervisors, I used what I found the most appropriate methods and areas of investigation for collecting relevant data from the relevant sources and then analyzed and synthesized them. After assessing the quality of the knowledge obtained, the results were communicated to several target groups through a number of channels. The results were used to answer the research questions, solve the practical/research problems, and for further discussions in chapters 4 and 6.

2.2.1 Defining practical and research problems

As elaborated in the last chapter, in the early phases of the research process, it became clear that supply chains activities have several negative effects on the natural environment. If early remedies for mitigating the negative effects cannot be found, the costs will be too high for future generations to cope with the effects. It might also be too late for them to find and implement long-term solutions to keep our planet a sustainable place to live and to keep our businesses sustainable to operate. It also became clear that holistic perspectives for dealing with environmental issues in supply chains were lacking. Gradually, it became clear to me that developing environmentally sustainable supply chains requires a packet of several evolving remedies with minimum antagonistic effects but grounded in energizing paradoxical discourses in order to drive the necessary change processes. However, for me to understand and better comprehend the scientific status of the area, a thorough investigation was found essential of the challenges (difficulties, obstacles, dilemmas) which could/can hinder the environmental sustainability of supply chains. Afterwards, themes and challenges were explored more in-depth in different empirical settings, namely transport, logistics services, and urban freight distribution. These represent areas that are critical while challenging for sustainable development of supply chains (Section 1.3).

During the research process, especially after the analysis and synthesis of the contemporary research on environmentally sustainable supply chains, it was found that supply chains have several negative effects on their surrounding societies that have to be mitigated. They also have responsibilities for both sustaining and developing their surrounding societies. However, it has been inadequately and asymmetrically addressed, both in theory and practice, as to what the responsibilities exactly are, the extent to which businesses are responsible, and among whom the responsibilities are to be shared. It became clear that there is lack of frameworks/ models and theories for dealing with the social responsibilities of supply chains; especially those that emphasize holistic perspectives. In addition, a thorough investigation of the challenges and barriers that could/ can hinder the social sustainability of supply chains was found essential.

2.2.2 Defining research questions

By realizing the challenging nature of developing sustainable supply chains activities and the rather limited scientific frameworks/ models and theories for dealing with sustainable supply chains, the research questions were defined (Booth *et al.*, 2008). Other factors also had a direct or indirect influence on defining the research questions. These included my personal interests and previous knowledge and experience (especially from the fields of logistics and supply chains management); the research projects' interests (challenges were also interesting for project stakeholders); support from the advisory groups including supervisors and colleagues; and feedback from other stakeholders such as researchers, consultants, decision and policy makers, industries, and businesses.

The first research question was defined in the initial stages of the research process. Finding answers to this question was very useful as I could take a more holistic view on what themes had been discussed, what themes had not been discussed that could be opportunities for further research, what the pattern of challenges was, and how scientific knowledge was produced. The third and fourth research questions were developed and defined during the research process, particularly when the necessity of exploring more in-depth settings was revealed. Although the second research question was developed during the entire research process, it was defined in the later stages when the focus shifted from environmental to social aspects of sustainable supply chain activities.

2.2.3 Defining scientific standpoints

Scientific standpoints are related to my ontological, epistemological, axiological, teleological, and theoretical stances as well as the perspectives that were with me all the time during the research process.

Ontological stance

“*Ontology is a branch of metaphysics dealing with the nature of being*” (Oxford Dictionaries). According to Bryman and Bell (2007), social ontology is concerned with the nature of social entities and the meanings of social phenomena where the central point of orientation is *objectivism (realism) or constructionism (constructivism or nominalism)*.

My ontological stance was mainly towards constructionism. In my opinion, supply chains are constructed by social actors. In fact, it is the supply chain agents and stakeholders that give meaning to its existence. Supply chains do not emerge without integrating the agents' processes along with information about the flow of goods and resources. Management, governance, and development of supply chains require an understanding of subjectivity and revisions in supply chains strategies, design, and operations. Supply chains resources are also tied to revision, change and reconstruction in the short or long term. These resources can be classified as *tangible* (physical [static and movable], financial), *intangible* (brand, reputation, culture) and *human* (skills, knowledge, motivation, capacity for communication and collaboration, capabilities) (inspired by Magnusson, 2008). Some examples of static resources are: terminals, hubs, distribution centers, warehouses, offices, machineries. Some examples of movable resources are: vehicles, unit loads, cargo carriers, tools, and instruments.

The sustainability of supply chain activities is also tied to subjectivity. The sustainable development of supply chains depends on the eyes of the beholder. Its social activities, for example, may be sustainable for social actors of a specific society (like a country) while

unsustainable for actors of another. Sustainable development of supply chains may also vary at different time periods.

Epistemological stance

Epistemology is the theory of knowledge (Rescher, 2003) and justification (Audi, 2003). It involves long-standing debates about what knowledge is and how it is obtained (Kvale and Brinkmann, 2009). The central point of orientation in epistemology is *positivism* or *interpretivism* (*anti-positivism* or *relativism*) (Burrell and Morgan, 1979; Bryman and Bell, 2007).

My epistemological stance in this research was mainly towards interpretivism. This is because the knowledge generated about themes and challenges relatively, subjectively – and perhaps even impartially – reflect the reality of developing sustainable supply chains and may change over time. The knowledge produced by exploring a complexity theory perspective (CTP) was also subject to interpretation of the meanings of an aggregated body of its dimensions in the complex phenomena of sustainable development in complex supply chains.

Axiological stance

Axiology is a branch of philosophy that deals with the role of values, such as ethics and aesthetics (Dictionary.com, Merriam-Webster.com, Niiniluoto *et al.*, 2004) in the research process. In my stance, the research process was influenced by what I considered valuable: generating and communicating knowledge in a scientific and systematic way. However, I tried to do investigate what I was interested in and motivated to do and run the research process in a way that was beneficial both for me and the group (i.e., the stakeholders of our division at the university as well as our research projects). As Nilsson (2005, p. 35) states: *“Processes and phenomena, where human beings are involved, are not simply a sequence of mechanical devices which can be assumed to work along positivistic beliefs, are instead a complex network of living, innovative, creative and evolving creatures which react and adapt dynamically to their perceived environment, and try proactively to create what they themselves, or collectively with others, find to be beneficial to their own interests.”*

Teleological stance

As explained in section 1.2, I take a transformative teleology stance (Stacey *et al.*, 2000) in supply chains, where moving towards the future is both known and unknown because the future of supply chains and their agents are barely recognizable – they have to become sustainable and develop sustainably by fulfilling the targets – but the strategies and challenges in achieving the targets are subject to change and driven by self-organizing processes. In addition, the reasons for the movement concern both continuity (sustainability) and transformation of identity (developing sustainably). The new strategies and challenges are influenced by the previous ones; they might be replication of the past but with the potential for transformation. Transformative teleology also facilitates understanding paradoxes, conflicting constraints, and gradual or abrupt changes that may exist in moving towards sustainability targets.

Theoretical stance

My theoretical stance developed during the entire program. Chapters 3 and 4 clarify my theoretical stance to supply chain management, sustainable development, and complexity theory. Complexity theory provided a perspective/ view on my research and influenced how I navigated it; how I clarified my ontological, epistemological, and teleological stances; how I collected, analyzed, and synthesized data; how I understood trends and changes in supply

chains and their surrounding environments; how I defined self-organizing, emerging, co-adaptive, and co-evolutionary characteristics of supply chains; and how I considered the nonlinear dynamics of interconnections and existing paradoxes in managing, governing, and developing sustainable supply chains.

2.2.4 Clarifying research strategy

The strategy for the research emerged by determining each of the research questions and clarifying the scientific standpoints. Research strategies can be considered as quantitative, qualitative, or mixed. Inspired by Bryman and Bell (2007), the strategy for carrying out this research was mainly qualitative due to its constructionist ontological, interpretivist epistemological, and transformative teleological stances (section 2.2.3); and because it was properly fitted to management studies (Gummesson, 2000). A qualitative strategy can better deal with subjectivity, meaning, and interpretation of sustainability aspects of the actions of supply chain agents/ stakeholders/ actors since many more dimensions are considered rather than excluded in the favor of precision.

2.2.5 Designing the research

Research design presents a structure that guides the execution of research method(s) and the analysis of the subsequent data. Bryman and Bell (2007) outline five prominent research designs: experimental, cross-sectional, longitudinal, case study, and comparative.

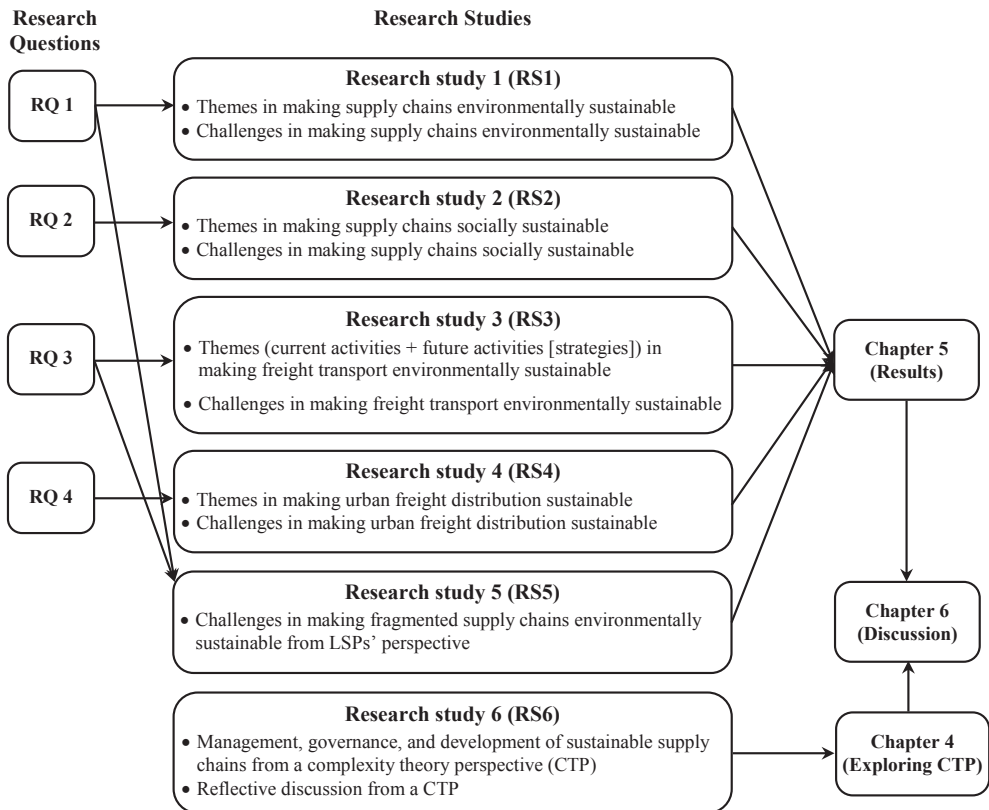


Figure 2.3. Design of the research studies

Although due to trade-offs there is not a perfect research design (Patton, 2002, p. 223), this research has a dominant cross-sectional design (Bryman and Bell, 2007) as data were collected from different sources over a period of time (i.e., during the doctoral program) in order to detect the pattern of themes and challenges in making supply chains sustainable. In some parts of the research process, case studies were also designed to gain a deeper insight into logistics service providers in context of supply chains.

As mentioned in the previous chapter and shown in Figure 2.3, six research studies (RS) were designed. The purpose of RS1-5 was to find trustworthy and authentic answers to the four research questions (RQ) (RQ1-4). The themes and challenges identified in the research studies were further classified – in order to explore (Livesey, 2003) their patterns of association – and elaborated in chapters 4, 5, and 6. RS6 led to a discussion about management, governance, and development of sustainable supply chains activities reflected in chapter 4 as well as reflective discussion in chapter 6. All the data were collected from different sources at a single point in time.

2.2.6 Clarifying research approach

The research approach (Kovács and Spens, 2005; Spens and Kovács, 2006) or reasoning logic (Hugh and Gauch, 2003) behind the research were mainly inductive and abductive which have appeared in relatively few existing studies in the logistics and supply chain literature (Kovács and Spens, 2005; Carter and Rogers, 2008; de Brito and van der Laan, 2010).

As illustrated in Figure 2.4, due to the inductive approach in this research, the themes and challenges emerged and were generalized from the study of supply chains, freight transport, urban freight distribution, and logistical services. Such an inductive approach was considered suitable in dealing with the qualitative research strategy and a broad spectrum of aspects that could be of relevance for the research questions. However, the reasoning logic behind the fifth study had elements of deduction because it was driven from the results that emerged in the first and third research studies. The characteristic of the discussion from the central dimension of a complexity theory perspective (CTP) became deductive, too. However, the reflective discussion about the emerged central themes and challenges as well as the discussion about management, governance, and development of sustainable supply chains activities in the six research study became abductive as they also co-developed with other research studies during the research process.

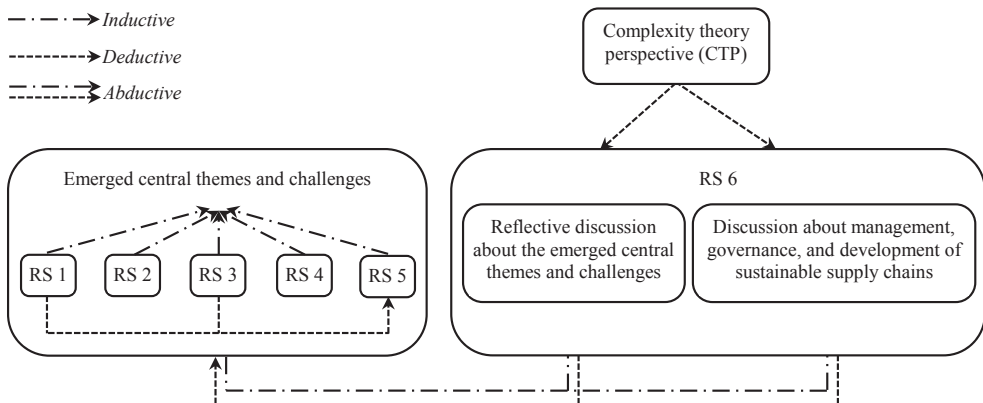


Figure 2.4. Inductive, deductive and abductive research approaches

2.2.7 Collecting data

During and after the design of each research study (RS), data were collected from a variety of sources, by different researchers on some occasions and by different methods. However, the research design, data collection, and data analysis were mixed (Patton, 2002, p. 248) and overlapping as they were not completely sequentially carried out.

RS1, RS2, and RS6 were treated theoretically while RS3, RS4, and RS5 were treated both theoretically and empirically. A summary of different research methods for the collection of data is presented in Table 2.1.

Method of data collection	Research Study	Description
A) Narrative literature review	RS1 RS2 RS3 RS4 RS5 RS6	<ul style="list-style-type: none"> • Peer reviewed journal and conference articles • Books, licentiate and doctoral theses • Documents and reports from selected websites and media • Documents and reports of the research projects • Primary sources of literature
B) Systematic literature review	RS2 RS4	<ul style="list-style-type: none"> • Systematic selection and review of peer reviewed journal articles
C) Content analysis	RS1	<ul style="list-style-type: none"> • Content analysis of selected articles (unit of analysis) from selected journals
D) Interviews	RS3	<ul style="list-style-type: none"> • Qualitative semi-structured interviews with selected LSPs
E) Survey	RS5	<ul style="list-style-type: none"> • Qualitative open-ended survey with selected LSPs

Table 2.1. Methods of data collection in this research

A) Narrative literature review

Review of existing literature was the common method of data collection for all the research studies in the whole research process. The purpose of exploring the existing literature was to become familiar with the common ground of the research area including the main concepts, theories, themes, challenges, and evolution. The purpose was also to think critically; to explore significant controversies, untested assumptions, and unanswered research questions; to provide a knowledge base for myself and other researchers, practitioners, and decision-makers; and to position my research in relation to previous research. However, the literature review was challenging due to the fragmentary and trans-disciplinary characteristics of management and organizational studies and difficulties in accumulating a knowledge base from diverse literature (Denyer and Tranfield, 2009).

According to Bryman and Bell (2007), a literature review can be categorized as *narrative* or *systematic*. The former tends to be less focused and more wide-ranging in scope than the later. All the research studies took advantage of the narrative literature review while the second and fourth studies were initiated by a narrative literature review and continued with a systematic one (for more information, please refer to the appended papers).

The narrative literature review was mostly from secondary sources and documents (summarized below). However, some primary sources of literature – such as theses, reports, and book chapters previously written by the author – were also considered during the collection of data.

Peer reviewed journal and conference articles

To collect a reliable number of reliable articles, the online database at the Lund University Library in Sweden (LUBsearch – previously named ELIN and Summon) was selected. It includes sources such as electronic journals, E-print archives, JSTOR, IEE/IEEE standards and proceedings, the Proquest ABI database, EBSCO databases, publisher websites (e.g., Emerald, Elsevier, Springer, and Wiley, Taylor & Francis Ltd., INFORMS), and the internal databases of the Lund University.

Books, licentiate and doctoral theses

Some hard copy or electronic books as well as licentiate and doctoral theses relevant to the purpose of the study were also read and referred to during the research process.

Documents and reports from selected websites and media

Some relevant documents (reports; public, organizational, and company documents; mass media outputs) from trustworthy websites and media were also read and referred to during the research process.

Documents and reports of the research projects

Some publications and documents available on websites or intranets of the research projects were also read and referred to during the research process. The research projects included: LETS 2050¹, Øresund EcoMobility², and Outcome-Driven Innovation at SCA Company³.

B) Systematic literature review

The second and fourth research studies (RS2 and RS4) also took advantage of systematic literature reviews for data collection.

In the RS2, after formulating the research question, the search system of Lund University Libraries (LUBsearch) was used for books, articles, and journals. LUBsearch was searched for (social sustain* AND supply chain*)⁴ in the title and/or abstract of articles. As the unit of analysis in this study was “peer-reviewed journal articles”, the search results were refined to: peer reviewed academic journals (magazines, trade publications, books, conference materials, and internal library catalogues were excluded) and their articles, written in English, until the end of 2012. In total, 458 available articles were found.

In the next step, abstracts of all the 458 articles were examined and on some occasions the entire article was read. The abstracts that were duplicated or had irrelevant topics for RS2 (where the actual focus was on chemistry, physics, medicine, neurology, immunology, pharmacology, or arithmetical subjects [e.g., “Markov chain”, “causal chain”]) or had used “social” in reference to “social science” were excluded during the review process. In total 197 abstracts were considered as pertinent for the purpose of RS2. Afterwards, the full texts of the pertinent articles were saved in a database and read by the author. During the reading process,

¹ http://www.lth.se/lets2050/english/about_lets/

² <http://www.interreg-oks.eu/se/Menu/Projektbank/Projektlista+%C3%96resund/%C3%98resund+EcoMobility>

³ <http://www.sca.com>

⁴ (soci* AND sustain* AND supply chain*) also led to the same search results.

the articles were classified as less relevant (90) and relevant (107). The less relevant ones were those that mainly referred to environmental and/ or economic aspects of sustainable supply chains, although mentioning CSR or soci* in the abstracts. There were also several articles in this category that treated sustainability as the ability to maintain and continue the business relationships, trust and competitive advantage; resistance and resilience; and risk management. Three of the less relevant articles were editorial reviews. The relevant articles were those that implicitly or explicitly elaborated on a socially relevant theme (e.g., concept/ aspect/ terminology/ activity/ topic) and/ or challenge (e.g., difficulties, obstacles, or dilemmas).

In RS4, after formulating the research question, the online database of Lund University Libraries (LUBsearch) was searched by a combination of selected keywords, namely ((Urban freight* OR City logistic*) AND (Sustain* OR Environment* OR Green)). The keywords searched for had to be in title and/or abstract and/or keywords of the articles. This resulted in 470 available articles. Next, the abstracts of all available articles were read. On some occasions, the introduction and conclusion sections of the articles were also read or the entire article was skimmed.

The most relevant articles for the purpose and scope of the RS4 were then selected and registered in an Excel file. In total, 61 articles (13% of the total available) were selected. The criteria for selection of the articles were that the discussed data had a thematic character because it referred to a sustainability or an environmentally sustainable concept/ aspect/ terminology/ activity/ topic (e.g., management, education, innovation, developing environmentally friendly modes of transportation), or explicitly referred to a challenge (e.g., difficulties, obstacles, or dilemmas). It is worth mentioning that some articles appeared repeatedly in one or several categories. In such cases, just one of them was counted. The articles/ abstracts that were written in a language other than English were not included. The selected articles were then totally read.

C) Content analysis

The first research study (RS1) also took advantage of content analysis for both data collection and analysis. Content analysis is a set of research tools for the scientific study of written communications with the objective of determining key ideas and themes contained within them (Cullinane and Toy, 2000).

Content analysis can be both qualitative and quantitative, where the latter seeks “*to quantify content in terms of predetermined categories and in a systematic and replicable manner*” (Bryman and Bell, 2007, p. 302). Qualitative content analysis can satisfy the inductive assumptions of qualitative researchers. It comprises an exploration of underlying themes in the materials being analyzed. The aim is to be systematic and analytical but not rigid. The process of content analysis in RS1 was mainly qualitative, as the area of investigation was complex and based on a variety of examples, cases, methods, perspectives, etc. In what follows, several steps of the content analysis are briefly explained.

Selection of a sample

In order to answer the first research question, a relevant and valid sample of literature had to be systematically selected. The sampling method in RS1 was based on convenience and non-probability. The selection of convenience sampling was used not only to obtain a reliable and relevant base of journals and articles but also due to their availability and accessibility (other types of sampling are *snowball* and *quota*).

In the first step, the *Electronic Library Information Navigator@Lund* (ELIN) (currently known as LUBsearch) was selected as a database for journals. The research question called for sampling two types of journals: those related to supply chain management (type one) and those related to environmental sustainability (type two). In order to narrow the number of journals, relevant keywords were chosen. Type one journals were restricted to those that contained one or some of the following keywords: “Supply chain”, “Logistic-”, “Transport”, and “Transportation”. Selected keywords for type two journals were “Sustainability”, “Sustainable”, “Environment”, “Environmental”, and “Green”.

The next step was the selection of a sample from the number of journals of both types. This selection was carried out through a ranking process. Two criteria were considered to rank the journals: *citations* and *impact factors*. Journals with the highest citation number were selected through the website *www.journal-ranking.com*, while those with the highest impact factor were chosen based on the website *www.isiwebofknowledge.com*. The result was that six type one journals and twelve type two journals were selected based on the highest number of citations and impact factors (see appended Paper I).

Unit of analysis

The recording unit is the smallest body of text in which an example of one of the content categories appears. *Relevant article* was the unit of analysis in RS1. The reason for this selection was to analyze how relevant articles in the journals selected deal with environmentally sustainable/ friendly/ sound/ preferable supply chains. Such articles were selected according to the following procedure:

- Based on the initial literature review, concepts related to the research area were used to identify suitable articles in both types of journals. Articles selected from type one journals were organized and recorded in a database. They had to include one or more of the following words in the title, keyword, or abstract: “Sustainability”, “Sustainable”, “Environment”, “Environmental”, and “Green”. For type two journals, “Supply chain”, “Logistic- or Logistic*”, and “Transport-” were the keywords chosen for the search. The sample included published articles dating from the first issue of each journal until the end of 2009.
- The articles were analyzed and ranked by the authors working individually. Both authors were responsible for reading an abstract of each article and ranking its relevance to the research question by color coding it into the following: relevant (green), semi-relevant (yellow) or not relevant (red).
- Finally, results of analyses by both authors were compared and further discussions were held to select the most relevant articles.

In total, the review resulted in 190 relevant articles out of the total sample of 3637 (5.2%). However, 2407 of the suitable articles were from *Environmental Science and Technology*.

D) Interviews

Qualitative semi-structured interview was another method of data collection in the third research study (RS3). A semi-structured interview typically refers to a context in which the interviewer has a series of questions, often referred to as an interview guide, that are in the general form of an interview schedule but in which the sequence of questions can be varied (Bryman and Bell, 2007). The main reason to select this type of interview was to understand themes and challenges in making freight transport (environmentally) sustainable from the

interviewee's (LSPs) perspective by an intersubjective social co-construction of knowledge among interviewers and interviewees. The interviewees were encouraged to describe their current activities, future activities (strategies), and challenges in making freight transport (environmentally) sustainable precisely in the way that they experience and feel it. The interviewers exhibited openness to new relevant dimensions or discussions outside of the interview guide (refer to the appendix). The interviews were neither strictly structured with standardized questions, nor entirely nondirective.

The interview study in RS3 was designed based on the seven stages of a qualitative interview investigation suggested by Kvale and Brinkman (2009): thematizing, designing, interviewing, transcribing, analyzing, verifying, and reporting. The first four stages are explained in this section while analyzing, verifying, and reporting are elaborated in sections 2.2.8, 2.2.9 and 2.2.10, respectively.

Thematizing and designing

Based on our earlier research and experience of sustainable development in the context of logistics together with a number of discussions and seminars with logistics managers, several challenges were identified in making freight transportation sustainable. The main actors in freight transportation in supply chains are the LSPs. Hence, in an explorative manner it became natural to obtain an LSP perspective on the challenges of (environmentally) sustainable freight transportation.

The research focused on the LSPs active in the Scandinavian countries to ensure a comprehensive yet feasible sample. We drafted a list of 30 LSP companies based on our experience, contacts during research projects, and after asking other experts. The list included small, medium-sized, and large LSPs as we aimed to detect the pattern of themes and challenges by looking at different types. Each potential interviewee was then contacted by an e-mail that included the purpose of the study, a description of the research area (sustainable freight transportation), and an invitation to be interviewed. Telephone calls were then made to those who responded to the e-mails and had shown a willingness to participate. They were told about the purpose and the structure of the interviews. In total, 14 managers from 10 LSP companies were interviewed. The majority of the interviewees had long experience of working in the industry and had management positions in regional LSP offices for the Scandinavian markets (if the LSP was part of an international organization) or in a management team (for those operating in one nation).

The interview data collection process ended when saturation was reached. After interview seven, we evaluated the process and found that no more significant or new information was being gained for the purpose of the study. To ensure research quality, however, three more interviews were conducted from which we then concluded that theoretical saturation had been reached. The sample size for this type of research is, according to McCracken *et al.* (1990), eight for homogeneous samples. Carter and Jennings (2002) suggest 12-20 for heterogeneous samples. In this case, the companies and interviewees operate in the same geographical regions, working on similar issues and customers. Consequently, compared to global studies or ones in different industries, the sample can be regarded as homogeneous.

Interviewing

The interviews were semi-structured (Bryman and Bell, 2007, p. 474), based on open-ended questions. They lasted about 90 minutes and were primarily carried out in English. Interview guidelines (provided in the appendix) were created for the open-ended questions and were

structured into three major areas: current activities for sustainable development, future activities and trends for sustainable development (up to 2050), and challenges of sustainable development. The discussions focused on these areas for LSPs specifically and for freight transportation in general. If essential, the sequence of the questions was changed or additional questions were asked. Prior to each interview, the website of each LSP was studied in depth and information was compiled about the company in general and about sustainability-related activities, statements, reports, etc. All relevant information was documented in the interview study database so it would be accessible at other stages of the study.

Transcribing

Every interview was taped and thereafter transcribed. If there were any possible misinterpretations, uncertainties, or questions found during the transcriptions, follow up contact was made with the interviewee. Interviewees were asked to read the transcribed text and send the reviewed transcription to the authors. Each sound file as well as transcription was then placed in the interview study database.

E) Survey

RS5 was run in parallel with RS3. In the RS5, the interviewed LSPs in RS3 were surveyed about the challenges identified in RS1. In line with Leeuw *et al.*'s (2008) guidelines for conducting a survey, the following steps were taken: design, implementation, and data analysis. After the questionnaire was designed, feedback for improvement was received from both academics and industry representatives. When answering the survey questions (on a 5-degree Likert scale) the interviewees were asked to reason out loud as to how and why they made their choices. Their reasoning was recorded and later transcribed for analysis (reflected in section 2.2.8).

2.2.8 Analyzing and synthesizing data

Analysis is the craft of finding or creating the meaning of the collected data by (re)organizing them in a meaningful way. The aim of the analysis in this research was to generate knowledge (Reeves, 1996) by (re)organizing and categorizing the collected data; exploring their meanings (i.e., generate information); and identifying their patterns of associations. The analysis was carried out during and after data collection. Qualitative analysis transforms data into findings. Although there is not any formula or recipe for this transformation (Patton, 2002, p. 432), the analyses were guided by principles of content analysis, discourse analysis, analytic induction, and grounded theory (Table 2.2).

The first research study (RS1) applied content analysis to the interpretation of discussed themes and challenges in the units of analysis (selected articles). There are two main elements to a content analysis coding scheme: designing a coding schedule and designing a coding manual. The *coding schedule* is a form into which all the data relating to an item being coded are entered. The *coding manual*, sometimes referred to as the *content analysis dictionary*, is a set of instructions to coders that specifies the categories used to classify the text. Categories need to be devised to provide the basis for classifying textual content (Cullinane and Toy, 2000).

The coding manual in RS1 was both deductive and inductive. In RS1, two categories were determined in advance: level of discussion in the supply chain, and treatment of sustainability. In the qualitative analysis of themes, the sub-categories were created inductively and were driven by the question of which themes and challenges had been put forward and how these had been discussed.

Method of data analysis	Research Study	Description
Content analysis	RS1	<ul style="list-style-type: none"> • Interpretation of themes and challenges reflected in selected articles (unit of analysis) from selected journals
Discourse analysis	RS3 RS5	<ul style="list-style-type: none"> • Construction of themes and challenges in subject to the interviews and surveys with LSPs
Analytic induction	RS2 RS4	<ul style="list-style-type: none"> • Universal explanation of categories of themes and challenges
Grounded theory	RS1 RS2 RS3 RS4 RS5 RS6	<ul style="list-style-type: none"> • Towards development of hypotheses and further discussion after theoretical saturation of categories of themes and challenges

Table 2.2. Methods of data analysis in this research

Principles of discourse analysis were the main tools for data analysis in the third and fifth research studies (RS3, RS5). The principles were inspired by discourse psychological aspects (Winther and Phillips, 2000) as the standpoint was that current activities and future strategies of the logistics service providers interviewed and surveyed construct the main parts of themes and challenges and are relative to what and how they express and interpret them. Data analysis in RS5 involved both the qualitative reasoning and the quantitative marks given by the respondents. This process provided insights into the difficulty of grading some of the issues addressed while other issues were much easier to assess/ grade. On many occasions the interviewees first reasoned about answering with a score of 2 or 3 but after some reasoning they gave a 5 on the Likert scale or vice versa. The uncertainty and the great variety of dimensions to handle were raised in different ways at the same time as interviewees felt that some of the measures that can be made to improve environmental performance were quite obvious. The subjective interpretation of themes and challenges in RS3 and RS5 strengthened my interpretivistic epistemological stance.

Analytic induction (Bryman and Bell, 2007; Patton, 2002) was the main strategy for data analysis in the second and fourth research studies (RS2, RS4). The principle was to seek a universal explanation of categories of themes and challenges in making supply chains socially sustainable and urban freight distribution sustainable by pursuing the collection of data until no cases that were inconsistent with the emergent categories were found.

All the methods of data analysis discussed in the research studies were inspired by tools of grounded theory (Miles and Huberman, 1994; Strauss and Corbin, 1998). The analyzed data were then synthesized (aggregated, integrated, substantiated, and interpreted) which led to the development of hypotheses in the research articles, a proposed framework, and further discussion in the discussion chapter. The common tools of grounded theory in all research studies were sampling, coding, and saturation (taken from Bryman and Bell, 2007). Collection of data was continued until theoretical saturation was reached. This means that successive interviews/ literature had both formed the basis for the creation of a category – after open and focused/ axial coding (Charmaz, 2006) – and confirmed its importance. There was no need to continue with data collection in relation to that category or cluster of categories, and themes

and hypotheses were generated out of the categories that were established. The purpose of open coding was to codify and classify the identified aspects or challenges by looking for similarities, differences, comparison, and modification of collected data (Pullman and Dillard, 2010). The purpose of focused coding (Winther and Phillips, 2000; Charmaz, 2006) or axial coding (Pullman and Dillard, 2010) was to further classify the emergent codes, seek connections and patterns of associations of the codes, and finally synthesize the similar open codes.

It is worth mentioning that “*code memos*” (Kvale and Brinkmann, 2009), “*code schedules and manuals*” (Bryman and Bell, 2007) were used during open and focused/ axial coding where the following were recorded: the names of the different codes, who coded which parts of the material, the date when the coding was done, definitions of the codes used, instructions for coding, and notes about the codes.

The generation of codes was “*data driven*” rather than “*concept driven*”. Concept-driven coding uses codes that have been developed in advance by the researcher, either by looking at some of the material or by consulting existing literature in the field. Data-driven coding means that the researcher starts out without codes and develops them through reading of the material (Winther and Phillips, 2000).

2.2.9 Assessing quality of the results

In line with Bryman and Bell’s (2007) suggestions for evaluating qualitative research, two criteria were considered: trustworthiness and authenticity.

A) Trustworthiness

Trustworthiness has four aspects: credibility, transferability, dependability, and confirmability.

Credibility

“Credibility” parallels “internal validity” in quantitative research. It entails both “*ensuring that research was carried out according to the canons of good practice and submitting research findings to the members of the social world who were studied for confirmation that the investigator had correctly understood that social world*” (Bryman and Bell, 2007, p. 411).

Results of the research studies were continuously peer reviewed by the supervisors, some of the colleagues as well the research projects’ stakeholders. To increase credibility in RS1, the corresponding Paper I was initially peer reviewed by editors of the NOFOMA 2010 Conference. After revising the paper, it was sent to *Supply Chain Management: An International Journal* and peer reviewed by its editors. Paper I was published in this journal after further revisions. According to the publisher (Emerald), Paper I has been cited several times.

Papers II and IV, corresponding to RS2 and RS5, were reviewed by editors of the NOFOMA 2014 Conference. Paper III, corresponding to RS3, was peer reviewed by editors of the NOFOMA 2011 and the TRF 2012 Conferences. It is also under review in the journal, *Transportation Research – Part D: Transport and Environment*. Paper IV, corresponding to RS4, was also peer reviewed by editors of the *Journal of Traffic and Transportation Engineering*, NOFOMA 2012 Conference, and Øresund EcoMobility research project book. In addition, in order to increase credibility in RS3, the transcribed interviews were sent to interviewees for their confirmation.

Transferability

“Transferability” parallels “external validity” in quantitative research. It is concerned with the possibility of generalizing the findings beyond the research context or transferring to other milieu (Bryman and Bell, 2007). The main factor for increasing transferability was to generate representative samples of journals and papers (in RS1, RS2, and RS4) as well as interviewees (in RS3 and RS5). In addition, a broad range of appropriate literature and documents from reliable sources was included in all parts of the research process. The identified themes and challenges in RS1 were completely transferable to RS3, RS4, and RS5 as freight transport, urban freight distribution, and logistical services are sub-activities of supply chains. The further discussion and proposition in RS6 can also be transferable to all the other research studies as they are examples of complex systems or phenomena.

Dependability

“Dependability” parallels “reliability” in quantitative research. It is concerned with the applicability of findings at other times. To increase dependability during the research process, a research logbook/ black box was created with complete records of every single phase of the research including: problem formulation, selection of samples, literature reviews, coding schedule and manual of contents analyses, data extraction forms, protocols and databases of interviews, survey guidelines, memos of open and focused coding, and data analysis procedures. However, qualitative subjectivity is inherent in the coding procedures of categories of themes and challenges. To decrease the probable bias in some of the studies, the co-authors of the papers also performed the coding procedures and finally unified the emergent categories after several hours of discussion.

Confirmability

“Confirmability” parallels “objectivity” in quantitative research. As Bryman and Bell (2007, p. 414) state: “*Confirmability is concerned with ensuring that the researcher can be shown to have acted in good faith; in other words, it should be apparent that he or she has not overtly allowed personal values or theoretical inclinations manifestly to sway the conduct of the research and findings deriving from it.*” The confirmability of the research has been assured as a research logbook/ black box was created, the standpoints and underlying assumptions were explained, all steps of the research process were explicitly highlighted, all the papers were peer reviewed, and supervisors and other colleagues, teachers, and project workers controlled all or parts of the research studies.

B) Authenticity

In line with Bryman and Bell’s (2007) suggestions for evaluating the authenticity of the research, the following criteria were considered:

Fairness

This is concerned with if the research “*fairly represents different viewpoints among members of the social settings*” (Bryman and Bell, 2007, p. 414). Diverse samplings of journals, articles, and interviewees as well as a sufficient number of them were measures to increase fairness authenticity. The next chapters also highlight several theories and perspectives that were considered during the research process.

Ontological authenticity

This is concerned with if the research helps members of the social settings “*to arrive at a better understanding of their social milieu*” (Bryman and Bell, 2007, p. 414). The research studies aimed to increase awareness of supply chain stakeholders about patterns of existing

themes and challenges in sustainable development of their activities. Although it is ultimately up to others to judge, the stakeholders involved showed their satisfaction with and support of the results of the research studies during the workshops, projects seminars, conferences, and meetings. However, in occasional cases of misunderstanding, I tried to clarify and explain my standpoints and perspective as well as the interconnections among the research studies.

Educative authenticity

This is concerned with if the research helps members “*to appreciate better the perspectives of other members of their social setting*” (Bryman and Bell, 2007, p. 414). Taking a holistic view of the entire supply chain as well as freight transport, urban freight distribution, and logistical services in the context of supply chains might made the LSPs and research projects stakeholders aware of the challenges experienced by other members of their networks such as shippers (consignors and consignees), final consumers, urban stakeholders, policy makers, and decision-makers.

Catalytic authenticity

This is concerned with if “*the research acted as an impetus to members to engage in action to change their circumstances*” (Bryman and Bell, 2007, p. 414). Although it is ultimately up to others to judge, I hope that the results of this research persuade them that changes and transformations in management, governance, and sustainable development of complex systems (like supply chains) can be better studied from a complexity theory perspective (CTP).

Tactical authenticity

This is concerned with if the research empowered the members of the social settings “*to take the steps necessary for engaging in action*” (Bryman and Bell, 2007, p. 414). Although it is ultimately up to others to judge, this research aimed to increase awareness about challenges and facilitate simultaneous operationalization of the triple bottom lines of sustainable development in the context of supply chains from a complexity theory perspective.

2.2.10 Communicating the results

After assessing the quality of the synthesized knowledge, the results were communicated to several target groups through several communication channels (Table 2.3). The results were also used to answer the research questions and for further discussion in chapters 4 and 6. Table 2.3 presents a list of some communication channels in this research.

Scientific journals

The research results have the potential to be published in different scientific journals (peer-reviewed and open access [green and gold]) in the disciplines of supply chain, logistics, transport, distribution, sustainable development, environment, social sustainability and urban studies. Paper I (result of RS1) was published in *Supply Chain Management: An International Journal*. Paper IV has been accepted for publication in *Journal of Traffic and Transportation Engineering*. Paper III (result of RS3) has been submitted to a peer-reviewed journal.

Conferences

Conferences provided good opportunities to inform other researchers of the results of the research studies as well as to ask for feedback. They also were good occasions to explore the novel research areas as well as expansion of my network. Papers I, III, and IV corresponding to RS1, RS3, and RS4 were presented at NOFOMA (Nordic Logistics Research Network) Conferences in 2010, 2011, and 2012, respectively. Paper IV was also published in the

conference proceeding. Revised versions of papers II and V have been accepted for publication in the NOFOMA 2014 Conference Proceeding. They will be presented at the Conference in June 2014. Paper III was also published in the 53rd TRF conference proceeding after some revisions.

Communication channels	Research Study	Corresponding paper/chapter	Description
Scientific journals	RS1	Paper I	<ul style="list-style-type: none"> Published in <i>Supply Chain Management: An International Journal</i>
	RS3	Paper III	<ul style="list-style-type: none"> Submitted to the journal of <i>Transportation research – Part D: Transport and Environment</i>
	RS4	Paper IV	<ul style="list-style-type: none"> Accepted for publication in <i>Journal of Traffic and Transportation Engineering</i>
Conferences	RS1 RS2 RS3 RS4 RS5	Paper I Paper II Paper III Paper IV Paper V	<ul style="list-style-type: none"> NOFOMA (2010, 2011, 2012, 2014) 53rd Annual Transportation Research Forum in USA (TRF)
Seminars, courses, workshops, meetings	RS1 RS2 RS3 RS4 RS5 RS6	Paper I Paper II Paper III Paper IV Paper V Chapters 4 & 6	<ul style="list-style-type: none"> Related seminars Colleagues' courses, PhD courses Research projects' workshops and internal meetings Popular science papers, posters, presentations
Book chapters and reports	RS1 RS3 RS4 RS5 RS6	Paper I Paper III Paper IV Paper V Chapters 4 & 6	<ul style="list-style-type: none"> Report of the fifth work package (WP5) of the LETS 2050 research project Book chapters in documents and reports of the Øresund EcoMobility research project
Tools of web 2.0	Research main messages	All papers & chapters	<ul style="list-style-type: none"> Blogs, social networks and media, podcast and videocast

Table 2.3. Some communication channels in this research

Seminars, courses, workshops, meetings

All or parts of the research results were communicated at several seminars, courses, research projects workshops, and internal meetings by popular science papers, posters, and presentations.

Book chapters and reports

Parts of Papers I, III, IV, V as well as chapters 4 and 6 of this dissertation were used in writing the fifth work package (WP5) report of the LETS 2050 research project. Parts of Papers I and III as well as a primary version of Paper IV were published as book chapters in documents and reports of the Øresund EcoMobility research project.

Tools of web 2.0

With the growing role of ICT in learning – sometimes called E-learning – new tools for communication of research and scientific information are emerging. Some of the tools of web 2.0, such as blogs, social networks and media, podcast and videocast have also been used to communicate some of the research results.

2.2.11 Answering the research questions

The results of the research studies have provided answers to the four research questions. A summary of the results of the first five research studies is presented in chapter 5. Results of the sixth research study are presented in chapters 4 and 6.

2.2.12 Solving the practical/ research problems

The results of the research studies were also used for solving the practical and research problems which motivated the formulation of the research questions. Based on the results as well as the complexity theory perspective, reflective discussion about the emerged central themes and challenges as well as complementary discussion about management, governance and development of sustainable supply chain were presented.

3. FRAME OF REFERENCE

Our standpoints form our attitude and altitude.

This chapter presents a brief explanation of the main concepts discussed during the research process. In addition, my standpoints on these concepts are clarified.

The building blocks of the research studies and other chapters of this dissertation are a set of concepts that were adopted from different disciplines. These concepts represent the labels that were given to the elements of the social world – that seem to have common features (Bryman and Bell, 2007, p. 158) – around which the research was conducted. This chapter provides a brief explanation of the main concepts of this multi- and interdisciplinary research.

3.1 Standpoint on the supply chain discipline

“Supply chain” is a concept that has evolved through several fields (Stock and Boyer, 2009) and been defined from different perspectives (Halldórsson *et al.*, 2008) and hence lacks a comprehensive and encompassing definition. Supply chains are also referred to as “demand chains”, “value chains”, and “supply/ demand/ value networks” (Christopher, 2005; Vitasek, 2010).

My standpoint in this research is that the supply chain involves processes/ activities in delivering a product or service from raw material to the customer including: purchasing and procurement (such as sourcing raw materials and stock keeping units, forecasting, order entry); manufacturing/ production (such as design and engineering, assembly, processing, testing); packaging and handling; transportation (such as carrier selection); physical distribution across all channels (such as warehousing/ storing, consolidating, cross docking, transshipment, order delivery, collecting, vehicle scheduling and routing, sorting, kitting, sequencing); marketing; selling; and information sharing. Hence, the art of supply chain is its management. This includes planning, control, review, measurement, benchmarking, evaluation, modeling, coordination, cooperation, integration, and organization of key business processes, relationships/ interactions, and channel partners (Lambert and Cooper, 2000; Vitasek, 2010) across the chain from materials extraction to consumption (i.e. the supplier/s to the customer/s) and vice versa.

However, different scholars shed light differently on the “supply chain” (SC). Handfield and Nichols (1999, p. 2) put “goods” at the center of the SC as they state: “*supply chain encompasses all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flows; Material and information flow both up and down the supply chain.*” Mentzer *et al.* (2001, p. 4) highlight entities and flows in the SC by defining it as “*a set of three or more entities (organization or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/ or information from a source to a customer.*” Although a supply chain emerges from the interactions between a business and its customer and supplier, in practice, a supply chain is a network of multiple businesses and relationships more than just a chain of businesses with one-to-one, business-to-business relationships.

Similarly, supply chain management (SCM) is also defined differently by different scholars although almost all of them encompass common elements of “interactions” or “integration”.

Simchi-Levi *et al.* (2004, p. 1) put “merchandise” at the center of SCM by defining it as “*a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements.*” Drake and Schlachter (2008, p. 851) put both “product” and “service” at the center of SCM which encompasses all upstream and downstream interactions including “*all of the activities involved in producing and distributing a product or service from the supplier’s supplier to the customer’s customer.*” Other definitions add “information” to the center of SCM and define it as “*the integration of key business processes from end-user through original suppliers, that provides products, services, and information that add value for customers and other stakeholders*” (Lambert, 2006, p. 2), “*for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole*” (Mentzer *et al.*, 2001, p. 18).

The objectives of SCM can be several such as:

- value creation, increasing efficiency, customer satisfaction (Stock and Boyer, 2009; Fawcett and Fawcett, 1995);
- reduction or minimization of total or transactional costs (Schonsleben, 2000; Hall and Matos, 2010) and waste (Handfield and Nichols, 1999);
- improved total quality (Schonsleben, 2000) and customer service (Adetunji *et al.*, 2008);
- competitive advantage (Handfield and Nichols, 1999; Mentzer *et al.*, 2001);
- maximized profitability for the company and the whole supply chain network including the end-customer (Lambert *et al.*, 1998);
- generation and development of inter-organizational resources and capabilities (Gold *et al.*, 2010).

“Logistics management” is another concept which is defined as “*that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers’ requirements*” (Council of Supply Chain Management Professionals (CSCMP. org)). Logistics management activities typically relate to flows in supply chains encompassing the management of inbound and outbound transportation, information, inventories, sourcing and procurement, warehousing, packaging, materials handling, and service providers (Ciliberti, 2008; Chesneau *et al.*, 2012). Logistics management in this research is treated from a unionist perspective (Halldórsson *et al.*, 2008) to SCM as the former is subsumed by the latter. In this sense, supply chain management goes one step further than logistics management by integrating key business processes and relationships, rather than just flows, across the chains (Lambert and Cooper, 2000).

“Distribution” is another concept that was mostly discussed in research study 4 (RS4). It is related to outbound movement and storage of finished products (McKinnon *et al.*, 2010) associated with movement from a manufacturer or distributor to customers, retailers or other secondary warehousing/ distribution points (Vitasek, 2010). Distribution is usually related to outbound logistics that have to do with downstream activities of a supply chain from a specific organization (Gripsrud *et al.*, 2006). The fourth research study (RS4), however, took a more holistic view of the aggregated distribution of several chains or organizations in an urban context. Urban freight distribution activities vary from delivery and collection of goods; goods’ transport, storage, consolidation, and inventory management; waste handling; and office and household removals (Van Duin and Van Ham, 2001; Yamada and Taniguchi, 2006; McKinnon *et al.*, 2010, pp. 282-302) to cooperation among freight stakeholders (Kawamura

and Lu, 2006) and freight distribution policies (Marcucci and Danielis, 2008). Urban freight distribution can also be referred to as “city logistics”, “urban freight logistic”, “urban logistics”, and “urban goods movement” (Dablanc, 2007). From Dablanc’s perspective (2007, p. 284), “urban logistics can be defined as any service provision contributing to an optimized management of the movement of goods in cities,”

Themes and challenges in making freight transport sustainable was the subject of the third research study (RS3). “Transport” in this study was defined as the physical movement of goods from a consignor (shipper/ sender/ hollow/ sink [outbound gateway]) to a consignee (receiver/ source [inbound gateway]). Themes and challenges were studied from selected logistics service providers. “Logistics service provider” (LSP) refers to any business that provides logistical services such as:

- transportation, storage, and warehousing (Wolf and Seuring, 2010)
- packaging, freight forwarding, and inventory management (Liu *et al.*, 2006)
- cross-docking at terminals, consolidation services at distribution centers, and transload of shipments (Stefansson, 2006; Vitasek, 2010)
- managerial activities related to flows of goods and production (Fabbe-Costes *et al.*, 2009)
- value-added activities such as merge-in-transit setups (Stefansson, 2006)

Outsourcing logistical activities to LSPs is rapidly growing (Gripsrud *et al.*, 2006) although the degree of outsourcing and the outsourced activities differ greatly (Stefansson, 2006). LSP is also referred to as “third-party logistics (3PL)”, “fourth-party logistics (4PL)”, “lead logistics partner (LLP)”, “third-party logistics provider”, and “third-party service provider (3PSP)” (Fabbe-Costes *et al.*, 2009; Vitasek, 2010).

“Packaging logistics” is another concept that was reflected on during the research process. It deals with interactions and relationships between the packaging system and logistics system (Hellström, 2007) that add value to the combined, overall system – the enterprise (Johnsson, 1998). Interactions and relationships are investigated by analyzing the mutual effects of logistics and packaging systems (products as well as primary, secondary, and tertiary packages) on each other as well as their total effects on supply chains. Saghir (2004, p. 6) defines packaging logistics as “*The process of planning, implementing and controlling the coordinated packaging system of preparing goods for safe, efficient and effective handling, transport, distribution, storage, retailing, consumption and recovery, reuse or disposal and related information combined with maximizing consumer value, sales and hence profit.*” In this research, the packaging system was addressed but not in detail at the different levels unless it was highlighted in particular by an informant or in the literature. With regard to this, goods (freight) were not solely related to work-in-process or finished products but also to the packaging system around them and the unit loads carrying them.

3.2 Standpoint on the sustainable development discipline

“Sustainable”, according to the Oxford Dictionaries, is defined as “*able to be maintained at a certain rate or level*” or “*able to be upheld or defended.*” In the same dictionary, “development” is defined as “*the process of developing or being developed*” or “*a specified state of growth or advancement*” or “*a new and advanced product or idea.*” Sustainable development in a general sense is thus related to a growth or development that can be continuously maintained or upheld.

The origins of the “sustainable development” concept date back to the mid-1960s and early 1970s. After the 1972 UN Conference on Human Environment in Stockholm, (Mebratu,

1998), the concept of sustainable development evolved from having purely an environmental focus (such as environmental assessment and management) and appeared among professionals in environment and development circles (Björklund, 2005). It was then that environmental and developmental ideas were concurrently considered and terminologies such as “environment and development”, “development without destruction”, “environmentally sound development”, and “eco-development” were used.

In 1987, a United Nations sponsored report published by the World Commission on Environment and Development (WCED) and entitled *Our Common Future*, also known as the *Brundtland Report*, popularized the term and provided it with its widely known definition: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” According to Mebratu (1998), major internationally related documents such as the “Rio Declaration”, “Agenda 21”, and “conventions on desertification, biodiversity, and climate change” were produced at the UN Conference on Environment and Development (UNCED) also known as the Rio Conference or the Earth Summit held in June 1992. Following the United Nations’ 2005 World Summit (United Nations, 2005), sustainable development encompasses the interdependent and mutually reinforcing pillars of economic development (Profit), social development (People) and environmental protection (Planet). The three pillars or Ps of sustainable development are also called the “three bottom lines” or “triple bottom lines” (3BL or TBL) (Elkington, 1997).

Sustainable development is also referred to as “corporate sustainability” (MacLean, 2010; Jeffers, 2010) or just “sustainability” (Shrivastava, 1995; Aras and Crowther, 2009).

The environmental protection pillar of sustainable development is also referred to as “environmentally sustainable/ friendly/ sound/ preferable/ responsible”, “corporate environmental responsibility”, “eco”, “green”. The term “environment” in this regard is related to the natural environment rather than the business or organizational or social environments (Aras and Crowther, 2009), which are exponentially discussed among contingency theorists (Pfohl and Zöllner, 1997; Zacharia and Mentzer, 2004). According to *The Free Dictionary*, “social”, as an adjective, is defined as “of or relating to human society and its modes of organization”. “Society”, as a noun, is defined as: a) “the totality of social relationships among humans”; b) “the institutions and culture of a distinct self-perpetuating group.” As a result, the social pillar of sustainable development is related to both preserving and developing humans and their relationships, culture, and institutions.

In recent years, sustainable development has become a buzzword for various activities ranging from protecting the environment, reducing negative environmental impacts and pollutions, protecting endangered species, protecting biodiversity, saving natural resources and energy, ending poverty, eradicating hunger, achieving universal primary education, improving health, job creation, achieving social amenity and equity, avoiding corruption, to economic growth, global trade, financial effectiveness, achieving economic equity, improved marketability, education for sustainable development, and lifelong learning (Gell-Mann, 1995; Dale and Newman, 2005; Filho, 2005; Viezzer, 2006; Jeffrey and Walter, 2006; Atkinson *et al.*, 2007; Aras and Crowther, 2009; Unruh, 2009; Venkataraman, 2009; Ramirez, 2012).

Sustainable development also carries a label for climate change, natural ecology, energy, vulnerability to droughts, fast desertification, scarcity of water, pollution, deforestation, crop

failure, health, safety, land degradation, chemical food adulteration, social responsibility, social/ economic/ political justice, gender equality, humanity, human rights, humanitarian aids and philanthropy, cultural diversity, peace, conflicts resolutions, economic growth, full and active citizenship, migration, bio-social-cultural diversity, and distribution of power (Gell-Mann, 1995; Clayton and Radcliffe, 1996; Filho, 2005; Atkinson *et al.*, 2007; Ramirez, 2012).

Although the three inter-dependent pillars of sustainable development were originally defined from a macro level of society (the entire world or a nation [Aras and Crowther, 2009]) and economy, they are equally relevant at the micro level of the society/ corporation or economy. Triple bottom lines are increasingly appearing in the literature on business, management, engineering, organization, and operations disciplines (Byrch *et al.*, 2007; Carter and Rogers, 2008; Aras and Crowther, 2009; Unruh, 2009) and are adapted by industries and companies (MacLean, 2010; Carter and Rogers, 2008).

However, it is difficult to explain the multi/ inter/ trans-disciplinary concept of sustainable development (from a micro perspective) in concrete terms (Viezzzer, 2006; Venkataraman, 2009) or operationalize/ implement it (Bowen *et al.*, 2001), especially when it comes to a holistic view of all aspects and the interconnection of its pillars (MacLean, 2010).

3.3 Standpoint on sustainable supply chains

The literature on sustainable supply chains has co-evolved with the concept of sustainable development by growing from a purely environmental/green perspective to a wider sustainability perspective. Increasing numbers of businesses and companies are also publishing sustainability reports and codes of conduct (Andersen and Skjoett-Larsen, 2009; Ramirez, 2012) in contrast to the primary focus on environmental reporting (Carter and Rogers, 2008).

Sustainable supply chains have been treated in the literature in various ways. Some literature reflects on the embodiment of all the triple bottom lines of sustainable development in the context of SCM (Svensson, 2007; Carter and Easton, 2011). Carter and Rogers (2008) add four supporting facets to the triple bottom lines: risk management, transparency, strategy, and culture.

According to Dyllick and Hockerts (2002), sustainable supply chains management (SSCM) is the integration of sustainable development and supply chain management. Carter and Rogers (2008, p. 368) define SSCM as “*the strategic, transparent integration and achievement of an organization’s social, environmental, and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and its supply chains.*” Gimenez *et al.* (2012, p. 150) refer to SSCM as “*a firm’s plans and activities that integrate environmental and social issues into SCM in order to improve the company’s environmental and social performance and that of its suppliers and customers without compromising its economic performance.*” Seuring and Müller define SSCM as:

. . . the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements. (2008, p. 1700)

Zailani *et al.* (2012) summarize that SSCM can reduce health, safety, recruitment, and labor costs; reduce waste; increase the ability to design for reuse and disassembly; enhance reputation; and proactively shape future regulations. It can also improve the brand, knowledge, public image, long-term success, long-term profitability, productivity of and trust in businesses (Luken and Stares, 2005; Perez-Aleman and Sandilands, 2008; Vachon and Mao, 2008; Tencati *et al.*, 2008; Worley *et al.*, 2010; De Chiara and Spena, 2011; Pietro and Giuseppe, 2012; Gimenez *et al.*, 2012; Jacob, 2012; Govindan *et al.*, 2013); increase employees' loyalty, motivation and commitment to work (Paramanathan *et al.*, 2004; Björklund, 2010; Zailani *et al.*, 2012); increase customer satisfaction (Ageron *et al.*, 2012); improve supply chain performance (Gimenez *et al.*, 2012); increase technology, innovation, and risk management skills (Paramanathan *et al.*, 2004); lead to gaining a potential competitive advantage over other businesses (Welford *et al.*, 2003); and ultimately deliver sustainable values to the broader society (Majumdar and Nishant, 2008; Dao *et al.*, 2011).

Some literature reflects on the embodiment of all the triple bottom lines of sustainable development in the context of supply chains activities such as sustainable procurement (Walker and Brammer, 2009; Preuss, 2009); sustainable mobility (Banister *et al.*, 2000; World Business Council for Sustainable Development, 2004); sustainable transport (Gudmundsson and Höjer, 1996; Black, 1996; Richardson, 2005); sustainable production (Welford *et al.*, 2003); sustainable packaging (James *et al.*, 2005); and sustainability oriented innovation and entrepreneurship (Isaksson *et al.*, 2010; Barbieri *et al.*, 2010; Peters *et al.*, 2011).

There are also plenty of literature that reflects on “collaboration” as an inherent part of SCM and SSCM. Collaboration facilitates the existence and integration of inter-processes and interrelationships. It can: leverage the information, interests, skills, experiences, innovations, and technologies of other stakeholders to the firm; facilitate compliance with codes of conduct (Worley *et al.*, 2010); facilitate joint action (Perez-Aleman and Sandilands, 2008; Hartlieb and Jones, 2009); facilitate access to scarce resources (Holloos *et al.*, 2012); leverage emerging valuable and rare inter-firm resources and capabilities (Gold *et al.*, 2010); facilitate corporate strategy alignment (Leppelt *et al.*, 2013); minimize risks and conflicts (Jacob, 2012); build trust in the chain (Spence and Rinaldi, 2012; de Carvalho and Barbieri, 2012); maintain a firm's competitive advantage (Dao *et al.*, 2011; Maltz and Schein, 2012); leverage stakeholders engagement, satisfaction, and feedback (Matos and Hall, 2007; Ciliberti *et al.*, 2008; Erol *et al.*, 2009); add democratic value to the regulatory arrangement (Hartlieb and Jones, 2009); build credibility and legitimacy (van Heerdenn and Bosson, 2009; Worley *et al.*, 2010; Boons, 2012); provide social support (Majumdar and Nishant, 2008) during the adoption of sustainability practices (Perez-Aleman and Sandilands, 2008); and strengthen relational embeddedness in the network (Bernardes, 2010).

Environmentally sustainable supply chains

Some literature elaborates on definitions and dimensions of “environmentally sustainable/ friendly/ sound/ preferable/ responsible” or “eco”, or “green” supply chain management/ supply chains.

Klassen and Johnson (2004) describe “green supply chain management” as the alignment and integration of environmental management within supply chain management. Srivastava (2007, p. 54-55) define it as “*integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of*

the product after its useful life.” According to McKinnon *et al.* (2010), the origins of green supply chain management can be traced back to two functional areas in which companies’ environmental responsibilities interfaced with external agencies: green purchasing/ supply and reverse logistics.

Green supply chains, and logistics more specifically, have developed from reverse logistics to closed-loop supply chains combined with GHG emissions and the consideration of ecological footprints. The perspectives have also evolved from public-to-private, operational-to-strategic, and local-to-global (McKinnon *et al.*, 2010). Abukhader and Jönson (2004, p. 146) take a relabeling perspective on the supply chain and logistics (Halldórsson *et al.*, 2008) and describe the green supply chain as *“mainly a discussion about assessment of the impact of environment on logistics. It evolves discussion of how implementing environmental measures would influence, negatively or positively, the logistics/supply chain infrastructure, and how we can find win-win solutions so that we satisfy the government regulations, satisfy the end customers and stay cost-effective.”* As Ping (2009, p. 340) states, *“modern green logistics management is based on the theory of sustainable development, which formed the relationship of promotion and constraint between logistics and the environment.”*

Several articles highlight one activity or some activities of green supply chains/ supply chain management (Klassen and Johnson, 2004; Srivastava, 2007; McKinnon *et al.*, 2010; Mollenkopf *et al.*, 2010; Kirchoff *et al.*, 2011). According to Björklund (2005), the definition of an environmentally friendly/ sound activity can be anything from choosing a more environmentally friendly/ sound technique to choosing an activity which is friendly/ sound to the environment (i.e. has no negative effects on the environment). Some examples are: green logistics (Wu and Dunn, 1995; Aronsson and Hüge Brodin, 2006; Ping, 2009; Chunguang *et al.*, 2008; McKinnon *et al.*, 2010;), green LSPs (Perotti *et al.*, 2012; Lieb and Lieb, 2010; Wolf and Seuring, 2010; Philipp and Militaru, 2011), green purchasing (Min and Galle, 1997; Björklund, 2005), green marketing (MacLean, 2010; Kirchoff *et al.*, 2011), carbon auditing of supply chains including products and companies (McKinnon, 2010; McKinnon *et al.*, 2010), transportation and climate change (Chapman, 2007), energy efficiency (Halldórsson and Kovács, 2010) including transport energy efficiency and emissions (McKinnon *et al.*, 1993; Nygrén *et al.*, 2012), environmental assessment (Jones, 2002; Merrick and Bookbinder, 2010), reverse logistics (Zikmund and Stanton, 1971; Bernon *et al.*, 2011), and closed-loop supply chains (Clendenin, 1997; Defee *et al.*, 2009).

Reverse logistics deals with the role of logistics in closed-loop supply chains activities such as product returns, source reduction, recycling, materials substitution, reuse of materials, waste disposal and refurbishing, repair, recovery, and remanufacturing (Zikmund and Stanton, 1971; Stock, 1998; Carter and Ellram, 1998; de Brito and van der Laan, 2010; Bernon *et al.*, 2011). It may also include after-sales service functions, maintenance services, and other types of activities related to continually satisfying the customer (Handfield and Nichols, 1999). Rogers and Tibben-Lembke (1999, p. 2) define reverse logistics as *“the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or of proper disposal.”* According to Sarkis *et al.* (2010, p. 344), reverse logistics *“can benefit health and safety when it is combined with process modifications and material substitutions that generate environmental improvements.”*

Closed-loop supply chains aim to integrate both forward and reverse flows that according to Defee *et al.* (2009) *“require the strategic integration, planning, and operation of both*

forward and reverse flows of supply chains operated by a firm. (...) It includes three major themes; namely 'returns management, product acquisition and asset recovery', 'issues of remanufacturing', and 'secondary markets and channel design'."

There is also literature that investigates the effects of logistical concepts on environmental sustainability of supply chains such as the environmental effects of online versus conventional shopping (Sarkis *et al.*, 2004; Edwards *et al.*, 2010), postponement (Yang *et al.*, 2005), virtual logistics (Clarke, 1998), logistics structure decisions (Aronsson and Høge Brodin, 2006), and carbon intensity and footprints of "last mile" deliveries (Edwards *et al.*, 2010).

Socially sustainable supply chains

In the context of supply chains and logistics, the social pillar of sustainable development refers to concepts such as "social sustainability" (Hutchins and Sutherland, 2008; Vachon and Mao, 2008; Björklund, 2010; Sarkis *et al.*, 2010; Sarkis *et al.*, 2010; Gimenez *et al.*, 2012); "corporate social sustainability" (Dyllick and Hockerts, 2002; Tsoi, 2010); "social responsibility" (Carter and Jennings, 2002; Lee *et al.*, 2007; Koplin *et al.*, 2007; Ciliberti *et al.*, 2008; Halldórsson *et al.*, 2009; Becker *et al.*, 2010; Sarkis *et al.*, 2010; Carter and Easton, 2011; Gopalakrishnan *et al.*, 2012); "corporate responsibility" (Kogg and Mont, 2012; Carbone *et al.*, 2012); "corporate sustainability" (Isaksson and Steimle, 2009); and "corporate citizenship" (Liu *et al.*, 2011; Jacob, 2012). However, a number of articles show that the social pillar of sustainable supply chains has not been as well discussed as the environmental pillar (Vachon and Mao, 2008; Björklund, 2010; Sarkis *et al.*, 2010; Lozano and Huisingh, 2011; Abbasi and Nilsson, 2012).

Another concept discussed in different literature is "corporate social responsibility (CSR)", which refers to responsibilities of businesses in both micro and macro societies. However, there is not a general consensus on the meaning of CSR (Garriga and Melé, 2004; Markley and Davis, 2007; Dahlsrud, 2008; Keating *et al.*, 2008; Defee *et al.*, 2009; Schwartz and Saiia, 2012; Boulouta and Pitelis, 2014). Some literature refers to it as solely voluntary responsibilities of businesses in the area of environmental and social issues (Andersen and Skjoett-Larsen, 2009; Björklund, 2010; Govindan *et al.*, 2013), while the others see it as being both obligatory and voluntary (Schwartz and Saiia, 2012). However, there is a consensus in different definitions: that the responsibilities of businesses in developing their societies are something that according to Porter and Kramer (2006) should be more proactive and strategic than just responsive.

Bowen was one of the pioneers in the field who claimed that "*companies have the obligation to pursue those policies, to make those decisions, or to follow those lines of action that are desirable in terms of the objectives and values of our society*" (Bowen, 1953, p. 6). Davis (1973, p. 312) defined CSR as "*the firm's consideration of, and response to, issues beyond the narrow economic, technical, and legal requirements of the firm.*" Carroll (1979, p. 500) offered one of the most cited models of CSR which encompasses "*the economic, legal, ethical, and discretionary expectations that society has of organizations at a given point in time.*" Schwartz and Saiia (2012, p. 6-12) elaborate on two positions on CSR, namely "Friedman's position" and "the broad position." According to the former, "*a corporation's only social responsibility is to make as much money as possible*" (i.e., maximize profits) while conforming to the "rules of the game" or "basic rules of the society" in which the firm is operating which include: (1) obeying the "law"; (2) conforming to "ethical custom" (i.e., business norms where you do business); and (3) acting "without deception or fraud." The broad CSR position requires firms to take into account additional ethical constraints: (1)

universal core ethical values, (2) utilitarianism, (3) Kantianism, (4) moral rights, and (5) justice/ fairness.

Several articles shed light on the structure and degree of relationships and responsibilities of businesses in societies (Liu *et al.*, 2011) greatly driven by a stakeholder theory perspective on business practices (Freeman, 1984; Elg and Hultman, 2011). Liu *et al.* (2011) state that stakeholder theory aims to operationalize CSR by identifying societal groups to which a corporation has responsibilities and by providing a basis for legitimizing and prioritizing stakeholder influence on corporate decisions. As Evan and Freeman (1993) elaborate, a corporation has a responsibility to all those groups that may be harmed by, or benefit from, the corporation's activities and/ or whose rights may be affected by the corporation.

Matos and Silvestre (2013) refer to the most cited definition of stakeholder, which is that of Freeman's (1984, p. 46): "*any group or individual who can affect or is affected by the achievement of organization's objectives*" which divides stakeholders into primary and secondary ones. The primary stakeholders are those that have a direct interest in the organization (e.g., customers, shareholders, employees, suppliers and regulators), while the secondary stakeholders are those that are not engaged in transactions with the organization but can affect, or are affected by the organization (e.g., academic institutions, non-government organizations and social activists). Tsoi (2010) refers to Henriques and Sadorcky (1999) who group stakeholders into (1) organizational stakeholders (e.g., employees, customers, shareholders, and suppliers), (2) community stakeholders (e.g., local residents, special interest groups), (3) regulatory stakeholders (e.g., municipalities, regulatory systems), and (4) media stakeholders. Gopalakrishnan *et al.* (2012) refer to employees, management, shareholders, government, suppliers, communities and end-customers as different stakeholders. Jacob (2012) refers to the traditional management model that recognizes four stakeholder groups: shareholders, customers, employees and suppliers. The stakeholder model also includes a larger number of other stakeholders such as governments, competitors, and civil society. Isaksson and Steimle (2009) classify stakeholders as market-related (e.g., customers, shareowners, suppliers), internal (e.g., employees, board of directors), and societal (e.g., government, NGOs).

In the articles reviewed, stakeholders have also been divided into internal stakeholders such as suppliers, customers, and investors/ shareholders (Paramanathan *et al.*, 2004; Boons and Mendoza, 2010; Maltz and Schein, 2012), and external stakeholders such as NGOs, governmental agencies, knowledge institutes, financial institutes, innovators, trade associations, media (Freeman, 2003; Paramanathan *et al.*, 2004; Smith, 2008; van Heerdenn and Bosson, 2009; Boons and Mendoza, 2010; Dao *et al.*, 2011; Boons, 2012; Ageron *et al.*, 2012).

Other literature fragmentally highlights the criteria/ dimensions of social responsibility including employees' human rights and welfare; fair wage, work hours, and benefits; equal treatment and opportunities; gender equality; avoiding discrimination, harassment, violence, child labor, forced/ bonded labor; compensation management; health and safety; personnel recruitment and selection; education, training, and carrier development; employees participation; diversity; organizational behavior; consumer comfort; socially responsible buying/ purchasing social responsibility; freedom of association and collective bargaining; relationships with the unions; transparency; ethics; compliance; investing in social projects; contribution to the well-being of society; philanthropy; supporting and involvement in local communities (Drumwright, 1994; Luken and Stares, 2005; Vachon and Mao, 2008; Ciliberti

et al., 2008; Erol *et al.*, 2009; Björklund, 2010; Leat *et al.*, 2011; Lozano and Huisingh, 2011; Yakovleva *et al.*, 2012; Gimenez *et al.*, 2012; Gopalakrishnan *et al.*, 2012; Berg *et al.*, 2012; Hall *et al.*, 2012).

Economically sustainable supply chains

As most of the literature in the fields of logistics and supply chains originates from the management and engineering disciplines, economic sustainability is considered as the underlying assumption. In other words, the literature takes the economic feasibility of supply chains as a warrant for long-term sustainability and elaborates mostly on other pillars of sustainable supply chains.

Although the economic pillar of sustainable development was not in the scope of this study – as it was considered as the underlying assumption – its interactions with environmental and social pillars were. Some of the literature reviewed highlighted purely economic or socio-economic or eco-economic criteria/ dimensions of sustainable supply chains such as annual turnover, total production, total sales, total costs, total wages and salaries, earning before tax, total tax paid, profits, gross value added, total assets, rate on return on capital employed, efficient utilization of resources, resources productivity, competitiveness and viability, market presence, attaining and sustaining competitive advantage, customers and shareholders, total payments per share, investments, trade balance, patents and intellectual properties, innovational capabilities, and R&D expenditures (Luken and Stares, 2005; Erol *et al.*, 2009; Björklund, 2010; Leat *et al.*, 2011; Yakovleva *et al.*, 2012; Gopalakrishnan *et al.*, 2012; Berg *et al.*, 2012).

4. Exploring a complexity theory perspective

Our perspective forms our behavior and the pattern of our behavior forms our character.

This chapter provides an overview of the central themes of a complexity theory perspective and reflects upon their applications in managing, governing, and developing sustainable supply chain activities.

4.1 Introduction to a complexity theory perspective (CTP)

Complexity theory is the theory of complex phenomena. As Allen and Strathern (2003, p. 8) state, it is a scientific theory of change and transformation, (...) without it “*social and organizational change could only be driven by trial and error and by people’s accumulating experience and confusion.*” Complexity theory challenges the Newtonian and positivist rationale of science such as order, objective reality, reductionism, deliberate design, rationality, stability, determinism, value-freeness, controllability, linearity, centralization, hierarchy, and uniformity (Nilsson, 2003, 2005; McMillan, 2006; Nilsson and Gammelgaard, 2012). It suggests that “*it is in the dynamic interactions and adaptive orientation of a system that new phenomena, new properties and behaviors emerge; that new patterns are developed and old ones change (...)* Complexity theory seeks the sources of and reasons for change in the dynamic complexity of interactions among elements or agents that constitute a particular environment” (Mason, 2009, p. 119).

Complexity theory provides a transformational perspective for the study of complex phenomena and is regarded as the evolution of systems theories together with contemporary social and behavioral theories (Simon, 1996; MacIntosh and MacLean, 2001; Nilsson and Gammelgaard, 2012). With this perspective, changes, interrelationships, nonlinearities, learning and innovative capacities, dynamics, and paradoxes existing in supply chains can truly be studied. A complexity theory perspective can comprehend transformative transition of supply chains towards sustainability targets and consider the fact that the transition path may not be uniform, deterministic, and controllable for different types of supply chains (Rotmans *et al.*, 2001).

While the traditional research and management approach in logistics and supply chain management is dominated by simplification, the use of a complexity theory perspective is both interesting and potentially valuable when studying supply chains and not least when dealing with sustainable development. As stated by Stacey *et al.* (2000, p. 155), “*When one succumbs to the powerful drive to reduce complexity to simplicity one loses sight of what is so striking about the possibility of self-organizing interaction producing emergent coherence.*” Hence, a complexity theory perspective (CTP) enables the researcher and manager to explore and understand the emergent phenomena generated in the micro-interactions of supply chain actors, and the purposes these actors have for doing what they are doing, i.e., the teleological dimension.

A CTP goes one step further than most of the system theory perspectives/ system approaches used in SCM and logistics (Nilsson and Gammelgaard, 2012) and reflects why and how changes occur and co-influence each other; how the changes emerge and transform the actors and their identities and values; and considers the nonlinear dynamics of interconnections and paradoxes inherent in the social and business lives of the involved actors.

Hence, CTP challenges the predominant positivistic assumptions underlying logistics and supply chain management (Nilsson, 2003; 2005). Nilsson and Gammelgaard (2012) provide a comparative analysis of underlying assumptions of two branches of CTP, namely complex adaptive systems (CAS) and complexity thinking (CT), and a system approach (SA) dominant in theories and practices of logistics and supply chain management. Some exemplary assumptions that are challenged in the CTP are: complete rationality and perfection of human behavior, decisions, and actions; thorough match between intents and actions; error freeness; an objective context-independent reality where uncertainties and differences are mistreated; simplification of the system to make it completely efficient, optimized, uniform, and controllable; reductionism; determinism; complete predictability and reliability; deliberate design; linearity; value-freeness; unbiased, symmetric, and noise-free information flows; order and stability.

What the simplifying assumptions represent are “effective” and very successful ways of breaking down descriptions of phenomena of interest, which have been the natural means of advancing theories for a long time (assumptions of the traditional view). Nonetheless, the complexity theory perspective does not neglect these assumptions but rather extends them and includes other, more viable and empirically valid assumptions that relate to human and organizational phenomena as raised above. Thus, complexity theory extends the traditional

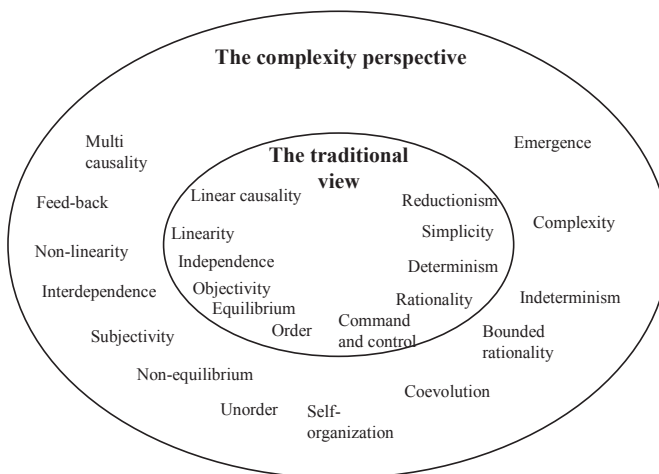


Figure 4.1. The complexity theory perspective as an extension of the traditional research view. The complexity perspective is illustrated here in a figure derived from Nilsson (2003, p. 32) and Dent (1999, p. 9).

assumptions and focuses on the situation, purpose, context, sense making, and subjectivity in order to generate appropriate understanding and explanations. As stated by Bar-Yam (1997, p. 293), “*the study of complex systems focuses on understanding the relationship between simplicity and complexity.*” Figure 4.1 illustrates the extended view of complexity theory based on the work by Nilsson (2003) and Dent (1999). Additional complexity theory perspective criteria are uncontrollability, non-hierarchy (networked), and diversity.

The rationale for the extensiveness of complexity theory is based on the notion of paradoxes apparent in any complex phenomena. According to Stacey (2000, p. 328), a paradox “*may mean an apparent contradiction, a state in which two apparently conflicting elements appear to be operating at the same time.*” Another way to define the term “paradox” is in line with Hegel’s dialectical logic. Here, “*paradox means the presence together at the same time of*

contradictory, essentially conflicting ideas, none of which can be eliminated or resolved” (ibid., 2000, p. 328). Smith and Lewis (2011, p. 387), in their theoretical development of paradoxes, provide the following definition of paradox: *“Contradictory yet interrelated elements (dualities) that exist simultaneously and persist over time; such elements seem logical when considered in isolation, but irrational, inconsistent, and absurd when juxtaposed.”* As Nilsson (2005, p. 36) puts forward, *“in such a situation there is no way the paradox can be resolved or eliminated by positivistic assumptions and claims, and therefore a different kind of logic is needed; a logic of a dialectic character.”*

The dialectic logic on sustainable development and/ or supply chain management, for example, calls for the need for several perspectives that can contribute and challenge each other in the pursuit for improved situations. As Richardson *et al.* (2001, p. 13) state, *“a principal requirement of a complexity-based epistemology is the exploration of perspectives.”* The prime goal is not to reach harmony or resolve all paradoxes since the generation of solutions only creates new paradoxical situations in new circumstances; it is all part of the transformational process of identities, values, etc., that humans and organizations are co-creators of. Instead, paradoxes are sources of important tensions that, due to self-organization, can lead to new innovative configurations as well as destructive ones (Ramirez, 2012). Nonetheless, while predictability and being fully objective and rational are seen as non-valid in any complex phenomenon involving people, a central assumption in complexity theory is that approaches and solutions can be developed that are more appropriate than others. For many situations this calls for contextually derived approaches and methods, or at least contextually modified ones.

However, based on transformative teleology, the generation of such approaches and methods cannot be made from an outside observer that can predict or determine the future states of the phenomenon at hand. Instead, the assumption is that the epistemological differences and theoretical discourses are created in the dynamic interplay of deliberate and undeliberate actions. Hence, as concluded by Ramirez (2012, p. 74) in his study on sustainable development, *“the challenge is not just to build learning organizations, for organizations always learn, at the very least by trial and error. The point is to develop organizations that are intelligent in the sense of being effective learners, and wise in the sense of being free from prejudices and hubris.”* Consequently, in the endeavor to develop sustainable supply chains, a central assumption based on complexity theory is that approaches and solutions exist that are more appropriate than others, at least for a period of time. At the same time, the process of learning is transformative and involves a number of paradoxes that supply the energy needed, if handled correctly (i.e., in a balanced and constructive way).

A growing number of researchers are applying complexity theories and approaches. They conclude that these are beneficial in creating increased understanding of the complex and challenging issues companies are confronted with today, and of the complex phenomena that supply chains or networks represent. Tracks of complexity theory can be found in supply chains (Surana *et al.*, 2005; Abbasi, 2008) and their several dimensions. These range from logistics (Waidringer, 2001; Nilsson, 2003, 2005); to manufacturing and production (Wu, 2000; ElMaraghy and Urbanic, 2003; ElMaraghy *et al.*, 2005; Nilsson and Darley, 2006; Wu *et al.*, 2007); to operations management (Baldwin *et al.*, 2010); to the supply base (Choi and Krause, 2002); to warehousing (Faber *et al.*, 2002); and to information systems (Jacucci *et al.*, 2006; Merali and McKelvey, 2006; Merali, 2006). There are also articles that apply complexity theory in sustainable development ranging from, for example, organizational learning (McKenna, 1999; Keene, 2000; Allen, 2002; Backlund, 2002; Siemieniuch and

Sinclair, 2002; Browaeyns and Baets, 2003; Cunha and Cunha, 2006; Espinosa *et al.*, 2008; Mitleton-Kelly, 2011; Espinosa and Porter, 2011; Ramirez, 2012); educational development (Mason, 2009); to global health (Haffeld, 2013); ergonomics (Dekker *et al.*, 2012); social systems (Valentinov, 2013); and policy making (Wallis, 2013).

4.2 A complexity theory perspective (CTP) on sustainable supply chains

Reflecting on the magnitude of sustainable development, supply chains and the management of these phenomena, it is quite easy and common to try to break these concepts into parts in order to understand and deal with them (as the normal reductionist standpoint proclaims). However, what happens if we instead treat them as a complex whole? What if instead of breaking the phenomena from the top down, we focus on the actual interactions among actors and the emergent outcomes and patterns based on their self-organizing processes (deliberate or not)? What happens if instead of unquestionably believe in setting fixed strategies and then working to realize them (the deterministic approach), we regard the future as unknown and work on more adaptive strategies and activities (the emergent approach)? These exemplary questions, typical for a CTP that addresses central paradoxical phenomena, are necessary to explore in order to handle in the development of sustainable supply chains.

A number of complexity theory frameworks and models have been considered to provide a comprehensive and reflective discussion of a CTP on supply chains and sustainable development. These were gathered and analyzed from literature on complexity theory in general (Kauffman, 1995; Bar-Yam, 1997; Anderson, 1999; McMillan, 2006) as well as when applied in the context of supply chains or logistics (Choi *et al.*, 2001; Nilsson, 2003, 2005, 2006; Abbasi, 2008; Nilsson and Gammelgaard, 2012) and sustainable development (Ramirez, 2012; Porter and Derry, 2012; Foxon *et al.*, 2013). The analysis led to a number of themes of complexity theory, that is, the central dimensions of a CTP. In the following subchapters, these central dimensions are described and a reflective discussion of SD and SCM from a CTP is provided. Then a framework based on their applications to sustainable supply chains is proposed (Figure 4.3). The framework is used in the synthesizing discussion in section 6.3 in chapter 6.

4.2.1 Level of scale and details of description – the complexity profile

In the process of understanding changes in any phenomenon, the actors involved choose different levels of observation and details in description. While the choices are based on a great number of factors, the consequences of level and description are central from a CTP.

A fundamental argument in supply chains is the avoidance of sub-optimization, implicating the need for holistic considerations. However, the scale of observation depends on the eyes of the beholder (Casti, 1994), and how it is socially constructed in the interaction among actors (i.e., the inter-subjective views that can be made). As Gell-Mann (1995, p. 33) highlights “*any definition of complexity is necessarily context-dependent, even subjective. Of course, the level of detail at which the system is being described is already somewhat subjective – it too depends on the observer or the observing equipment.*” An involved actor can define the holistic phenomenon as “the chain of all actors” involved in the flow of goods or services, and position it in different contexts ranging from local, urban, and regional to national, multi-national, continental, or global levels. The actor can also define the details in describing what other actors are involved in the chain, and to what extent their details will be described. A supply chain becomes more complex in its description if it includes more heterogeneous

actors/ stakeholders/ subsystems on the same scale or more information or time is required for a description of its activities, processes and operations from the same observer's point of view. However, an example provided by Choi *et al.* (2001, p. 351) shows the difficulties of mapping supply chains:

A few years ago, our engineers mapped a supply chain of a small assembly [by] tracing it all the way back to the mine. From that exercise, we demonstrated the benefits of supply chain management, and we set out to manage the supply chain as a system. Frankly, we have not been able to do it. The problem was, as soon as we came up with a strategy for managing the chain, the chain changed on us – we got new suppliers and new relationship configurations. It took a lot of effort to map one supply chain, and we could not possibly map it every time something changed.

Supply chains are rightfully described as complex phenomena as they are made up of a high number of heterogeneous subsystems (i.e., components and processes in every scale of observation). Components may relate to focal companies, suppliers, customers, distribution centers (terminals, hubs, consolidation centers, etc.), warehouses, retailers (outlets), transport actors, logistics service providers, goods (materials, packages, work-in-process inventories, products, etc.), human resources, and so on. On the other hand, processes may relate to different production and manufacturing, procurement and purchasing, inventory control, distribution, marketing, and (reverse) logistical services. The subsystems are themselves complex systems, which increases the details of description. For example, a focal company may consist of several assembly lines, workstations, staffs, tools, machinery, unit loads, cargo carriers, vehicles, robots, assets, and departments using different types of artifacts in relation to each other and in the quest of achieving goals and pursuing activities. Hence, as Christopher (2005) argues, supply chain management concerns the management of relationships across a complex network of companies. Each component may also belong to supply chains of different supply networks.

Consider the three different ways to describe a supply chain:

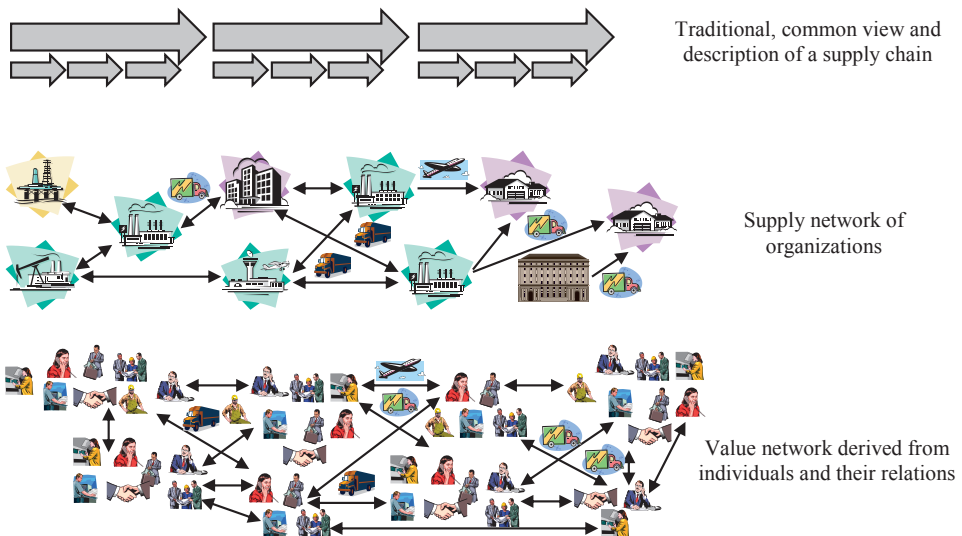


Figure 4.2. Different descriptions and perceptions of supply chains in logistics research and practice

Depending on the details of the SC's description, different measures, approaches, or strategies can be created and used in developing, managing, or governing its activities. Using the process description (top of Figure 4.2) to describe the flow from one part to another by an arrow implies a mechanistic approach and simple measures based on the notion and belief of defined input and output measures. While such simplified descriptions are popular and provide an easy way to describe processes and flows, this may have consequences for the way things are understood and operationalized in organizations or as Dent (1999, p. 12) describes it, *"how we see things determines much of what we see."* Moreover, as Lissack (1999) reports, the language used in a discipline or a firm reflects how reality is conceived. This limits the possibilities available for the members to improve their mutual understanding as well as to improve solutions to various problems both within the discipline and within firms. Axelrod and Cohen (2000, p. 29) provide a good explanation for this mechanical approach when they state, *"No doubt, machines and hierarchies provide easier metaphors to use than markets and gene pools. So it is no wonder that most people are still more comfortable thinking about organizations in fixed, mechanical terms rather than in adaptive, decentralized terms."*

The network description of inter-organizational setups (middle of Figure 4.2) extends the scope from chains to networks, and thus makes the description more complicated. This perspective has been elaborated in the supply chain management field for a long time, for example, in the industrial network perspective (Håkansson and Persson, 2004) and more recently in the debate that "supply network" is a better description than "supply chain" when addressing the networks of companies engaged in the supply relationships (Rice and Hoppe, 2001; Christopher, 2005). Furthermore, as raised by Bovet and Martha (2001), the key conceptual shift in supply chain management is from a sequential, linear model to a networked, systemic approach. However, despite all the statements made by researchers and practitioners concerning supply networks, most of the research that has been carried out rarely goes beyond triadic relationships.

The bottom of Figure 4.2 illustrates supply chains as a network of individuals and their artifacts in co-relationships with other individuals that belong to the same or other organizations working together to provide customers with their goods or services. This can be argued to be one of the only empirically valid descriptions of supply chains; but at the same time, it is much more complicated to handle and describe. However, it differs from the other two because it manifests the complexity involved in handling supply chain issues: the involvement, motivation, change and development of human agents.

It is important to define the complexity profile in managing/ governing supply chains. This is because at first it should be clear how holistic the observer is and who the stakeholders/ subsystems/ actors are that are influenced by and that influence decision/ policy making. However, because recognition of all stakeholders of all tiers of the chains can be counterproductive, *"the key is to sort out some basis for determining which members are critical to the success of the company and the supply chain and, thus, should be allocated managerial attention and resources"* (Lambert and Cooper, 2000, p. 69). Nonetheless, as it will be discussed in the next section, due to nonlinearities of interactions, even a small or secondary stakeholder may have a great impact on the supply chains over time. More information is often seen as the way to gain better control of supply chain stakeholders. However, as reported by Nilsson (2006, p. 47) in a study of logistics managers, *"while information was regarded as important, the real challenge was of a more subtle character,*

more related to the understanding and sense-making of the information generated and what to do with it.”

A complexity profile can facilitate recognition of primary and secondary stakeholders and the degree of environmental, social, and economic responsibilities of each stakeholder. It can also be beneficial in benchmarking, Life Cycle Assessment (LCA), and labeling of goods and services by clarifying the scales and details in the description of supply chains. The interesting question in making supply chains sustainable is if the appropriate level of scale and details of description in management and research are considered in order to substantially deal with the challenge of sustainable development?

SCM has traditionally been subordinated to the theory of the firm (Coase, 1937), where the focus on profit maximization and survival is the predominant assumption even in the discussion of sustainable supply chain management. To internalize stakeholders in the sustainable development of a firm's supply chains, though, the interesting question is what if the theory of the firm was changed to a theory of simply chains that was overarching and the theory of the firm was subordinated?

4.2.2 Interactions and emergence

Complexity also depends on the degree of interactions between the holistic system and its surrounding environments as well as among the subsystems: the more the interactions, the more the complexity.

The nature of interactions can be both linear and nonlinear. Due to nonlinearity, causes are not directly proportional to their effects. Small variables over a period of time can lead to major changes in a non-linear system (Young, 2012). In complex systems, interactions are also highly sensitive to the history of the components and to their current context (Hogue and Lord, 2007). Because complex systems are open, their state depends on the degree and nature of their interactions.

Supply chains are open systems built on interactions among interdependent stakeholders/subsystems/ actors/ components and processes that enable the dynamic flows of goods, services, information, and emerged resources. Their management requires investigation of the degree and nature of interactions among the components and the integration of the processes, which can be hard (by means of technology, information sharing, and connectivity) and soft (by means of trust, cooperation, coordination, and collaboration). Doing the opposite – closing complex systems, such as supply chains – yields closed systems knowledge (Reeves, 1996, p. 107), whereas *“the total amount of information stays the same and, if it is initially concentrated in important information, some of it will tend to flow into unimportant information that is not counted. As that happens, entropy, which is like ignorance of important information, tends to increase”* (Gell-Mann, 1995, p. 371).

To develop sustainable supply chains, the degree of interactions among the subsystems should also escalate. As Vachon and Mao (2008) discuss, economic growth, positive environmental performance, corporate environmental practices, and environmental innovation are directly proportional to the richness of interactions – what they call supply chains strength – in the industrial and commercial networks. Interactions among the heterogeneous agents facilitate creation of shared values (Vurro *et al.*, 2009) and make them robust (Gershenson, 2007) as well as innovative (Allen, 2000).

As explained before, supply chains are so interactive and interdependent that they construct networks where changes in one subsystem can lead to changes in other subsystems or the entire networks. There are examples of the nonlinear effects of interactions in supply chains like the bullwhip effect (Datta, 2004), tremendous reduction of transport and traffic intensity and as a result, negative environmental impacts by small changes in dimensions and materials of packages (Olsson and Larsson, 2009), and the nonlinear relation between vehicles' speed and fuel consumption in transportation (McKinnon *et al.*, 2010, p. 130). Nonlinearities are also important in estimating the thresholds and transition from complexity zone to chaos zone. They may also be beneficial in understanding the effects of today's decisions and actions. Some may highly affect future decisions and actions. For example, decisions about investment in the logistical infrastructure or the design of supply chains may have long-term effects on the future of the supply chain's operations. The priority for developing sustainable supply chains should be given to the activities that can have a larger sustainability effects over others. Nonlinearities can also be beneficial in governing supply chains. Priority should be given to implementation of rules and policies that may have larger effects than others. For example, it is expected that several new technologies needed for greening the (freight) transport, infrastructures, production, and base industries be introduced by 2020 (LETS-Rapport, 2011). After 2020, governing rules and policies should be defined that encourage implementation of those technologies that can have the largest effects beyond greening (i.e., job creation, safety and security, etc.).

Global governing rules and policies are required because supply chains are open systems with continuous flows through them from the entire globe and lead to global environmental damages (like CO₂, CH₄, N₂O emissions). Although tougher national regulations (rules and policies) can be defined, international regulation are also required. For example, introducing GHG emissions taxes or sustainability labels should become global to make the price and trade of products and services fair.

As a result, the question is if the appropriate interactions and perspectives are being dealt with in management and research to handle the challenge of sustainable development.

Due to changes in the complexity profile of the system and the degree and nature of its interactions, the holistic system has a dynamic macroscopic property that differs from the microscopic properties of its subsystems. In other words, the whole is more than (and certainly different in kind to) the sum of its parts (Holland, 1998; Letiche, 2000; Reitsma, 2001; Cilliers, 2005; Merali, 2006). As Nilsson (2003, p. 20) states: *“Emergence could be addressed as the outcome of collective behavior i.e. self-organization of several units, elements or human beings i.e. agents, performing something individually, or together, that creates some kind of pattern or behavior that they themselves cannot produce.”*

Due to linearities in complicated systems, they show a simple emerging (emerging simplicity) property that makes them predictable. Due to both linearities and nonlinearities in complex systems, they show a complex emerging (emerging complexity) property that makes them semi-determined or non-determined (Bar-Yam, 1997). This means that complex systems are not completely predictable (Gershenson and Heylighen, 2004). Nevertheless, it is important to realize that because a system is not predictable in the long term, does not mean that it is impossible to understand or even to explain its behaviors (Kauffman, 1995). Complex systems reveal patterns of behavior over time. According to Mason (2009, p. 119), *“new properties or behavior emerge when sufficient numbers and varieties of constituent elements cluster together to form a sufficiently complex arrangement of incredible scale. Once a system*

reaches a certain critical level of complexity, otherwise known as the critical mass, a phase transition takes place which makes possible the emergence of new properties and behaviors and a new direction of self-sustaining momentum.”

In managing supply chains, the patterns of emergent properties of the system can be identified and learned. The emergent property of the system represents its capabilities. According to Olavarrieta and Ellinger (1997, p. 563), capabilities are “*complex bundles of individual skills, assets and accumulated knowledge exercised through organizational processes that enable firms to co-ordinate activities and make use of their resources.*” Capabilities should be directed towards fulfillment of values in the supply chains. Thanks to emergence, values can be fulfilled even if some subsystems might show other values on some occasions. With regard to this, in order to study supply chain performance and capabilities, holistic assessments of the system must go beyond assessment of performance and capability of each subsystem in isolation.

4.2.3 Adaptive and autonomous/self-organizing agents with multiple identities

Complex adaptive systems (CAS) learn from the patterns of emergent behaviors and adapt to changes based on their schemata (norms, values, assumptions, beliefs, mental images). In other words, they can anticipate the future (Holland, 1992) based on what they have learned from the past patterns in time (Nilsson, 2005). However, the future is subject to both revolutionary and evolutionary changes and cannot be deterministically predictable (Casti, 1994; McMillan, 2006).

The schemata influence the behavior of agents (the subsystems that are able to interact meaningfully in the course of events) of CAS while they are reacting to changes in their environments or creating their local surroundings. As Gell-Mann (1995, p. 17) states: “*A CAS acquires information about its environment and its own interaction with that environment, identifying regularities in that information, condensing those regularities into a kind of ‘schema’ or model, and acting in the real world on the basis of that schema.*” While the patterns and schemata are learned, the agents self-organize by spontaneously rearranging their structures and interactions with each other in order to maximize their sustainability and overall fitness without the need for an internal or external controller (Kauffman, 1995). As a result of this process, the components dynamically achieve a global function or behavior (Gershenson, 2007) by intrinsically showing new emergent properties and patterns of behavior. According to McMillan (2006, p. 29), “*spontaneity is an important feature of self-organizing systems as they interact and reshape themselves. The ability to spontaneously self-organize, for example, enables fish to shoal to protect themselves from predators, birds to flock for foraging or protection, and social ants and termites to organize themselves so that their nests or mounds are built and their young fed.*”

Supply chains and logistics are CAS (Choi *et al.*, 2001; Nilsson, 2003, 2005; Wycisk *et al.*, 2008) as they have some subsystems with characteristics of agency (like intelligent resources [humans, machineries] and goods) that are able to intervene meaningfully in the course of events. Supply chains have schemata that are shared among the agents throughout the whole system. The agents self-organize based on what they have learned from the patterns of their emergent properties and schemata in order to adapt to changes and maximize their overall fitness. To adapt to the schemata, the “agency” characteristics of supply chains should increase in order to intelligently save, process, and analyze the changes; identify the patterns; and learn (Abbasi, 2008). Existing schemata help the agents to act more predictably and cybernetically by giving them altruistic characteristics. However, giving more freedom and a

higher degree of autonomy to the agents increases the probability of the emergence of innovative properties. Self-organization also enables the supply chains to follow different strategies in different markets. To self-organize, the agents of the chain must have enough autonomy to interact with other agents of their networks outside their functional boundaries.

In developing sustainable supply chains, their schemata should be in favor of sustainability. Supply chains adapt to the schemata by self-organizing without an internal or external controller or centralized decision maker. However, to decrease opportunistic behaviors and increase trust in the chain, further top-down governing regulations (such as juridical and market-based rules and policies) can be defined and the agents can be periodically audited. However, the governing regulations should respect the bottom-up interactions among and freedom in agents as well as decentralization of decision-making. Thanks to bottom-up interactions and freedom, innovative sustainability oriented ideas can flourish. In addition, as Casti (1994, p. 272) states: “[decentralized] systems tend to be somewhat more resilient and stable than centralized structures because they are more forgiving of mistakes by any one decision-maker and are more able to absorb unexpected environmental fluctuations.”

Although too much control detracts supply chains from innovation and flexibility, allowing too much freedom can undermine managerial predictability and work routines (Choi *et al.*, 2001). The challenge in practice is to balance the degree of regulations and freedom/ openness for self-organization. Global patterns of corporate social responsibility can emerge wherever self-organizing economies can be correctly regulated.

4.2.4 Evolutionary properties

Evolution is related to gradual change or development in the complexity of complex systems over time. As Gell-Mann (1995, p. 244) highlights, “*evolution proceeds by steps, and at each step, complexity can either increase or decrease, but the effect on the whole set of existing species is that the greatest complexity represented has a tendency to grow larger with time.*” Accordingly, the capacity of a complex system to learn (Gell-Mann, 1995, p. 19) or adapt (MacIntosh and MacLean, 2001) can change over time. As stated by Bar-Yam (1997, p. 538-539), “*the theory of evolution is based upon two processes, mutation and selection, that are assumed to give rise to incremental changes in organisms.*” Mutation is related to heritable variations largely through changes in the genome from generation to generation while selection is related to differential reproduction.

Evolution can guide us to understand how supply chains sustain themselves and how they gradually change over time. Learning from the principles of biological evolution, the fittest agents (those that fulfill values in their supply chains) or fittest supply chains (those that fulfill values in their surrounding environments) have the highest chance to survive and sustain (inspired by Gell-Mann, 1995, p. 252). By drawing an exemplary analogy from biological evolution (Lewontin, 1970; Bar-Yam, 1997; Alexander and Bar-Yam, 2013), supply chains can both keep themselves sustainable and gradually increase developing if they: (a) replicate heredity by, for example, transferring memory of the system to its next generation in time; (b) have enough variety and diversity by, for example, keeping back-ups from the subsystems, double sourcing, diversifying the agents, products, services, processes, and markets; (c) select competitively by, for example, letting the subsystems democratically decide, select and constructively compete in order to move both themselves and the system to a higher level of prosperity. As Gell-Mann (1995, p. 257) highlights, “*always exploring, seeking out opportunities, experimenting with novelty, the complex adaptive system tries out increases in complexity and occasionally discovers gateway events that open up the*

possibility of whole new structures, including new kinds of complex adaptive systems. Given enough time, the likelihood of the evolution of intelligence would seem to be high.”

4.2.5 Co-properties

Complex adaptive systems have reflexive relationships with their surrounding natural, organizational, business, or social environments. Changes in the system both shape and are shaped by changes in the surrounding environments. Dynamic interactions between the system and its environment – in addition to dynamic interaction among the subsystems – (Bar-Yam, 1997) take us from issues of simple adaptation and evolution to issues of co-adaptation and co-evolution (Merali, 2006). Schemata of CAS co-adapt and co-evolve with schemata of their surrounding environments.

Supply and demand for goods and services in the surrounding environments shape the supply chains. They are also shaped by available infrastructures, technologies, resources, and the natural environments. On the other hand, changes in supply chains like launching new products and services reshape the existing environments. A concrete example is the globalization of supply chains, which co-evolves with the emerging technologies as well as infrastructures and co-adapts with regulations (rules and policies) in their environments. Globalization can be due to declining barriers to trade, access to free markets, market diversification and expansion, increase in outsourcing and offshoring, advancement in overseas mobility, and reduced transportation costs.

Another example is co-evolution between supply chains and demographic changes in their environments. An observing trend is the approaching increase in the world’s population from 7.2 billion in mid-2013 to almost 8.1 billion in 2025; 9.6 billion in 2050; and 10.9 billion by 2100 (World Population Prospects: The 2012 Revision, 2013). As a result, demand for goods and services may far exceed the supply, especially when the income levels (UNEP, 2012) or purchasing power of middle class consumers escalates. This can pressurize access to limited non-renewable or slowly renewable natural resources of the world as well as its carrying capacity. As a result, it is expected that these will lead to innovative sustainable supply chains that may overcome the restrictions.

However, as highlighted in *World Population Prospects: The 2012 Revision* (2013), the population aged 60 or over is the fastest growing globally. It is estimated that, in the more developed regions, this population will rise from 287 million in 2013 to 417 million in 2050 and to 440 million in 2100. In the less developed regions, this rise will be from 554 million in 2013 to 1.6 billion in 2050 and to 2.5 billion in 2100. As a result, it is expected that more goods and services that consider the needs of this group of the population will be produced and consumed.

The new schemata for governing sustainable supply chains should encourage adaptation of emerging sustainability oriented technologies, norms, and behavior. Sustainability schemata of supply chains co-adapt with increasingly emerging clean technologies, infrastructures, and regulations. Increasing the degree and diversity of interactions between the supply chains and their surrounding environments may open the doors to co-evolution.

4.2.6 Trade-offs and paradoxes

As discussed before, the rationale for the extensiveness in complexity theory is based on the notion of paradoxes apparent in any complex phenomenon. Instead of treating situations or

alternatives as “either-or” e.g. either being controlled or letting go of it, the paradoxical view proclaims situations as “both-and” since many complex issues cannot be separated in either identity, time, or meaning. Hence, instead of fruitlessly trying to resolve paradoxes managers and other actors should learn to go with the flow or as Smith and Lewis (2011, p.385) state: *“living with paradox implies that actors shift their expectations for rationality and linearity to accept paradoxes as persistent and unsolvable puzzles.”*

The growing research area of ambidexterity takes on such a perspective and challenges the old notion of organizations that focus either on exploration or exploitation and instead, with the notion of paradox, argue that success and long-term performance are a simultaneous process of both (O’Reilly and Tushman, 2008; Raisch and Birkinshaw, 2008). Smith and Lewis (2011, p. 391) provide a dynamic equilibrium model for understanding and dealing with paradoxes proposing that *“attending to competing demands simultaneously requires cognitive and behavioral complexity, emotional equanimity, and dynamic organizational capabilities.”* For individuals, this means abilities to understand, accept, and handle interrelated relationships i.e. aspects that cannot be separated and treated on their own but instead as a complex whole. For organization, it means having absorptive capacity for novel situation as well as dynamic capabilities (Teece et al., 1997) in order to deal with emergent phenomena and ambidexterity in maximizing efficiency at the same time as identifying and developing innovations. Hundsnes and Christine (2006) report on the common notion of paradoxes as unintended and unwanted tensions that should be resolved or eliminated. However, they conclude that tensions among interdependent and diversified parts of organizations, near the edge of chaos, leads to the creation of novel paths and hence competitive advantage.

There are several examples of paradoxes that coexist in management, governance, and sustainable development of complex supply chains. Below are examples of paradoxes. Several examples of paradoxes are also highlighted in section 6.2.

- a) Coopetition or horizontal collaboration (i.e. simultaneous existence of cooperation and competition among the supply chains agents) (Nilsson, 2005; Beckman, 2011).
- b) Increase in the self-regulatory survival capacity by an increment in variety which is also a hindrance to rapid adaptation (central paradox of complex adaptive systems) (Ramirez, 2012).
- c) Simultaneous processes of innovation, which is the learning and internalizing of new ways and discarding of older and less effective ones (paradox of learning) (Ramirez, 2012).
- d) Increasing freedom and autonomy for the sake of self-organization and creativity while setting restrictions and rules for the sake of control of the work routines, management, and governance or taking advantage of capabilities emerged by bundling the resources.
- e) Increasing diversity while maintaining organizational unity and integrity.
- f) Pollution reduction from goods, services, and resources in parallel with increasing diversity for (co-) evolutionary sustainability or for developing the intangible resources discussed in section 6.1.
- g) Encouraging increased consumption for economic growth while decreasing it for environmental protection.
- h) Developing core competency/division of labor/division of perception and knowledge while being multi- and interdisciplinary/holistic.
- i) Centralization of decision-making to increase efficiency and simultaneously its decentralization to make the supply chains/ networks democratic, resilient, and robust.

4.3 Towards a framework in applying a CTP on sustainable supply chains

The complexity in supply chains and sustainable development is vast. In dealing with it to make supply chains sustainable, perspectives, frameworks, and models based on extended assumptions about reality should be developed and used to complement the dominant analytical and reductionist ones. By doing so, the discourse required for the transformation of supply chains and their contexts can be energized. Hopefully this will provide novel intersections between the epistemological, technological, and behavioral in which innovations and real changes can be realized.

A framework for applying a CTP to sustainable supply chains is proposed and illustrated in Figure 4.3. It is based on the central dimensions of a CTP discussed in the previous section. The framework is later used in the synthesizing the discussion in section 6.3.

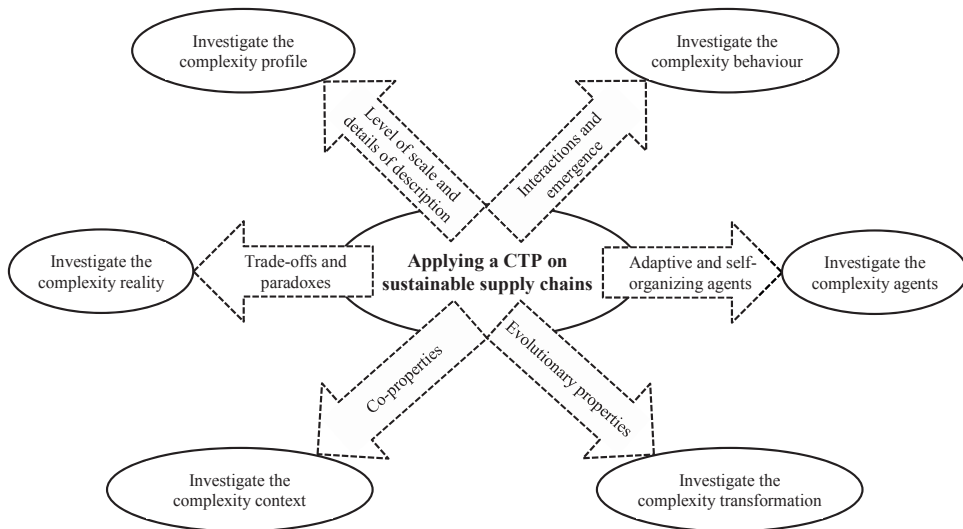


Figure 4.3. A framework for applying a CTP to sustainable supply chains

Investigation of the “complexity profile” involves the clarification of scales and details of description of supply chains. Investigation of the “complexity behavior” takes interactions of stakeholders/subsystems/actors/components and emergent properties into account. Investigation of the “complexity agents” is carried out to understand how the agents of the supply chains adapt by learning from the patterns of their emergent behavior and sustainability schemata. It is also carried out to understand how they self-organize by spontaneously rearranging their structures and interactions with each other to maximize their sustainability and overall fitness without the need for an internal or external controller.

The “complexity transformation” is investigated to understand gradual changes in how supply chains keep themselves sustainable and improve sustainably. As discussed in the previous chapters, context dependency is also important in a CTP as sustainability in complex supply chains co-adapts and co-evolves with their surrounding environments. These co-properties are the subject of investigation of the “complexity context”. Investigation of the “complexity reality” deals with trade-offs and paradoxes in management, governance, and sustainable development of complex supply chains are considered.

5. RESULTS

We harvest based on what we plant and how we watch over the plant.

This chapter provides trustworthy and authentic answers to the research questions. The answers are also a summary of the appended papers.

During the first research study (RS1), five major themes and challenges in making supply chains environmentally sustainable were identified. The fifth research study (RS5) resulted in a deeper understanding of the insights of LSPs about the challenges identified in RS1. The second research study (RS2) led to the identification of five major themes and eight major challenges in making supply chains socially sustainable. In the context of freight transport in RS3, fifteen major themes and five major challenges emerged. In the context of urban freight distribution in RS4, eight major themes and seven major challenges emerged.

However, as already clarified in chapter 2, the results (the knowledge produced about the themes and challenges) are subjective (influenced by my interpretation of what had been said, observed, or scientifically written), relative (related to what had been said, observed, or scientifically written), and influenced by different methods behind the collection and analysis of the data.

5.1 Themes and challenges in making supply chains environmentally sustainable

The systematic review of selected articles and the application of an inductive content analysis resulted in the identification of the major themes and challenges. In RS5, the LSPs were surveyed about these identified challenges. Section 5.1.3 presents a summary of results of the survey.

5.1.1 Identified themes

Management issues	<ul style="list-style-type: none"> • Environmental and sustainability assessment, measurement, monitoring, analysis, and evaluation of supply chains activities/ concepts
Green activities, policies, and strategies	<ul style="list-style-type: none"> • Explanation of concept and trends of green supply chains • Green activities and processes of green supply chains • Strategies and policies for management or development of green supply chains
Reverse logistics/closed-loop supply chains	<ul style="list-style-type: none"> • Analysis of one or some aspect(s) of reverse logistics • Conceptual development of closed-loop supply chains
Concept of sustainable supply chains	<ul style="list-style-type: none"> • Study of the embodiment of the three bottom lines of sustainable development in the context of supply chains
Transport fuel, energy and emissions	<ul style="list-style-type: none"> • Reducing transport emissions, and fuel/ energy use

Table 5.1. The five major themes in making supply chains environmentally sustainable

Five major themes emerged during the first research study: (1) management issues, (2) green activities, policies, and strategies, (3) reverse logistics/closed-loop supply chains, (4) concept of sustainable supply chains, (5) transport fuel, energy and emissions. An extract of the themes is presented in Table 5.1. For a detailed explanation of each major theme, please refer to Paper I.

5.1.2 Identified challenges

A number of challenges in making supply chains environmentally sustainable emerged in the process of synthesizing the content of the reviewed literature. While several specific and detailed challenges were raised, the synthesis resulted in five major categories of challenges, presented in Table 5.2: (1) costs, (2) complexity, (3) operationalization, (4) mind-set and cultural changes, (5) uncertainties. For a detailed explanation of each category of challenges, please refer to Paper I.

Costs	<ul style="list-style-type: none"> ● Increasing financial costs in reducing negative environmental impacts ● Quantifying environmental costs of processes/ activities ● It must financially pay to be green
Complexity	<ul style="list-style-type: none"> ● Diagnosis of environmental aspects and effects of processes/ activities ● Diagnosis of social aspects and effects of processes/ activities ● Measurement/ assessment of environmental effects of processes/ activities ● Measurement/ assessment of social effects of processes/ activities ● Trade-offs and conflicts of a paradoxical character in sustainable development of supply chains
Operationalization	<ul style="list-style-type: none"> ● Interpretation of dimensions of sustainable development in different parts of the supply chain ● Inertia against development of environmentally sustainable processes/ activities ● Inertia against development of socially sustainable processes/ activities
Mind-set and cultural changes	<ul style="list-style-type: none"> ● Changing mind-sets/ culture/ values on international, national, and organizational levels ● Making customers aware of the dimensions of sustainable development ● Changing customers' behavior/ mind-sets/ culture/ values ● Making decision-makers aware of dimensions of sustainable development ● Changing decision-makers' behavior/ mind-sets/ culture/ values ● Making co-workers aware of dimensions of sustainable development ● Changing co-workers' behavior/ mind-sets/ culture/ values
Uncertainties	<ul style="list-style-type: none"> ● Uncertainties to the degree and nature of governmental regulations and policies ● Uncertainty in long-term development ● Uncertainties in consumers' behavior and demands ● Uncertainties in competitive advantages and strategies formulated by stakeholders

Table 5.2. The five major challenges in making supply chains environmentally sustainable

5.1.3 Results of the survey

The following sub-sections present detailed results of the survey. The challenges were divided into five categories (Table 5.2) and nineteen sub-categories. Each sub-section elaborates on one category including the tabular illustrations of the opinions of the LSPs. The results of the

survey indicate that the main challenges of LSPs in making logistics sustainable are related to: (1) dealing with increasing costs (A1, A2, A3 in Table 5.3); (2) handling the paradoxes that exist in sustainable development (B5 in Table 5.4); (3) interpreting all dimensions of sustainable development in the context of logistics (C1 in Table 5.5); (4) measuring/ assessing the social effects of logistical operations/ activities and processes (B4 in Table 5.4); (5) changing customer behavior (A3 in Table 5.3; D1, D2 in Table 5.6); and (6) dealing with uncertainties (E1, E2 in Table 5.7).

A. Costs

<i>A.1. To develop and carry on logistical solutions (e.g., services, infrastructures, fuels, technologies, education, and training) where sustainability is prioritized cost _____ than to develop and carry on solutions where sustainability is less prioritized.</i>					
	<i>1 Much less</i>	<i>2</i>	<i>3 Same</i>	<i>4</i>	<i>5 Much more</i>
Total answers (Respondents)	0	3 (R1, R2, R4)	2 (R3, R9, R10)	3 (R5, R6, R8)	1 (R7)
<i>A.2. Quantifying environmental costs of processes/ activities is:</i>					
	<i>1 Very easy</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Very difficult</i>
Total answers (Respondents)	1 (R4)	1 (R5)	1 (R8, R10)	4 (R3, R6, R7, R9)	2 (R1, R2)
<i>A.3. It must financially pay to be green:</i>					
	<i>1 Not important</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Very important</i>
Total answers (Respondents)	1 (R2)	0	3 (R4, R5, R6)	2 (R1, R3)	3 (R7, R8, R9, R10)

Table 5.3. LSPs' opinions about challenges of costs

Although developing sustainability-prioritized logistical solutions, from the LSPs' perspectives, may not necessarily cost more than non-prioritized ones, the issue of costs was interpreted in different ways. Sustainability-prioritized logistical solutions can cost less (R1, R2, R4) or the same (R3, R9, R10) in the long term and/ or if the costs are shared among the supply chain stakeholders. The rest of the respondents stated that even though every solution may not trigger costs, it is costly to, for example, develop new clean technologies, vehicles, and fuels: "If you, for example, look at the second or third generation of biofuels this cost should show itself somewhere" (R8).

Most of the respondents agreed on the difficulties in quantifying the environmental costs of logistical operations/ activities and processes. This can be due to lack of standards (R1) and differences among modes of transportation (R8). As a result, it was argued that it is difficult to include the costs of environmental degradation of logistical operations/ activities and processes in total costs.

That it must pay to be green is something respondents found important or very important. R2 is the only one who had a different view; this person recognized that the challenge of becoming sustainable must be prioritized and that the benefits for the company were indirect and longer term. All the respondents argued, more or less explicitly, that the main things their customers prioritize are cost and time.

B. Complexity

<i>B.1. The diagnosis of environmental aspects and effects of logistical processes/ activities is:</i>					
	<i>1 Not difficult</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Very difficult</i>
Total answers (Respondents)	1 (R4)	4 (R1, R6, R7, R8)	0	2 (R3, R10)	3 (R2, R5, R9)
<i>B.2. The diagnosis of social aspects and effects of logistical processes/ activities is:</i>					
Total answers (Respondents)	0	5 (R1, R5, R6, R8, R9)	1 (R4)	2 (R3, R7)	2 (R2, R10)
<i>B.3. The measurement/ assessment of environmental effects of logistical processes/ activities is:</i>					
Total answers (Respondents)	0	4 (R2, R4, R7, R10)	1 (R1)	3 (R3, R6, R8)	2 (R5, R9)
<i>B.4. The measurement/ assessment of social effects of logistical processes/ activities is:</i>					
Total answers (Respondents)	0	2 (R3, R9)	3 (R1, R2, R5)	3 (R4, R6, R8)	2 (R7, R10)
<i>B.5. There are antagonistic effects and paradoxes in sustainable development (e.g., making one part sustainable may make another part unsustainable!)</i>					
	<i>1 Not agree</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Fully agree</i>
Total answers (Respondents)	1 (R2)	0	2 (R3, R5)	3 (R4, R7, R8)	4 (R1, R6, R9, R10)

Table 5.4. LSPs' opinions about challenges of complexity

Half of the LSPs experienced difficulties when it came to diagnosing environmental aspects and effects of logistical activities/ processes. The most elaborated environmental effect was CO₂ emissions. The LSPs also expressed different degrees of difficulty in measuring and assessing the environmental effects of logistical processes/ activities. Two of the respondents (R4 and R7) did not feel that it would be difficult to diagnose or measure and assess the environmental effects. On the other hand, R2 experienced big difficulties in diagnosing, but not as much in measuring and assessing. R8 who felt that it would be less difficult to diagnose while very difficult to measure and assess, stated: *"It is easier to know the emissions for example, but their effects or how much damages they cause are not so easy to assess."*

Although the respondents did not feel there would be so much difficulty in diagnosing the social aspects and effects of logistical activities and processes, they had a limited perception of the social aspects of sustainability. The most elaborated social aspects were safety and security. For example, R1 and R3 referred to the "alcolock" which can increase driving safety in transportation. Some of the respondents spoke of Corporate Social Responsibility (CSR) and highlighted some of its aspects like education, training, safety, and customer satisfaction: *"We are not the direct employer of the drivers ... but of course we have to take responsibility for road accidents of trucks which have our logotype ... we communicate this with our haulers. We have also training modules for drivers and interactive programs for haulers which they can access by the internet. We have a spot where our haulage companies can log into when they have a contract with us. We have, of course, direct communication with our haulers as well"* (R8).

While diagnosing the social aspects and effects sounded less difficult for LSPs, it was the opposite for measuring and assessing. 80% had difficulties with this. Four (R2, R4, R7, R10) felt difficulties in diagnosing, measuring, and assessing the social aspects and effects.

The last category of complexity-related challenges had to do with the antagonistic effects and paradoxes in making supply chains sustainable. Almost all the respondents agreed that there were paradoxes in sustainable development. R1 referred to carbon leakage from transportation by electric vehicles to production of electricity. R6 explained that exports – which enable increase in GDP – may increase the demand for logistical services, transport intensity (ton-km), and traffic intensity (vehicle-km), and as a result lead to higher environmental degradation.

R8 elaborated on the paradoxical dilemma among decreasing fill-rates/ resources utilization, higher service levels, and environmental degradation by stating: *“There is a dilemma when it comes to ‘customer service’! We would like to offer daily departures for our customers but then we get a lower degree of utilization ... so, we have to find out what is acceptable for the customers and at the same time increase the fill-rate ... And I think that our branch or line of business is a little guilty as we have been competing with daily departures and perhaps the transport buyers may not need these services ... While we offer it then we have to speed up the whole society ... perhaps it is not so necessary to get the delivery tomorrow, they could get it, for example, next week but then we can make a better planning ...”*.

C. Operationalization

<i>C.1. The interpretation of dimensions of sustainable development (triple bottom lines) in logistical processes/ activities is:</i>					
	<i>1 Not difficult</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Very difficult</i>
Total answers (Respondents)	1 (R10)	2 (R4, R5)	2 (R1, R8)	2 (R2, R3, R6, R7, R9)	0
<i>C.2. Inertia (resistance to change) in the organization against development of environmentally sustainable processes/ activities is:</i>					
	<i>1 Very low</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Very high</i>
Total answers (Respondents)	0	5 (R1, R2, R4, R6, R7)	2 (R5, R10)	3 (R3, R8, R9)	0
<i>C.3. Inertia (resistance to change) in the organization against development of socially sustainable processes/ activities is:</i>					
Total answers (Respondents)	0	4 (R1, R2, R6, R7)	3 (R4, R5, R8)	3 (R3, R9, R10)	0

Table 5.5. LSPs’ opinions about challenges of operationalization

One challenge against the operationalization of sustainable development is difficulties in interpretation and integration of all its dimensions and pillars. Similarly, most of the respondents experienced difficulties in interpreting and implementing sustainable development in the context of logistics. R7 highlighted the operationalization challenges with their subcontractors: *“I usually say that we made a journey together with our haulers. [...] Nowadays, we also have environmental demands which they have to fulfill in order to qualify as a subcontractor or hauler for us.”*

Organizational inertia and resistance to change in developing environmentally sustainable activities and processes were other challenges against the operationalization of sustainable development discussed in the RS1. This challenge was less felt by the LSPs interviewed (5 regard inertia as low and only 3 as high). However, in the discussion, some issues emerged. R8 perceived high inertia due to the conservativeness of the company owners and their fear of change, and R3 reflected on the fact that there is less inertia among younger colleagues than older ones.

D. Mind-set and cultural changes

<i>D.1. Making customers aware of dimensions of sustainable development is:</i>					
	<i>1 Not difficult</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Very difficult</i>
Total answers (Respondents)	0	2 (R4, R10)	2 (R5, R7)	2 (R3, R6)	4 (R1, R2, R8, R9)
<i>D.2. Changing customers' behavior is:</i>					
Total answers (Respondents)	0	1 (R3)	2 (R4, R10)	1 (R7)	6 (R1, R2, R5, R6, R8, R9)
<i>D.3. Making decision-makers aware of dimensions of sustainable development is:</i>					
Total answers (Respondents)	1 (R1)	4 (R2, R3, R8, R9)	5 (R4, R5, R6, R7, R10)	0	0
<i>D.4. Changing decision-makers' behavior is:</i>					
Total answers (Respondents)	1 (R1)	3 (R2, R3, R8)	5 (R4, R5, R6, R7, R10)	1 (R9)	0
<i>D.5. Making co-workers aware of dimensions of sustainable development is:</i>					
Total answers (Respondents)	2 (R1, R2)	2 (R6, R9)	4 (R4, R7, R8, R10)	2 (R3, R5)	0
<i>D.6. Changing co-workers' behavior is:</i>					
Total answers (Respondents)	1 (R1)	2 (R3, R6)	6 (R2, R4, R7, R8, R9, R10)	1 (R5)	0

Table 5.6. LSPs' opinions about challenges of mind-set and cultural changes

To change mind-set and culture calls for awareness about the meaning of sustainable development and its dimensions and pillars. LSPs found it difficult to make their customers aware of this: *"We have customers of all sizes ... the bigger ones are well-aware and to some extent even push us. However, the majorities are not well-aware or at least not willing to change their buying patterns"* (R8).

According to the LSPs, it was even more difficult to change customers' behavior. R6 stated: *"They are very good at placing demands on us. And they tell us what they think we should do although they do not do it themselves. They put pressure just on us."* As raised several times during the interviews, time and cost are prioritized by customers and when more sustainable alternatives are presented that either cost a little more or are less time-accurate, they are often omitted in the process.

The respondents had different perceptions when it came to sustainability awareness and changing the behavior of decision-makers and organizational co-workers. This was as difficult and challenging as other changes in their organizations. It was regarded to be more of a normal management challenge than specific to sustainability.

E. Uncertainties

<i>E.1. Uncertainties to the degree and nature of governmental regulations & policies are:</i>					
	<i>1 Very low</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Very high</i>
Total answers (Respondents)	0	2 (R5, R10)	4 (R4, R6, R7, R9)	2 (R3, R8)	2 (R1, R2)
<i>E.2. Uncertainty in long-term development is:</i>					
	<i>1 Not challenging</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Very challenging</i>
Total answers (Respondents)	0	1 (R5)	2 (R6, R9)	4 (R3, R4, R7, R10)	3 (R1, R2, R8)

Table 5.7. LSPs’ opinions about challenges of uncertainties

The LSPs interviewed were unaware of and uncertain about future regulations, policies, and legislation formulated by governments and policy makers. They were also very uncertain about sustainability-related strategies formulated by supply chain stakeholders as well as customers’ behavior and future demands.

5.1.4 Results of the case studies

Results of the case studies highlighted “customer priorities” (discussed in sections 5.1.2 and 5.1.3) and “fragmentation of the logistics industry” (discussed in section 5.2.2) as two challenges in sustainable development of LSPs in relations to their supply chains stakeholders.

The results of the three case revealed that at the end of the day, costs and delivery time are placed far ahead of environmental and social friendliness. The cases also revealed a great difference between how two LSPs (Case A and Case B), with similar CSR and environmental policies enforce and monitor their subcontractors differently. This difference in actual practice can have major implications on the validity of environmental or sustainability reports that are published by LSPs.

5.2 Themes and challenges in making supply chains socially sustainable

The systematic review of relevant articles and the application of an analytic induction in RS2 resulted in the identification of the major themes and challenges in making supply chains socially sustainable.

5.2.1 Identified themes

Five categories of themes were identified after the focused/axial coding: (1) goods/ service-centric, (2) human-centric, (3) organization-centric, (4) corporate-centric, and (5) management-centric (summarized in Table 5.8).

Goods/ service-centric	<ul style="list-style-type: none"> ● Safety, security, and healthiness of goods and services ● Transparent traceability of goods and services ● Respecting non-humanistic rights (e.g., property rights & animal rights/ welfare)
Human-centric	<ul style="list-style-type: none"> ● Healthcare and safety of employees and their families ● Respecting employees/lobar rights (e.g., equal employment opportunities, written contacts, legal wages and compensations, retirement funds, increase in the minimum wage rate in accordance with economic growth, maternity leave, fair working hours, decent working conditions, fair return on contributions, freedom of movement and association, right to collective bargaining, right to strike, democratic decision-making) ● Preventing discrimination (e.g., discrimination based on nationality, ethnicity, race, gender, religion, class, or wealth of the employees) ● Prohibition of child labor, forced labor, bonded labor, harassment and abuse
Organization-centric	<ul style="list-style-type: none"> ● Creating a right culture for development ● Create a learning context (by education, lifelong learning, training, sharing information and knowledge) ● Exploit innovation and creativity (by increasing absorptive capacities, social interaction and networking, being open to new suggestions and external stakeholders) ● Foster diversity (while maintaining organizational integrity and inclusion) ● Develop employees' skills, talents, and careers over time ● Enhance the ability to attract, retain, and motivate employees ● Reduce employee absenteeism ● Protect the employees' dignity, well-being, satisfaction, loyalty, and commitment to work ● Respect and advance minorities
Corporate-centric	<ul style="list-style-type: none"> ● Ethical sourcing/ sound sourcing/ social responsible buying/ purchasing social responsibility (sourcing from ethical/ socially responsible suppliers, transparency of suppliers, developing suppliers' skills and capabilities) ● Ethical trade/ fair trade/ business ethics (e.g., setting equitable pricing system; providing pre-payment; fair distribution of revenue across the supply chain; avoiding fake trade; avoiding obscure contract terms; avoiding corruption, extortion, bribery, and illegal payments; being honest and transparent; conducting business consistent with morals and values of society) ● Corporate responsibilities (e.g., responsibilities in relationship with supply chain stakeholders and corporate citizenship such as responsibilities in social investment, supporting public services, community development, and philanthropy) ● Collaboration
Management-centric	<ul style="list-style-type: none"> ● Modeling, assessment, and measurement (e.g., social life cycle assessment, multi-criteria performance measures, sustainability indices and indicators) ● Compliance with standards and guidelines (e.g., SA 8000, AA1000SES, OHSAS 18001, following guidelines such as ISO 26000, the OECD Guidelines for Multinational Enterprises, the Global Sullivan Principles, and conventions and declarations like those of the International Labor Organization [ILO]) ● Self-regulatory mechanisms (e.g., setting guidelines and codes of conduct, publishing reports, voluntary self-assessments, setting KPIs, taking initiatives)

Table 5.8. The five major themes in making supply chains socially sustainable

5.2.2 Identified challenges

Eight categories of challenges were identified after the focused/ axial coding: (1) inadequate and asymmetric knowledge, (2) shifting the values, (3) operationalization, (4) subjectivity in evaluation, (5) difficulties of SMEs, (6) governance complexity, (7) sustainability leakage,

and (8) sustainability washing (summarized in Table 5.9). For a detailed explanation of each category of challenges, please refer to Paper II.

Inadequate and asymmetric knowledge	<ul style="list-style-type: none"> ● Inadequate and asymmetric knowledge about different aspects of social sustainability ● Low attention to social sustainability in the entire supply chain
Shifting the values	<ul style="list-style-type: none"> ● Unequal weighting of social aspects compared to economic aspects of sustainability ● Exclusion of social degradation costs in the total costs
Operationalization	<ul style="list-style-type: none"> ● Interpretation of the Brundtland Commission definition in concrete operational terms ● Changing the business models ● Changing attitudes of the employees and customers ● Lack of strategic thinking, persistence or commitment from management
Subjectivity in evaluation	<ul style="list-style-type: none"> ● Differences in expectations, cultures, social practices, local conditions, contextual setting, legal requirements ● Changes at different stages of development ● Loose definitions of CSR and subjectivity in meaning, scope, and degree of responsibilities ● Lack of a meaningful/ adequate/ unified indicator or unified labels ● Difficulties in defining the boundaries and scales of description of tiers and stakeholders of supply chains
Difficulties of SMEs	<ul style="list-style-type: none"> ● Difficulties and uncertainties regarding the benefits of upgrading to new sustainability standards and codes of conduct ● Lack of knowledge, skills, time, enforcement, financial and human resources in responding to requirements and regulations
Governance complexity	<ul style="list-style-type: none"> ● Difficulties in auditing and controlling due to fragmentation ● Difficulties in adaptation to a wide range of corporate codes of conduct, standards, certificates, and labels ● Heterogeneity regarding sustainability practices between and within industries ● Lack of accountability, credibility, and independency of certifiers
Sustainability leakage	<ul style="list-style-type: none"> ● Evade responsibilities by transferring to/ sourcing from places or stakeholders with looser regulations and standards
Sustainability washing	<ul style="list-style-type: none"> ● Lack of consensus or misalignment between behavior or practice and sustainability visions and goals

Table 5.9. The eight major challenges in making supply chains socially sustainable

5.3 Themes and challenges in making freight transport environmentally sustainable

After and in parallel with the data collection (interviews with selected logistics service providers and literature review), a data analysis was run to determine the answers that were trustworthy and authentic for the third research question. The analysis after focused coding and then categorizing/ clustering them led to identification of themes and challenges. Themes in the third research study were divided into current and future activities.

5.3.1 Identified current activities

The analysis of current activities resulted in the emergence of eight major categories (summarized in Table 5.10). Three were most emphasized by most of the interviewees (primary activities); the remaining five were less emphasized (secondary activities). The primary activities were: (1) resources efficiency, effectiveness, and utilization; (2) environmentally and sustainability cautious behavior; (3) measurement and assessment. The secondary activities were: (4) taking initiatives; (5) compliance with legislation and standards; (6) efficient utilization of transport infrastructure; (7) well-connected information and goods flows; (8) vertical and horizontal collaboration. For a detailed explanation of each current activity, please refer to Paper III.

Primary activities	Resources efficiency, effectiveness, and utilization	<ul style="list-style-type: none"> ● Efficient and effective movable resources (right mode of transportation [intermodality], using environmentally friendly vehicles) ● Efficient static resources (energy- and eco-efficiency in terminals, hubs, distribution centers, warehouses, offices, etc.) ● Higher resource utilization (by increasing load factor, fill-rates, efficiency, etc.)
	Environmentally and sustainability cautious behavior	<ul style="list-style-type: none"> ● Educating and training the stakeholders (e.g., personnel) about ethically and environmentally friendly operations ● Responsible sourcing/ procurement (scanning all suppliers to assure that they fulfil social and environmental [corporate social responsibility] requirements)
	Measurement and assessment	<ul style="list-style-type: none"> ● Internal standards and scorecards to measure/ assess sustainability related parameters ● Online platform for calculation of GHG emissions from transport operations ● Publishing annual sustainability reports
Secondary activities	Taking initiatives	<ul style="list-style-type: none"> ● United Nations (UN) Global Compact initiative ● United Nations Development Program (UNDP) initiative ● Logistics Emergency Teams (LET) initiative
	Compliance with legislation and standards	<ul style="list-style-type: none"> ● Following organizational, national, continental, and/or global legislation/ requirements/standards (e.g., ISO 14001, EMAS certification, Sulfur emission and Ballast water legislation by IMO)
	Efficient utilization of transport infrastructure	<ul style="list-style-type: none"> ● Using up-to-date technologies/ devices/ software for route planning and optimization ● Coordinated air traffic control and single sky in air sector
	Well-connected information and goods flows	<ul style="list-style-type: none"> ● Implementing Intelligent Transport and Track-and-Trace systems
	Vertical and horizontal collaboration	<ul style="list-style-type: none"> ● Collaboration and lobby work with other LSPs, authorities, and stakeholders

Table 5.10. Current activities in making freight transport environmentally sustainable (LSPs' perspective)

5.3.2 Identified future activities

All the interviewees agreed upon the tremendous difficulty and uncertainty in the design of future sustainability-related activities and strategies for freight transport in a long-term

perspective like 40 years (until 2050). Most of them took a shorter perspective (two up to 2020, 3-5 years for others) to elaborate future activities and strategies.

The analysis of future activities resulted in the emergence of seven major categories (summarized in Table 5.11). Three were strongly and explicitly emphasized by most of the interviewees (primary activities); the remaining four were less emphasized (secondary activities). The primary activities were: (1) innovation and research; (2) energy and fuel efficiency; (3) increasing awareness. The secondary activities were: (4) technological development; (5) design for sustainability; (6) adaptation to future policies and corporate governance; (7) taking supply/ value chain view.

It is worth mentioning that all LSPs are going to continue their current activities in making freight transport sustainable mentioned in section 5.3.1. For a detailed explanation of each future activity, please refer to Paper III.

Primary activities	Innovation and research	<ul style="list-style-type: none"> ● Openness to innovative solutions/ strategies/ out of the box ideas/ business models ● Invest in research and collaboration with researchers and advisory councils
	Energy and fuel efficiency	<ul style="list-style-type: none"> ● Utilizing resources (vehicles and facilities) fed by non-fossil/renewable while economic fuels ● Collaboration with vehicle manufacturers (designing environmentally friendly trucks, trains, vessels, and aircrafts) ● Collaboration with base industries (moving towards zero emission from energy production and consumption) ● Benchmarking energy efficiency with other businesses ● Investments in innovation, research, and technical development, for lower energy consumption and higher efficiency
	Increasing awareness	<ul style="list-style-type: none"> ● By collaborating with other stakeholders on organizational, national, regional, and international levels
Secondary activities	Technological development	<ul style="list-style-type: none"> ● Such as development or adaptation of Transport Management Systems (TMS), Intelligent Transport Systems (ITS), Enterprise Resource Planning (ERP), future generation of vehicles
	Design for sustainability	<ul style="list-style-type: none"> ● Better design of supply chain statics such as number and arrangement of terminals, hubs, distribution centers, etc.
	Adaptation to future policies and corporate governance	<ul style="list-style-type: none"> ● Collaboration with authorities and policy makers regarding coming policies and directives (like CO₂ tax, emissions right, emissions trading, emissions restrictions)
	Taking supply/value chain view	<ul style="list-style-type: none"> ● Collaboration with products' producers/manufacturers and consumers and passenger carriers (both horizontal and vertical collaboration with upstream and downstream actors)

Table 5.11. Future activities in making freight transport environmentally sustainable (LSPs' perspective)

5.3.3 Identified challenges

In total, four major categories were identified of challenges in making freight transport sustainable from the LSPs' perspective (summarized in Table 5.12): (1) customer priorities;

(2) managerial complexity; (3) network imbalances; (4) technological and legislative uncertainties.

For a detailed explanation of each category of challenges, please refer to Paper III.

<p>Customer priorities</p>	<ul style="list-style-type: none"> ● LSPs customers usually look at transport as a non-value activity which must be fulfilled with lowest time and price ● Increase customer awareness and change their behavior and perspective in favor of sustainability
<p>Managerial complexity</p>	<ul style="list-style-type: none"> ● Difficulties in measurement and assessment of environmental externalities ● Different standards, methods, and platforms for measuring GHG emissions or assessing environmental impacts ● Different customer demands in different markets and industries ● Difficulties in change and adaptation in favor of sustainability ● Complexity in the implementation of sustainability ● Difficulty of cooperative sustainable development due to fragmented nature of logistics industry ● Low united sustainability interests inside LSPs (especially the global ones)
<p>Network imbalance</p>	<ul style="list-style-type: none"> ● Restrictions in delivery times, diverse load and unload (pick and delivery) operations ● Geographical positions ● Imbalances due to globalization, exports, and free trade
<p>Technological and legislative uncertainties</p>	<ul style="list-style-type: none"> ● Uncertainties about future fossil-free fuels and infrastructural changes for their production and distribution ● Uncertainties about future changes in transport infrastructure ● Uncertainty in legislation, regulations, and long-term strategies

Table 5.12. The four major categories of challenges in making freight transport environmentally sustainable (LSPs' perspective)

5.4 Themes and challenges in making urban freight distribution sustainable

The systematic review of selected articles by the application of an analytic inductive analysis process resulted in the identification of major themes and challenges in making urban freight distribution sustainable. This section provides a classified synthesis of the themes and challenges identified.

5.4.1 Identified themes

Eight major themes emerged during the third research study: (1) juridical and financial regulations/ restrictions/ limitations; (2) structural and infrastructural; (3) managerial; (4) environmentally friendly modes of transportation; (5) technological developments; (6) emissions and fuels economy; (7) distribution services; (8) educational.

An extract of the grouped themes is presented in Table 5.13. For a detailed explanation of each major theme, please refer to Paper IV.

Juridical and financial regulations/ restrictions/ limitations	<ul style="list-style-type: none"> • Time restrictions, delivery timing, vehicle access time restrictions • Vehicle load capacity restrictions, vehicle access weight/ size/ capacity restrictions • Environmental zones/ low emission zones/ clear zones • Financial regulations/ means
Structural and infrastructural	<ul style="list-style-type: none"> • Urban Consolidation Centers (UCCs) • Maximizing capacity utilization of existing infrastructures • Underground urban goods distribution
Managerial	<ul style="list-style-type: none"> • Planning, control, measurement, monitoring, modeling, assessment/ evaluation, cooperation/ coordination/ collaboration, and partnership
Environmentally friendly modes of transportation	<ul style="list-style-type: none"> • Inter- and co-modality; shifting to non-road modes of transport • Developing environmentally friendly vehicles
Technological developments	<ul style="list-style-type: none"> • Developing clean/ green/ environmental technologies such as ICT
Emissions and fuels economy	<ul style="list-style-type: none"> • Developing sustainable fuels with zero emissions and without antagonistic effects somewhere else
Distribution services	<ul style="list-style-type: none"> • Home service distribution/ delivering the goods to the customers' homes • Neighborhood drop-off points • Use of packaging automates or stations in the distribution process
Educational	<ul style="list-style-type: none"> • Increasing sustainability awareness/ change of behavior by investing in research and education

Table 5.13. The eight major themes in making urban freight distribution sustainable

5.4.2 Identified challenges

In total, seven major categories of challenges in making urban freight distribution sustainable were identified (presented in Table 5.14): (1) decoupling; (2) restructuring; (3) costs/ financial

viability; (4) operationalization; (5) uncertainties; (6) lack of visionary leadership; (7) corporate governance. For a detailed explanation of each category of challenges, please refer to Paper IV.

Decoupling	<ul style="list-style-type: none"> ● Decoupling economic growth from freight distribution and transport growth
Restructuring	<ul style="list-style-type: none"> ● Antagonistic effects of distribution trends on environment and sustainability ● Restructuring of urban distribution due to globalization (global change and chains)
Costs/ financial viability	<ul style="list-style-type: none"> ● Higher average costs of freight distribution in urban areas (short distance) than inter-city (long distance) freight distribution ● High set-up and total costs of city logistics initiatives especially in the short term ● High investment costs in developing, constructing, or restricting the infrastructure
Operationalization	<ul style="list-style-type: none"> ● Considerable lack of knowledge in understanding what city logistics and its initiatives/themes are ● Reluctance of city logistics stakeholders to accept or participate in initiatives ● Inefficiencies in urban freight distribution
Uncertainties	<ul style="list-style-type: none"> ● Strategic uncertainties ● Operational uncertainties ● Uncertainties due to psychological reluctance of customers to buy clean technologies ● Uncertainties due to antagonistic effects of city logistics initiatives in urban areas
Lack of visionary leadership	<ul style="list-style-type: none"> ● Vague vision and goals ● Short-term market perspectives in focus ● Creating a new and innovative urban mobility culture ● Inertia and resistance to change
Corporate governance	<ul style="list-style-type: none"> ● Bureaucratic difficulties and administration barriers ● Decision-making by several actors from the municipality and regional to the state levels ● Variations in policy measures as well as governmental policies and rules in different urban areas ● Lack of political commitment ● Scarce and out-of-date national and local policy frameworks regarding freight distribution

Table 5.14. The seven major categories of challenges in making urban freight distribution sustainable

6. DISCUSSION

None of us can do alone what we can do together.

This chapter synthesizes the themes and challenges identified in the research studies. Based on the complexity theory perspective presented in chapter 4 and the framework in Figure 4.3, a reflective discussion about the central themes and challenges in making supply chains sustainable is put forward.

6.1 Central themes in making supply chains sustainable

Ten themes in making supply chains environmentally and socially sustainable were reported in chapter 5, and more specifically, twenty-three themes in making freight transport and urban distribution sustainable. This shows that the research presents a broad and pluralistic array of pathways to make supply chain activities sustainable. However, few examples were found of themes (or processes for that matter) that provide empirical evidence of how to actually go about doing so in practice. Consequently, it can be assumed that supply chains cannot become sustainable with just one or a few sustainability-oriented activities.

The themes identified in RS1 and RS2 are the patterns that could be extracted from several environmentally and socially-oriented activities in the entire supply chains. As a result, there are similarities and overlap among them and those found in RS3, RS4, and RS5 (because freight transport, urban freight distribution, and logistical services are sub-activities of supply chains). For instance, “management issues”, “green activities, policies and strategies”, and “transport fuel, energy and emissions” from RS1 or “management-centric” from RS2 are also discussed in RS3, RS4, and RS5.

However, the discussions in RS3 and RS4 are more explicit. For example, “management issues” and “transport fuel, energy and emissions” in RS1 are more specifically discussed in RS3 under “measurement and assessment” and “energy and fuel efficiency”, or in RS4 under “managerial”, “environmentally friendly modes of transportation”, and “emissions and fuels economy”.

To cite another instance, “green activities, policies and strategies” in RS1 are more specifically discussed in RS3 as “resources efficiency, effectiveness, and utilization”, “efficient utilization of transportation infrastructure”, “taking initiatives”, “compliance with legislation and standards”, “environmentally and sustainability-cautious behavior”, “increasing awareness”, “vertical and horizontal collaboration”, “taking supply/ value chain view”, and “adaptation to future policies and corporate governance”; or in RS4 as “juridical and financial regulations/ restrictions/ limitations”, “structural and infrastructural”, “environmentally friendly modes of transportation”, and “educational”; or in both RS3 and RS4 as “technological developments”; or in RS5 as “environmental policy” and “reporting”.

There are also similarities between RS2 and other studies although RS2 has a dominant social perspective rather than an environmental one. For example, transparent traceability under “goods/ services-centric”, “corporate-centric”, and “management-centric” can also be traced in RS1 under “green activities, policies and strategies”, “concept of sustainable supply

chains”, and “management issues”; or in RS3 under “well-connected information and goods flows” and “design for sustainability”; or in RS4 under “managerial”.

However, there are some differences among the identified themes in the research studies. For example, “reverse logistics/ closed-loop supply chains” identified in RS1 were not well elaborated in RS3 and RS4 because it was not clear how freight transport and distribution can play their roles in the reverse logistical flows or in closing the loop of supply chains. On the other hand, the role of “innovation and research” – identified in RS3 and RS4 – was not well elaborated in RS1. “Distribution services” were also discussed mostly in RS4 than in RS1 or RS3. As expected, “human-centric” and “organization-centric” themes were mostly highlighted in RS2, although some parts of the later (such as exploit innovation and creativity, develop sustainability capabilities, and create a learning context) were more or less elaborated in RS3.

In addition, some missing themes were found in the research studies that present opportunities for further research. For example, RS1, RS2, and RS4 highlighted that a sustainable development (triple bottom lines) perspective is missing in the discussion about downstream parts of supply chains, reverse logistical activities, and closed-loop supply chains. Similarly, it was concluded in RS3 and RS5 that such a perspective is missing in the discussion about logistical services in the supply chains.

It was also concluded that there is a need to study how sustainability emerges and co-evolves in supply chains and how responsibilities and values are shared among stakeholders and in change over time. However, it was confirmed in both the literature reviews and the empirical studies that long-term changes and perspectives are rarely considered.

RS1 and RS2 concluded that more models and theories in managing sustainable supply chains are needed. There is also a need for more research on how logistical activities influence or are influenced by other supply chains activities and what the sustainability consequences are. Similar to the conclusions in RS2, other research studies verify that there is a need for further study of sustainable supply chain governance, sector and regional-specific governing mechanisms, rights and ethics in logistics and supply chains, and sustainable business models.

By combining all thirty-three themes and then classifying them based on their similarities and overlap (Table 6.1), four central themes in making supply chains sustainable emerged:

- *Sustainability in goods and services* (those directly related to goods and services);
- *Sustainability in resources* (those related to emerged resources that are necessary for generating goods and services);
- *Sustainability in corporation* (those related to inter-processes and interrelationships among tiers of supply chains as well as the corporations and wider/ macro society); and
- *Sustainability in management and/or governance* (those related to management of sustainable supply chains).

Sustainability in goods and services	Sustainability in resources	Sustainability in corporation	Sustainability in management and/or governance
<ul style="list-style-type: none"> • Green activities, policies and strategies (RS1) • Reverse logistics/closed-loop supply chains (RS1) • Concept of sustainable supply chains (RS1) • Goods/service-centric (RS2) • Well-connected information and goods flows (RS3) • Environmentally friendly modes of transportation (RS4) • Emissions and fuels economy (RS4) 	<ul style="list-style-type: none"> • Green activities, policies and strategies (RS1) • Concept of sustainable supply chains (RS1) • Transport fuel, energy and emissions (RS1) • Human-centric (RS2) • Organization-centric (RS2) • Resources efficiency, effectiveness, and utilization (RS3) • Environmentally/sustainability cautious behavior (RS3) • Efficient utilization of transport infrastructure (RS3) • Well-connected information and goods flows (RS3) • Energy/fuel efficiency (RS3) • Technological development (RS3) • Design for sustainability (RS3) • Innovation and research (RS3) • Increasing awareness (RS3) • Structural and infrastructural (RS4) • Environmentally friendly modes of transportation (RS4) • Technological development (RS4) • Distribution services (RS4) • Educational (RS4) 	<ul style="list-style-type: none"> • Green activities, policies and strategies (RS1) • Reverse logistics/closed-loop supply chains (RS1) • Concept of sustainable supply chains (RS1) • Corporate-centric (RS2) • Environmentally/sustainability cautious behavior (RS3) • Vertical and horizontal collaboration (RS3) • Increasing awareness (RS3) • Taking supply/value chain view (RS3) 	<ul style="list-style-type: none"> • Management issues (RS1) • Green activities, policies and strategies (RS1) • Concept of sustainable supply chains (RS1) • Transport fuel, energy and emissions (RS1) • Management-centric (RS2) • Measurement and assessment (RS3) • Taking initiatives (RS3) • Compliance with legislation and standards (RS3) • Vertical and horizontal collaboration (RS3) • Energy/fuel efficiency (RS3) • Adaptation to future policies and corporate governance (RS3) • Taking supply/value chain view (RS3) • Juridical and financial regulations/restrictions/limitations (RS4) • Managerial (RS4)

Table 6.1. Four central themes in making supply chains sustainable

6.1.1 Sustainability in goods and services

The first central theme reflects directly on characteristics of sustainable goods and services. Summing up the results of the research studies, sustainability aspects of goods and services can be related to their *effectiveness, efficiency, renewability, recyclability, pollution-reduction, safety, healthiness, security, and transparent traceability*. All these aspects, explained in the following, can influence all the triple bottom lines in the supply chains.

- *Effectiveness* means doing the right things in generating sustainable goods and services such as using the appropriate material, selecting the appropriate processes, sharing the right information, and respecting non-human rights.
- *Efficiency* means doing things right such as using appropriate amounts of material, user-friendly formation, aerodynamic design, avoiding under or over packing, or increasing fill-rates in the packaging systems (Gray and Guthrie, 1990; Prendergast and Pitt, 1996; van Hoek, 1999; Skjoett-Larsen, 2000; Mollenkopf *et al.*, 2005; Garcia-Arca and Prado, 2008; Cheng *et al.*, 2008).
- *Renewability* is related to sourcing the raw materials or energy from the natural resources that can be replaced with minimum antagonistic effects somewhere else (as exemplified in section 6.2).
- *Recyclability* of products and their packaging systems (primary, secondary, and tertiary packages) is another activity that is mostly discussed in the literature that deals with reverse logistics such as product returns (Srivastava and Srivastava, 2006), disposal (Chandrashekar and Doudless, 1996; Daugherty *et al.*, 2001; Skinner *et al.*, 2008), and collection (Hanafi *et al.*, 2008). Section 6.1.3 discusses that reverse logistical activities should be considered in the wider concept of closed-loop supply chains and integrated with their other activities such as remanufacturing, recovering, retesting, repairing services, refurbishing, reusing, remarketing, and reselling.

- *Pollution reduction* is another theme that was more or less discussed in all of the research studies. In this regard, all sorts of waste, emissions, toxicants, noise and visual pollution in generating goods and services should be minimized.
- It was more specifically discussed in RS2 that goods and services are considered as sustainable if they are also *safe* and *healthy* for consumption, *secure* in the logistical flows, and *transparently traceable* in the entire supply chain.

However, some of these aspects go hand in hand, such as information sharing and transparency or pollution reduction and efficiency. There is also subjectivity inherent in how “appropriateness” and “rightness” are defined, as these are in the eyes of the beholder and the contexts where supply chains activities are carried out. In addition, there are trade-offs among the triple pillars of sustainable development regarding appropriateness and rightness. For example, a lighter or renewable material may be environmentally appropriate while socio-economically inappropriate. Paradoxes can emerge when different aspects are mixed, such as pollution from reverse logistical activities.

As a result, it is counterproductive to draw clear boundaries between the identified aspects from the complexity theory perspective. It is also counterproductive to simplify the supply chains by just making their goods and services or some of their aspects objectively sustainable, without considering their interrelationships with other parts or aspects of sustainable supply chains (discussed in what follows) and their contextual situations. Moving from the current theoretically and practically simplistic to a more holistic may co-evolve theoretical and practical efforts in dealing with the sustainable development of supply chains.

Another conclusion is that the effectiveness aspects of sustainability in goods and services have not been as well elaborated as the other aspects. Researchers and practitioners rarely challenge their habits by asking if they really do the right things in what they try to do right, i.e. make efficient.

6.1.2 Sustainability in resources

The second central theme is related to sustainable development of the emerged resources that are necessary for generating sustainable supply chains. Sustainability capabilities are developed when complex bundles of heterogeneous human and non-human resources for achieving sustainability goals, norms, and shared values are effectively coordinated (Pullman and Dillard, 2010; Gold *et al.*, 2010; Dao *et al.*, 2011). What follows is a summary of how the sustainability of resources (physical, financial, human, and intangible) can influence the emergence of sustainability in the supply chains.

Sustainability in physical resources

Summing up the results of the research studies, sustainability aspects of the physical resources can be related to their *effectiveness*, *efficiency*, *recyclability*, *pollution-reduction*, *safety/security*. All these aspects can influence all the triple bottom lines in the entire chains.

- *Effectiveness* of resources means using appropriate resources in the supply chains. Examples of this are the right combination of available transportation modes (inter- and co-modality); using cleaner and more secure/ safer vehicles (with lower particle emissions and energy intensities, driverless ones, installing safety and security instruments); using clean technologies such as Carbon Capture and Storage (CCS), decentralized fuel/ energy cells; and ICT (LETS rapport, 2013). The role of ICT was elaborated in all of the studies as it is a general purpose technology (LETS rapport,

2013) that can be found in the tracking and tracing of goods and resources, traffic management systems, route optimization, identification tags, smart cards, intelligent transport systems, enterprise resource planning, emission calculators, parking monitoring tools, on-line load zone reservations, paperless operations, virtual reality, etc. ICT is a key to integrated, connected, visible, adaptive, and intelligent supply chains.

- *Efficiency* of resources means “using resources right” by, for example, increasing the resources utilization of the existing production/ manufacturing/ processing capacities; load factors of vehicles (by triangulation or urban consolidation centers [Browne *et al.*, 2005]) and unit loads; and the existing infrastructure capacity (for example by ICT, track and trace systems, coordinated traffic control, single sky, control towers). RS4 reported that the infrastructure capacity can be increased as a result of: multi-use lanes; common use of public and private parking lots – mainly used for passenger vehicles – or other reserved spaces (taxi zones, bus lanes, motorcycle parking spaces, and parking spaces for disabled people) during certain time; load zone provision; delivery zones; and dynamic allocation of reserved loading and unloading spaces for delivery vehicles in dense urban areas – as well as temporal individual load spaces and short time double parking (Munuzuri *et al.*, 2005; Álvarez and de la Calle, 2011; Awasthi *et al.*, 2011).
- Physical resources should also be *recyclable* with *minimized pollution* (waste, emissions, toxicants, noise and visual pollution) and *safe/ secure* to use.

Similar to the discussion in section 6.1.1, some of these aspects go hand in hand. This includes increasing effectiveness by using cleaner vehicles (including all modes) or increasing efficiency by higher resources utilization and pollution reduction. Increasing effectiveness and efficiency while reducing pollution could also be traced in the reviewed literature and empirical studies. For example, de-speeding the supply chains may increase effectiveness as a result of shifting to slower modes of transport (and consequently reduce energy intensity) and raise efficiency (i.e., utilization of resources) (LETS rapport, 2013). The constellation of resources and supply chain design can influence both efficiency and pollution. RS4 presented examples of the use of neighborhood drop-off points (Goldman and Gorham, 2006), packaging automates (Pawlak and Stajniak, 2011), and home delivery (Álvarez and de la Calle, 2011) in urban distribution to increase load factors of vehicles and reduce pollutions by reducing the last-mile problem and transport as well as traffic intensities.

Subjectivity is also inherent in how “rightness” is defined depending on the eyes of the beholder and the contexts where supply chains activities are carried out. There are also several trade-offs and paradoxes regarding sustainability in physical resources when taking all the triple bottom lines into account (discussed under challenges in section 6.2), for example, when efforts to increase effectiveness may lead to increasing costs or paradoxically encourage mobility; increasing efficiency may lead to lower service levels; and the re-constellation of resources may lead to higher set-up costs or increase transport intensities. As a result, it would be counterproductive to take objective, deterministic, context-independent, and simplistic perspectives to sustaining the physical resources.

In conclusion, there is a need for more research on how the facility layout or localization/ near-shoring (for the branches that can be localized/ near-shored) can influence all the triple bottom lines of sustainable supply chains. Research has mostly been dealt with the static resources (such as terminals, hubs, distribution centers, warehouses) and vehicles. There is also a need for more research on the role of movable resources other than vehicles, such as unit loads, cargo carriers, tools, and instruments in sustainable development of supply chains.

Sustainability in financial resources

Although the economic pillar of sustainable development was not in the scope of this research, its interactions with the environmental and social pillars were. These interactions were raised in both the literature reviews and the empirical studies when the issues of “costs” and “financial viability” were discussed. All the previously mentioned sustainability aspects (effectiveness, efficiency, recyclability, pollution-reduction, safety, healthiness, security, and transparent traceability) can also lead to economic gains in the short or long terms. In addition, the right financial resources (assets, cash, stocks, bonds, investments, and intellectual properties) should be rightly utilized and developed.

Sustainability in human resources

Summing up the results of the research studies, sustainability aspects of the human resources can be related to *effectiveness, efficiency, and human resources/ human capitals/ labor/ employees’ rights*. These aspects mostly reflect the socio-economic aspects of sustainable supply chains.

- *Effectiveness* of human resources means using the right/ appropriate/ responsible ones, while *efficiency* means utilizing employees’ capacities/ capabilities. Responsibilities, capacities, and capabilities should be directed to fulfilling the values in supply chains. These aspects open up opportunities for further research as they were inadequately elaborated in the research studies. In the next section, the role of organizations in developing human resources is discussed.
- As expected, *employees’ rights* emerged in RS2. The most highlighted criteria were employees’ *safety and healthcare* followed by their *equal and fair treatment* (e.g., equal employment opportunities, written contracts, legal wages, compensation, retirement funds, gradual increase in the minimum wage rate in accordance with economic growth, maternity leave, fair working hours, fair return on contributions, freedom of movement and association, right to collective bargaining, right to strike, inclusion in decision-making, decent working conditions). There were also a set of *normative* examples such as avoiding discrimination, child labor, forced labor, bonded labor, harassment and abuse.

As discussed in sections 6.2 and 6.3, subjectivity and context dependency are inherent in the discussion about employees and their rights, which can be appropriately treated from a CTP.

Sustainability in intangible resources

The research studies also highlighted the role of intangible resources in the emergence of sustainability in supply chains. Intangible resources are embedded in the bundles of employees and organizations of supply chains.

a) Sustainability culture

A sustainability culture is related to preferable beliefs and codes of behavior that can facilitate the sustainable development of supply chains. In what follows, some criteria in shaping a sustainability culture of a supply chain’s stakeholders according to the reviewed literature or empirical studies are described. However, it is counterproductive to draw boundaries between these criteria as they go hand in hand and reinforce each other.

- *Developing a learning context*
The first criteria in developing a leaning context was the role of education that was more or less elaborated in all of the research studies. RS3 and RS5 exemplified how

several LSPs have started educating their internal and external stakeholders about environmental and ethical operations. According to Venkataraman (2009, p. 8), education for sustainable development differs from environmental education. The latter focuses on “*humankind’s relationship with the natural environment and on ways to conserve and preserve it and properly steward its resources*” while the former “*encompasses environmental education but sets it in the broader context of socio-cultural factors and the socio-political issues of equity, poverty, democracy and quality of life.*”

Other criteria were fragmentally discussed in the search studies such as encouraging lifelong learning; training; and sharing knowledge that according to Grewal and Haugstetter (2007, p. 169) makes up “*the intangible assets on which business sustainability and growth are founded. Knowledge is a dynamic, social resource.*” Developing the learning context is crucial in developing a knowledge intensive (Salas-Fumás, 2010) and dematerialized/ weightless economy (Essential Economics, 2004, pp. 274).

- *Exploring and exploiting innovation*

A sustainability culture also favors exploring and exploiting sustainability-oriented innovation by carrying out research; by increasing absorptive capacities (Grewal and Haugstetter, 2007); by social interaction and networking; and by being open to new suggestions and external stakeholders.

- *Fostering diversity*

The role of diversity was mostly highlighted in RS2 that goes paradoxically hand in hand with (organizational) integrity and inclusion. RS6 discussed diversity as a critical criterion in the evolution of sustainable supply chains. Diversity is also advantageous “*in terms of innovative capabilities if set within a conducive organizational culture*” (Baldwin *et al.*, 2010, p. 702).

- *Developing the employees*

A sustainability culture favors the development of the skills, talents, and carriers of employees over time. In such a culture, employees are motivated; their absenteeism is reduced; their dignity, wellbeing, satisfaction, loyalty, and commitment to work are protected; and minorities are respected and advanced.

b) *Protecting trust, brand, and reputation* are classic intangible resources in supply chains that were highlighted in the discussion about their sustainable development, especially regarding the socio-economic aspects. Other classic examples that emerged included the *ability to maintain and continue business relationships, dealing with risks, and resistance and resilience.*

6.1.3 Sustainability in corporation

The third central theme originated from those that shed light on inter-processes and interrelationships among tiers of supply chains as well as the corporations and wider/ macro society. Summing up the results of the research studies, these can be related to *closed-loop supply chains, shared responsibilities, corporate responsibilities, and collaboration.*

Closed-loop supply chains

The aim of closed-loop supply chains is to integrate forward processes and flows (upstream to downstream) with the reverse ones (downstream to upstream). As highlighted in section 6.1.1, forward supply chains should be integrated with reverse ones dealing with activities such as reverse logistics, remanufacturing, retesting, repairing, refurbishing, recovering, reusing, remarketing, and reselling. However, as elaborated in RS1, closed-loop supply chains have

mostly been treated from environmental and economic dimensions. An analysis of all the triple bottom lines on closed-loop supply chains would present an opportunity for further research.

Shared responsibilities

As highlighted in the research studies, sustainability aspects should be shared among the stakeholders in the entire supply chains. Without sharing the responsibilities in interrelationships, supply chains will break. *Responsible sourcing* and *responsible trade* were two criteria of shared responsibilities that emerged although the former is subsumed by the later.

- *Responsible sourcing* calls for sourcing from environmentally responsible, ethical, and transparent suppliers who follow the commonly shared norms and minimum standards/ requirements. RS2 more specifically discusses that firms can act more proactively to move beyond selection and evaluation of suppliers by also educating and training them, developing their skills and capabilities and starting a process of collaborative continuous improvement and co-operation. As Meehan and Bryde (2011) and Gimenez *et al.* (2012) state, effective follow-up and engagement of suppliers is more effective than just their selection and evaluation.
- *Responsible trade* goes one step further than responsible sourcing and calls for all trade processes of goods and services to comply with commonly shared norms and minimum standards/ requirements. In RS2, examples were highlighted that had socio-economic characteristics such as setting equitable pricing system; providing pre-payment; a more equitable redistribution of revenue along the supply chains; respecting property rights; avoiding fake trade; avoiding obscure contract terms; being honest and transparent; avoiding corruption, extortion, bribery, and illegal payments to authorities; and conducting business consistent with the morals and values of society.

Like the socio-economic responsibilities, the environmental responsibilities should also be taken into account in all trade processes. However, the highlighted responsibilities have been mostly elaborated in B2B interrelationships than in B2C, as well as from a micro than from a macro-economic perspective. In addition, as will be discussed in section 6.2, commonly shared norms and minimum standards/ requirements are treated objectively, non-dynamically, and context-independently. It is also challenging to clarify the scale of interrelationships and the extent of responsibilities in relation to other businesses and final consumers. A CTP can be beneficial in resolving such challenges.

Corporate responsibilities

Corporate responsibilities are related to the responsibilities of a corporation in relationship to its stakeholders (such as shareholders) and the wider/ macro society. The results of RS2 revealed the asymmetry of the definitions of “stakeholders” as well as the characteristics and extent of responsibilities. The focus of the reviewed literature was on the inter-cooperative social responsibilities of a corporation (i.e., between a corporation and its stakeholders) rather than on shared responsibilities among the stakeholders in the entire supply chains.

RS2 further provided examples of the responsibilities of corporations in developing their wider/ macro society including social investment, supporting public services, community development, and philanthropy. The responsibilities the wider society placed on corporations or co-development of corporations (micro society) with the wider society (macro society)

were not adequately elaborated in the reviewed literature. These present opportunities for further research.

Collaboration

Collaboration is an inseparable part of sustainable supply chains and was highlighted in all the research studies. Collaboration is inherent in the above and following stated criteria and facilitates the existence and integration of inter-processes and interrelationships.

6.1.4 Sustainability in management and/ or governance

The fourth central theme originated from those that refer to management and/ or governance of sustainable supply chains. Some examples of activities are modeling, assessment, measurement, monitoring, analysis, evaluation, rating, benchmarking, prioritizing, planning, control, compliance with standards, certification, sanctions, influence, accountability, codes of conduct, reporting schemes, and alliance building.

Sustainability management

Managerial activities were more or less elaborated in all of the research studies. Some examples are highlighted here.

- *Assessment* activities with the dominance of Life Cycle Assessments (LCA) followed by impact assessments of supply chain activities such as transport and logistical services; specific concepts including postponement, e-commerce, virtual logistics, logistics structure decisions; and supply chains in more holistic terms.
- *Measurement, monitoring, modeling, and evaluation* with the dominance of multi-criteria performance measures or decision-making approaches by setting scorecard indices, and indicators especially based on the analytic hierarchy process (AHP).

However, there were no clear-cut boundaries among these activities. For example, LCA was occasionally elaborated under modeling and analysis or measuring and prioritizing were combined with rating and benchmarking. There is still a gap between the theoretically and practically simplistic managerial activities that rarely go beyond the triadic interrelationships.

Sustainability governance

Governmental activities mostly aim to understand a more strategic picture of trends and steer by setting rules/ regulations and norms (inspired by Hallding *et al.*, 2013; Bäckstrand *et al.*, 2010; Wu and Dunn, 1995). Governance can have a top-down mechanism (such as compliance with legislation, standards, and norms) or bottom-up mechanism (Hallding *et al.*, 2013).

- Several examples of *top-down mechanism* were highlighted in the research studies, classified as follows:
 - *Financial mechanisms*: subsidies and tax incentives, tax on fossil fuels and GHG emissions, vehicle license duty/ vehicle tax, emissions trading schemes, infrastructure charges/ tolls, congestion charging, public investment.
 - *Juridical mechanisms*: environmental zones/ low emission zones/ clear zones, environmental classification of vehicles, technology-replacement schemes, vehicle maintenance control, vehicle size/ length/ width/ height/ load capacity/ weigh/ circulation/ idling/ access time/ delivery time restrictions.

- *Setting standards*: ISO 14001, ISO 14025, EMAS, Social Accountability 8000 (SA 8000), AccountAbility (AA1000) Stakeholder Engagement Standard (AA1000SES), and OHSAS 18001.
 - *Setting guidelines* (e.g., ISO 26000, the OECD guidelines for multinational enterprises, the Global Sullivan Principles and conventions and declarations like those of the international labor organization [ILO]).
 - *Setting codes of ethics, schemata or preferences* as well as *setting organizational goals/ visions/ strategies*.
- Several examples of *bottom-up mechanism* were highlighted in the research studies classified as follows:
 - *Information giving, advising, and support for education, training, R&D, and innovation* (providing incentives to entrepreneurs; supporting demonstration projects).
 - *Taking initiatives* (following the UN Global Compact, UN Millennium Development Goals, Business Social Compliance Initiative [BSCI], Global Social Compliance Program [GSCP], International Social and Environmental Accreditation and Labeling [ISEAL] Alliance, and Ethical Trading Initiative [ETI]).
 - *Setting voluntary assessments or Key Performance Indicators (KPIs)*.
 - *Publishing reports* especially according to the *Global Reporting Initiative (GRI)* framework.
 - *Alliance building*.

However, top-down and bottom-up mechanisms are complementary and one does not favor the other. Some of the criteria go hand in hand, such as taking the initiative in applying for sustainability labels and certificates by followings standards and guidelines. As discussed in the next section, a CTP can be beneficial in tackling the objectivity and reductionism inherent in most of the studies reporting the above mentioned mechanisms.

6.2 Central challenges in making supply chains sustainable

Transforming supply chains towards sustainability targets calls for the dynamic identification and analysis of challenges (i.e., difficulties, obstacles, or dilemmas) in reaching them. The identification of thirteen categories of challenges in making supply chains environmentally and socially sustainable, and eleven for freight transport and urban distribution, shows that the path to achieving the targets may be rough and differ for different types of supply chains.

The challenges identified in RS1 and RS2 are the patterns that could be extracted from several sustainability-oriented challenges discussed in different parts of supply chains. As a result, there are similarities and overlap among them and those found in RS3 and RS4 (because freight transport and distribution are related to logistical activities in the supply chains), as well as in RS5, which was based on the results of RS1 and RS3. To cite two instances, “costs” and “uncertainties” from RS1 are also found in RS3, RS4, and RS5; “operationalization” from RS1 and RS2 also are present in RS4. The tracks of complexity can be followed in all research studies. “Complexity” in RS1 reflects upon similar challenges such as “subjectivity in evaluation”, “governance complexity”, “sustainability leakage” in RS2; “managerial complexity” in RS3, “decoupling” and “corporate governance” in RS4, and “fragmented industry” in RS5. “Lack of visionary leadership” became explicitly and implicitly apparent in RS4 and RS2, respectively.

Some challenges varied among the studies. For example, “network imbalance” explicitly emerged in RS3; “restructuring” was apparent in RS4; and “sustainability washing” and “SMEs’ difficulties” turned up explicitly in RS3 and implicitly in RS4. “Mind-set and cultural changes” and “inadequate and asymmetric knowledge” were considered less challenging in RS3 and RS5, but were highlighted in RS1 and RS2.

Five central challenges in making supply chains sustainable emerged from combining the twenty-four identified challenges in the research studies and then classifying them based on their similarities and overlap (Table 6.2). The five central challenges are:

- *Shifting the values;*
- *Difficulties of operationalization;*
- *Dealing with complexity;*
- *Difficulties of corporate governance;* and
- *SMEs difficulties.*

Shifting the values	Difficulties of operationalization	Dealing with complexity	Difficulties of corporate governance	SMEs difficulties
<ul style="list-style-type: none"> • Costs (RS1) • Shifting the values (RS2) • Customer priorities (RS3) • Restructuring (RS4) • Costs/Financial viability (RS4) 	<ul style="list-style-type: none"> • Complexity (RS1) • Operationalization (RS1, RS2, RS4) • Mind-set and cultural changes (RS1) • Uncertainties (RS1, RS4) • Inadequate and asymmetric knowledge (RS2) • Governance complexity (RS2) • Sustainability washing (RS2) • Technological and legislative uncertainties (RS3) • Restructuring (RS4) • Lack of visionary leadership (RS4) 	<ul style="list-style-type: none"> • Complexity (RS1) • Subjectivity in evaluation (RS2) • Managerial Complexity (RS3) • Network imbalance (RS3) • Decoupling (RS4) 	<ul style="list-style-type: none"> • Governance complexity (RS2) • Sustainability leakage (RS2) • Managerial Complexity (RS3) • Corporate governance (RS4) 	<ul style="list-style-type: none"> • SMEs difficulties (RS2) • Inadequate and asymmetric knowledge (RS2) • Corporate governance (RS4)

Table 6.2. Five central challenges in making supply chains sustainable

6.2.1 Shifting the values

It is fairly challenging to shift the values in the supply chains where the non-economic pillars of sustainable development are equally weighted with the economic pillar (Welford *et al.*, 2003; Pagell and Wu, 2009; Chi, 2011; Millard, 2011).

One difficulty in shifting the values is short-term profit maximization (Leppelt *et al.*, 2013). This is based on the underlying logic of the theory of the firm and transaction cost economics in supply chain management (Boons, 2012) that discourage the inclusion of human and environmental degradation costs or social responsibilities (Gray and Guthrie, 1990; Wu and Dunn, 1995; Simpson and Power, 2005; Walker and Brammer, 2009). While corporate social responsibility and environmental concerns are regarded as very important for the future of supply chains, the issue of cost is still predominant: costs and revenues are the main drivers in the development of supply chains. This is troublesome since sustainable development, like any type of development, might initially be costly (McIntyre *et al.*, 1998b).

To cite examples, it is costly to carry out research on and to develop new infrastructures, clean technologies (such as carbon capture and storage [CCS] and distributed electricity production), fossil-free fuels and sources of energy, and environmentally friendly vehicles. It is also costly to redesign the supply chains, change the logistical set-ups, change the physical resources like the fleets, find alternatives for non-renewable natural resources, educate the stakeholders about their responsibilities, and even apply for certifications (RS1; RS3; RS4; LETS rapport, 2013; Binsbergen and Bovy, 2000; Tencati *et al.*, 2008; EU, 2011; Angheluta and Costea, 2011). In RS4 it was concretely exemplified that although environmentally beneficial, adding urban consolidation centers/ terminals/ cross-docks can result in potentially high set-up and operating costs. There is also an increase in delivery costs because of the additional stage in supply chains, potential costs associated with additional companies handling goods, and increased transaction costs (Browne *et al.*, 2005; Dablanc, 2007; Quak and de Koster, 2007; Marcucci and Danielis, 2008; McKinnon *et al.*, 2010; Álvarez and de la Calle, 2011).

Another difficulty in shifting the values is to change the customers' priorities. It was apparent from the results of the research studies, that customers still prioritize financial criteria such as delivery time, price, functionality, and service rate ahead of environmental and social criteria such as recyclability, emissions, working conditions, and workers' rights (RS3; Vurro *et al.*, 2009; Su and Miller, 2011; Kalleitner-Huber *et al.*, 2012; Govindan *et al.*, 2012; Ageron *et al.*, 2012). RS3 and RS5 discussed from the interviews, surveys, and case studies how problematic the current business models are where all pillars of sustainable development are more or less sacrificed for short-term financial sustainability, especially due to the customer's single focus on time and cost when selecting logistics service providers or suppliers.

It was also discussed that for the moment, it seems that neither producers nor consumers (in greater masses) are willing to pay the initial costs. In addition, there is a circular pattern of different actors and their responsibilities concerning who is going to start or initiate such. This challenge becomes even more troublesome in global markets and businesses with low profit margins, where fair trade and business ethics are clearly ignored. Non-economic aspects are mostly considered when customers (Hartlieb and Jones, 2009; Tsoi, 2010; Hisjam *et al.*, 2012; Ramirez, 2012; Ageron *et al.*, 2012) or legislators (Beske *et al.*, 2008) demand or accept them (Seuring and Müller, 2008).

6.2.2 Difficulties of operationalization

The second central challenge that emerged in making supply chains sustainable is related to difficulties of operationalization. The following factors can add to the challenge of operational feasibility by creating inertia, that is, a fear and high resistance to change.

Knowledge asymmetry

Although awareness about the triple bottom lines is increasing (Carter and Rogers, 2008; Ramirez, 2012), it was apparent from the results of the research studies that knowledge asymmetry regarding all of their criteria has also increased as they are interpreted differently in practice (Taplin *et al.*, 2006; Hutchins and Sutherland, 2008; Erol *et al.*, 2009; Govindan *et al.*, 2012; Maltz and Schein, 2012).

Due to the wide range of criteria that come under the umbrella of the macro definition of sustainable development offered by the Brundtland Commission (Jorgensen and Knudsen, 2006; Vachon and Mao, 2008; Lehmann *et al.*, 2011; Gimenez *et al.*, 2012), it is difficult to interpret all its triple bottom lines and their criteria from the micro levels and what it

concretely means in different parts of supply chains (Livingstone and Sparks, 1994; Murphy *et al.*, 1995; Murphy and Richard, 2003; Browne *et al.*, 2005; McKinnon *et al.*, 2010). There is also knowledge asymmetry about the nature and extent of business responsibilities, which makes it difficult to comprehend who is going to share them in the supply chains. Because of the difficulties in translating the triple bottom lines into relevant and prioritized activities for every process and/ or stakeholder, they are rarely addressed beyond triadic relationships in the supply chains.

Change of mind-sets and behavior

Another obstacle towards operationalization is related to difficulties in changing the stakeholders' mind-sets and behavior.

Although there are evidence-based scientific claims about environmental and social problems caused by supply chains activities, there are still resisting mind-sets that reject the claims or ignoring mind-sets that erase the claims. To change the mind-sets becomes further challenging when the cultural or organizational distances in the supply chains increase (Srivastava and Srivastava, 2006; Badami, 2005; Wittneben *et al.*, 2009; Tsoi, 2010; Awaysheh and Klassen, 2010; Elg and Hultman, 2011).

It became apparent in the research that long-term strategic thinking and visioning; persistence or engagement by top-management (Preuss, 2009; Hasle and Jensen, 2012; Gopalakrishnan *et al.*, 2012); strategic and visionary leadership (Petersen, 2006; Angheluta and Costea, 2011; Ageron *et al.*, 2012); and continuity or commitment by co-workers are still lacking (Paramanathan *et al.*, 2004; Carter and Rogers, 2008; Huesemann and Huesemann, 2008; Defee *et al.*, 2009). Reluctance to turn intent into action (Lyons, 2004; Himanen *et al.*, 2004) and lack of consensus or misalignment between behavior or practice and visions will wash the sustainability as its talk cannot walk (Isaksson and Steimle, 2009; Halldórsson *et al.*, 2009; Leppelt *et al.*, 2013).

However, in RS3 and RS5, it became clear that the LSPs interviewed had more difficulties in increasing awareness and in changing the behavior of their customers than of their internal co-workers or decision-makers.

Difficulties in changing behavior may also be due to reductionist, positivistic, objective, and linear ways of thinking (Nilsson, 2005, 2006); compartmentalization and lack of completeness and continuity in perceiving sustainability (Lozano and Huisingsh, 2011); bounded rationality (i.e., imperfection of human reasoning and impossibility of ideal societal decisions) (Matos and Silvestre, 2013); and satisficing (i.e., behavior that satisfies limited aspirations without optimizing) (Casti, 1994).

Uncertainties

Uncertainties can also hinder operationalization. There are still uncertainties about the sustainability consequences of supply chain design. These include time perspectives concerning changes in logistical set-ups and infrastructures; government legislation/regulations and decisions; localization of production; sourcing of material and components; facility location of static resources; commercialization of new clean technologies; competitive advantages and strategies formulated by stakeholders; and the nature of future fossil-free fuels and renewable energies and infrastructural changes for their production and distribution especially in global markets (RS1; RS3; RS4; RS5; LETS rapport, 2013; Murphy *et al.*, 1995; Rodenburg *et al.*, 2002).

There are also a number of operational uncertainties or dilemmas in the choice of existing fuels, routing of the vehicles/ fleet, negotiation of contracts (Murphy and Herberling, 1994; Angheluta and Costea, 2011), or quality and timing in return flows in reverse logistics (Inderfurth, 2005; Hanafi *et al.*, 2008). Operational uncertainties can occur because of unexpected/ unforeseen incidents like order cancellations, delivery-time changes, consumer behavior and demands, traffic congestion, road construction, flea markets, natural disasters, weather changes, accidents, mechanical failures, etc.

6.2.3 Dealing with complexity

Dealing with increasing complexity due to the sustainable development of complex supply chains is the third central challenge.

The first dimension that emerged is related to difficulties in evaluating sustainability in supply chains. One factor that contributes to such difficulties is inherent in the multiple ways that supply chain activities affect or are affected by their surrounding environments and societies. Because of this, it may be counterproductive to measure or assess all the social and environmental effects of supply chains activities (Murphy *et al.*, 1995; McIntyre *et al.*, 1998a; Johnson and Ferreira, 2001; Suh *et al.*, 2004; Wee *et al.*, 2005; Bickel *et al.*, 2006; Vieira and Horvath, 2008; Matthewa *et al.*, 2008). Another factor is inherent in the dynamics of supply chain activities and changes in their social and environmental effects. For example, it may be difficult to measure or assess the sustainability of intangible resources or the shared responsibilities or corporate responsibilities, especially when they vary at different stages of development.

As discussed in chapter 4 and exemplified in RS2 and RS5, there is also subjectivity in defining the boundaries and scales of description of tiers and stakeholders of supply chains. Another factor that adds to such difficulties is inherent in the multiplicity of interests and differences in expectations, cultures, social practices, local conditions, contextual settings where decisions are made, and legal requirements.

Due to these factors, the evaluation of sustainability in complex supply chains lacks a meaningful, adequate, or unified indicator, standard, or label. The ones that exist consider neither the changes over time nor the interactions among all the triple bottom lines. The lack of a united standard, method, or platform for measuring GHG emissions or for assessing the environmental impacts of freight transportation operations is another example that was underlined in RS3.

The second dimension that emerged in RS1 and RS2 is related to leakage/ spillovers in open supply chains. In RS1, it appeared that carbon leakage/ spillovers could happen as a result of the shift of emissions from one sector to another (e.g., from transport to production of electricity) or from one country to another. In RS2, it appeared that leakage could happen when a stakeholder evades its responsibilities or externalizes its social and environmental degradation costs by transferring to/ sourcing from places or stakeholders with looser regulations and standards.

The third dimension that emerged in the research studies is related to several trade-offs in sustainable development of supply chains. One example is the trade-off between economic gains and environmental damages. RS3 and RS4 exemplified that exports, free trade, or geographical positions may lead to imbalances in both goods and resources flows and even increase mobility and consequently environmental damage/ degradation (Taniguchi and Van

Der Heijden, 2000; Afroz *et al.*; 2011; Gebresenbet *et al.*, 2011). Shorter delivery times, just-in-time (JIT), lean production, and higher service levels can also be seen as competitive advantages that result in economic gains. But they also result in speeding up supply chains, sacrificing full utilization of resources (due to small order problems, less than truckload [LTL], empty running), increasing packaging and handling services, and leading to transport and traffic intensities (Holweg and Miemczyk, 2002; Yang *et al.*, 2005; McKinnon *et al.*, 2010; Gebresenbet *et al.*, 2011). E-commerce can also decrease person transport while increasing goods transport (Cetinkaya *et al.*, 2011).

Reverse logistical activities may increase transport demand and potentially reduce utilization rates (Cetinkaya *et al.*, 2011). Another exemplary observation in recent years is that the shifting and offshoring of the upstream parts of supply chains to developing countries and emerging economies can accelerate social and economic growth while decelerating occupational growth or employment in the home country (Ramirez, 2012); at the same time, they can result in deteriorating the natural environment because of the longer transport distances among the supply chains stakeholders.

There are examples of re-bounce effects. One is when energy efficiency or inexpensive fuel encourages higher consumption and mobility. Another is when improvements in infrastructure increase safety and security while encouraging mobility and consequently leading to environmental degradation (LETS rapport, 2013; UNEP, 2012; Jonsson and Johansson, 2006). A third example is made up of the trade-offs that exists in the production of non-fossil fuels: extracting biofuels from biomass may result in higher income for rural communities, increase food output per hectare (productivity), and industrialize agriculture and forestry, while at the same time increasing land price, food prices, and hunger (Azar, 2005), deteriorating the cultural carrying capacity (Hardin, 1991), or endangering biodiversity. Urbanization and industrialization can also strain the availability of biomass sources especially in developing countries (International Energy Agency, 2002). For further examples of paradoxes, please refer to section 4.2.6.

6.2.4 Difficulties of corporate governance

The fourth central challenge raised in the research studies is related to difficulties in corporate governance of sustainable supply chains. This is due to the fragmented nature of supply chains and the logistics industry since each stakeholder can be a part of several other chains, can belong to a variety of economic sectors and business federations (Ramirez, 2012), can have contracts with various organizations, and can be regulated by different rules and laws (Worley *et al.*, 2010). Fragmentation was specifically exemplified in RS3 and RS5 where the LSPs interviewed and surveyed typically had contract with several logistics service intermediaries (LSI), forwarders, and carriers to perform their services. Consequently, the management or audit of all LSIs, forwarders, and carriers is challenging, especially when it comes to the triple bottom lines of sustainable development. Fragmentation can increase because of the increase in outsourcing, offshoring, market expansion, internationalization, and moving downstream in the chain (Elg and Hultman, 2011).

Corporate governance difficulties are also due to the many contexts in which supply chains operate. These can vary from a local place to urban areas, regions of a country, and different countries. This increases the difficulties in carrying out the following: audit and control of all the processes, activities, and stakeholders; transparent tractability in the chain; collaboration among the stakeholders; acceptations and adaptation to a wide range of corporate codes of conduct, standards, certificates, labels, norms, bureaucracies, administration processes, rules

and laws especially in a multinational environment (Koplin *et al.*, 2007; Hartlieb and Jones, 2009; De Chiara and Spena, 2011) where consensus among stakeholders or a social dialogue may be lacking (van Heerdenn and Bosson, 2009).

There is also considerable heterogeneity in sustainability practices between and within industries based on their size, constellation, customer demands, segments, and market place. This heterogeneity encourages different governing mechanisms and legislation (Vurro *et al.*, 2009; Awaysheh and Klassen, 2010; Elg and Hultman, 2011; Boons, 2012; Hall *et al.*, 2012). Carbone *et al.* (2012, p. 488) highlight that “*national (and cross-country) context, industry and time are all factors that affect and shape corporate and supply chain sustainable practices, outlining patterns changing through time and characterising differently the social, environmental and overall CR behaviours and strategies put in place by companies in the very specific context.*”

As explained in the fourth research study, another obstacle is the reluctance of city logistics stakeholders to accept legislation or to participate in initiatives. One example is night deliveries where the receiver must be present when the delivery is made, which is not always acceptable (Munuzuri *et al.*, 2005). There are additional concerns about higher driver wages, higher reception/dispatch costs, and safety when it comes to night deliveries (Anderson *et al.*, 2005).

Another example is the construction and operations of a UCC (Urban Consolidation Center) initiative that may ultimately be doomed to failure if the potential customers refuse to participate. Some evidence-based studies attest that businesses with frequent, differentiated, and high-volume deliveries are less willing to use UCC services (Marcucci and Danielis, 2008) where much of the urban freight is already consolidated at the intra-company level or by parcels carriers (Browne *et al.*, 2005; McKinnon *et al.*, 2010). Businesses dealing with valuable goods (van Rooijen and Quak, 2008) as well as bars, restaurants, and hotels – which demand higher frequency, punctuality, and logistics quality – (Marcucci and Danielis, 2008) are more reluctant to participate. Difficulties can also emerge for a single UCC as it may be unable to handle the wide range of goods moving in and out of an urban area, due to such factors as different handling and storage requirements (McKinnon *et al.*, 2010). Obligation and compulsion can also threaten the sustainability of UCCs by making the potential customers as well as the private sector unwilling to participate and/or pay (Browne *et al.*, 2005).

The second research study showed that there are concerns over transparency, accountability, and credibility of self-regulatory initiatives, standards, and codes of conduct (Hartlieb and Jones, 2009; Vurro *et al.*, 2009; Kogg and Mont, 2012) or third-party or external auditors and certifiers (Weinthal, 2010).

6.2.5 SMEs difficulties

RS2, RS3, RS4, and RS5 showed that moving SMEs towards sustainability is the fifth central challenge. SMEs can have uncertainties about the benefits of upgrading to new sustainability standards and codes of conduct as well as lack of knowledge, skills, time, financial and human resources in responding to the social and environmental requirements of global buyers and supply chains. RS5 exemplified that currently, several large LSPs (3PLs) have CSR policies, but many small and medium-sized LSPs do not (Piecnyk and Björklund, 2012).

SMEs are also likely to lack the bargaining power required to sanction suppliers who fail to comply with standards (Jorgensen and Knudsen, 2006). This challenge is felt more by SMEs that operate at the bottom of the pyramid (Perez-Aleman and Sandilands, 2008) and in developing countries (Luken and Stares, 2005; Tencati *et al.*, 2008; Hartlieb and Jones, 2009; Govindan *et al.*, 2012).

6.3 Reflective discussion about a CTP on the central themes and challenges in making supply chains sustainable

The proposed framework (Figure 4.3) presented in chapter 4 can be beneficial in dealing with the complexity involved in the central themes and challenges of making supply chains sustainable. The following reflective discussion from a CTP can be valuable in handling the subjectivity, interactions, changes, transformation, context dependency, trade-offs and paradoxes involved in making supply chains sustainable.

Investigate the complexity profile

A complexity profile can be beneficial to embody a supply chain. It subjectively clarifies the scale of a supply chain (i.e., the contextual level at which it is positioned); the holism of a supply chain (i.e., its boundary and what is included in it); and clusters as well as prioritizes the goods, services, resources, and stakeholders. This can help decision-makers and other actors of a supply chain to understand the extent of the sustainability aspects that have to be developed in goods, services, and emerged resources. It may also help to reduce knowledge asymmetry and tackle corporate governance difficulties by better understanding the nature and degree of the responsibilities of a supply chain in relation to its emerged resources as well as the ones shared among the stakeholders.

In managerial and/ or governmental thematic activities such as LCA, sustainability measurements, evaluation tools, benchmarking, and labeling of goods and services investigating the complexity profile bring to light possibilities for handling the ambiguities of subjectivity in defining the scales and details in the description of a supply chain or network. Hence, decision-makers and researchers are encouraged to revise their perspectives on the practice and literature of sustainable supply chains first by clarifying what they consider a supply chain to be and then discussing its sustainability.

Investigate the complexity behavior

Supply chains are not really chains but rather transformative phenomena of people representing different organizations that interact with each other to fulfil their own wishes and their customers' demands for goods and services. Understanding the interactions can be beneficial in investigating emerging behaviors related to intended and executed behaviors and outcomes. Sustainability emerges in the supply chains when all four central themes and their aspects discussed in section 6.1 are bundled together in the interactions among stakeholders/ subsystems/ actors/ components and processes.

Supply chain activities lead to environmental damages (like CO₂, CH₄, N₂O emissions) in every scale of observation with each other in the creation, exchange and movement of goods, services, information, and resources. The same goes for social aspects where interactive behavior has different effects on different actors based on self-organizing processes and their emergent outcomes. Globally agreed sustainability norms and minimum standards/ requirements/ rules are needed because of global interactions and damages. This can also justify the subjectivity that was highlighted in the discussion about "rightness" in efficiency,

effectiveness, and employees' rights. A supply chain that acts proactively may gain a competitive advantage over one that acts reactively by just following the norms, standards, requirements, and rules.

Furthermore, interactions among resources and stakeholders should increase to foster inter-organizational resources, innovation, creativity, resilience, and robustness in supply chains. Increasing the interactions can also be beneficial in tackling the challenge of operationalization (knowledge asymmetry, change of mind-sets and behavior, and uncertainties). This can be done by ensuring that the central themes are well understood and that all the stakeholders are persuaded. Increased interactions can also facilitate finding contextually modified approaches and methods for dealing with trade-offs and paradoxes. Hence, decision-makers and researchers are encouraged to revise their perspectives on the practice and literature of sustainable supply chains. They can do this by viewing the goods, services, and resources that emerge from interactions among the stakeholders in the entire supply chain, rather than just a single stakeholder and its triadic interactions with its up and downstream stakeholders.

Nonlinearities of interactions should also be taken into account in managing and governing a sustainable supply chain. They become important when a subsystem (such as a resource or stakeholder) or the whole chain reaches a critical mass or approaches a phase transition. To understand the nonlinearities, the emergent patterns of behaviors of a supply chain and its subsystems should be saved in their memories and learned. Hence, neither decision-makers nor the researchers have sufficiently investigated the effects of their interactions in making supply chains sustainable and how they may nonlinearly change over time.

Investigate the complexity agents

A supply chain can learn from its sustainability schemata/ norms/ preferences and emergent patterns of behaviors. To increase the learning capacity, the “agency” and “decentralized decision-making” characteristics of a supply chain should increase by, for example, developing the sustainability aspects of human and intangible resources or developing artificial intelligence in goods and physical resources (Abbasi, 2008). Learning from the emergent patterns of behaviors may also facilitate coping with uncertainties.

The schemata/ norms/ preferences in governing a supply chain and its subsystems should fulfill the sustainability aspects described in section 6.1. To shift the sustainability values, new schemata that evaluate non-economic pillars on equal terms with economic one have to be developed. Hence, in order to normalize the higher initial costs in developing long-term environmentally sustainable solutions (such as infrastructures, clean technologies, clean vehicles, and fossil-free fuels), the schemata should be updated by, for example, adjusting the laws, providing subsidies and incentives, and encouraging research and innovation.

The schemata should also consider the different requirements of different industries/businesses. In other words, *one shoe does not fit all*: one schema cannot be suitable for different industries or markets. Sustainability-oriented schemata should be adapted to different requirements of different types of industries/businesses – while adjusted inside every industry/business – and should consider changes at different stages of development. For example, SMEs and new startups should receive sufficient support and incentives to deal with the difficulties of adaptation to new schemata and comply with standards, licenses, and labels.

The subsystems adapt to the schemata by self-organizing without an internal or external controller or centralized decision-maker if they have the capacity for decentralized decision making. However, to increase trust and efficiency as well as to reduce probable opportunistic behaviors, further top-down governing mechanism can be defined. Using further bottom-up mechanisms can bring innovation, democratic values, and competitive advantage to a supply chain.

There is also a need for independent agencies to periodically scan and modify the sustainability licenses and labels. This may increase trust among authorities and stakeholders as well as acceptance of new schemata/ norms/ preferences, standards, requirements, and rules. However, due to the fragmentation of supply chains and the impossibility of controlling all the subsystems, the responsibilities should be shared and integrated into their behavior, strategies, and operations. Without operationalizing the strategies, sharing the responsibilities, taking part and initiatives, turning intent into action, and continuity or commitment sustainability will be washed.

Investigate the complexity transformation

Evolution can guide us to understand how a supply chain sustains itself and how it transforms itself by gradually changing over time. Due to evolution, goods, services, resources, and stakeholders and even their capacities to interact, learn, and adapt gradually change over time. As a result, all the central themes and sustainability aspects discussed in section 6.1 are also subject to change over time. Hence, researchers are encouraged to revise their perspectives on the literature of sustainable supply chains by considering further longitudinal studies that take into account the gradual changes over time.

A supply chain that has the highest chance to survive and sustain itself: acts at the edge of chaos (that has enough diversity, interactions, and integrated processes); is fit (fulfills sustainability values in its surrounding environments); has the fittest agents (goods, resources, and stakeholders that fulfill sustainability values and share the responsibilities in the supply chain); transfers its memories of emergent behaviors and intangible resources to the next generation of resources; and lets its subsystems democratically decide, select and constructively compete.

Investigate the complexity context

This calls for an understanding of what goes hand in hand between a supply chain and its surrounding environments. As a result, goods and services offered by a supply chain change and are changed by changes in the surrounding environments. A sustainable supply chain co-adapts with the sustainability-oriented values and schemata/ norms/ preferences defined in its surrounding environments. The new schemata for governing a sustainable supply chain should encourage adaptation of emerging sustainability oriented technologies, norms, infrastructures, and regulations in the surrounding environments. Increasing the degree and diversity of interactions between the supply chains and their surrounding environments may open the doors to co-evolution.

As supply chains are subject to evolutionary and co-evolutionary changes, all uncertainties in their transitions towards the sustainability targets cannot be omitted. However, the decision-makers should give the stakeholders enough confidence and persuade them that the long-term targets and visions will be pursued, that transparency in regulations and norms will be guaranteed, and that innovative acceptable solutions/ strategies will be fostered. Hence, decision-makers and researchers are encouraged to revise their perspectives on the practice

and literature of sustainable supply chains. They should do so by taking into account the gradual/ evolutionary, radical/ revolutionary, and co-evolutionary changes. Additionally, models and theories have to be developed that can help to better grasp uncertainties, instabilities, and context-dependency in developing sustainable supply chains.

Investigate the complexity reality

There are several trade-offs and paradoxes that can emerge when the central themes are bundled together. Some examples were mentioned in sections 4.2.6, 6.1, and 6.2.3. Investigating these can be valuable for decision-makers when dealing with management, governance, and development of sustainable supply chains.

To deal with the trade-offs, a more holistic view on the system as well as the investigation of the complexity behavior (i.e., effects of interactions) should be taken into account.

However, paradoxes simultaneously co-exist and cannot be completely resolved, since the generation of solutions only creates new paradoxical situations in new circumstances.

7. CLOSING REMARKS

There is always something left to be further developed.

This chapter presents the closing remarks on the research and suggestions for further research.

7.1 Conclusions

To develop sustainable supply chains in so that their negative environmental and social effects are minimized, short and long-term targets should be set together with immediate and deliberate action. However, the process should be handled as transformative and learning oriented rather than as a predetermined route waiting to be unfolded. The transition of supply chains towards targets is complex as it includes socio-economic and technical changes with different time scales and is governed by the decision-making of a variety of actors. Furthermore, the transition path is and will continue to be different for different types of supply chains as well as supply chain actors, as they may be in different stages of development and influenced by different types of social structures, natural resources, geographic location, and technical knowledge. To transform supply chains in this direction and to create and recreate sustainability-oriented strategies, the patterns of trends and themes (i.e. topics, activities) that can influence sustainable development of supply chains activities in the short and long term should be continuously explored and reassessed.

Similarly, to transform supply chains activities towards targets, the pattern of challenges (i.e. difficulties, obstacles, or dilemmas) needs to be identified and classified and the influence of the challenges on sustainability assessed. Finally, the challenges need to be tackled and continually reassessed. Hence, the strategies and challenges are subject to change and to being driven by self-organizing processes involving a number of stakeholders over time. New strategies and challenges are influenced by previous ones; they might be replication of the past but with the potential for transformation.

The purpose of this research was to explore themes and challenges in developing sustainable supply chain activities from theoretical and empirical perspectives. However, the results of the research (the knowledge produced about the themes and challenges) are subjective (influenced by my interpretation of what had been said, observed, or scientifically written), relative (related to what had been said, observed, or scientifically written), and influenced by different methods behind the collection and analysis of the data.

The identification of thirty-three themes in the research studies shows that the research presents a broad and pluralistic array of pathways to make supply chain activities sustainable. However, few examples were found of themes (or processes for that matter) that provide empirical evidence of how to actually go about doing so in practice. Consequently, it can be assumed that supply chains cannot become sustainable with just one or a few sustainability-oriented activities. By combining all thirty-three themes and then classifying them based on their similarities and overlap, four central themes in making supply chains sustainable emerged: *sustainability in goods and services*, *sustainability in resources*, *sustainability in corporation*, and *sustainability in management and/or governance*.

The first central theme originated from the direct characteristics of sustainable goods and services. Goods and services can be sustainable if they are effective and efficient with minimized pollution, if they are sourced from renewable raw materials and natural resources, and are recyclable, safe, healthy, secure, and transparently traceable. The second central theme was related to sustainability in the resources necessary for generating goods and services, including the physical, financial, human, and intangible ones. Among the aspects discussed are: effectiveness and efficiency (appropriate resources, rightly utilized) with minimized pollution; recyclability; safety; security; respecting the rights of employees; developing a learning context; exploring and exploiting innovation; fostering diversity; developing the employees; protecting trust, brand, and reputation; maintaining and continuing business relationships; dealing with risks; as well as resistance and resilience.

Sustainability does not emerge in just the goods, services, and resources of SCs, though. The third central theme sheds light on inter-processes and interrelationships in sustainable SCs including the flows of goods and services from suppliers to consumers and vice versa that should be integrated. All the businesses involved in SCs should take and share responsibilities in following the ethical norms and minimum standards and requirements. They should also be responsible and collaborative in their relationships with other stakeholders and the wider/macro society. Businesses have responsibilities in developing their wider/macro society such as social investment, supporting public services, community development, and philanthropy. Finally, the fourth central theme underlined managerial and/ or governmental activities in developing SCs. Some of the highlighted managerial activities were: assessment, measurement, monitoring, modeling, evaluation. On the other hand, some of the highlighted governmental activities were: setting financial and juridical mechanisms; setting standards, guidelines, codes of ethics, schemata or preferences; setting organizational goals/ visions/ strategies; information giving, advising, and support for education, training, R&D, and innovation; taking initiatives; setting voluntary assessments or KPIs; publishing reports; and alliance building.

The identification of twenty-four categories of challenges in the research studies reveals the fact that the path towards achieving the targets may be rough and different for different types of supply chains (non-uniform and non-deterministic) and change over time. By combining all twenty- four challenges and then classifying them based on their similarities and overlap, five central challenges in making supply chains sustainable emerged: *shifting the values, difficulties of operationalization, dealing with complexity, difficulties of corporate governance, and SMEs difficulties.*

The first central challenge was to shift the values in the supply chains in a way that the two non-economic pillars of sustainable development (environmental and social friendliness) are equally weighted with the economic pillar. This can hinder sustainable development of SCs when short-term costs are in focus or when customers prioritize financial criteria such as delivery time, price, functionality, and service-rate ahead of environmental and social criteria such as recyclability, emissions, and working conditions or rights of employees. The second central challenge was related to the difficulties of operationalization due to asymmetric knowledge in the interpretation of criteria for sustainable development in different parts of SCs; difficulties in changing the resistant, reluctant, disregarding, or short-term mind-sets and behavior; and uncertainties about short- and long-term changes that might affect SCs.

The third central challenge was dealing with the increasing complexity associated with the sustainable development of SCs. The first dimension that contributes to this complexity is the

difficulty in evaluating SC sustainability. This is due to the subjectivity in defining the changing SC boundaries, the organizations and individuals involved, as well as the multiple ways that SC activities affect or are affected by their surrounding societies and environments. The second dimension relates to leakage/ spillovers in open SCs because of the shift of emissions from one sector to another (from transport to production of electricity, for example) or from one country to another. Leakage may also occur when a stakeholder evades its responsibilities or externalizes its social and environmental degradation costs by transferring to or sourcing from places or stakeholders with looser regulations and standards. The third dimension involves several trade-offs that exist in the sustainable development of SCs, where making one part sustainable leads to unsustainability in another. There are also several conflicts of a paradoxical character that simultaneously exist in managing, governing, and developing sustainable SCs.

The fourth central challenge was related to the difficulties in corporate governance of sustainable SCs due to the large scale of interactions and activities. There are several contexts where supply chains operate, ranging from local to urban areas, regions, and different countries. Different rules, laws, standards, certificates, labels, norms, bureaucracies, and administration processes exist. There is considerable heterogeneity regarding sustainability practices between and within industries, and a reluctance of businesses to accept legislation or to participate in initiatives. There are also concerns over transparency, accountability, and the credibility of standards, norms, and third party or external auditors and certifiers. Finally, the fifth central challenge was related to the difficulties of small and medium sized enterprises, as they may be uncertain about the benefits of upgrading to new sustainability standards and codes of conduct. They may also lack the knowledge, skills, time, money and human resources to respond to the social and environmental requirements of global buyers and SCs.

It is also concluded that taking a complexity theory perspective (CTP) can be beneficial in understanding the complex phenomena that both sustainable development and supply chains represent when it comes to subjectivity; interactions; interrelationships; nonlinearities; learning and innovative capacities; dynamics; diversity; spontaneity; gradual/ evolutionary, radical/ revolutionary, and co-evolutionary changes; transformation; irrationality; instability; indeterminism; context dependency; trade-offs; and paradoxes.

Based on the central dimensions of a CTP, a framework was proposed to apply to sustainable supply chains (Figure 4.3). The framework was beneficial in dealing with the complexity involved in the central themes and challenges. Investigating the complexity profile can be beneficial in handling the ambiguities of subjectivity in defining the scales and details in descriptions of a supply chain or network. The framework can help decision-makers and other actors of a supply chain to understand the extent of sustainability aspects that have to be developed in goods, services, and emerged resources. It can help to reduce knowledge asymmetry. It can also tackle corporate governance difficulties by better understanding the nature and degree of the responsibilities of a supply chain in relation to its emerged resources as well as the ones shared among the stakeholders.

Investigating the complexity behavior can be beneficial in examining emerging behaviors related to both intended and executed behavior and outcomes. Sustainability emerges in the supply chains when all the four central themes and their aspects are bundled together in the interactions among stakeholders/ subsystems/ actors/ components and processes. Increasing the interactions may foster emergence of inter-organizational resources, innovation, creativity, resilience, and robustness in supply chains. It may also be beneficial in tackling the challenge

of operationalization (knowledge asymmetry, change of mind-sets and behavior, and uncertainties). This can be done by ensuring that the central themes are well understood and that all the stakeholders are persuaded. Investigating the complexity behavior can also facilitate finding contextually modified approaches and methods for dealing with trade-offs and paradoxes. It was also suggested that because of global interactions and damages, globally agreed sustainability norms and minimum standards/ requirements/ rules are needed. This can justify the subjectivity that was highlighted in the discussion about “rightness” in efficiency, effectiveness, and employees’ rights.

Investigating the complexity agents can be beneficial in increasing the learning capacity of supply chains and updating their schemata/ norms/ preferences in favor of fulfilling the central themes and their aspects. The schemata should also consider the different requirements of different industries/ businesses. In other words, *one shoe does not fit all*: one schema cannot be suitable for different industries or markets. Sustainability-oriented schemata should be adapted to different requirements of different types of industries/ businesses – while adjusted inside every industry/ business – and should consider changes at different stages of development. The subsystems adapt to the schemata by self-organizing without an internal or external controller or centralized decision-maker if they have the capacity for decentralized decision making. However, due to the fragmentation of supply chains and the impossibility of controlling all the subsystems, the responsibilities should be shared and integrated into their behavior, strategies, and operations. Without operationalizing the strategies, sharing the responsibilities, taking part and initiatives, turning intent into action, and continuity or commitment sustainability will be washed.

Investigating the complexity transformation can be valuable in understanding how a supply chain sustains itself and how it transforms itself by gradually changing over time. A supply chain that has the highest chance to survive and sustain itself: acts at the edge of chaos (that has enough diversity, interactions, and integrated processes); is fit (fulfills sustainability values in its surrounding environments); has the fittest agents (goods, resources, and stakeholders that fulfill sustainability values and share the responsibilities in the supply chain); transfers its memories of emergent behaviors and intangible resources to the next generation of resources; and lets its subsystems democratically decide, select and constructively compete.

Investigating the complexity context can be useful in understanding what goes hand in hand between a supply chain and its surrounding environments. A sustainable supply chain co-adapts with the sustainability-oriented values and schemata/ norms/ preferences defined in its surrounding environments. The new schemata for governing a sustainable supply chain should encourage adaptation of emerging sustainability oriented technologies, norms, infrastructures, and regulations in the surrounding environments. Increasing the degree and diversity of interactions between the supply chains and their surrounding environments may open the doors to co-evolution. Understanding co-adaptation and co-evolution can also be beneficial in dealing with uncertainties existing in their transitions towards the sustainability targets.

Last but not least, investigating the complexity reality empowers dealing with several trade-offs and paradoxes in developing sustainable supply chains. To deal with the trade-offs, a more holistic view on the system as well as the investigation of the complexity behavior (i.e. effects of interactions) should be taken into account. However, paradoxes simultaneously co-

exist and cannot be completely resolved since the generation of solutions only creates new paradoxical situations in new circumstances.

7.2 Contributions

The ultimate contribution of this dissertation was the generation of a little scientific knowledge for developing sustainable supply chains activities. Although it is hard to judge or measure everything, the major contributions of this dissertation are highlighted in what follows.

Theoretical

The main theoretical contribution is the proposed framework in chapter 4 (Figure 4.3) and its application in the synthesizing discussion in chapter 6. Chapter 3 as well as frames of references in the attached articles may also theoretically contribute by clarifying, analyzing, and even comparing different existing definitions and theories in the discipline of logistics and supply chain management as well as sustainable development.

Methodological

The methodology sections of the appended papers and chapter 2 (craft of research) are the methodological contributions. Chapter 2 explained how the research and learning processes were co-developed by shedding light on how knowledge was scientifically generated, communicated, accumulated, and learned as well as how experience was accumulated and learned.

Managerial and governmental

I do believe that knowledge is co-constructed and co-evolved by applying perspectives and tools of one scientific discipline to another. Chapters 4 and 6 aimed to contribute to the fact that management, governance, and development of sustainable supply chains can be better studied by applying perspectives and tools of the science of complexity. This may guide decision- and policy-makers when they design the future strategies for moving towards sustainability targets and in analyzing the changes that influence and are influenced by sustainable supply chains activities.

The exploration and classification of the challenges and suggested propositions for tackling them were central to the dissertation. As management of supply chains is a challenging task (Lambert *et al.*, 1998; Simchi-Levi *et al.*, 2004), the appended papers, chapters 4 and 6 may be beneficial for managers and leaders when they approach sustainable supply chain challenges. Challenges should be dynamically explored when transforming supply chains towards sustainability targets.

Practical

The identified themes may also be beneficial in increasing the absorptive capacity of industrial and business practitioners when they design innovative strategies in developing sustainable supply chains. However, as it was discussed in chapters 4 and 6, different industries/ businesses call for different types of strategies as one shoe does not fit all. The identified challenges may also be beneficial in understanding the difficulties, obstacles, or dilemmas in developing sustainable supply chain activities in practice. The suggestive propositions in the discussion chapter as well as the appended papers may guide also the industrial and business practitioners in their future sustainability efforts.

7.3 Opportunities for further research

As improvement is continuous, the knowledge generated in this dissertation has the potential to be continuously improved by carrying out more research and empirical investigations. Opportunities for further research were identified during the research process, which are discussed here.

As the identified themes and challenges are subject to change, one opportunity for further research is exploration of innovative themes and emerging challenges. Tackling the currently identified and challenges also deserve further research. Similar to the conclusions in RS1 and RS2, there is a need for models and theories in dealing with sustainable supply chains and their management. Hence, more holistic models which consider interactions, context dependencies, and (co-) changes should be developed. In RS2, it became apparent that this research field also requires more longitudinal and comparative studies (Bryman and Bell, 2007) as well as conceptual papers, systematic literature reviews, and content analysis.

As the research studies highlight, there is a need for further examination of sustainable supply chain governance, sector and regional-specific governing mechanisms, sustainability strategies and challenges for different types of supply chains/ businesses/ industries, sustainability in global supply chains, rights and ethics in logistics and supply chains, interactions between logistics and other parts of supply chains, role of innovation in developing sustainable supply chains, and sustainable business models.

In RS1, RS2, and RS4 it was discussed that a sustainable development (triple bottom lines) perspective is missing in the discussion about downstream parts of supply chains, reverse logistical activities, and closed-loop supply chains. Similarly, it was concluded in RS3 and RS5 that such a perspective is missing in the discussion about logistical services in the supply chains.

The proposed framework in chapter 4 (Figure 4.3) has the potentiality to be applied and tested in empirical settings. It can be concluded that here is a need to further study how sustainability emerges, co-adapts, and co-evolves in the supply chains and how responsibilities and values are shared among stakeholders and change over time. However, it was confirmed in both the literature reviews and the empirical studies that long-term changes and perspectives are rarely considered. Co-adaptation and co-evolution can be further studied in the interaction between micro and macro economies and societies. As mentioned in RS2, there is also a need for the investigation of responsibilities of wider/ macro society on corporations.

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Themes and Challenges in Making Supply Chains Environmentally Sustainable

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Themes and challenges in making supply chains environmentally sustainable

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Abstract

Purpose – The purpose of this article is to explore themes and challenges in making supply chains environmentally sustainable.

Design/methodology/approach – The study began with a systematic review, and content analysis of articles in top-ranking related journals from logistics, transport, sustainability and environmental areas, and ended with research propositions contributing to the further advancement of supply chain management.

Findings – The findings illustrate the major themes published in 18 journals concentrating on sustainable supply chains with special focus on environmental issues. From the systematic review five major areas of challenges for supply chain management are derived: costs, complexity, operationalisation, mindset and cultural changes, and uncertainties. From all of these areas synthesising discussions are provided and research propositions suggested. It is concluded that there is a great need for models and frameworks that consider the complexity involved, take holistic perspectives, and challenge the basic assumptions underlying most of the research published (i.e. reductionism, positivism and economic growth).

Research limitations/implications – Sustainability in this article is mainly related to environmental issues. Analysis of complex interactions between environmental, social and economic aspects might provide opportunities for future research.

Practical implications – The results presented in this paper provide a systematic structure for classifying issues related to logistics sustainability; something which will be beneficial for managers and policy-makers when they approach sustainable supply chain management challenges.

Originality/value – This paper provides propositions for research based on the emergent outcome of challenges that can guide research, industry and policy-makers in future sustainability efforts.

Keywords Environment, Logistics, Transport operations, Supply chain management, Sustainability, Research, Sustainable development

Paper type Literature review

Introduction

The history of the world reveals a pattern of development in human life. Nonetheless, current industrial growth is increasingly jeopardising the future sustainability of the Earth and its natural resources and environment. To overcome such concerns, humans should take responsibility to develop environmentally friendly activities both efficiently and effectively. Supply chain activities, which are the enablers of today's social life, are fundamental to such responsibilities. Supply chain management (SCM) encompasses “the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities” (www.CSCMP.com, retrieved May 14 2010). Furthermore, SCM entails “the integration of key business processes from end-user through original suppliers, that provides products, services, and information that add value for customers and other stakeholders” (Lambert, 2006, p. 2), “for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole” (Mentzer *et al.*, 2001, p. 18). Due to

worldwide economic growth and globalisation of industries, a trend over recent decades has been global supply chains resulting in increased emphasis placed on long-distance logistics and transport activities. Economic advantages have motivated Western companies to move production, assembly, etc. to countries where wages are lower and regulations less strict than in the West. However, from ecological and social perspectives it is not clear how, for example, the localisation of production impacts on societies; locally or globally? How do logistics structures and the transport of parts and products influence the environment? On what grounds are supply chain decisions made concerning revenue in relation to social and ecological issues? Over what time perspectives must changes to different supply chain activities be made?

While being economically feasible in supply chains, logistics and transport activities have several negative impacts on the environment. Conservation of resources (like energy, materials, etc), pollution, emissions, noise, congestion and waste disposal are just some negative impacts worth

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mentioning (World Business Council for Sustainable Development, 2004). Logistics and transport activities are some of the main sources of emissions of greenhouse gases, mostly CO₂. In addition, the transport sector represents the fastest-growing source of greenhouse gas emissions (Brown, 2005).

As a consequence of global supply chains, freight transport is expected to grow from approximately 15 trillion ton-kilometres in 2000 to around 45 trillion ton-kilometres in 2050. In a business-as-usual scenario, the result of this growth is going to be an increase in CO₂ emissions in the same period and for both passenger and freight transport, from 6 gigaton to more than 14 gigaton (World Business Council for Sustainable Development, 2004).

What is obvious at the moment is the necessity of urgent action involving both corporate and inter-corporate (i.e. SCM) responsibility for the mitigation of the negative environmental effects of logistics and transport activities. However, perspectives, solutions and strategies which lead to such mitigation are vague (van Hoek, 1999), especially when it comes to solutions which emphasise the holistic perspective of supply chains or industries. The holistic perspective is especially important when sustainability issues are addressed since “in the long run there can be no such thing as “80 per cent sustainable”” (Haake and Seuring, 2009, p. 284). As a result, even if several partners or parts of a supply chain are sustainable, the whole is still unsustainable and more work needs to be done. Nonetheless, one important step, a contribution to the supply chain management field, consists of finding, analysing and synthesising the perspectives, solutions and strategies which are currently reported. Consequently, the authors’ standpoint is that the exploration of difficulties, barriers and challenges, as well as learning from the past, will contribute to the emergence and adaptation of new remedies and solutions to handle sustainability issues.

This leads to two research questions being set for this paper:

- RQ1.* What sustainability themes have been studied in relevant literature related to supply chains, especially concerning logistics and transport?
RQ2. What are the main challenges, identified in previous research, in making supply chains environmentally sustainable?

The purpose of this paper is thus to explore the themes and challenges in making supply chains environmentally sustainable and to suggest propositions for further development of supply chain management theory and practice. In this paper we therefore investigate the central aspects of supply chain management and its alignment and integration with sustainability in general, and environmental aspects more specifically.

In the next section, a brief frame of reference is provided to introduce sustainable development and its connection to supply chains and SCM. From this follows the method. The research is mainly based on a systematic review and content analysis of a sample of related journal articles. Emergent themes are thereafter presented, followed by challenges identified from which research propositions are drawn. The paper then ends with concluding remarks and the limitations of the research.

Frame of reference

The concept of “sustainable development” first appeared in the 1970s and was widely used among professionals in environment and development circles (Björklund, 2005). Despite the current widespread attention paid to the concept internationally, there is no universal definition (Björklund, 2005; Pihl, 1997; Pezzy, 1992). However, the most popular and widely known definition is that of the Brundtland report which is a United Nations-sponsored report: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987). Following the United Nations, 2005 World Summit, sustainable development encompasses the interdependent and mutually reinforcing pillars of economic development, social development and environmental protection.

Principles of sustainable development have been widely debated in the context of logistics and supply chains (Carter and Rogers, 2008) and concepts such as sustainable supply chain management (Carter and Rogers, 2008; Svensson, 2007), corporate social responsibility (Keating *et al.*, 2008; Dyllick and Hockerts, 2002), green purchasing (Min and Galle, 1997), reverse logistics (Zikmund and Stanton, 1971), and environmental logistics (Wu and Dunn, 1995) have been presented in research for some time. Abukhader and Jönson’s (2004) review of environmentally related journals claims that the concept of “greening supply chains” has been one of the main themes of discussion in several articles. The authors explain: “green supply chain is mainly discussion about assessment of the impact of environment on logistics. It evolves discussion of how implementing environmental measures would influence, negatively or positively, the logistics/supply chain infrastructure, and how we can find win-win solutions so that we satisfy the government regulations, satisfy the end customers and stay cost-effective” (Abukhader and Jönson, 2004, p. 143). Recently, sustainability has been widened in supply chain literature. Carter and Rogers (2008, p. 368) define sustainable supply chain management as “the strategic, transparent integration and achievement of an organisation’s social, environmental, and economic goals in the systemic coordination of key inter-organisational business processes for improving the long-term economic performance of the individual company and its supply chains.” Klassen and Johnson (2004) define “green supply chain management” as the alignment and integration of environmental management within supply chain management, and, as stated by Seuring and Müller (2008, p. 1629) “sustainable business practices have become a prerequisite for suppliers (entrepreneurs) within global supply chains”. Consequently, while the main focus of this article is on environmental aspects of sustainability, due to the integrated nature of sustainable development, the integration of environmental issues with economic and social concerns, have also been considered.

Based on an initial literature review, concepts such as “environmentally sustainable” logistics, “environmentally friendly/sound/ preferable” logistics, and “green” logistics were found to be widely used synonymously (see Ping, 2009; Chunguang *et al.*, 2008). Ping (2009, p. 340) states that “modern green logistics management is based on the theory of sustainable development, which formed the relationship of promotion and constraint between logistics and the

environment". According to Björklund (2005), the definition of an environmentally friendly/sound activity can be anything from choosing a more environmentally friendly/sound technique to choosing an activity which is friendly/sound to the environment (i.e. has no negative effect on the environment). In this paper, we have chosen the concept of "environmentally sustainable" as the denominating term.

Research methodology

This paper is based on a systematic review and a content analysis and synthesis of relevant literature. It takes an interpretive form of synthesising chosen literature (Rousseau *et al.*, 2008) as the goal is to provide propositions and tentative theoretical constructs of themes and challenges found in relevant literature. While there have been other recent literature reviews on sustainable supply chains (e.g. Carter and Rogers, 2008; Seuring and Müller, 2008; Srivastava, 2007) this research provides a modest, but important, contribution by providing propositions for research based on the emergent outcome of themes and challenges derived from the scope of literature reviewed. The paper by Seuring and Müller (2008) is closest in some aspects to this paper. It reports on a literature review on sustainability and supply chain management based on a content analysis, and provides a conceptual framework for the research field. However, while their focus is on the focal company of supply chains (barriers, risk minimisation and product strategies) this paper looks at themes and challenges for both policy-makers and supply chain actors. Srivastava (2007) limits the review to environmental aspects and reverse logistics. The paper by Carter and Rogers (2008) sets out to define and apply sustainability to supply chain management and concludes with a definition and framework for sustainable supply chain management. Their literature review focuses on definitions of sustainability in the logistics and supply chain management context. The Carter and Rogers paper has been a useful starting point for this paper as we have used the results to develop our reasoning and results.

Literature review

This article was initiated by a narrative literature review (Bryman and Bell, 2007). Sources of literature were mainly selected from secondary sources (e.g. books, theses and the internet) and documents (mainly public documents, company documents and mass media items). The purpose of exploring the existing literature was to be familiar with the following: what is already known about the research area (sustainability, supply chain management, logistics); main concepts, theories and themes of this area; and finally, significant controversies and unanswered research questions. Consequently, the initial literature review formed the basis for the research at hand. The research was then focused on the research questions with content analysis as main method used.

Content analysis

Content analysis is a set of research tools for the scientific study of written communications with the objective of determining key ideas and themes contained within them (Cullinane and Toy, 2000). Content analysis can be both qualitative and quantitative, where the latter seeks "to quantify content in terms of predetermined categories and in a systematic and replicable manner" (Bryman and Bell,

2007, p. 302). Qualitative content analysis can satisfy the inductive assumptions of qualitative researchers. Qualitative content analysis comprises an exploration of underlying themes in the materials being analysed. The aim is to be systematic and analytical but not rigid. Content analysis is often initially guided by some pre-set categories, in this case the three pillars of sustainable development and three levels of supply chain activities. However, other methods of data analysis should be allowed as they provide more value to the final result. With qualitative content analysis there is much more movement back and forth between conceptualisation, data collection, analysis and interpretation than is the case with quantitative content analysis (Bryman and Bell, 2007). The process we have used for content analysis in this paper is based on a qualitative one, as the area of investigation is complex and is based on a variety of examples, cases, methods, perspectives, etc. The major steps in the content analysis are now described.

Research questions

Based on the initial literature review, and together with several discussions with industry representatives and researchers working within SCM and/or sustainable development, the research questions were set (Cullinane and Toy, 2000; Bryman and Bell, 2007). Due to the complexity involved in sustainable development, i.e. it encompasses social, economic and environmental aspects, and covers the global setting of humans, organisations and societies, it was challenging to set the scope of the research. While the focus of the paper had been set on environmental aspects, with special emphasis on logistics and transport issues in supply chains, it is by definition impossible to exclude the other basic tenets of sustainable development. Consequently, the research questions are formulated with the goal of encompassing sustainability in SCM holistically rather than being focused on a specific area or industry for analysis. The main perspective is thus set to be from a supply chain management view.

Selection of a sample

In order to answer the research question, a relevant and valid sample of literature and/or documents should be selected (Bryman and Bell, 2007). The sampling method in this paper was based on convenience and non-probability. The selection of convenience sampling is not only to obtain a reliable and relevant base of articles but also due to their availability and accessibility (other types of sampling are snowball and quota). In the first step, the Electronic Library Information Navigator@Lund (ELIN) was selected as database of population of journals. ELIN is an online database at the library of Lund University in Sweden. It includes sources such as electronic journals, E-print archives, JSTOR, IEE/IEEE standards and proceedings, Ebsco fulltext databases, Proquest ABI database.

The research questions call for sampling two types of journals: those related to supply chain management (Type one) and those related to environmental sustainability (Type two). In order to narrow down the amount of journals, relevant keywords were chosen. Journals of type one were restricted to those which contain one or some of the following keywords: "supply chain", "logistic-", "transport", and "transportation". Here, we choose to use both transport and transportation due to their English language differences (e.g. US and UK) while logistic- became a hyphenated link to

related terms. Selected keywords for journals type two were: “sustainability”, “sustainable”, “environment”, “environmental”, and “green”. Table I presents the total number of journals found of both types.

The next step was the selection of a sample from the number of journals of both types. This selection was carried out through a ranking process. Two criteria were considered to rank the journals: citations and impact factors. Journals with the highest citation number were selected through the website www.journal-ranking.com, while those with the highest impact factor were chosen based on the website www.isiwebofknowledge.com. The result was that six journals of type one and twelve journals of type two were selected based on the highest number of citations and impact factors. The journals of type two were then formed into type two A and type two B as half of the journals focus on the environment and the other half on sustainability (see Table II).

Unit of analysis

The recording unit is the smallest body of text in which an example of one of the content categories (see next section)

Table I Population of journals types one and two

Journal types	Searching keyword	Number of journals	
		at ELIN@Lund	Total
Journals type one	Supply chain	7	142
	Logistic-	31	
	Transport	66	
	Transportation	38	
Journals type two	Sustainability	13	564
	Sustainable	28	
	Environment	166	
	Environmental	338	
	Green	19	

Table II Journals selected with the highest number of citations and impact factors

Journal types	Journals selected with the highest number of citations and impact factors	Total
Journals type one	<i>International Journal of Physical Distribution and Logistics Management</i>	6
	<i>Journal of Business Logistics</i>	
	<i>International Journal of Logistics Management</i>	
	<i>Supply Chain Management: An International Journal</i>	
	<i>Transport Reviews</i> <i>Transportation Science</i>	
Journals type two A	<i>Critical Reviews in Environmental Science and Technology</i>	6
	<i>Environmental Science & Technology</i>	
	<i>Journal of Environmental Economics and Management</i>	
	<i>Global Environmental Change</i>	
	<i>Environmental Management</i> <i>Journal of Environmental Engineering</i>	
Journals type two B	<i>Environment, Development and Sustainability</i>	6
	<i>Sustainability</i>	
	<i>Sustainability: Science, Practice, & Policy</i>	
	<i>International Journal of Sustainable Development & World Ecology</i>	
	<i>Journal of Sustainable Development</i> <i>Sustainable Development</i>	

appears (Cullinane and Toy, 2000). According to Bryman and Bell (2007), decisions about what should be counted in the course of a content analysis are bound to be profoundly affected by the nature of the research questions under consideration. “Relevant article” was considered as the unit of analysis in this research. The reason for this selection was to analyse how relevant articles in the journals selected deal with environmentally sustainable/friendly/sound/preferable supply chains. Such articles were chosen according to the following procedure:

- 1 Initially, based on the initial literature review concepts related to the research area were used to identify suitable articles in both types of journals. Articles in type one journals selected were refined and recorded in a database. They had to include one or more of the following words in the title, keyword, or abstract: “sustainability”, “sustainable”, “environment”, “environmental” and “green”. For type two journals “supply chain”; “logistic- or logistic*”, and “transport-” were the keywords chosen for the search. The sample included published articles dating from the first issue of each journal until end of 2009.
- 2 The refined number of articles were analysed and ranked by the authors working individually. Both authors were responsible for reading an abstract of each article and ranking its relevance to the research question by colour coding it into the following; relevant (green), semi-relevant (yellow) or not relevant (red).
- 3 Finally, results of analyses by both authors were compared and further discussions were held out to select the most relevant articles (Tables III-V).

In total, the review resulted in 190 relevant articles out of the total sample of 3637, i.e. 5.2 per cent. However, 2,407 of the suitable articles are from environmental science and technology. Excluding these, the percentage of selected articles is 11 per cent.

Table III Total number of relevant articles and total number of those selected – Journals and articles type one

Journal articles selected type one (837 (90))	Number of suitable articles (total number of those selected)				
	Sustainability	Sustainable	Environment	Environmental	Green
<i>International Journal of Physical Distribution & Logistics Management</i> (253 (25))	6 (2)	7 (0)	166 (14)	66 (9)	8 (0)
<i>Journal of Business Logistics</i> (117 (8))	0 (0)	4 (0)	70 (4)	39 (4)	4 (0)
<i>International Journal of Logistics Management</i> (145 (9))	7 (1)	13 (0)	94 (2)	30 (6)	1 (0)
<i>Supply Chain Management: An International Journal</i> (182 (21))	12 (6)	22 (4)	70 (4)	47 (7)	31 (0)
<i>Transport Reviews</i> (111 (26))	6 (2)	39 (15)	24 (2)	41 (7)	1 (0)
<i>Transportation Science</i> (29 (1))	1 (0)	0 (0)	19 (0)	4 (1)	5 (0)

Table IV Total number of relevant articles and total number of those selected – Journals and articles type two A

Journal articles selected type two A (2719 (62))	Number of suitable articles (total number of those selected)		
	Supply chain	Logistic-	Transport-
<i>Critical Reviews in Environmental Science and Technology</i> (3 (0))	0 (0)	0 (0)	3 (0)
<i>Environmental Science & Technology</i> (2407 (49))	16 (12)	24 (1)	2367 (36)
<i>Journal of Environmental Economics and Management</i> (20 (2))	0 (0)	5 (0)	15 (2)
<i>Global Environmental Change</i> (14 (6))	0 (0)	0 (0)	14 (6)
<i>Environmental Management</i> (100 (4))	4 (3)	26 (0)	70 (1)
<i>Journal of Environmental Engineering</i> (175 (1))	0 (0)	1 (1)	174 (0)

Table V Total number of relevant articles and total number of those selected – Journals and articles type two B

Journal articles selected type two B (81 (38))	Number of suitable articles (total number of those selected)		
	Supply chain	Logistic-	Transport-
<i>Environment, Development and Sustainability</i> (18 (10))	0 (0)	4 (0)	14 (10)
<i>Sustainability</i> (10 (4))	5 (3)	0 (0)	5 (1)
<i>Sustainability: Science, Practice, & Policy</i> (2 (1))	0 (0)	0 (0)	2 (1)
<i>International Journal of Sustainable Development & World Ecology</i> (12 (7))	1 (1)	0 (0)	11 (6)
<i>Journal of Sustainable Development</i> (9 (3))	2 (1)	3 (0)	4 (2)
<i>Sustainable Development</i> (30 (13))	14 (5)	0 (0)	16 (8)

Coding

Coding is a crucial stage in the process of performing content analysis. There are two main elements to a content analysis coding scheme: designing a coding schedule and designing a coding manual. The coding schedule is a form into which all the data relating to an item being coded are entered. The coding manual, sometimes referred to as the content analysis dictionary, is a set of instructions to coders which specifies the categories used to classify the text. It is based on a set of written rules which define how the text is classified (Bryman and Bell, 2007). Categories need to be devised to provide the basis for classifying textual content (Cullinane and Toy, 2000). The coding manual in this qualitative content analysis is both deductive and inductive.

Initially, two categories were determined in advance: level of discussion in the supply chain, and treatment of sustainability (see Table VI). In the qualitative analysis of themes the sub-categories were created inductively and were driven by the question of which themes and challenges have been put forward and how these have been discussed (Table VI). In this analysis the set of articles was broken down and grouped together based on themes found, e.g. sustainable

procurement, green transport policies. The criterion for a theme was that it should either be treated in several articles in similar ways, e.g. “reverse logistics” or be of a thematic character, e.g. “management issues”. While the themes could be separated out and related to specific articles, the challenges identified were of a much more integrative nature, i.e. the issue of cost was raised directly or indirectly in almost every article, as were the issues of mindset and culture. As a result, instead of breaking down the challenges in an analytical manner the challenges were deduced through a synthesis of all articles.

For this synthesis to take place, the authors were inspired by the inductive reasoning suggested by Glaser and Strauss (1967) in the analysis of data. While Glaser and Strauss (1967) propose the reasoning for analyzing empirical data, we also found the reasoning useful for inductive analysis of literature. Practically, this meant that the authors, after reading all the articles and performing the content analysis, used a workshop setup to elaborate on the challenges found, trying to relate these to each other and finally, after several steps of emergent coding, identified five main areas of challenges. The first coding step involved challenges which

Table VI Coding schedule and manual

Category	Features to be considered (deductively)	Emergent features (inductively)
Level of discussion in supply chain	Supply/demand/value chain /network – organisation and management Logistics processes and activities Transport focus	What themes and challenges have been discussed?
Treatment of sustainability	Environmental focus Sustainable development focus (interaction of basic tenets or new dimensions)	How have the themes and challenges been discussed?

were explicitly stated in the articles. Most of the challenges found were directly linked to the phenomenon studied in each paper, e.g. knowing if bio-fuel would become the dominating source of energy for transport or the role of logistics service providers in sustainable urban transport. The second step focused on the conclusions, discussions, future research and limitations of the articles from which implicit challenges could be found in comparison between articles. A third step focused on how issues and challenges had been treated and discussed, i.e. methods and approaches used, type of underlying research (e.g. conceptual, empirical or analytical) as well as main supply chain aspects considered (collaboration, transport, purchasing, etc.). In total this led to a great number of correlated issues and challenges which, after a fourth synthesising step, ended up as five areas of challenges.

Evaluation of quality of content analysis

Based on a review of definitions of content analysis, Bryman and Bell (2007) expose two qualities of this methodology: objectivity and being systematic. Objectivity in this sense resides in the fact that there is transparency in the procedures for assigning raw material to categories so that the analyst’s personal biases intrude as little as possible in the process. The quality of being systematic means that application of rules is done in a consistent manner so that bias is again suppressed. As a result of these two qualities, anyone could employ the rules set and come up with similar results. In this research we have tried to be as transparent as possible with the journals selected, the articles analysed and the coding scheme used. Furthermore, the analyses have primarily been carried out by two sets of researchers (Seuring and Müller, 2008; Guthrie *et al.*, 2004) but other researchers were also involved in the discussions to increase the validity of the results (Seuring and Müller, 2008). In line with Spens and Kovács’ (2006) suggestions for abductive reasoning we have fine-tuned our categories during the analysis and synthesis processes in order to generate as valuable contributions as possible. At the same time as we have tried to generate exhaustive and mutually exclusive categories (Cullinane and Toy, 2000). While we have been consistent with the research quality recommendations discussed here there are some limitations which need to be highlighted. While the content analysis, especially the quantitative part, is quite easy to follow and reproduce, the qualitative, inductive analysis and synthesis of the 190 articles being reviewed is of a more complex character as it relates to our previous levels of knowledge and experience. In order to mitigate this issue, the emergent outcomes have been presented at conferences involving both logistics/SCM experts and environmental/sustainability ones from both academia and industry. Furthermore, our choice of

journals also influences the results. Studies which are either more focused or of a wider scope, might result in either greater depth of some issues (e.g. procurement) or new factors found in different sources (e.g. decision science, behavioural science).

Findings from the content analysis

The goal of deductive content analysis was to find the number of articles in each category of coding manual. The results (Table VII) show levels of discussion in the supply chain (supply chain management as a whole, logistical processes and activities, and purely transport-focused) as well as treatment of sustainability (environmental focus and sustainable development). For the sustainable development category at least two of the basic tenets of sustainable development should be treated explicitly in the articles. In Table VII, the first number in each square represents the number of articles of type one and the second number refers to articles from type two journals. As the numbers show, there are many articles in both type one and type two with a mainly environmental focus. However, the articles of type two either focus on supply chains as a whole or on transport activities. Logistics is seldom raised as a concept in type two journals (one environmental and three sustainable development) but is treated quite extensively in the literature of type one when environmental issues are addressed (31 environmental). Sustainable development is treated less, especially in relation to logistics in both types of journals (four in type one and three in type two).

Themes of articles

In the next step, inductive content analysis was run to explore themes. The themes identified in accordance to the pre-set matrix of categories are presented in Table VIII.

The systematic review of the articles and identified themes led to a synthesis in which the themes could be grouped together, e.g. those with a management focus (Supply chain environmental management, Logistics environmental management, Transport environmental management, Transport sustainability management), etc. The criterion for a theme was that it should either be treated in several articles

Table VII Number of articles in each category of coding manual (type one + type two)

	Supply chain	Logistics	Transport
Environmental (61 + 59)	18 + 30	31 + 1	12 + 28
Sustainable development (28 + 42)	8 + 24	4 + 3	16 + 15

Table VIII Major themes with an environmental and sustainable development focus in literature analysed

	Supply chain	Level of discussion in supply chain	
		Logistics	Transport
Treatment of Environmental sustainability	Supply chain environmental management (a)	Logistics environmental management (a)	Transport environmental management (a)
	Green supply chains (b) Closed-loop supply chains (c)	Green packaging/purchasing (b) Green logistics policies and strategies (b) Reverse logistics (c)	Green transport policies (b) Transport fuel/energy/emissions (e)
Sustainable development	Closed-loop supply chain orientation (c)	Sustainable procurement (b)	Transport sustainability management (a)
	Aspects/concept of sustainable supply chain (d) Sustainable food supply chain (d)	Sustainable product recovery (c)	Sustainable transport policies (b) Sustainable urban transport (b)

in similar ways, e.g. “reverse logistics”, or be of a thematic character, e.g. “management issues”. As a result, five major themes emerged: Management issues; green activities, policies and strategies; reverse logistics/closed-loop supply chains; concept of sustainable supply chains; and finally transport fuel, energy and emissions. The grouped themes are illustrated in Table IX.

Management issues

Plenty of articles deal with managerial issues of environmentally sustainable supply chains such as assessment, measurement, monitoring, analysis, evaluation of environmental and sustainable activities. Impact assessment of supply chain activities is one of these management activities which have been covered in several dimensions, i.e. focusing on transport, e.g. noise, air pollution, congestion, aesthetics, safety (Nicolas, 2000; Jonsson and Johansson, 2006), specific concepts, e.g. postponement (Yang *et al.*, 2005), e-commerce (Sarkis *et al.*, 2004), virtual logistics (Clarke, 1998), vehicle distribution (Holweg and Miemczyk, 2002); logistics structure decisions (Aronsson and Huge Brodin, 2006);

biomass fuel supply (Allen *et al.*, 1998); or more holistic aspects of supply chains. Wu and Dunn (1995) take a holistic view to value chain activities from raw material acquisition and inbound logistics to marketing and after-sale services, and McIntyre *et al.* (1998a) life cycle impact analysis (LCA) of products or services. Environmental measurement and monitoring are other managerial aspects which can be found in McIntyre *et al.* (1998b), Bickel *et al.* (2006), and Janic (2006), respectively. Analyses of roles of information and communication technology (ICT) in sustainable transport (Janelle and Gillespie, 2004) as well as environmental evaluations of suppliers (Enarsson, 1998) also deal with management of environmentally sustainable supply chains.

Green activities, policies, and strategies

Green supply chains deal mainly with activities, policies and strategies which aim to make supply chains environmentally sustainable. Treatment of green supply chains in the articles reviewed can be summarised as follow:

- Construction of the concept of green supply chains as well as explanation of trends found in the area of green supply

Table IX The five major themes derived from grouping of sub-themes found in the content analysis

Management issues	Supply chain environmental management (a) Logistics environmental management (a) Transport environmental management (a) Transport sustainability management (a)
Green activities, policies and strategies	Green supply chains (b) Green packaging/ purchasing (b) Green logistics policies and strategies (b) Green transport policies (b) Sustainable procurement (b) Sustainable transport policies (b) Sustainable urban transport (b)
Reverse logistics/close-loop SC	Closed-loop supply chains (c) Reverse logistics (c) Closed-loop supply chain orientation (c) Sustainable product recovery (c)
Concept of sustainable SC	Aspects/concept of sustainable supply chain (d) Sustainable food supply chain (d)
Transport fuel, energy and emissions	Transport fuel/energy/ emissions (e)

chains and their development (van Hoek, 1999; Skjoett-Larsen, 2000; Cheng *et al.*, 2008).

- Green activities and processes of green supply chains with a predominant focus on packaging (Prendergast and Pitt, 1996; Gray and Guthrie, 1990; Mollenkopf *et al.*, 2005; García-Arca and Prado, 2008), purchasing (Green *et al.*, 1998; Murray, 2000; Murphy and Herberling, 1994), supply and manufacturing (Simpson and Power, 2005), and sustainable procurement (Walker and Brammer, 2009; Preuss, 2009).

What is obvious from analysis of green supply chain-related articles is the predominance of upstream activities. Studies of green downstream activities and concepts such as consumer demand and behaviour, distribution, etc. are lacking in the relevant literature.

Strategies and policies for management or development of green supply chains with a predominant focus on transport policies. Murphy *et al.* (1995), and Murphy and Richard (2003) are the only researchers who shed specific light on logistical strategies and policies. Focus of policies for green/sustainable transport are mainly on urban (Bratzel, 1999; Pucher *et al.*, 2007; Banister, 2000), local (Haywood, 2002), national (Schade and Schade, 2005; Pucher *et al.*, 2007), or continental (Rodenburg *et al.*, 2002; Banister, 2000). Himanen *et al.* (2004), as well as Witteben *et al.* (2009) discuss the characteristics of environmental policies and conclude that they must be integrated and adaptive.

Analysis of policy-related articles reveals that transport has been the main focus for policy making. However, Himanen *et al.* (2004) truly emphasise that policies for sustainable freight transport have been paid much less attention than policies for passenger transport have.

Furthermore, scenario building and analysis are the most popular tools for study and analysis of policies in such articles. However, scenarios are mainly from a macro (national or continental) perspective. What is lacking is the following: construction, analysis, and planning of scenarios from a micro (local, regional or industrial) perspective. Policy-related articles also reveal that policies and strategies for sustainable development of supply chains are mainly studied in isolation as policies for transport. No consideration is given to other policies which may interact with transport policies. All-encompassing holistic, systematic and evolutionary policy making for supply chain sustainable development is needed.

Reverse logistics/closed-loop supply chains

Reverse logistics deals with products, processes and resources which flow in opposition to the normal stream in supply chains; namely, from downstream to upstream. Closed-loop supply chains aim to integrate reverse logistical activities and processes with forward ones. Reverse logistics/closed-loop supply chains in articles analysed have been treated in the following ways:

- Analysis of one or some aspect(s) of reverse logistics like disposition (Daugherty *et al.*, 2001; Skinner *et al.*, 2008; Chandrashekar and Doudless, 1996), product returns (Srivastava and Srivastava, 2006), repair services (Blumberg, 1999), collection strategy (Hanafi *et al.*, 2008), remanufacturing, and product recovery (Inderfurth, 2005).
- Conceptual development of closed-loop supply chains (Clendenin, 1997; Defee *et al.*, 2009).

Study of those articles related to reverse logistics and closed-loop supply chains reveals that environmental concern has been the major focus. Such articles mostly deal with the environmental aspects of sustainability. What is missing is an analysis of reverse logistics or closed-loop supply chain from a sustainable development perspective.

Another missing point is the connection of closed-loop supply chain activities to greenhouse gas (GHG) emissions. A paradoxical concern in supply chains is the reduction of GHG emissions from reverse logistics activities. Closing the loop of supply chains by efficient co-ordination, collaboration and adaptation of reverse and forward flows can bring opportunities for reduction of emissions.

Concept of sustainable supply chains

The main goal of articles of this category is to embody the three bottom lines of sustainable development in the context of supply chains. In this regard, the discussion covers something wider than just an environmentally sustainable supply chain.

A common issue raised in several articles is that research on sustainable supply chains and its management suffers from insufficient theories, models and frameworks. A few articles such as those written by Carter and Rogers (2008), and Markley and Davis (2007) present novel concepts or theories regarding sustainable supply chains. The major purpose of these articles is to bring up some other aspects than just environment, society and economics which may be related to the long-term management of sustainable supply chains. Svensson (2007) emphasises the necessity of having a broad view of all aspects of sustainable supply chain management. Other articles of this category aim to study aspects and concepts of sustainable supply chains in a specific industry with a predominant focus on sustainable food supply chains (Vasileiou and Morris, 2006; Seuring, 2008).

Transport fuel/energy/emissions

The last groups of articles deal mainly with transport fuel and energy use as well as transport emissions. In general, the focus is on emissions. Even those articles which analyse transport fuel and energy usage look for opportunities for reduction of emissions. In the following section, a summary of treatment of transport emissions in selected articles is mentioned:

- Some articles discuss opportunities for reduction of emissions as a result of fuel efficiency in road freight transport (McKinnon *et al.*, 1993), efficient energy usage of land transport modes, etc.
- Particle emissions from vehicles (Johnson and Ferreira, 2001).
- Tradable greenhouse emission permits in the transport sector (Dobes, 1999).

The first conclusion from study of this category of articles is that transport emissions are mainly related to vehicles' fuel or energy usage. Even opportunities for reduction of emissions are mainly related to vehicle efficiency and less fuel or energy consumption.

What we have found is missing is the calculation, measurement or analysis of emissions from transport fuel or energy production. In fact, a broader view of transport-related emissions is required. Secondly, the articles suffer from empirical evidence. The solutions and conservation measures suggested have been mostly brainstormed without being tested, proven or examined in any empirical settings. Thirdly,

micro-aspects of transport emissions are usually neglected. For example, packaging can be a main source of reduction of emissions in freight transport, but it is usually neglected in such articles. Efficient packaging design, shape, material and weight, etc. can contribute tremendously to reduction of emissions, especially in the case of mass transport of freights.

Identified challenges for supply chain management

Transforming supply chain processes and activities toward sustainable operations call for identification and analysis of barriers, difficulties and challenges. From our systematic review and content analysis, a number of challenges for supply chain management emerged during the process of synthesising the content of the reviewed literature. While several specific and detailed challenges were raised the synthesis resulted in five main categories of SCM challenges as depicted in Figure 1.

Costs

The most frequently highlighted challenge of sustainable development in supply chains is cost. There is certainly a dilemma between reducing environmental impact of business activities and increasing financial cost (McIntyre *et al.*, 1998b). The majority of articles put forward the notion that it must pay to be green. The issue of cost is raised in most SCM areas. In procurement, for example (Wu and Dunn, 1995; Walker and Brammer, 2009; Simpson and Power, 2005), the dilemma of buying from low-cost vendors and the difficulties of incorporating environmental aspects in purchasing criteria are examined. In transport (Murphy *et al.*, 1995; Bickel *et al.*, 2006) difficulties in quantifying environmental costs are raised as are the high costs of environmental compliance. Welford *et al.* (2003) focus on economic growth and free trade from a sustainability perspective and question the causal relationship of economic growth and welfare which seems to be a fundamental assumption in global supply chains. Gray and Guthrie (1990) put forward the question that: “In the business of packaging the dilemma is, should a company pursue profit regardless, or pursue an environmentally responsible track at the cost of profit?” In conclusion, we find that while corporate social responsibility and environmental concerns are regarded as very important for the future of SCM, the issue of cost is still predominant, i.e. costs and revenues are the main drivers in the development of supply chains. This is troublesome since the

Figure 1 The five main areas of challenges facing sustainable supply chains



complexity and uncertainty in new concepts and models better aligned to a sustainable future might be very financially costly, at least initially, and therefore need other basic tenets than cost to be measured upon. The first research proposition is therefore:

- P1. In order to make supply chains sustainable, the underlying financially driven logic of supply chains needs to be reassessed in both research and practice, and the other basic tenets treated and prioritised by policy makers and organisations in the same way as costs are today.

Complexity

Dealing with increased complexity due to sustainable development issues in supply chains is another challenge raised by many researchers (Wu and Dunn, 1995; Enarsson, 1998; Carter and Rogers, 2008; Wittneben *et al.*, 2009). The complexity is inherited in the multiple ways in which supply chain processes and logistics affect society and the environment. There are several dilemmas involved in the choice of fuel, the routing of vehicles, the sourcing of material and components, how production is set up, the negotiation of environmental contracts (Murphy and Herberling, 1994) etc. In many ways these contribute to greater or lesser degrees of economic, environmental and social sustainability. Tradeoffs between environmental effects and delivery times (Holweg and Miemczyk, 2002) as well as service levels (Yang *et al.*, 2005) are other challenging examples worth mentioning. Furthermore, several difficulties contribute to this complexity in how to measure and assess the effects caused by different processes and activities within supply chains. McIntyre *et al.* (1998a) highlight the difficulty of measuring logistics environmental performance. While life cycle assessments (LCA) provide valid information about environmental effects for assorted products, they are limited to contemporary flows of goods and demarcated to certain areas (Vieira and Horvath, 2008; Mathewa *et al.*, 2008; Suh *et al.*, 2004). Consequently, there are several issues which need to be addressed which cannot be covered easily by LCAs such as the secondary effects of material flows (Johnson and Ferreira, 2001; Wee *et al.*, 2005), the structural setup of logistics activities, the behavioural changes the use of e-commerce contribute to and how all this in turn affects the environment. Jonsson and Johansson (2006) examine the dilemma between social and environmental sustainability where improvements in accessibility and infrastructure may increase mobility, the use of resources, and as a result lead to the deterioration of environmental sustainability. Consequently, a great challenge for supply chain management research and practice is the development of new perspectives, models and tools which can help individuals, companies and supply chains to deal with the increased complexity sustainable development brings. The reductionist paradigm inherent in most logistics research (Nilsson, 2006) must be challenged, and novel approaches which do not try to eliminate but instead comprehend the complexity are needed:

- P2. For the integration of sustainable development into supply chain management to become reality, holistic models and perspectives in which comprehension, not elimination or reduction, of the emergent complexity needs to be explored, developed and used.

Operationalisation

The operationalisation of sustainable development in supply chains is another challenge which emerged from our systematic synthesis of the relevant literature. In the literature two main factors are identified which contribute to the challenge of making sustainable development operationally feasible in supply chains; interpretation and inertia. Based on the complex nature of sustainable development the interpretation of what it means in different parts of an organisation or supply chain is difficult to comprehend. While everyone can agree on the Brundtland definition (World Commission on Environment and Development, 1987) it is far more challenging to translate the economic, social and environmental dimensions into relevant and prioritised activities for every process and/or individual in a supply chain. As a consequence of the difficulties in interpretation, environmental issues are generally neglected or unrecognised in the design (Murphy and Richard, 2003), legislation (Livingstone and Sparks, 1994), or policies (Murphy *et al.*, 1995) of logistics systems. This difficulty of interpretation might be one reason to explain the perceived lack of priority for sustainability issues at the senior level in companies, and the reluctance to turn intent into action (Preuss, 2009; Lyons, 2004; Himanen *et al.*, 2004). Inertia, being the second factor which limits the operationalisation of sustainable development in supply chains, is highlighted several times in literature. A fear of change connected to difficulties of interpretation, the complexity involved, and the underlying business logic with its clear focus on financial aspects, all contribute to the inertia in reaching sustainable supply chains (Welford *et al.*, 2003; Jacobs and Greaves, 2003; Kennedy *et al.*, 2005; Keating *et al.*, 2008). Carter and Rogers (2008), as well as Defee *et al.* (2009), put forward inertia as a main obstacle for organisations in adopting environmentally friendly initiatives:

P3. In order to transform sustainability ideas and theories into action, i.e. be operationalised, the difficulties of interpreting the concept of sustainable development and the inertia of change inherit in the majority of supply chains must be made priority issues for decision- and policy makers.

Mindset and cultural changes

Change of mindset and culture on international, national and organisational levels are other challenges for environmentally sustainable logistics. For example, Wittneben *et al.* (2009) address the increasing reliance on motorised road transport in developing countries as an international challenge while Srivastava and Srivastava (2006), as well as Badami (2005), identify the lack of environmentally sensitive behaviour in India as a national challenge.

On an organisational level several authors also address the need for a change for mindset in order for any major steps towards sustainable supply chains to be made. The lack of engagement by top management in environmentally related issues (Preuss, 2009; Lyons, 2004; Himanen *et al.*, 2004) is one part of this but the challenge goes even further than that. Even if decisions are taken these must be turned into action by the great mass of people working in organisations. Hence, the values and mindsets of co-workers must also be addressed. Huesemann and Huesemann (2008, p. 817) state that “without a significant change in society’s values, the current

direction of progress in science and technology will only implement the existing values of growth, exploitation, and inequality, thereby accelerating our approach to collapse.” One assumption forming the mindset of supply chain management is the collaboration for the good of all parties in the chain. This assumption provides a rather “romantic” view of supply chains and is vastly apparent in articles of type one while less emphasised in articles of type two. Instead, in articles of type two, a harsher picture of the activities and collaboration in supply chains is put forward, e.g. power distributions, transaction of cost, etc. An example seen in the supply chains of fresh fruit, e.g. grapes, in which producers (found in less developed countries) are forced to pay for audits performed to be accredited and do not get paid until consumers have bought their products in Europe (Vermeulen and Seuring, 2009). Furthermore, the producers also carry all the risk in the supply chain as damaged goods and lost goods will not be paid for by other members downstream in the supply chain (Ras and Vermeulen, 2009).

Consequently, there is a great challenge in incorporating sustainability and environmental management principles into the daily decision-making process and the processes carried out in supply chains. For this to happen, the mindset of supply chain managers and logisticians needs to be changed and assumptions taken for granted have to be continually reassessed, both by top management and by the co-workers performing the actual work. As a result, the fourth proposition reads:

P4. For sustainable development to be a natural part of future supply chains the mindset of people within organisations, supply chains and nations needs to be critical, creative and incorporative of sustainability perspectives and assumptions.

Uncertainties

A collection of articles pinpoints uncertainty as a barrier to developing environmentally sustainable activities. Murphy *et al.* (1995) consider “uncertainty as to the degree and nature of government regulations” as an obstacle to establishing environmental policies. Rodenburg *et al.* (2002) develop policy scenarios for achieving sustainable transport in Europe highlight substantial uncertainty in long-term development. The challenge of uncertainty can also be found in a number of articles, especially those related to reverse logistics. For instance, Hanafi *et al.* (2008) refer to quality and timing uncertainty of returned products. Inderfurth (2005) discusses about uncertainty in returns and demands as a considerable obstacle to following environmentally benign recovery strategy within a reverse logistics system. Uncertainty in different types of environmental effects of logistics is also a challenge raised by Gilmour *et al.* (1995).

The literature reviewed raises a number of uncertainties related to government actions and decisions, consumer behaviour and demands, and competitive advantages and strategies formulated by organisations. The impression from a number of articles is that this great uncertainty is a barrier to change as it is not clear which part of society will take the first real moves. Hence, in a Kuhnian sense (Kuhn, 1962) the uncertainty experienced with sustainable development might call for a paradigm shift. Similar to the challenge of complexity (definitively a correlated factor to uncertainty), uncertainty is a matter of fact in sustainable development as it

is novel to mankind and challenges some of our basic assumptions. Consequently, for research and practice a fifth proposition is made:

- P5. In making supply chains sustainable, organisations must take advantage of uncertainty by exploring, developing and communicating different business logics, and from these, establish new ethical, environmental and social programmes and policy measures.

Concluding discussion

This paper set out to explore themes and challenges in making supply chains sustainable. Based on a systematic review and content analysis of 190 articles from 18 journals we are able to report on what the themes related to sustainable supply chains, logistics and transport have been and currently are in the literature we reviewed. From this analysis, missing themes, as well as the identification of five main challenges for the field of supply chain management, have been provided together with suggested research propositions which provide guidance for further research and practice.

Development of supply chains in a sustainable and environmentally friendly way is complex. The diversity and the nature of identified themes and challenges is evidence of this claim. Both environment and supply chains consist of gigantic subsystems as well as massive processes and resources which make management of their development fairly complex. The difficulties in demarcation of supply chains and natural environment, as well as the existence of paradoxes (Enarsson, 1998; Murphy and Herberling, 1994) reveal complex attributes, too. Challenges of changing cultures and mindsets, difficulty in control and management of uncertainties and tradeoffs are other examples of the complexity of this area. The complexity of problems and challenges makes agreements about the priorities for action and policy initiatives very difficult (Brown, 2005). In conclusion, there is a great need for models and frameworks which consider the complexity involved, take holistic perspectives, and challenge the basic assumptions underlying most of the research published (i.e. reductionism, positivism and economic growth). Furthermore, based on the propositions put forward in this paper both managers and policy makers can be guided as to the extent and areas that changes need to be addressed. For policy makers there is a need to deal with uncertainties as many companies are still at the stage of compiling laws and regulations. In setting policies which can guide and mitigate uncertainty, companies can adapt to the policies and be willing to invest more in order to gain a competitive advantage. However, these policies need holistic thinking and research models which can deal with the complexity related to sustainable development. Otherwise, the risk is that suboptimal policies might be manifested which undermine the purpose of sustainable development. For managers, operationalisation is mandatory since the policies set must be transformed into purposeful actions by every actor and participant in the supply chain. In this operationalisation, the issues of social and environmental sustainability must be prioritised as highly as financial issues are today.

One limitation of this study is, of course, the number of journals included. Choosing six of the highest ranked and

most-cited journals from each of the three types was to balance rigour and feasibility, i.e. more journals might have increased the number of articles which would theoretically have been good, but practically, would exceed the amount we would be able to review and analyse in a reasonable time period. A sample of fewer journals might, on the other hand, mean that we would miss some important aspects. Consequently, we encourage further research to review a much broader sample of journals but over a limited period of time.

As a final comment, we argue that sustainability should be integrated into supply chain management and not be treated as a concept or theory of its own (like sustainable supply chain management, environmental logistics management). This separation, of as literature today manifests, identifies sustainability as a factor of its own; an add-on to SCM. Instead, environmental and social issues should be treated in SCM in the same way as revenues and costs are today. Otherwise, sustainability will only be an add-on which will be given lower priority in research, boardrooms and management teams.

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Paper II

Themes and Challenges in Making Supply Chains Socially Sustainable

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THEMES AND CHALLENGES IN MAKING SUPPLY CHAINS SOCIALLY SUSTAINABLE

ABSTRACT

Purpose

This paper presents the results of a study that explores and classifies themes and challenges in making supply chains socially sustainable.

Design/methodology/approach

The study was cross-sectionally designed by collecting and analyzing data across a diverse range of literature at a single point of time. The methodology was based on a systematic review of the existing literature in order to explore the major themes and challenges that have been discussed as well as the significant gaps where opportunities for further research can be found.

Findings

In total five categories of themes were identified, namely goods/service-centric, human-centric, organization-centric, corporate-centric, and management-centric. Challenges were classified into eight categories namely, inadequate and asymmetric knowledge, shifting the values, operationalization, subjectivity in evaluation, difficulties of SMEs, governance complexity, sustainability leakage, and sustainability washing.

Research limitations/implications

The focus of the article is on the social pillar of sustainable development and its interactions/integration with other pillars, namely environmental and economic.

Practical implications

This paper hopes to increase awareness about the social responsibilities of supply chains stakeholders. The discussion section provides suggestions for tackling the challenges and a section that elaborates on opportunities for further research.

Originality/value

The identification and classification of themes and challenges can be helpful in providing insights and in guiding managers, decision makers, practitioners, and researchers in their efforts to design and operationalize sustainability strategies.

Keywords: sustainable, sustainable development, social sustainability, supply chain, logistic, management

1. INTRODUCTION

Businesses are increasingly being asked to take responsibility for the environmental and social consequences of their activities. However, what the responsibilities exactly are, the extent to which businesses are responsible, and who shares the responsibilities are issues that have been inadequately and asymmetrically addressed both in theory and practice.

Supply chains co-evolve with their surrounding (natural) environments as well as societies while both influencing and being influenced by them. They can be considered as open and dynamic socio-economic systems formed by the interaction among various actors such as suppliers, producers/manufacturers, distributors, retailers, consumers, authorities, trade unions, NGOs, and research and educational organizations. Supply chains cannot survive without the social capital (Dyllick and Hockerts, 2002) or natural resources that enable their activities.

Supply chains also co-adapt with their surrounding societies (Abbasi, 2012) by creating shared values with them (Porter and Kramer, 2006). Supply chains can contribute to the sustainable development of their surrounding societies by: fulfilling demand and needs for safe, secure, and healthy goods and services; creating new jobs; employing the labor forces while respecting their rights and dignity; developing employees' innovation and absorptive capacities while maintaining their loyalty and motivation; reducing poverty; and supporting public services and humanitarian aid. However, supply chains activities may have negative effects on their surrounding societies that should be mitigated. Some examples are the negative effects on residents' health and safety, noise, congestion, injuries, accidents, visual intrusion, mobbing of employees, human right abuses, land take, and deterioration of the cultural carrying capacity.

The surrounding societies can contribute to sustainable development of supply chains, too. They do so by providing proactive welfare and healthcare services; by creating a solid infrastructure; and by educating a labour force that understands and respects human rights, gender equality, democracy, peace, liberty, social solidarity and inclusion. They also do so by building and preserving a culture supportive of creativity, innovation, entrepreneurship, and diversity in which the sustainable development of supply chains can directly flourish. However, surrounding societies may have negative effects on the sustainable development of supply chains that should also be mitigated. Some examples are corruption, scandals, bribery, extortion and blackmail, power abuse, thefts, hijacking, smuggling of goods, violating intellectual properties rights, and prejudice.

Sustainable development (World Commission on Environment and Development, 1987; United Nations 2005 World Summit outcome, 2005) encompasses all three of the interdependent and mutually reinforcing pillars or bottom lines: economic development (Profit), social development (People) and environmental protection (Planet) (Elkington, 1997). Sustainability values are co-created, co-adapted, and co-evolved among supply chains stakeholders and their surrounding (natural) environments and societies, which may change over time. However, the social pillar of sustainable supply chains has not been as well discussed as the environmental one, neither in theory nor in practice (Seuring, 2013; Abbasi and Nilsson, 2012; Hutchins and Sutherland, 2008). This article presents and explores the main themes and challenges reported in the literature for making supply chains socially sustainable. The focus is on the social pillar of sustainable development and its interactions/integration with other pillars, namely the environmental and economic.

The next section provides the frame of reference by means of an overview of the main definitions and terminologies. This is followed by the methodology of collection, analysis,

and synthesis of data. The results section sheds light on the inductively-emerged main categories of themes and challenges in making supply chains socially sustainable. The article ends with a complementary concluding discussion.

2. AN OVERVIEW OF DEFINITIONS AND TERMINOLOGIES

According to *The Free Dictionary* (2013), *social*, as an adjective, is defined as: “of or relating to human society and its modes of organization”. *Society*, as a noun, is defined as: a) “the totality of social relationships among humans”; b) “the institutions and culture of a distinct self-perpetuating group.” As a result, the social pillar of sustainable development is related to both preserving and developing humans and their relationships, culture, and institutions.

In the context of supply chains and logistics, the social pillar of sustainable development refers to concepts such as: *social sustainability* (Sarkis *et al.*, 2010; Vachon and Mao, 2008; Gimenez *et al.*, 2012;); *corporate social sustainability* (Dyllick and Hockerts, 2002; Tsoi, 2010); *social responsibility* (Lee *et al.*, 2007; Carter and Jennings, 2002; Becker *et al.*, 2010; Koplin *et al.*, 2007; Ciliberti *et al.*, 2008; Gopalakrishnan *et al.*, 2012); *corporate responsibility* (Kogg and Mont, 2012; Carbone *et al.*, 2012); *corporate sustainability* (Isaksson and Steimle, 2009); and *corporate citizenship* (Jacob, 2012; Liu *et al.*, 2011). Another common concept is corporate social responsibility (CSR) although there is no consensus on its meaning (Garriga and Melé, 2004; Dahlsrud, 2008; Boulouta and Pitelis, 2014). However, the most common is the one offered by Carroll (1979, p. 500): “the economic, legal, ethical, and discretionary expectations that society has of organizations at a given point in time.”

3. METHODOLOGY

The study was cross-sectionally designed (Bryman and Bell, 2007) by collecting and analyzing data across a diverse range of literature at a single point of time. The methodology was based on a systematic review of the existing literature in order to explore what major themes and challenges have been discussed as well as the significant gaps where opportunities for further research can be found. In what follows, the steps in a systematic literature review are explained according to Denyer and Tranfield’s template (2009, p. 671-672).

Step 1: Question formulation

There are a number of articles showing that the social pillar of sustainable supply chains has not been as well discussed as the environmental pillar (Vachon and Mao, 2008; Björklund, 2010; Sarkis *et al.*, 2010; Lozano and Huisinigh, 2011; Abbasi and Nilsson, 2012; Abbasi, 2012). Several research projects, conferences, seminars, workshops, and meetings have also made it clear that different supply chains stakeholders have inadequate knowledge and are uncertain about their social responsibilities in practice. In addition, some researchers claim that the published literature in the field is trans-disciplinary and fragmented (Gimenez *et al.*, 2012). Lack of knowledge in theory and practice and support from advisory groups, such as management and the research community, has led to the formulation of the research question: What are the major themes and challenges in making supply chains socially sustainable?

Step 2: Locating studies

After formulating the research question, search system of Lund University Libraries (LUBsearch) for books, articles, and journals was used. LUBsearch has access to EBSCO databases, publisher websites (e.g., Emerald, Elsevier, Springer, Wiley, Taylor & Francis Ltd., informs), and the internal databases of Lund University. The following search term was

used in LUBsearch: (social sustain* AND supply chain*)¹ in the title and/or abstract of articles. As the unit of analysis in this study was “peer-reviewed journal articles”, the search results were refined to peer reviewed academic journals (magazines, trade publications, books, conference materials, and internal library catalogues were excluded) and articles written in English until the end of 2012. In total, 458 available articles were found.

Step 3: Study selection and evaluation

In this step, abstracts of all the 458 articles were examined and in some cases, the entire article was read. The abstracts that were duplicated or had irrelevant topics for this study (where the actual focus was on chemistry, physics, medicine, neurology, immunology, pharmacology, or arithmetical subjects [for example ‘Markov chain’, ‘causal chain’]), or had used ‘social’ in reference to ‘social science’ were excluded in the review process. In total 197 abstracts were considered pertinent for the purpose of this article. Afterwards, the full versions of the articles were saved in a database and read by the author. In the process, 107 articles were classified as relevant and 90 as less relevant.

The less relevant articles were those that mainly referred to environmental and/or economic aspects of sustainable supply chains, although mentioning CSR or soci* in the abstracts. There were also several articles in this category that treated sustainability as the ability to maintain and continue business relationships; trust and competitive advantage; resistance and resilience; and risk management. Three of the less relevant articles were editorial reviews. The relevant articles (Reference list 1) were those that implicitly or explicitly elaborated on a socially relevant theme (such as a concept/aspect/terminology/activity/topic) and/or challenge (difficulties, obstacles, or dilemmas).

Step 4: Analysis and synthesis

In line with Denyer and Tranfield’s recommendation (2009, p. 685-686), a “data extraction form” was created where all the following information was registered in detail when reading the selected articles: author(s)’ name(s), publication year, title of the article and journal, research design/methodology/approach, key findings, parts of the articles that dealt with different aspects and challenges in making supply chains socially sustainable, and recommendations for further research.

During and after reading the articles, an open coding process started. The purpose of open coding was to codify and classify the identified aspects or challenges by looking for similarities, differences, comparison, and modification of collected data (Pullman and Dillard, 2010). This was followed by a focused coding (Charmaz, 2006; Winther and Phillips, 2000) or axial coding (Pullman and Dillard, 2010) where similar open codes were further classified and finally synthesized. This resulted in the emergence of the major categories of themes and challenges discussed in the results section. The aim of synthesis was to interpret associations among the focused codes by “recasting the information into a new or different arrangement and developing knowledge that is not apparent from reading the individual studies in isolation” (Denyer and Tranfield, 2009, p. 685).

Step 5: Reporting and using the results

The results section reports the answers to the research question. It highlights the distribution of articles based on publication year, journals, research approach and methodology. The discussion section sheds further light on an inductive framework for making supply chains socially sustainable and provides suggestions for tackling the challenges. It also elaborates on opportunities for further research.

¹ (soci* AND sustain* AND supply chain*) also led to the same search results.

Judging quality of the research

According to Denyer and Tranfield (2009, p. 674), standard systematic reviews are traditionally expected to be replicable, exclusive, aggregative, and algorithmic. However, they offer four alternative principles for systematic reviews that may be more useful in management and organization studies. They suggest that reviews be tested for their transparency, inclusivity, explanatory, and heuristic nature.

Transparency

To increase transparency of the systematic literature review, three aspects were considered. First, the standpoint and underlying assumptions of sustainable development and social sustainability in the context of supply chains and logistics were described in section 2. Second, all review steps (1 to 5 in the methodology section) including the list of selected articles (Reference list 1) were highlighted. This enables the readers to determine precisely the scope and boundaries of the review and track it in the future. In addition, all the data necessary for processing the results section were clearly defined and stored in the data extraction form. Third, the synthesized information presented in the results section includes evidences from the relevant articles reviewed.

Inclusivity

To increase inclusivity of the systematic literature review, a relevant sample of articles was selected that explicitly fit the purpose of the study. Using the (social sustain* AND supply chain*) as search keywords led to a reasonable number of articles that could be thoroughly read and analyzed in a reasonable amount of time. In addition, a broad range of appropriate literature and documents from reliable sources was included in all parts of the study from its design to reporting.

Explanatory

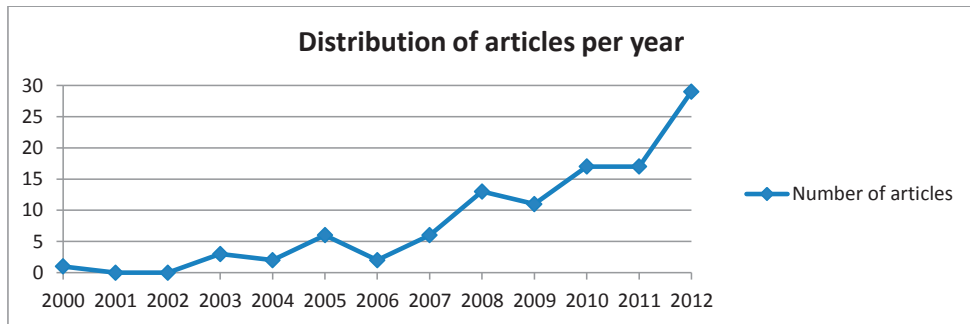
The second and fourth sections are based on an interpretive and explanatory, rather than an aggregative synthesis of information, i.e. processed collected data. The themes and challenges presented in the results section are based on an interpretation of the patterns of the aggregated data. They cannot be found in any of the relevant articles reviewed, i.e. the whole is more than the sum of the parts.

Heuristic

The discussion section links the results with an inductive framework for making supply chains socially sustainable and provides suggestions for tackling the challenges. However, the framework and suggestions are heuristic. In other words, they are not guaranteed, detailed solutions as they are anti-positivistic (Bryman and Bell, 2007; Rousseau *et al.*, 2008). This means that they are subject to relativity and change over time. They may be helpful in providing insights and in guiding the managers, decision makers, practitioners and researchers when they design and operationalize sustainability strategies.

3. RESULTS

As shown in Figure 1, all the relevant articles were published after 2000 and only 13% of them were published before 2007. The trend shows an increase of published articles since 2007, although slightly decreasing between 2008 and 2009, and remaining even between 2010 and 2011. The number of articles greatly increased between 2007 and 2008 as well as between 2011 and 2012. The articles were published in 70 different journals. Table 1 summarizes the distribution of articles per journal.



Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Number of articles	1	0	0	3	2	6	2	6	13	11	17	17	29

Figure 1 – Distribution of articles per year

More than 8% of the articles were published in the *Journal of Cleaner Production*. This was followed by the *International Journal of Production Economics* and *Sustainability* with 10 articles (5 in each), and *Business Strategy and the Environment* as well as *Ecological Economics* with 8 articles (4 in each). Fifty-five articles were equally distributed among the remaining 55 journals (1 in each).

Table 1 – Distribution of articles per journal

Distribution of articles per journal	Journal(s) name(s)
9	Journal of Cleaner Production
5 each	International Journal of Production Economics; Sustainability
4 each	Business Strategy and the Environment; Ecological Economics
3 each	Corporate Governance; Corporate Social Responsibility and Environmental Management; International Journal of Production Research; Journal of Business Ethics; Sustainable Development
2 each	Agriculture and Human Values; Business and Politics; International Journal of Operations & Production Management; Journal of Corporate Citizenship; Journal of Supply Chain Management
1 each	Accounting, Organizations and Society; Advanced Engineering Informatics; Aquaculture Economics and Management; Business Education & Accreditation; California Management Review; China-USA Business Review; Civil and Environmental Research; Clean Technologies & Environmental Policy; Computers and Chemical Engineering; Computers and Electronics in Agriculture; Construction Management and Economics; Development in Practice; Ecological Indicators; Energies; Engineering Sustainability; Environment and Development Economics; Environment International; Environmental Management; European Journal of Forest Research; Fuzzy Sets and Systems; Greener Management International; Human Resource Development Review; ICAFI Journal of Entrepreneurship Development; International Journal of Agricultural Sustainability; International Journal of Business and Management Science; International Journal of Sustainable Development and World Ecology; International Review of Retail, Distribution and Consumer Research; Italian Journal of Agronomy; Journal of Global Responsibility; Journal of Management and Sustainability; Journal of Operations Management; Journal of Strategic Information Systems; Journal of Technology Management & Innovation; Journal Of The Textile Institute; Land Use Policy; Leisure Studies; Livestock Production Science; Logistics Research; Management Science; Maritime Policy and Management; Nordic Journal of International Law; Organizational Dynamics; Philosophical Transactions of the Royal Society B: Biological Sciences; Procedia – Social and Behavioral Sciences; R & D Management; Renewable Agriculture and Food Systems; Renewable and Sustainable Energy Reviews; Revue Management et Avenir; SAM Advanced Management Journal; Simulation; Social Responsibility Journal; The TQM Journal; Tobacco Control; Work; Zeitschrift Fur Arbeitsmarktforschung/Journal for Labour Market Research

The articles were also analyzed based on their research strategy: qualitative vs. quantitative. Sixty-one articles (57%) were considered as qualitative and 46 (43%) as quantitative. In addition, they were classified as conceptual vs. empirical: 28 articles (26%) were conceptual while the remaining 79 (74%) were empirical.

Figure 2 presents the distribution of research methodologies of the articles. However, the sum is more than 107 (i.e., 116) as some articles had mixed methodologies (2 and even 3 methods) for collection or analysis of data.

Case studies made up 40% of the methodologies, used in 46 articles. Some articles referred to case study as a research design or strategy rather than a methodology. A few articles were based on fieldwork and action research. They all are included in the case study illustrated in Figure 2. Interviews, including Delphi studies and focus group discussions, made up the second largest group (21%) followed by surveys (12%) and reviews of reports and documents (9%). Framework development and grounded theory, systematic literature reviews and content analysis were mostly found in conceptual papers, while observation was found in empirical papers.

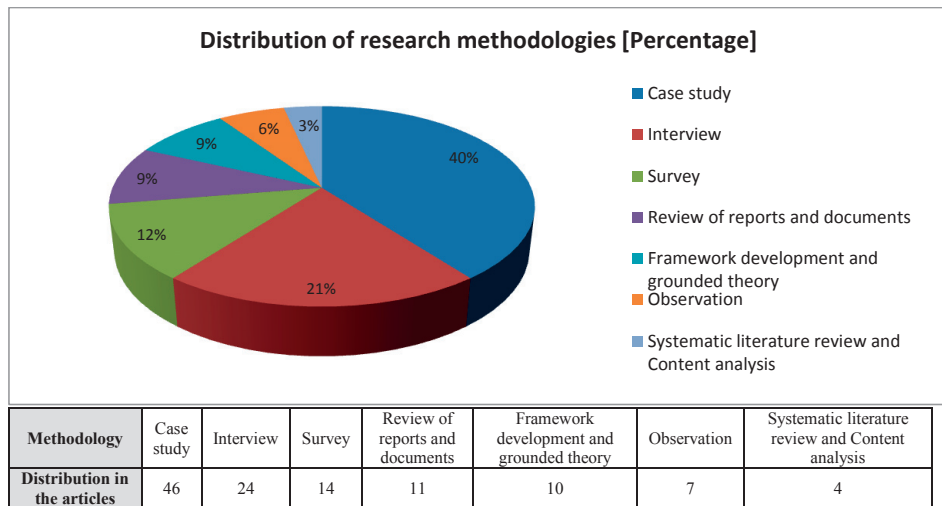


Figure 3 – Distribution of research methodologies

4.1. Identified themes

Five categories of themes were identified after the focused coding, namely *goods/service-centric*, *human-centric*, *organization-centric*, *corporate-centric*, and *management-centric*.

Goods/service-centric

The first theme is originated from those that reflect upon direct characteristics of goods and services. The most highlighted characteristics are: *safety*, *security*, and *healthiness* (Kalleitner-Huber *et al.*, 2012; Halog and Manik, 2011; Paloviita, 2010; Hutchins and Sutherland, 2008; Smith, 2008; Lehmann *et al.*, 2011; Leat *et al.*, 2011; Euclides Filho, 2004) followed by *transparent traceability* (Wognum *et al.*, 2011; Pietro and Giuseppe, 2012; Spence and Rinaldi, 2012; Euclides Filho, 2004; Awaysheh and Klassen, 2010).

There are also some *non-humanistic rights* that must be respected such as: *property rights* (Anderson, 2008) and *animal rights/welfare* (Ilbery and Maye, 2005; Hartlieb and Jones, 2009).

Human-centric

The human-centric theme directly relates to human resources, or human capital or labor or employees of supply chains. *Healthcare of employees* (Hasle and Jensen, 2012) and *even their families* (Cross *et al.*, 2009), and their *safety* are the most highlighted criteria in the reviewed

articles (Erol *et al.*, 2011; Matos and Hall, 2007; Ahmed *et al.*, 2007; Halldórsson *et al.*, 2009; Adetunji *et al.*, 2003; Erol *et al.*, 2009; Liu *et al.*, 2011; Corbière-Nicollier *et al.*, 2011; Isaksson and Steimle, 2009).

Humans also have several rights which are usually called *labor rights* for employees in businesses. Employees have rights to be *treated equitably* by having: *equal employment opportunities* (Govindan *et al.*, 2012); *written contracts* (Freeman, 2003); *legal wages* (Worley *et al.*, 2010); *compensation* (Björklund, 2010); *retirement funds* (Gopalakrishnan *et al.*, 2012); *gradual increase in the minimum wage rate* in accordance with economic growth (Chi, 2011); *maternity leave* (Müller *et al.*, 2009); *fair working hours* (Becker *et al.*, 2010); and *fair return on their contributions* (Pagell and Wu, 2009). Labor rights also include: *freedom of movement and association* (Björklund, 2010); *right to collective bargaining* (Welford *et al.*, 2003); *right to strike* (Benoit-Norris *et al.*, 2012); *inclusion in decision-making* (Su and Miller, 2011) or *democratic decision-making* (Anderson, 2008); and *decent working conditions* (Luken and Stares, 2005).

Moreover, the following should be banned: any form of *discrimination*, including *discrimination based on nationality, ethnicity, race, gender, religion, class, or wealth of the employees* (De Chiara and Spina, 2011); *child labor* (Govindan *et al.*, 2012); *forced labor* (Ciliberti *et al.*, 2008); *bonded labor* (Jorgensen and Knudsen, 2006); and *harassment and abuse* (Luken and Stares, 2005).

Organization-centric

Some of the reviewed articles elaborate on the importance of organizations in shaping social values – or what some highlight as “culture” (Lozano and Huisingh, 2011; Dao *et al.*, 2011) – of supply chains stakeholders (Su and Miller, 2011) especially the employees (Becker *et al.*, 2010). Pagell and Wu (2009) and Gopalakrishnan *et al.* (2012) highlight *organizational commitment* as a key driver of sustainability. To create such a culture, the articles’ recipe is that organizations should:

- *Create a learning context* by: education (Halog and Manik, 2011); encouraging lifelong learning (Grewal and Haugstetter, 2007); training (Becker *et al.*, 2010); sharing information and knowledge which according to Grewal and Haugstetter (2007, p. 169) are “the intangible assets on which business sustainability and growth are founded. Knowledge is a dynamic, social resource.”
- *Exploit innovation and creativity* by increasing absorptive capacities; social interaction and networking; and being open to new suggestions as well as external stakeholders (Dao *et al.*, 2011; Grewal and Haugstetter, 2007; Welford *et al.*, 2003)
- *Foster diversity* (Worley *et al.*, 2010) while at the same time [organizational] integrity (Otañez and Glantz, 2011) and inclusion (Gopalakrishnan *et al.*, 2012)
- *Develop the employees’ skills, talents, and career* over time (Dao *et al.*, 2011; Sarkis *et al.*, 2012; Sarkis *et al.*, 2010; Mares, 2010). In addition, some articles highlight that in such culture, employees are motivated (Becker *et al.*, 2010; Pagell and Wu, 2009); their absenteeism is reduced (Luken and Stares, 2005); their dignity, wellbeing, satisfaction, loyalty, and commitment to work are protected (Becker *et al.*, 2010; Adetunji *et al.*, 2003; Dao *et al.*, 2011; Björklund, 2010); and minorities are respected and advanced (Halog and Manik, 2011).

Corporate-centric

Some of the reviewed articles seek social sustainability beyond the boundaries of an organization by looking upon its relationship with stakeholders and the wider society. They

can be classified into four subthemes, namely *ethical sourcing*, *ethical trade*, *corporate responsibilities*, and *collaboration*.

- *Ethical sourcing*

Ethical sourcing/sound sourcing/social responsible buying/purchasing social responsibility is related to responsibility of sourcing from ethical (Spence and Rinaldi, 2012) or socially responsible (Millard, 2011; Koplin *et al.*, 2007) suppliers who follow the criteria previously mentioned or minimum standards/requirements. Pagell and Wu (2009, p. 49) also call for transparency of suppliers as a social responsibility as it may “help to ensure that no one in the chain is being abused.” Although setting social criteria for selecting supplier(s) has been mainly discussed from a microeconomic perspective (Govindan *et al.*, 2012; Su and Miller, 2011; Paloviita, 2010), it can also be relevant from a macroeconomic perspective (Chi, 2011; Perez-Aleman and Sandilands, 2008; Tencati *et al.*, 2008; Hisjam *et al.*, 2012).

Sourcing from local suppliers has been considered as a social benefit mainly in food supply chain related articles as it may: increase their autonomy, increase social interaction and networks, improve nutritional quality in the food stuffs, improve wellbeing of local communities, generate local employment and income, and maintain a community’s agricultural heritage (Cross *et al.*, 2009; Smith, 2008; Ilbery and Maye, 2005; Benoit-Norris *et al.*, 2012; Pretty *et al.*, 2008; Leat *et al.*, 2011). In addition, Ciliberti *et al.* (2008) highlight purchasing from suppliers of ethnic minorities or women-owned as a practice of purchasing social responsibility (PSR). However, Anderson (2008) discusses that although localization is associated with a cascade of environmental and social benefits, it is insufficient to rectify inequality if it further isolates those who have been treated unfairly, abused, or marginalized.

- *Ethical trade*

Ethical trade/fair trade/business ethics go one step further than just ethical sourcing as it sheds light upon all trade processes in the market(s) where the supply chain operates. Examples mentioned in the reviewed articles include: *setting equitable pricing system* (Millard, 2011); *providing pre-payment* (Welford *et al.*, 2003); *fair distribution of revenue along the supply chains* (Vachon and Mao, 2008); *avoiding fake trade* (Welford *et al.*, 2003); *avoiding obscure contract terms* (Koplin *et al.*, 2007; Lozano and Huisingh, 2011; Ciliberti *et al.*, 2008); *avoiding corruption, extortion, bribery, and illegal payments to authorities* (Welford *et al.*, 2003; Sarkis *et al.*, 2012; Lozano and Huisingh, 2011; Jorgensen and Knudsen, 2006); *being honest and transparent* (Welford *et al.*, 2003; Ciliberti *et al.*, 2008; Worley *et al.*, 2010); and *conducting business consistent with morals and values of society* (De Chiara and Spena, 2011).

- *Corporate responsibilities*

This theme pivots around the CSR-related articles that seek responsibilities of businesses in relationship with their stakeholders and wider/macro society. However, there is a great asymmetry among the reviewed articles regarding the definitions of stakeholders as well as characteristics and extent of responsibilities (Evan and Freeman, 1993; Liu *et al.*, 2011; Silvestre, 2013; Tsoi, 2010; Gopalakrishnan *et al.*, 2012; Isaksson and Steimle, 2009).

Those articles that refer to responsibilities of corporations in relationship with wider/macro – or what Liu *et al.* (2011) call “corporate citizenship” – mostly highlight: social investment, supporting public services, community development and philanthropy (Vachon and Mao, 2008; van Heerdenn and Bosson, 2009; Majumdar and Nishant, 2008; Hutchins and Sutherland, 2008). However, the responsibilities of wider society placed on corporations or co-development of corporations (micro society) with wider society (macro society) have not been adequately elaborated in the reviewed literature.

- *Collaboration*

Collaboration is an inseparable part of sustainable supply chains which facilitates the existence of inter-processes and relationships. Collaboration can: leverage the information, interests, skills, experiences, innovations, and technologies of other stakeholders to the firm; facilitate compliance with codes of conduct (Worley *et al.*, 2010); facilitate joint action (Perez-Aleman and Sandilands, 2008); facilitate access to scarce resources (Hollos *et al.*, 2010); leverage emerging valuable and rare inter-firm resources and capabilities (Gold *et al.*, 2010); facilitate corporate strategy alignment (Leppelt *et al.*, 2011); minimize risks and conflicts (Jacob, 2012); build trust in the chain (Spence and Rinaldi, 2012; de Carvalho and Barbieri, 2012); maintain a firm's competitive advantage (Maltz and Schein, 2012; Dao *et al.*, 2011); leverage stakeholders engagement, satisfaction, and feedback (Matos and Hall, 2007; Ciliberti *et al.*, 2008; Erol *et al.*, 2009); add democratic value to the regulatory arrangement (Hartlieb and Jones, 2009); build credibility and legitimacy (Boons, 2012; van Heerdenn and Bosson, 2009); provide social support (Majumdar and Nishant, 2008) during the adoption of sustainability practices (Perez-Aleman and Sandilands, 2008); and strengthen relational embeddedness in the network (Bernardes, 2010).

Management-centric

Some of the reviewed articles reflect upon aspects that have managerial and/or governmental themes. These can be classified into three categories: *modeling, assessment and measurement; compliance with standards and guidelines; as well as self-regulatory mechanisms.*

• *Modeling, assessment and measurement*

Although this sub-theme uses different terms, they are generally used for a common purpose: the evaluation of sustainability or social sustainability in supply chains.

Modeling and assessment is dominated by the Social Life Cycle Assessment (S-LCA) (Halog and Manik, 2011; Hutchins and Sutherland, 2008; Boons, 2012; Benoit-Norris *et al.*; 2012). The measurement-related articles are dominant by multi-criteria performance measures (Uysal, 2012; Godfrey and Manikas, 2012) especially the fuzzy ones (Govindan *et al.*, 2012; Erol *et al.*, 2011; Pishvaei *et al.*, 2012). Sustainability indices (like FTSE4Good and DJSI [Leppelt *et al.*, 2011]) and indicators also have been the subject of some studies, as they may be beneficial for describing and monitoring the situation being managed, evaluating the outcomes of actions taken, converting complex information into easily understandable units (Erol *et al.*, 2009), and facilitating benchmarking (Luken and Stares, 2005; Yakovleva *et al.*, 2012). Indices and indicators have mostly been based on the analytic hierarchy process (AHP) in the reviewed articles (Yakovleva *et al.*, 2012; Godfrey and Manikas, 2012; Zhou *et al.*, 2000; Yakovleva *et al.*, 2012; Brent *et al.*, 2005; Sarkis *et al.*, 2012). The results of this section are well matched with Seuring's (2013) findings that summarize the status of existing research on mathematical modeling of sustainable supply chains in four categories: life-cycle assessment based models, equilibrium models, multi-criteria decision making (MCDM) and analytical hierarchy process (AHP).

• *Compliance with standards and guidelines*

Some articles reflect upon standards with which supply chain stakeholders reactively or proactively comply. The most highlighted standard is *Social Accountability 8000* (SA 8000) (Worley *et al.*, 2010; Welford *et al.*, 2003; Seuring and Müller, 2008; Kalleitner-Huber *et al.*, 2012; Koplin *et al.*, 2007; Lozano and Huisinsh, 2011; Ciliberti *et al.*, 2008) followed by *AccountAbility (AA1000) Stakeholder Engagement Standard (AA1000SES)* (Frame, 2005; Ciliberti *et al.*, 2008) and *OHSAS 18001* (Hasle and Jensen, 2012). Business and organizations may also follow guidance/guidelines such as: *ISO 26000* (Mares, 2010; Su and Miller, 2011; Lozano and Huisinsh, 2011); *OECD Guidelines for Multinational Enterprises*

(Beske *et al.*, 2008); *Global Sullivan Principles* (Beske *et al.*, 2008); and conventions and declarations like those of the international labor organization (ILO) (Worley *et al.*, 2010).

- *Self-regulatory mechanisms*

The most highlighted example of self-regulatory mechanism is *setting guidelines and codes of conduct* which are also referred to as codes of ethics, codes of practice, corporate credos, mission statements, and values statements (Schwartz, 2001). This is followed by *publishing reports* (Hutchins and Sutherland, 2008; Erol *et al.*, 2011; Otañez and Glantz, 2011) especially according to *Global Reporting Initiative* (GRI) framework (Lozano and Huisingh, 2011; Björklund, 2010; Ciliberti *et al.*, 2008; Mares, 2010; Isaksson and Steimle, 2009). Other examples are: *voluntary self-assessments* (Otañez and Glantz, 2011); *setting key performance indicators (KPIs)* (Gopalakrishnan *et al.*, 2012); and *taking initiatives* (like following the UN Global Compact, UN Millennium Development Goals, Business Social Compliance Initiative (BSCI), Global Social Compliance Program (GSCP), International Social and Environmental Accreditation and Labeling (ISEAL) Alliance, and Ethical Trading Initiative (ETI).

There are also examples of sector-specific and industry-driven standards, guidelines, and initiatives in the reviewed articles such as: GlobalG.A.P. (Müller *et al.*, 2009); Fair Trade certified label (Starobin and Weinthal, 2010); Apparel Industry Partnership (AIP); Worldwide Responsible Apparel Production (WRAP) program (Tsoi, 2010; Bartley, 2010); Clean Clothes Campaign (Mares, 2010); and Outdoor Industry Association (OIA) Fair Labor Toolkit (Dargusch and Ward, 2010).

4.2. Identified challenges in making supply chains socially sustainable

Eight categories of challenges were identified after the focused coding namely, *inadequate and asymmetric knowledge, shifting the values, operationalization, subjectivity in evaluation, difficulties of SMEs, governance complexity, sustainability leakage, and sustainability washing.*

Inadequate and asymmetric knowledge

As highlighted in several articles, businesses still have inadequate knowledge (Hutchins and Sutherland, 2008; Beske *et al.*, 2008) or asymmetric knowledge (Boons, 2012) about social sustainability and rarely address or communicate their social responsibilities beyond relationships with suppliers or customers (Vachon and Mao, 2008); or in their entire supply chains (Wognum *et al.*, 2011). Nor have social issues been as well discussed as environmental issues in supply chain management and purchasing literature (Seuring and Müller, 2008).

Shifting the values

To shift the values in the chain where the non-economic pillars of sustainable development are equally weighted with the economic pillar is fairly challenging. Short-term profit maximization (Leppelt *et al.*, 2011) based on the underlying logic of transaction cost economics in supply chain management (Boons, 2012) discourages the inclusion of social parameters and human factors (Hasle and Jensen, 2012; Tsoi, 2010). Kalleitner-Huber *et al.* (2012, p. 1059) state that “*Price, functionality, and branding generally lead to purchase decisions, whereas sustainability aspects like material use, working conditions in production, or disposal usually do not.*” As observed by Govindan *et al.* (2012), Su and Miller (2011), and Ageron *et al.* (2012) it is still common in the logistics sector to evaluate the suppliers based on financial criteria like price, quality, reliability, service-rate, delivery, and flexibility ahead of social criteria (Govindan *et al.*, 2012; Su and Miller, 2011).

A profit maximization mindset – even if it leads to social and environmental degradation – is more common in private industries (Hisjam *et al.*, 2012), especially in times of economic crisis (Su and Miller, 2011). Non-economic aspects are mostly considered when customers (Hisjam *et al.*, 2012; Hartlieb and Jones, 2009; Tsoi, 2010; Ageron *et al.*, 2012; Beske *et al.*, 2008) or legislators (Beske *et al.*, 2008) demand or accept (Seuring and Müller, 2008). Profit maximization can also be the result of how CSR is interpreted. Those who interpret CSR as just a voluntary action consider profit making as the only responsibility of businesses (Becker *et al.*, 2010; Mares, 2010).

Operationalization

One of the principal challenges of sustainability is to operationalize the Brundtland Commission definition by expressing it in concrete operational term and using its mandate to guide decisions. As Vachon and Mao (2008) criticize, there is a lack of clarity regarding definition and applicability of sustainable development as there is a wide range of issues that come under its umbrella. As Gimenez *et al.* (2012, p. 150) highlight, this macroeconomic definition “*provides little guidance regarding how they (organizations) should identify present versus future needs, determine the technologies and resources to meet those needs, and understand how to effectively balance organizational responsibilities between multiple stakeholders.*” Other emerged factors that hinder operationalization of sustainability are: changing employees and customers’ attitude (Paramanathan *et al.*, 2004); and lack of strategic thinking and visioning (Ageron *et al.*, 2012; Adetunji *et al.*, 2003) or persistence (Hasle and Jensen, 2012) or commitment (Gopalakrishnan *et al.*, 2012) from management.

Subjectivity in evaluation

Some articles focus attention on subjectivity in evaluation due to multiplicity of interests and differences in: expectations, cultures, social practices, local conditions, contextual settings in which the decisions are made; legal requirements; and asymmetric interpretation of sustainability which all may change at different stages of social and economic development. Jacob (2012), Dargusch and Ward (2010), and Mares (2010) also highlight critique of unclear and loose definitions of CSR where meaning, scope, and degree of responsibility is subjectively defined by companies. Tsoi (2010) exemplifies different definitions of ethics in China compared to the western world.

Due to this subjectivity, the measurement/assessment of sustainability lacks a meaningful, adequate, or unified indicator (Godfrey and Manikas, 2012; Sarkis *et al.*, 2010); a standardized method (and Rinaldi, 2012); a unified label (Laine and Laine, 2009; Starobin and Weinthal, 2010); and change over time (Erol *et al.*, 2011; Boons and Mendoza, 2010; Hasle and Jensen, 2012; Awaysheh and Klassen, 2010).

Subjectivity can also be due to difficulties in defining the boundaries and scales of description of tiers and stakeholders of supply chains. Worley *et al.* (2010) refer to a common example where a firm is used by different brands or organized by different labor unions. This can add complexity as the firm might be subject to different codes of conduct and multiple annual audits. Matos and Hall (2007) highlight this challenge as ambiguity in the chain which refers to: absence of agreement on boundaries, inability to identify key stakeholders and potential social outcomes, and difficulties to identify not only interdependences among parameters but also the key parameters of sustainable development.

Difficulties of SMEs

Another challenge is to move SMEs towards social sustainability especially when it comes to homeworkers (Freeman, 2003) and those who operate at the bottom of the pyramid (Perez-Aleman and Sandilands, 2008) and in developing countries (Govindan *et al.*, 2012; Hartlieb and Jones, 2009; Luken and Stares, 2005; Tencati *et al.*, 2008). SMEs may lack knowledge

(Boons and Mendoza, 2010), skills (Ageron *et al.*, 2012), time, financial and human resources (Smith, 2008; Sarkis *et al.*, 2010; Gopalakrishnan *et al.*, 2012; Tencati *et al.*, 2008). In addition, the Jorgensen and Knudsen's (2006) study on Danish SMEs highlights that they are less likely than larger companies to apply social and environmental requirements to their suppliers. SMEs may also confront financial and social difficulties for improving the social welfare of their migrant workers (Cross *et al.*, 2009; Anderson, 2008). SMEs are also likely to lack the bargaining power required to sanction suppliers who fail to comply with standards (Jorgensen and Knudsen, 2006). SMEs may be unable to confront challenges in the development and implementation of CSR practices due to lack of CSR information and a corresponding system, relatively weak managerial and leadership skills, insufficient financial resources, and lack of enforcement of relevant laws and regulations (Chi, 2011; Perez-Aleman and Sandilands, 2008; Su and Miller, 2011).

Governance complexity

The increase in outsourcing, market expansion, and internationalization can increase the number of stakeholders of a firm as well as its supply chain fragmentation. This can harden: transparency (Benoit-Norris *et al.*, 2012); audit (Awaysheh and Klassen, 2010) and control of suppliers (Koplin *et al.*, 2007) and processes in the chain (Hutchins and Sutherland, 2008; De Chiara and Spina, 2011; Hasle and Jensen, 2012; Vurro *et al.*, 2009; Majumdar and Nishant, 2008); and support for acceptance (Boons, 2012) and adaptation of a wide range of corporate codes of conduct, standards, certificates, and labels (Perez-Aleman and Sandilands, 2008) especially in a multinational environment (Hartlieb and Jones, 2009; Koplin *et al.*, 2007) where consensus among stakeholders or a social dialogue may be lacking (van Heerde and Bosson, 2009).

As Kogg and Mont state (2012, p. 162): *“The element of control is highly complex and it can be extremely challenging to ensure that all hundreds of suppliers, potential sub-contractors and suppliers in the 2nd and 3rd tier of the supply chain follow the focal organization’s Code of Conduct or sustainability policy”*. Complexity may further increase while moving downstream in the supply chains. Among the very few articles that elaborate on downstream actors, Elg and Hultman (2011) highlight complexity and challenges of CSR for retailers, as they appear to have the responsibility for a broad range of products and issues.

As highlighted in some articles, there is still considerable heterogeneity regarding sustainability practices between and within industries (Boons, 2012; Elg and Hultman, 2011; Vurro *et al.*, 2009; Hall *et al.*, 2012; Carbone *et al.*, 2012) based on their customer segment and marketplace (Awaysheh and Klassen, 2010), countries (Carbone *et al.*, 2012), and size (Elg and Hultman, 2011).

Starobin and Weinthal (2010, p. 29) challenge the credibility of third-party certifiers – which resides in their transparency rather than their independence – by stating: *“without transparency, both civil society and individual consumers lack the information requisite to evaluate the expertise and trustworthiness of certifying parties and their associated labels.”* As Hartlieb and Jones (2009) and Kogg and Mont (2012) observe, self-regulatory initiatives, standards, and codes of conduct may lack accountability to external actors if carried out by the companies themselves or other self-appointed organizations. Vurro *et al.* (2009) provide the example of 250 global companies that have a supply chain code of conduct and standards, but only half of them disclosed details of the processes and mechanisms by which they activate and monitor them.

Sustainability leakage

Sustainability leakage may occur in the supply chain when a stakeholder evades its responsibilities by transferring to/sourcing from places or stakeholders with looser regulations

and standards (Hasle and Jensen, 2012; Carbone *et al.*, 2012; Tencati *et al.*, 2008) in order to externalize the social and environmental degradation costs (Welford *et al.*, 2003; Chi, 2011; Tsoi, 2010)

Sustainability washing

Sustainability washing relates to a lack of consensus or misalignment between behavior or practice (Isaksson and Steimle, 2009) of businesses and their sustainability visions and goals. Leppelt *et al.* (2011) and Halldórsson *et al.* (2009) call this challenge the “inability to walk the talk”.

5. CONCLUDING DISCUSSION

Figure 1 revealed an increase in the number of scientific peer-reviewed articles in this field in recent years. However, Table 1 showed the fragmented, multi- and inter-disciplinary nature of research in this field, which can be traced to 70 different journals. In addition, it was surprising that just two logistics and supply chain related journals were on the list. It became apparent that this research field requires more conceptual papers as well as systematic literature reviews and content analysis. There is also a need for more longitudinal and comparative studies (Bryman and Bell, 2007) since case studies, experimental, and cross-sectional ones dominated in the articles reviewed.

Goods, services, and employee safety, security, and health were among the most discussed criteria followed by discussions of CSR, stakeholders, and responsibilities. However, the themes identified revealed mostly upstream treatment of responsibilities in supply chains compared to downstream. There is a lack of research on the responsibilities of downstream actors such as customers and end consumers as well as after-sale and consumption responsibilities. There is also a need to study how social sustainability emerges in supply chains and how responsibilities and values are shared among stakeholders and change over time. The identified themes mainly referred to responsibilities of micro-economy and society on macro-economy and society. There is a need for research about co-adaptation and co-evolution of micro and macro. In the literature review, the following potential criteria were considered for further research: sustainable supply chain governance, sector and regional-specific governing mechanisms, rights and ethics in logistics and supply chains, and sustainable business models.

Suggestions for tackling the challenges

In order to decrease inadequate and asymmetric knowledge, social themes have to be well understood and all the stakeholders should be persuaded. Researchers and media have a great responsibility for reducing the existing gap. A pattern of sustainability emerges if the values and norms are understood, pursued, and integrated into behavior, strategies, and operations of all stakeholders as well as their organizations and interrelationships. Without operationalizing the strategies and sharing the responsibilities, sustainability will be washed. In order to walk the talk of sustainability, “taken for granted mindsets” (Worley *et al.*, 2010) need to be changed and inertia against the operationalization of innovative processes need to be minimized.

To shift the sustainability values and norms, new business models need to be developed that evaluate non-economic values on equal terms with economic ones. Both top-down (e.g., tougher regulations) and bottom-up (e.g., consumer initiatives) mechanisms can facilitate the development of such models. In addition, free markets of open and dynamic supply chains should also become fair, with harmonized global sustainability values, norms, and codes of ethics. Such a harmonization can minimize leakage as well as ambiguity in the chain by making the stakeholders behave reactively by following the minimum criteria. In addition,

harmonization can simplify benchmarking and labeling of goods and services, which can ultimately make the choice easier for customers and end consumers. Those who behave proactively by creating and following further criteria can have a competitive advantage. However, what should reactively be considered and what should be proactively done is an opportunity for further research.

There is also a need for independent agencies to periodically scan and modify the sustainability licenses and labels. In addition, SMEs should receive extra support from authorities in order to have sufficient resources to comply with minimum standards and obtain licenses and labels.

There is a great need for more holistic models that can grasp the multi- and inter-characteristics of sustainable supply chains. There is also a great need for evolutionary models that can grasp the changes, nonlinearities, and paradoxes that exist in sustainable supply chains over time. Without such models, decision and policymaking will become simplistic, reductionist, linear, deterministic, value-free, objective, and positivistic.

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Themes and Challenges in Making Freight Transportation Environmentally Sustainable – A logistics service provider perspective

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THEMES AND CHALLENGES IN MAKING FREIGHT TRANSPORTATION ENVIRONMENTALLY SUSTAINABLE

- A logistics service provider perspective

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ABSTRACT

The purpose of this paper is to explore themes and challenges in making freight transport environmentally sustainable from a logistics service provider perspective.

The approach is explorative and the main method for data collection is interviews. The study has a cross sectional design which takes advantage of ten semi-structured interviews from selected logistics service providers (LSPs) operating in the Scandinavian countries.

The findings illustrate the major themes by analyzing current and future activities in making freight transportation environmentally sustainable. In addition, four categories of challenges are identified: customer priorities, managerial complexity, network imbalance, and technological and legislative uncertainties. It is concluded that there is a great need for a holistic perspective where LSPs and product owners together analyze and design future freight transport setups.

The suggested holistic and integrative model, building on a three-dimensional concurrent engineering framework, provides new opportunities for research. Further research is needed to improve the interrelationship between LSPs and their customers in the development of sustainable logistics solutions. The inductive and explorative research design investigating LSPs operating in the Scandinavian countries limits the results to some degree.

The results provide a systematic structure for classifying issues related to sustainable freight transportation. This will be beneficial for managers and policy makers when they approach sustainable logistics challenges. The emergence and synthesis of themes and challenges are critical for a sustainable society. This paper puts forward recommendations for the sustainable development of freight transportation and logistics by combining the results from interviews with a review of related literature.

Keywords: logistics, freight transportation, logistics service provider (LSP), third-party logistics, sustainability, environment

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1. INTRODUCTION

Transportation has become an inseparable part of global societies and has both positive and negative effects. On the positive side, transportation generates accessibility as well as mobility, and is essential in the dynamic social life of people today. Transportation is also an enabler of social and economic development. Because of it, infrastructures are constructed, jobs are created, and new vehicles are manufactured. Transportation is one of the enablers of world trade, globalization, and industrialization, and contributes to economic growth. According to the European Union (2011), the transportation industry directly employs around 10 million people and accounts for about 5% of GDP in the EU.

Transportation activities are some of the main sources of emissions of greenhouse gases (GHG); mostly CO₂. According to the Intergovernmental Panel on Climate Change (IPCC, 2007), the transportation sector in 2004 produced 6.3Gt CO₂ emissions and was responsible for 23% of the world energy-related GHG emissions with about three-quarters coming from road vehicles. Over the past decade, transportation GHG emissions have increased at a faster rate than in any other energy-using sector (IPCC, 2007). According to Brown's predictions (2005), the transportation sector's GHG emissions will also be the fastest-growing in the future. Transportation activities are expected to grow robustly over the next decades. As a result of this growth, in a business-as-usual scenario, it is predicted that there will be an annual increase of world transportation energy use of 2% and 80% higher total transportation energy use and carbon emissions in 2030 compared to 2004 levels (IPCC, 2007). Freight transportation has been growing even more rapidly than passenger transportation and is expected to continue to do so in the future. In the EU, for example, the demand for freight transportation is expected to grow on average by 2.7% per year. Globally, freight transportation is expected to grow from approximately 15 trillion tonne-kilometers in 2000 to around 45 trillion tonne-kilometers in 2050 (World Business Council for Sustainable Development, 2004).

Sustainable development of transportation calls for activities that lead to the highest economic and social gains while reducing the negative environmental losses. However, in the long term these activities are complex and tied to tremendous challenges, dilemmas, difficulties, and barriers. The European Union (2011) highlights some of the current and future trends, such as migration and internal mobility, aging, urbanization, and globalization, all of which may challenge social and economic developments. The increasing scarcity of fossil fuels and global warming are examples of environmental challenges. McCauley (2008) sheds light on challenges in governing sustainable development. Abbasi and Nilsson (2012) elaborate on environmental challenges from a supply chain perspective and classify these into costs, complexity, operationalization, mindset and cultural changes, and uncertainties. Rodrigue *et al.* (2001) shed light on paradoxes of green logistics due to costs, time/speed, reliability, warehousing, and e-commerce.

The purpose of this paper is to explore themes and challenges in making freight transportation environmentally sustainable from the logistics service providers' (LSPs) perspective. The two main reasons for choosing an LSP perspective are: 1) their dominant role in handling freight due to the increased outsourcing of logistical services to LSPs (Wolf and Seuring, 2010) and, 2) the limited research available with an LSP perspective on sustainable development (Lieb and Lieb, 2010). As LSP transportation activities are the single largest source of environmental hazards and CO₂ emissions in the logistics industry (Wolf and Seuring, 2010), the focus of this paper is on transportation services offered by selected LSPs.

The next section provides the frame of reference, and reviews previous research on connecting logistics and freight transportation to sustainable development and to LSPs. This is followed by a description of the methodology used. The research is based on semi-structured interviews from selected LSPs operating in the Scandinavian countries. In the results section, emergent themes of environmentally sustainable freight transportation are presented, along with the challenges identified and discussed. The paper ends with the discussion and conclusions sections, of which the latter presents opportunities for future research.

2. SUSTAINABLE DEVELOPMENT AND FREIGHT TRANSPORTATION

Popularized after the Brundtland Report, *Our Common Future* (World Commission on Environment and Development, 1987), and followed by the United Nations 2005 World Summit, sustainable development (SD) encompasses the interdependent and mutually reinforcing pillars of economic development (Profit), social development (People) and environmental protection (Planet). The three 'P's of SD are sometimes called the 'three bottom lines (TBL or 3BL)' (Elkington, 1997).

SD and freight transportation have been discussed in relevant literature in several ways. Some studies have presented modified definitions and aspects of SD in the context of transportation (Black, 1996; Richardson, 2005). Others have reflected on specific concepts such as sustainable mobility (Gudmundsson, 1996; Banister *et al.*, 2000; World Business Council for Sustainable Development, 2004), environmental sustainability (McKinnon *et al.*, 2010), transportation and climate change (Chapman, 2007), energy efficiency, and emissions (McKinnon, 1993; Nygrén *et al.*, 2012). Welford (2000) presented different levels of greening when it comes to SD, ranging from superficial change to fundamental change, and argues that most organizations are on the lower levels of the spectrum.

The literature of the logistics and supply chain disciplines also demonstrates the increasing appearance of SD. Carter and Rogers (2008) elaborate on its three pillars together with four supporting facets: risk management, transparency, strategy, and culture. Much of the remaining literature focuses on some of the pillars, such as corporate social responsibility (Keating *et al.*, 2008; Dyllick and Hockerts, 2002); environmental logistics (Wu and Dunn, 1995); and green logistics (McKinnon *et al.*, 2010; Abukhader and Jönson, 2004; Aronsson and Hüge Brodin, 2006). Phrases such as environmentally sustainable / friendly / sound / preferable / responsible, eco, and green are widely used synonymously (Abbasi and Nilsson, 2011; Björklund, 2005).

Although outsourcing of logistical activities to LSPs and their role in the creation of trust and value in supply chains are considered to be imperative (Selviaridis and Spring, 2007; Marasco, 2008), little attention has been given to sustainability goals and aspects (Lieb and Lieb, 2010; Wolf and Seuring, 2010). Huemer (2012) puts forward the limitation of most SCM research and practice in focusing on the manufacturer or the retailer perspective. He suggests further investigation of the LSP perspective as an alternative to the dominant product and/or value chain perspective, especially in the cooperation among manufacturers and/or retailers in making logistics more environmentally friendly. The prevailing manufacturer and/or retailer perspective (the demand side) is evident when it comes to research on logistical services in general (procurement or outsourcing of logistical services) (Selviaridis and Spring, 2007), but also when it comes to sustainability issues (Philipp and Militaev, 2010).

Wolf and Seuring’s article (2010) was the only one found that includes both buyers and LSPs in the same study.

In two recent literature reviews on third-party logistics (Selviaridis and Spring, 2007; Marasco, 2008) a number of themes and challenges are raised. However, as also noted by Wolf and Seuring (2010), the discussion of sustainability and environmental issues are neither highlighted as central themes nor as areas for further research. The low level of interest is confirmed when examining the empirical literature on environmentally related activities of LSPs. For example, Maas *et al.* (2012) conclude in their study on third-party logistics actors that environmental differentiation is only a minor part in differentiating their practices. Lieb and Lieb (2010) report that 13% of LSPs receive substantial attention and 50% moderate attention from their customers on environmental initiatives. Lin and Ho (2008) argue that despite the great environmental impact of logistical activities, the logistics industry is still in its infancy when it comes to environmental issues. They go on to investigate the intentions of LSPs to adopt green innovation in Taiwan and find a number of significant factors needed in these organizations: explicitness and accumulation of green technology, organizational encouragement, quality of human resources, environmental uncertainty, and governmental support.

Journals reviewed	Number of LSP articles found	Number of LSP environmentally/sustainability relevant articles found
Supply Chain Management: An International Journal	5	0
Journal of Supply Chain Management	8	0
International Journal of Physical Distribution and Logistics Management	53	3 (Lieb and Lieb 2010; Wolf and Seuring 2010; Perotti <i>et al.</i> , 2012)
Journal of Business Logistics	16	0
International Journal of Logistics Management	12	0
International Journal of Logistics Research and Applications	13	1 (Philipp and Militaru, 2011)
Journal of Operations Management	1	0
International Journal of Operations & Production Management	7	1 (Jeffers, 2010)

Table 1 - Number of LSP and LSP environmentally/sustainability relevant articles published in top-ranking supply chain and logistics journals.

In order to gain insights into the role and perspectives of LSPs in relevant domains of logistics research, a manual systematic review of title, keywords and abstract was carried out in this study of all articles published in top-ranking supply chain, logistics, and operations management journals³ up to the end of 2012 (Table 1). It resulted in 115 articles that focused

³ The journals were selected based on Journal Citation Reports available on the ISI Web of Knowledge.

on LSPs and LSP activities. Of these, only 5 dealt with the environmental aspects of sustainability and none dealt with all three pillars. This is evidence of the lack of research dealing with environmental issues, in particular, the integration of all three pillars of sustainable development, in the context of logistics service providers.

The results of Wolf and Seuring (2010), and Philipp and Militaru (2011) elaborate on the buying behavior of shippers when purchasing environmentally friendly services offered by LSPs. Perotti *et al.* (2012) reflect on green supply chain practices adopted by third-party logistics (3PLs) in Italy and explore how they can affect company performance. Jeffers (2010) addresses sustainability from an economic perspective, especially related to IT investments by LSPs. Lieb and Lieb's survey (2010) is similar to ours as it also addresses the identification of environmental sustainability initiatives and challenges undertaken by 3PLs. However, our study digs into the challenges in more detail. In addition, the sample in our study was selected from major LSPs operating in the Scandinavian countries and the results are based on semi-structured interviews. The Scandinavian countries have solid and well-connected logistical infrastructures, strategic collaboration, and strict considerations and regulations when it comes to environmental issues.

3. METHODOLOGY

Researching sustainable development in the context of supply chain management and logistics is not easy due to the many aspects and trade-offs that need to be considered. This is also the case in practice. Cruz *et al.* (2006, p. 872) state that sustainable development is "perhaps one of the most complex and important demands that has occupied managers' reflection." Hall and Vredenburg (2003) report that managers have great difficulties in dealing with sustainable development. Consequently, in researching themes and challenges confronted by LSPs to make goods flow in an environmentally sustainable manner, an explorative and mainly qualitative method was found most appropriate. Due to the absence of literature dealing with environmental and sustainability issues from an LSP perspective (Table 1), and the need for research in this field argued by several researchers, an inductive research approach was chosen in order to gain in-depth understanding of themes and challenges. Inspired by grounded theory (Glasser and Strauss, 1967; Charmaz, 2006) and the way the methodology has been used in logistics research (Nilsson, 2006; Flint and Golicic, 2009), the research was designed as a combination of interviews, secondary data from websites and reports, and a literature review. The interviews were the main source of empirical data.

3.1 Interview study

The interview study was designed based on the seven stages of a qualitative interview investigation suggested by Kvale and Brinkman (2009): thematizing, designing, interviewing, transcribing, analyzing, verifying, and reporting. Inspired by the case study procedure suggested by Yin (2003), three documents were created: an interview study protocol, an interview study database, and an interview study report. This was done to ensure high-quality research. The protocol had two major purposes: 1) to document all relevant information to make the process of the interview study as effective and efficient as possible (overall purpose, names, addresses, maps, interview questions, etc.), and 2) to function as a logbook where impressions and experiences from each interview and company visit were documented. The purpose of the database was to collect the bulk of material investigated. The raw data (company reports, website documentation, sound files, interview transcriptions, presentations, photos, etc.) were assembled and stored there in the research process. It was beneficial to be

able to go back to the source when doing the analysis. The final document used in the research was the interview study report encompassing all the material in an interpreted and analyzed form. Here, the results from the coding processes and the connections to previous research were documented.

3.1.1 Thematising and designing

Based on our earlier research and experience of sustainable development in the context of logistics together with a number of discussions and seminars with logistics managers, several challenges were identified in making freight transportation sustainable. The main actors in freight transportation in supply chains are the LSPs. Hence, in an explorative manner it became natural to obtain an LSP perspective on the challenges of sustainable freight transportation. The research focused on LSPs active in the Scandinavian countries to ensure a comprehensive yet feasible sample. We drafted a list of 30 LSP companies based on our experience, contacts during research projects, and after asking other experts. The list included small, medium-sized, and large⁴ LSPs. Each potential interviewee was then contacted by e-mails that included the purpose of the study, a description of the research area (sustainable freight transportation), and an invitation to be interviewed. Telephone calls were then made to those who responded that they were willing to participate. They were told about purpose and the structure of the interviews. In total, we interviewed 14 managers from 10 LSP companies. As summarized in Table 2, the majority of the interviewees had long experience of working in the industry and had management positions in regional LSP offices for Scandinavian markets (if the LSP was part of an international organization) or in a management team (for those operating in one nation).

Interview number	Position of the interviewee(s)	Size of the company	Main transportation mode
1	Regional managing director	Medium	Rail
2	Regional managing director	Medium	Road
3	Regional manager	Large	All modes
4	Sustainability manager	Large	Sea
5	Environmental manager	Large	Air
6	Environmental and quality manager	Large	Land (rail and road)
7	Managing director	Small	Road
8	Environmental and quality manager	Medium	Land (rail and road)
9	Managing director, environmental manager, quality manager, and business developer	Small	Road
10	Environmental manager, and business developer	Small	Road

Table 2 - Information about interviewees

The interview data collection process ended when saturation was reached. After interview seven, we evaluated the process and found that no more significant or new information was being gained for the purpose of the study. To ensure research quality, however, three more interviews were conducted from which we then concluded that theoretical saturation had been reached. The sample size for this type of research is, according to McCracken *et al.* (1990), eight for homogeneous samples. Carter and Jennings (2002) suggest 12-20 for heterogeneous samples. In this case, the companies and interviewees operate in the same geographical regions, working on similar issues and customers. Consequently, compared to global studies or ones in different industries, the sample can be regarded as homogeneous.

⁴ According to the European Commission, small companies have between 10 and 50 employees, medium-sized companies between 50 and 250 employees, and large companies more than 250 employees.

3.1.2 Interviewing

The interviews were semistructured (Bryman and Bell, 2007, p. 474), based on open-ended questions. They lasted about 90 minutes and were primarily carried out in English. Interview guidelines (provided in the appendix) was created for the open-ended questions and were structured into three major areas: current activities for sustainable development, future activities and trends for sustainable development (up to 2050), and challenges of sustainable development. The discussions focused on these areas for LSPs specifically and for freight transportation in general. If essential, the sequence of the questions was changed or additional questions were asked. Prior to each interview, the website of each LSP was studied in depth and information was compiled about the company in general and about sustainability-related activities, statements, reports, etc. All relevant information was documented in the interview study database so it would be accessible at other stages of the study.

3.1.3 Transcribing

Every interview was taped and transcribed. If there were any misinterpretations, uncertainties or questions found in the transcriptions, the interviewee was contacted. Interviewees were asked to read and review the transcribed text and return it to the authors. Each sound file and its transcription were then entered into the interview study database.

3.1.4 Analyzing

The principle of grounded theory is that sampling, data collection, and analysis are interrelated and carried out in parallel (Glasser, 2002; Corbin and Struss, 1990) until theoretical saturation (Bryman and Bell, 2007, p. 459). The analysis of the interviews was conducted during the whole process and included the use of secondary material such as reports, websites, and documentation. The analysis was inspired by the principles of critical discourse analysis suggested by Winther and Phillips (2000). The analysis started by the transcribed interviews being copied into an Excel file. They were divided into segments (a sentence or group of sentences) that were individually interpreted to identify their relevance to current and future activities, and/or challenges. At this stage, we were interested in the content of what the interviewees said as well as how strongly they expressed their views. The latter were determined by weighing each segment on a Likert scale from 1 to 3, where 1 meant implicit (e.g., “we do not own any trucks and shall not either”), 2 explicit (e.g., “maybe we do not need to always send the container empty the whole way back”, and 3 strongly explicit (e.g., “our government has to do something to promote these new techniques”). Afterwards, a coding process was initiated where each segment of current and future activities, as well as challenges, was openly coded. This led to the emergence of different themes in each category. A second step, ‘focused coding’, was carried out (Charmaz, 2006; Winther and Phillips, 2000) and resulted in the emergence of the major themes and challenges reported in this paper.

3.1.5 Verifying

The results of the interview analyses were discussed by the authors on several occasions. With the help of secondary sources, syntheses of the analyzed interviews were conducted. After verification of the results by the authors, a first draft of this paper was sent to the interviewees. They were asked to comment on the overall quality and any missing points. The verified results were then used as input text for the final version of this paper.

3.1.6 Reporting

The interview study report was mainly used for our own research purposes. A final version of it was sent to all the interviewees and used for scientific communication with other researchers.

3.2 Research quality

Two criteria for evaluating the quality of our qualitative research were adapted: authenticity and trustworthiness (Bryman and Bell, 2007). To increase authenticity of the interview study, different measures were considered. In the thematizing and designing phases, a literature review and additional discussions with researchers were conducted to ensure that the perspective would be that of LSPs and that a sufficient number of them were interviewed. In the interviewing phase, an interview introduction and guidelines were sent to interviewees in advance. Both interviewers (the authors) and interviewees did their best to communicate enthusiastically and use their best conversation and language skills. To increase trustworthiness, websites, relevant reports, and documents of each LSP were read in advance of meetings by the interviewers. This was done to reduce the possible misunderstanding mismatch of understanding between interviewers and interviewees. In the transcription phase, sound files were saved in the database. In other phases, interviewees were sent the transcribed interview texts for verification as well as comments on the final version of the study. For the sake of research ethics, interview transcriptions have been kept as confidential.

4. RESULTS

Following the setup of the study, the results are presented in three sections: current activities, future activities, and challenges in making freight transportation environmentally sustainable. However, the first question we asked the interviewees was how they define sustainable development. The economic and environmental pillars of SD were mentioned by most of them. Two of them were not aware of the concept of pillars at all, while only one recognized the three bottom lines in the Brundtland Commission’s definition of SD. The focus on economics and the low awareness of the social dimension of SD are in line with the findings of Carter and Rogers (2008), and Seuring and Müller (2008).

4.1 Current activities in making freight transportation environmentally sustainable

Although all LSPs have plans and objectives for sustainable development, only a few of them have included such objectives in their mission or vision statements. Only one of the LSPs has designed its business model based on green and environmentally friendly offers. The analysis of current activities resulted in eight categories (summarized in Table 3). Three were strongly and explicitly emphasized by most of the interviewees (primary activities) while the other five were less emphasized (secondary activities). The primary activities are further elaborated below.

Categories of primary activities	Categories of secondary activities
Resources efficiency, effectiveness, and utilization	Taking initiatives (UN Global Compact, UN Development Program [UNDP], Logistics Emergency Teams [LET])
Environmentally and sustainability-cautious behavior	Compliance with legislations and standards (ISO 14001, EMAS certification, Sulfur emission and ballast water legislation by IMO)
Measurement and assessment	Efficient utilization of transport infrastructure (Single European sky, Coordinated air traffic control)
	Well-connected information and goods flows (by implementing “intelligent transportation” or “track-and-trace” systems)
	Vertical and horizontal collaboration (collaboration and lobbying with other LSPs , authorities, and stakeholders)

Table 3 - Categories of current activities in making freight transportation environmentally sustainable from the LSP perspective

Resource efficiency, effectiveness, and utilization

The most common activities to increase effectiveness and efficiency of freight transportation resources were related to the mode of transportation used and vehicle energy usage. The right combination of available modes to meet the transportation demand with the right cost at the right time with the lowest negative environmental effects was something all LSPs put forward. Their current activities and their aims were to take advantage of several modes of transportation in their operations and to continuously improve the efficiency of each mode. Nonetheless, due to the dominant drivers of cost and time on their services, road-based solutions were the most common. For any mode chosen, lowering vehicle energy use was prioritized (e.g., electric trains and EU 5.0 trucks⁵).

Another current activity mentioned by LSPs is to increase the utilization of movable and static resources. Higher resource utilization was suggested to increase load factor, fill rate, efficiency, as well as economic benefits. On the other hand, as some of the interviewees explained, it may decrease fuel/energy consumption and GHGs emissions per tonne-km, and/or volume-km. As explained by one LSP representative with competence in sea transportation, “The fill rate is a very important factor for making the bunker consumption per transported unit lower but also to improve the carriers’ income. In order to increase the fill rate, we do triangulation and try to decrease imbalances in goods flows. However, we can still increase the fill rate inside each unit load, like a container, if we collaborate directly with our customers while they fill the unit loads/containers.”

Finally, several LSPs have started to be energy- and eco-efficient by acting more responsibly with, and in, their static resources, such as terminals, hubs, distribution centers, warehouses, and offices.

Environmentally and sustainability cautious behavior

The behavior of different stakeholders was emphasized by most of the interviewees as an important area affecting sustainable development. Eight of the LSPs had started programs to make the behavior of stakeholders more environmentally/sustainably cautious. Some examples are:

- Educating all staff about ethical and environmental operations, like the ‘GoGreen’ and ‘GoTeach’ programs started by DHL.
- Training all fleet staff for ‘eco-driving’ in road and rail transportation, ‘eco-sailing’ in sea transportation, and ‘green take off and approach’ in air transportation.
- Responsible sourcing/procurement in order to scan all suppliers to ensure that they fulfill social and environmental requirements. One of the interviewees stated, “What we do is that we make a risk assessment on each supplier and if we find that there is a risk connected to that supplier, we work more with the supplier until we have either decided that there is not any risk or irresponsible behavior.”

Measurement and assessment

Measurement and assessment are inseparable LSP activities for sustainable development. As one of the interviewees stated, “We have developed an internal standard as well as scorecards regarding how to collect and measure different kinds of parameters connected to sustainability.” Some LSPs have taken advantage of independently verifying authorities for the execution of such activities.

⁵ The latest emissions standards for the vehicles operating in the EU.

One of the interviewees emphasized, “We would like that all measures and figures are checked by independent parties. [...] We are also asking our clients to ask for similar independent verification for our competitors’ figures... so, the figures are really accurate and possible to use in real benchmarking ... because we believe that we have figures that you can trust and can be used for your procurement process and that will also drive performance.” All LSPs collaborate actively with other stakeholders to increase the validity and reliability of their emissions calculations. Four out of ten LSPs interviewed offer online platforms for the calculation of GHG emissions from transportation operations. Eight out of ten publish annual sustainability reports that are openly available to customers, clients, and other stakeholders.

4.2. Future activities in making freight transportation environmentally sustainable

All the interviewees agreed upon the tremendous difficulty and uncertainty in designing future sustainability-related activities and strategies for freight transportation in a long-term perspective such as 40 years from now. Most of them took a shorter perspective (two up to 2020, 3-5 years for others) to elaborate future activities and strategies.

The analysis of future activities resulted in seven categories (summarized in Table 4). Three were strongly and explicitly emphasized by most of the interviewees (primary activities) while the other four were less emphasized (secondary activities). The primary activities are explained below. It is worth mentioning that the LSPs interviewed are planning to continue their current activities in making freight transportation environmentally sustainable as mentioned in section 4.1.

Categories of primary activities	Categories of secondary activities
Innovation and research	Technological development (development or adaptation of Transport Management Systems [TMS], Intelligent Transport Systems [ITS], Enterprise Resource Planning [ERP], future generation of vehicles)
Energy and fuel efficiency	Design for sustainability (better design of supply chain nodes like number and arrangement of terminals, hubs, distribution centers, etc.)
Increasing awareness	Adaptation to future policies and corporate governance (collaboration with authorities and policy makers regarding future policies and directives)
	Taking supply/value chain view (collaboration with product producers/manufacturers and consumers as well as passenger carriers)

Table 4 - Categories of future activities in making freight transportation environmentally sustainable from LSPs’ perspective

Innovation and research

The need and for innovations for sustainable development was stated by all the interviewees in different ways. For example, one of the LSPs with core competence in sea transportation elaborated on the role of innovation and research on energy consumption of vessels by stating, “Long-term investments in research, technical developments, and innovation are behind our strategies towards reduction of [total] energy consumption [...] we would like to be pioneers, prime movers, in reduction of emissions.” The need to further increase collaboration with researchers and advisory councils in research and development is something that several of them put forward.

Energy and fuel efficiency

Energy is an inseparable part of transportation. The interviewees reflected on one or more of the following issues for future activities related to energy- and fuel efficiency:

- To energize and utilize resources like vehicles and facilities fed by non-fossil/renewable fuels.
- Collaboration with vehicle manufacturers (e.g., Volvo, Scania) to design more environmentally friendly trucks, trains, vessels, as well as aircrafts that are lighter and more aerodynamic, have more efficient engines, and emit zero GHG emissions.
- To move towards zero emission from energy production and consumption. In this regard, LSPs will collaborate with base industries, like energy producers, to find alternative fuels that are produced without using raw material from food sources or endangering forests or biodiversity. As one of the interviewees stated, “It is very important that renewable energies be globally and ethically produced in a way that does not increase GHG emissions.”
- To benchmark energy efficiency with other businesses, as well as investments in innovation, research, and technical development, for lower energy consumption and higher efficiency.

Increasing awareness

LSPs are going to work with other stockholders on organizational, national, regional, and international levels to increase the awareness of new generations about the dimensions and importance of sustainable freight transportation and logistics. One of the interviewees stated, “In general, we have been much more aware of sustainable development after Al Gore and the IPCC Nobel Peace Prize in 2007. In fact, a new world has been opened. I think that future generations will be even more aware when it comes to energy resources, climate change, the environment, ethical trade, and so on.” The need to increase awareness among suppliers and customers (shippers and recipients/consignors and consignees) as well as carriers, forwarders, and logistics service intermediaries were elaborated on by LSPs several times in the interviews. They also emphasized the significance of changes in customer behavior and outlooks when it comes to purchasing sustainable freight transportation services. However, as all of the interviewees expressed, at the moment, cost and time are much more prioritized than environmental friendliness.

4.3 Challenges in making freight transportation environmentally sustainable

The third part of our interviews focused on the challenges LSPs perceived in making their operations, especially freight transportation, environmentally sustainable. The following four categories emerged from the analysis: customer priorities, managerial complexity, network imbalance, and technological and legislative uncertainties.

Customer priorities

All of the interviewees stated that customer interest in sustainable development is essential in order to develop and deliver more sustainable solutions. All LSPs felt that customers had a rather low interest in prioritizing more sustainable transportation solutions. One interviewee explained that in dealing with customers, “The challenges are mostly about time and price!” Most of the LSPs emphasized that, today, customer behavior is the opposite of environmental cautiousness. Customers usually look at transportation and logistical services as non-value-added activities that must be carried out quickly and at the lowest price. Consequently, LSP fill rates and resource utilization deteriorate which leads to higher emissions and negative environmental impacts. As one of the interviewees claimed, “In conclusion, it is very difficult to balance the cost, time, environmental friendliness, and at the same time competition with

other LSPs.” Consequently, there is a great challenge in finding ways to overcome the economically driven solutions. As explained by one interviewee, “...it is not the environmentally friendly solutions that should be costly. The non-environmental solutions should be more costly.” However, as another explained, “We have an eco-friendly solution [...] which is actually cheaper but then we need more time to plan the transportation. But there are not many companies using it even if it is cheaper because of time limits.” Consequently, the market need for timely deliveries is also a challenge to consider. Furthermore, the competences related to transportation effects on the environment were also found to be very fragmented. One interviewee stated that, “Sometimes they have their own environmental departments or groups in their companies, but we have found that they do not speak to each other internally about the importance of environmentally friendly transportation.” Other challenges emphasized by all interviewees were increasing customers’ awareness and changing their behavior and perspective in favor of sustainability. According to one of the interviewees, “To change the customers’ view on the importance of the environment from daily life to working processes is the most challenging task ... customers have also very low collaboration among themselves [both internally and externally] ... it is challenging to synchronize internal thinking about the environment.”

Managerial complexity

Developing sustainable freight transportation services was found to be tied to several managerial challenges. One dimension is that of difficulties in measurement and assessment. For example, different LSPs use different standards, methods, and platforms for measuring GHG emissions or for assessing the environmental impacts of freight transportation operations. One of the interviewees from the air sector stated, “Together with IATA and Star Alliance, we work with issues like global Emissions Trading Scheme (ETS)... This is an absolute challenge to reach the goals and I do not know if we can succeed!” Another dimension is different demands from customers in different markets. Working with different types of industries calls for a highly flexible transportation system. For example, on some occasions resources are restricted by volume (cubic meter) and on others by weight (tonne). Finding cooperative ways to develop sustainable solutions is also recognized as a major challenge due to the fragmented nature of the logistics industry.

While all LSPs offer freight transportation services using all modes of transportation, they typically contract with several logistics service intermediaries (LSI), forwarders, and carriers to perform out their services. Consequently, the management of all LSIs, forwarders, and carriers is challenging, especially when it comes to all the pillars of SD. For example, some of the global LSPs complain that it is difficult to check that all carriers use environmentally friendly trucks, such as the Euro 5.0 class, or difficult to measure their sustainability performance. Finally, change and adaptation take time and can be expensive. All the interviewees highlight the complexity of implementation: It takes a long time and is expensive to change the fleet to newer, more environmental vehicles; to adapt to new sustainability legislation; to synchronize internal thinking about the environment; to find adequate staff and educate and train them; to inform all the actors of a global supply chain, and sometimes politicians and decision makers, about the importance of all aspects of sustainability; and to get suppliers to adapt to sustainability criteria. Any manager who has to deal with these dimensions should understand that the effect of changes and his/her decisions might not be seen for a while. At the same time, the next economic period with its red or black figures is approaching, which will result in even more challenges in businesses where margins are low, such as in transportation and logistics.

Network imbalance

Another identified challenge is to balance the flows of goods and resources in the transportation network. Imbalances in goods flows are mostly due to restrictions in the system, such as delivery at an exact time as well as daily, and usually diverse, load and unload (pick and delivery) operations. Geographical positions may also lead to both imbalances in goods and resources flows. For example, one of the interviewees from the rail sector said, “If you look at the long geographical position of Sweden, there are huge amounts of goods from Göteborg/Skåne till Stockholm but little from Stockholm to Göteborg or from north to south.

This can also lead to empty running or imbalance in flows of trucks.” Network imbalances reduce fill rates as well as resource utilization, which means higher emissions and more negative environmental impacts. The scenario becomes worse when it comes to network imbalances in international markets. Globalization, exports, and free trade can all lead to imbalances in freight transportation networks. One of the interviewees from a global LSP company with core competence in sea transportation highlighted that, “If you look at global commerce – it is very easy to say that everything should be locally sourced ... but you should have in mind that no country has ever gone from extreme poverty to being developed without very heavy commerce with other countries.”

Technological and legislative uncertainties

Uncertainties about future fossil-free fuels and infrastructural changes for production of such fuels, especially in global markets, are very challenging. One of the interviewees stated, “My guess is that finding a fossil-free fuel for the future is not easy [...] so, if we can cut consumption, that would be really very good. But to take it to the very far end of finding fossil-free fuel that can be produced in enough quantity without other external negative effects is very tricky.” Other dimensions of uncertainties are related to future changes in the transportation infrastructure. Taking initiatives like investment in new infrastructures, or a combination of passenger and goods transportation infrastructures, such as rail networks in cities, are tied to tremendous uncertainties. As one of the interviewees expressed this challenge, “Although it is more expensive, there is not enough incentives to invest in more environmentally friendly vehicles ... there are also uncertainties regarding future fuel stations [for ethanol and electricity driven vehicles] and rail infrastructure, especially outside the borders of Sweden.”

Uncertainty in legislation and regulations is also a challenge emphasized by the interviewees. Without clear and long-term directions from regulators, the willingness in the LSP industry to take risks by increasing transportation by train and/or go for bio-fuel alternatives are low. As explained by one interviewee, “Regulators and governments must create concrete strategies and stay with these.” One of the interviewees in sea transportation elaborated on the importance of the global legislation by stating, “We believe that ... if you look at the development on the landside ... [how the truck emissions and energy efficiency has increased over the years] ... it has very little to do with voluntary actions ... It is very connected to legislation ... so, voluntary action can of course, be a very good [demonstration] to show examples, etc. ... but to really get the speed going for development, you need international political decisions ... otherwise, if the shipping industry remains forgotten, we will not develop as fast as we would like.” In general, it was found that uncertainties make the LSPs more reactive and less willing to act proactively by taking initiatives.

5. DISCUSSION

The results of our study confirm a number of areas that have been addressed in the/relevant literature, albeit to a limited extent. Few academic contributions address environmental and sustainability activities and challenges from an LSP perspective. This is somewhat remarkable since the impacts its core activity of transportation has on the environment are substantial. Furthermore – although already concluded by Wu and Dunn in 1995 (p. 34) that “Logistics has been a missing link in providing green products and services to the consumer” – advancements in the area in research or practice seem not to have been prioritized.

While there are a number of current, ongoing activities, and some being planned, mainly for the short period of time (3-5 years), the question remains whether these are enough to meet the sustainability challenges raised by the IPCC (90% reduction of CO_{2e} from transportation by 2050) or raised by the UN or the World Bank. An overall impression from the interviews is that the main strategy for LSPs is “wait-and-see”. While the activities they perform are mainly internally focused, the challenges identified are mostly of an external character. This means that it is customers, who have to reprioritize, or technology and/or governments that have to become more stable and more concrete. The management of different stakeholders (suppliers, partners, etc.) is rather complex. Categorizing the activities in the spectrum of Welford’s greening framework (2000, p.18), the activities are all on the lower levels; what he states are superficial changes where the focus is on a technological fix, pollution control, and environmental auditing. However, while the interviews raised “increasing awareness” as a key area in future activities, this relates to the higher level, cultural change, in Welford’s framework.

Based on the findings gained from an LSP perspective, we argue that there is a great need for holistic models and frameworks that take into consideration the complexity present, instead of solely trying to reduce or eliminate it. Without such a perspective, decisions and policy making will not be based on a true picture of reality or the consequences that can arise from the process. This is often the case right now when dominant/prevaling perspectives, often economically driven and based on simplified assumptions, have both negative ecological and social effects. By analogy, LSPs must also have a holistic perspective of the whole of the supply chain in order to avoid suboptimal and isolated decisions for sustainable development of freight transportation. The themes identified, current and future activities, also represent the importance of an integrative perspective. It is clear that sustainable freight transportation can never emerge through just one activity or operation. There is great need to develop a package of solutions with different activities with minimal conflicting goals or effects on each other.

The role and perspective of LSPs in supply chains opens up for new perspectives in making supply chains sustainable. As highlighted by Huemer (2012), the LSP perspective opens up for the question to be asked: What is the right product for the supply chain at hand? This could be especially interesting if it is integrated with the prevailing perspective in both research and practice; the product perspective. This perspective has been manifested for a long time, and in supply chain contexts research has very much focused on what Fisher (1997) puts forward in the question: What is the right supply chain for your product? In this line of reasoning, the concept of three-dimensional concurrent engineering (3DCE), in which the product, process, and supply chain are designed in parallel, was proposed by Fine (1998), Ellram *et al.* (2007), and Ellram and Stanley (2008). It is valuable for the discussion of holistic models and frameworks for SD and LSPs. Ellram *et al.* (2007, p. 322) state that, “Because three-dimensional concurrent engineering is itself a multifaceted combination of

processes that exist within a complex adaptive system, research methods that allow the modeling and understanding of such complexity are required.” This is applicable to the complex situation of SC and LSPs, and a base for both theoretical development and practical implications. Factors such as interdependences among the actors in supply chains, human factors, and other emerging phenomena such as resource reductions in logistics operations or legislative changes, ought to be considered as integrative with the design of the product, the processes, and the SC.

Putting the 3DCE concept on sustainability pillars provides a holistic framework where the role of LSPs and their competences are interesting (Figure 1). While the design of products and production processes are core to Original Equipment Manufacturers (OEMs), the source and delivery processes, as well as the structure of supply chains, are where LSPs can provide knowledge and competence. Currently, logistics is most often seen as a service which has to be acquired after products have been designed and developed (Zacharia and Mentzer, 2004). Chapman *et al.* (2003, p. 645) conclude that, by increasing knowledge sharing with logistics functions and/or providers in the SC, the achievement of greater efficiency, increased customer satisfaction, and better strategic planning can all lead to more flexibility, and adaptation to market changes, rapid and flexible supply chain management processes, and other benefits like rapid innovation capabilities. As a result, the possibility to influence products in the early phases is low. Instead, logistics services are to be adjusted and have to handle suboptimal product flows. Consequently, if customers of logistical services could involve LSPs in the early phases of product design and development not only would there be opportunities to optimize the movement of goods and products, but improved collaboration could also lead to increased prioritization of LSPs and their operations.

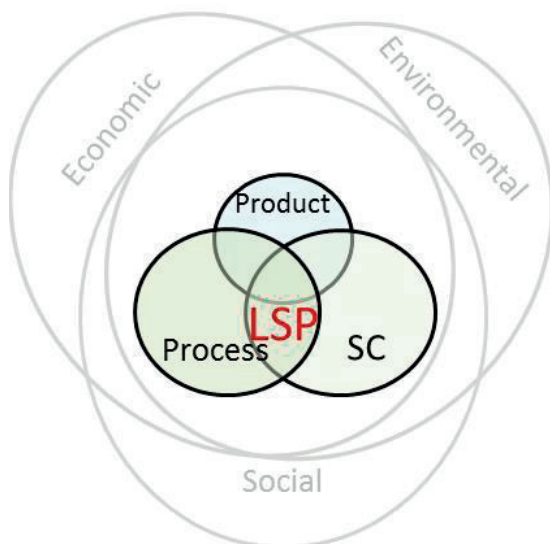


Figure 1 - The three-dimensional concurrent engineering concept put on sustainability pillars emphasizing the role and competence of LSPs in contributing to more sustainable development of products, processes, and supply chains

Finally, in dealing with a holistic view, as well as integrative perspectives like the 3DCE concept, complexity theory provides a compelling ground for understanding and further development. Complexity theory is driven by an attempt to move science away from the

strong thoughts of reductionism and instead provide support for the understanding of emergence, self-organization, sense making, and paradoxes (i.e. areas apparent in SD) (Nooteboom, 2007). A number of logistics scholars (Choi *et al.*, 2001; Ellram *et al.*, 2007; Holweg and Pil, 2008; Nilsson, 2005; Nilsson and Gammelgaard, 2012; Wycisk *et al.*, 2008) have used complexity theory to increase the understanding of supply chains and logistics phenomena. They claim that, given the contemporary, complex problems facing logistics, new mental models and theoretical frameworks are needed.

6. CONCLUSIONS

In this paper, we have explored major themes as well as challenges for developing environmentally sustainable freight transportation from the LSP perspective. A major conclusion of the findings is that sustainability issues from the LSP perspective have a strong tendency towards economic/profit-related issues followed by environmental concerns, and thereafter, social/people-related ones. It is also concluded that LSPs recognize cost and time to be of major importance to their customers; most of them feel that their efforts to provide more environmental solutions do not pay off since they are not prioritized when they come in conflict with cost or time. Furthermore, there are a number of uncertainties that restrain LSPs, such as uncertainty in technological development, regulations and legislation, and how their customers chose to prioritize.

The need for increased customer willingness to purchase the environmentally sustainable services offered by LSPs is pointed out in the/relevant literature as a prime challenge (Philipp and Militaru, 2011; Lieb and Lieb, 2010; Abbasi and Nilsson, 2012), and confirmed in our study. As Wolf and Seuring (2010) state, “Customers still give value to traditional performance, such as price, quality, and timely delivery ahead of environmental concerns.” It is also a challenge to foster green practices (Perotti *et al.*, 2012) and operationalize sustainability across entire supply chains (Abbasi and Nilsson, 2012) or internally within LSPs (Lieb and Lieb, 2010; Abbasi and Nilsson, 2012). Lack of sufficient cooperation/partnership, insufficient information flow (Wolf and Seuring, 2010), and low sustainability awareness/knowledge (Abbasi and Nilsson, 2012) among LSPs and their supply chain stakeholders are others barriers that, according to our interviewees, affect sustainability behavior and more specifically, reduce opportunities to achieve high fill rates and optimal resource utilization. Uncertainties about governmental regulations (Abbasi and Nilsson, 2012), as well as unclear regulations and policies (Wolf and Seuring, 2010), are also experienced by the LSPs we interviewed. The difficulties reported in the diagnosis, measurement, and assessment of the environmental impact of supply chain practices (Abbasi and Nilsson, 2012; Perotti *et al.*, 2012), and in setting appropriate environmental benchmarks/targets (Lieb and Lieb, 2010) are also in line with our findings. In addition, our results identify two other challenges that have not been addressed previously in relevant literature, namely network imbalance and uncertainties about infrastructural changes related to transportation.

There are some limitations that need to be reflected upon. This investigation has been inductive and explorative with a focus on an in-depth understanding of a limited number of representatives from LSPs. Furthermore, while several more LSPs were contacted it has only been those willing to participate we have investigated. This could potentially mean a bias towards those who are at least interested in environmental sustainability. Finally, the geographical focus has been the Scandinavian region, known for its environmental

proactivity, and further studies are needed that both explore and exploit the results of this research in other regions, as well as globally.

Further research is needed to understand the interrelationship between LSPs and their customers in the development of sustainable logistics solutions as well as the role and importance governments have in reaching the goals of 90% CO₂ reductions before 2050. The three-dimensional concurrent engineering framework should be further explored in this endeavor. A future step may be the analysis and design of future freight transport setups in collaboration with product producers and manufacturers, end-tier consumers, and passenger carriers. In addition, it is also necessary in further research to explore business models that focus on sustainable development and drive the prioritization of freight transportation buyers not only toward cost and time but also to examine environmental and social aspects related to the movement of goods.

Implications

The themes identified can help managers, governors, and decision makers when they design future strategies, policies, and legislation to transform freight transportation and logistics toward sustainability. Since one of their tasks is to tackle challenges, the ones identified here may help them to obtain a more holistic view of those experienced by LSPs.

A further implication is that freight transportation and other logistical services will not become sustainable without collaboration among the supply chain stakeholders. The sustainability strategies and challenges of one stakeholder both influence, and are influenced by, those of the others. Service buyers (such as cargo owners, shippers) have a direct influence on the sustainability strategies of LSPs by increasing resource utilization and fill rates, demanding environmentally and socially responsible services, and the calculation, measurement, and assessment of GHG emissions and carbon foot prints across supply chains. To tackle all the challenges identified calls for willingness and collaboration among cargo owners and shippers.

A final implication for both policy makers and LSP managers relates to one of the dominant pre-assumptions in developing sustainable transportation that more environmentally friendly modes should be used. This may be true in the short term but the standpoint from our analysis is that it will not solve the problem in the long term. The transportation system must be developed in a resilient way. This means that in the event of peak loads for one mode, the other modes must be able to be replaced. Peaks can occur because of natural disasters, weather conditions, risk and security reasons, terrorist attacks, etc. In addition, optimal competition among transporters, and modes of transportation, may decrease the price of transportation services for customers. Hence, further research is needed on the resilience of transport systems in the supply chain context.

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INTERVIEW GUIDELINE

Information collection during the interviews

Background Information

Gender:

Years of experience:

Department:

Position:

Main tasks / functional job:

Current sustainability – related activities

The aim of this section is to:

- Define aspects of sustainable development from interviewees' perspectives;
- Diagnose 3PL sustainability-related operations and activities;
- Analyze operations of 3PL supply chains.

- 1) How do you deal with/define sustainable development? *In this case, the interviewers and interviewees can match their definitions, perceptions, etc. Reduces misunderstanding.*
- 2) How do you deal with/define sustainable development and environmental sustainability for a TPL/goods transportation sector? *Finding themes of sustainable development for the goods transportation industry.*
- 3) Supply chain-related questions: *Actors they collaborate with, modes of transportation they use, information about fill rates and resource utilization.*

Future sustainability – related activities (up to 2020 & 2050)

The aim of this section is to:

- Diagnose and analyze 3PL future sustainability-related strategies, operations and activities.

- 1) What have they planned/ what strategies do they have for sustainable development by 2020 and 2050? *Ask if they have a shorter or longer vision than 2020.*

Challenges of sustainable development

The aim of this section is to:

- Diagnose current and probable future challenges for sustainable development;
- Diagnose remedies for challenges.

- 1) What were the difficulties and barriers for sustainable development and environmental sustainability up to now?
- 2) What difficulties and barriers do you predict/expect up to 2020 and 2050? *Ask if they have a shorter or longer vision than 2020.*
- 3) What do you suggest for mitigating/eliminating challenges?

Themes and Challenges in Making Urban Freight Distribution Sustainable

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THEMES AND CHALLENGES IN MAKING URBAN FREIGHT DISTRIBUTION SUSTAINABLE

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ABSTRACT

Purpose

The purpose of this article is to explore and classify themes and challenges in making urban freight distribution sustainable.

Design/methodology/approach

The study has a cross sectional design which started by a narrative literature review and analysis of a sample of related literature (like peer-reviewed articles and EU (European Union) documents). It ended with complementary discussion and recommendation for tackling the challenges.

Findings

The results of the study illustrate eight and seven emerged categories of themes and challenges, respectively. It is concluded that there is great need for a packet of mixed strategies as well as a more holistic perspective where all actors together analyse and design future set-ups and operation of urban freight distribution. Such a holistic view is essential in order to: understand how different actors of the chain look upon sustainable urban freight distribution, avoid sub-optimal policies/governing rules, and suggest close-to-reality solutions for tackling the challenges.

Research limitations/implications (if applicable)

Freight distribution in urban areas is the main focus of this article. In addition, the study is demarcated to eco/environmental aspect of sustainability although it is impossible to completely exclude its interaction with economic and social aspects.

Practical implications (if applicable)

The results offered in this paper provide a systematic structure for classifying issues related to sustainable urban freight distribution; something which will be beneficial for managers and policy-makers when they approach sustainable supply chain management challenges.

Originality/value

This study provides a synthesized classification of themes and challenges which can guide researchers, industries, authorities, and policy-makers in future sustainability efforts.

Keywords: *urban distribution, city logistics, logistics, sustainable, sustainability, environment, themes, initiatives, challenges*

1. INTRODUCTION

During the past century, the planet's urban population grew ten-fold. Now more than half of the world's population is living in urban areas. As a result of this rapid expansion, urban areas continue to grow at a faster rate than any other land-use type (Kinver, 2011). In Europe, approximately 80 percent of the citizens live in urban environment (McKinnon et al., 2010).

Due to urbanization: new infrastructures as well as buildings are built, jobs are created, diverse services are offered, and industrialization is advanced. Growth in urban areas has been a generator of economic growth as well. In Europe, 85 percent of the GDP (Gross Domestic Product) is generated in cities (EU, 2009).

Developments in urban areas are not tied with just good news. Evacuation of natural resources of the Earth like deforestation, shortage of land, and unequal distribution of power between rural and urban areas are just some cons to mention. Urbanization also increases mobility of humans and freights. Although economically and socially feasible, mobility in urban areas may lead to GHG emissions, local air pollution, energy/fuel consumption, congestion, accidents, noise, and visual intrusion. It has also negative effects on residents' health when they inhale GHGs and/or are injured by accidents and noise. Urban freight is also a large contributor to CO₂ emissions. It represents more than a quarter of the total CO₂ released by urban traffic; the fastest growing source of total CO₂ emissions in the urban environment (Dablanc, 2008). In European Union (EU), transportation still depends on oil and oil products for 96% of its energy needs (EU, 2011). According to Eurostat (2011) transport's CO₂ emissions are constantly increasing and are the fastest-growing sector in Europe. In the same continent, urban transport is responsible for about a quarter of CO₂ emissions from transport, and 69% of road accidents occur in cities (EU, 2011).

In this regard, EU (2011, p.3) has set goals to limit climate change below 2°C by drastically reduce GHG emissions – from all sectors of the economy – by 80-90% below 1990 levels until 2050. It is also estimated that a reduction of at least 60% of GHGs by 2050 with respect to 1990 is required from the transport sector. EU (2011, p.9) has also the goal to “*halve the use of 'conventionally-fuelled' cars in urban transport by 2030; phase them out in cities by 2050; and achieve essentially CO₂-free city logistics in major urban centres by 2030*”.

However, to achieve the EU's goals sounds tremendously challenging. It is clear that by current business as usual approaches, the goals cannot be reached (EU, 2011, p.4-5); instead new strategies with innovative solutions are required. Breaking the current approaches, ways of thinking, and patterns of behavior is fairly complex, costly, and time-consuming. Although innovation can be radical, adaptation of new solutions as well as change of behavior are just incremental (Rogers, 2003).

Complexity of freight- than passenger transport (Wigan and Southworth, 2004; Himanen et al., 2004; Lieb and Lieb, 2010) and, in specific, urban freight transport and distribution (McKinnon et al., 2010, p.294; Jönson and Tengström, 2005; Waddell et al., 2008) make their sustainable development challenging as well. One evidence of such complexity is large number of actors who influence freight distribution in urban/city areas such as Logistics Service Providers (LSPs), carriers, shippers/receivers (like retail stores, shops, restaurants, private consignees, and industries (construction industry, hotels, etc.)), residents, authorities, and researchers. Another dimension of such complexity is large number of activities which are/should be done in urban freight distribution operations. Some examples are consolidation, transshipment, coordination, sorting, kitting, sequencing, commercialization, packaging, storage, handling, and transportation of freight as well as reverse logistical activities (recycling, repacking, refurbishing, waste handling, etc.).

In addition, freight- than passenger movements in urban areas is much more heterogeneous and dynamic. Freights are distributed through many (distribution) channels. Furthermore, the

channels (including routs and paths) may change rapidly specifically in post- and home-delivery services. However, urban freight is more polluting than long distance freight transport as urban delivery vehicles are older on average, operating speeds are slower, constant acceleration and deceleration, and vehicle idling is frequent.

Due to such complexities, McKinnon et al. (2010, p.286) truly claim that “*the problems experienced by those performing freight transport and logistics operations in urban areas are far less well understood*”. Until relatively recently, little attention has been paid to urban freight by researchers and policy makers (Dablanc, 2007; McKinnon et al., 2010; Álvarez and de la Calle, 2011). On the other hand, different initiatives that may lead to- or the challenges that may hinder sustainable urban freight distribution are lacking in the literature (Behrends, 2011; Abbasi, 2012). Although the studies by McKinnon et al. (2010), Patier and Browne (2010), Lindholm (2008), and Behrends (2011) found to be contributing for this sake, this study aims to take a more holistic view on current discussed initiatives (themes) and challenges. Such a holistic view is essential in order to: understand how different actors of the chain look upon sustainable urban freight distribution, avoid sub-optimal policies / governing rules, and suggest close-to-reality solutions for tackling the challenges.

The purpose of this article is to explore and classify the pattern of themes of initiatives and challenges in making urban freight distribution sustainable.

1.2 Demarcation

This study is demarcated to logistics in city/urban areas. All initiatives related to city logistics/urban freight distributions are in the scope of the study.

While the main focus of this study is on eco/environmental aspects of sustainability, due to the integrated nature of sustainable development, the integration of environmental issues with economic and social concerns have also been considered. In addition, phrases such as environmentally- sustainable / friendly / sound / preferable / responsible, eco, and green have been used synonymously.

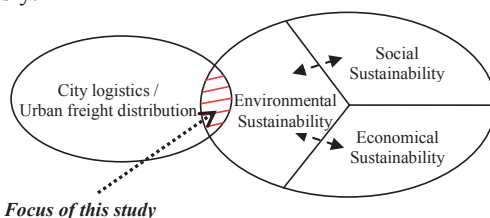


Figure 1 – Focus and demarcation of the study

2. FRAME OF REFERENCE

In 1987, a United Nations-sponsored report – published by Commission on Environment and Development (WCED) – entitled ‘Our common future’, also known as ‘Brundtland Report’, popularized the concept of ‘sustainable development’ and provided it with its widely known definition: “*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*”. Following the United Nations 2005 World Summit, sustainable development encompasses the interdependent and mutually reinforcing pillars of economic development (Profit), social development (People) and environmental protection (Planet). The three pillars or ‘P’s of sustainable development are also called the ‘three bottom lines’ or ‘triple bottom lines’ (TBL or 3BL). Sustainable development is also referred by similar concepts such as ‘corporate

sustainability’ (MacLean, 2010; Jeffers, 2010), ‘corporate responsibility’ (Zwetsloot, 2003), or just ‘sustainability’ (Aras and Crowther, 2009; Shrivastava, 1995). Environmental pillar of sustainable development is also labeled by phrases such as ‘environmentally- sustainable / friendly / sound / preferable / responsible’, ‘eco’, and ‘green’ (Björklund, 2005; Abbasi, 2012).

Urban freight distribution deals with logistics, mainly outbound, in urban areas. Urban, in contrast to rural, is usually referred to cities and towns. The combination of urban and rural areas is called metropolitan area. Urban freight distribution activities vary from delivery and collection of goods; goods- transport, storage, consolidation, and inventory management; waste handling; office and household removals; (Yamada and Taniguchi, 2006; McKinnon et al., 2010, pp. 282-302; Van Duin and Van Ham, 2001) to cooperation among freight stakeholders (Kawamura and Lu, 2006) and freight distribution policies (Marcucci and Danielis, 2008). Urban freight distribution may also be called by similar phrases like city logistics, urban freight logistics, urban logistics, and urban goods movement (Dablanc, 2007). City logistics is an important process for totally optimizing the logistics and transport activities by private or municipal companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy (Institute for City Logistics). From Dablanc’s perspective (2007), “*urban logistics can be defined as any service provision contributing to an optimized management of the movement of goods in cities*”. Alternatively, city logistics is involved in all the means over which freight distribution can take place in urban areas as well as the strategies that can improve its overall efficiency; such as mitigating congestion and environmental externalities.

3. METHODOLOGY

This study has a cross-sectional design. It entails collection of data from a variety of sources and at a single point in time (Bryman and Bell, 2007) in order to explore pattern of themes and challenges in making urban freight distribution sustainable.

The main method of data collection was literature review. During and after literature review, data were analyzed. Analysis was done by codification (open coding), classification, and synthesis of collected data based on principles of analytic induction. The results of the analyzed data (themes and challenges) are discussed in the next section. In the following subsections, methods of data collection and analysis are briefly explained (Table 1).

Table 1 – Methods- and sources of data collection and analysis in this study

		Source(s) of data
Methodology	<i>Literature review</i>	1) Peer reviewed journal and conference articles 2) Books and doctoral dissertations 3) Documents and reports from selected websites 4) Documents and reports from ‘Øresund EcoMobility’ project
	<i>Analytic induction</i>	Collected data from literature review

3.1 Literature review

The study began by collecting data by reviewing several mixes of literature from several sources. However, the literature review had a more narrative than systematic nature. According to Bryman and Bell (2007), the former one tends to be less focused and more wide-ranging in scope than the later one. Literature was selected from secondary sources and documents (Table 1); namely:

Peer reviewed journal and conference articles: In order to collect a purposeful sample (Patton, 2002, pp. 230) of articles, the online database at the library of Lund University in Sweden (LibHub) was selected. It includes sources such as electronic journals, E-print archives, JSTOR, IEE/IEEE standards and proceedings, and Proquest ABI database. At first, the LibHub database was searched by combination of selected keywords, namely (Urban freight*/City logistic* AND Sustain*/Environment*/Green). The search keywords had to be in title and/or abstract and/or keywords of the articles. This led to 470 available articles. Next, the abstract of all available articles were read. In some occasions, the introduction and conclusion sections of the articles were also read or whole of the article was skimmed.

The most relevant articles to purpose and scope of the study were then selected and registered in an Excel file. In total 61 articles (13% of the total available) were selected. The criteria for selection of the articles were that the discussed data shall have a thematic character (like managerial, educational), refer to an environmentally sustainable activity/issue (like developing environmentally friendly modes of transportation), or explicitly refer to a challenge/barrier. It is worth mentioning that some articles were appeared repetitively in one or several categories. In such cases, just one of them was counted. In addition, the articles/abstracts which were written in another language than English were not selected. The selected articles were then totally read by both authors.

Books and doctoral dissertations: Some hard copy or E- books and doctoral dissertations relevant to purpose of the study were read during the data collection and analysis phases.

Documents and reports from 'Øresund EcoMobility' project: This study was one part of the 'Øresund EcoMobility' research project (<http://www.oresundecomobility.org/>). All relevant publications, documents, and reports available on homepage or intranet of the project were read.

Documents and reports from selected websites: During the data collection phase, relevant documents and reports from two websites were also read. These websites are: 'European Commission-Mobility & Transport (http://ec.europa.eu/transport/index_en.htm)' and 'Europa-Gateway to the European Union (http://europa.eu/index_en.htm)'. These two were interesting for those financiers of the research project from European Union (European Regional Development Fund).

3.2 Analytic induction

Analytic induction (Bryman and Bell, 2007; Patton, 2002) was the main method for analysis of data in this study. The main reason to use this method was to allow the categories of themes and challenges emerge out of the collected data. This is very well in match with inductive reasoning of qualitative researchers. The principle was to seek universal explanation of categories of themes and challenges by pursuing the collection of data until no cases that were inconsistent with the emergent categories were found. On the other hand, collection of data was continued until theoretical saturation. This means that: successive literatures had both formed the basis for the creation of a category - after open and focused coding (Charmaz, 2006) - and confirmed its importance; there was no need to continue with data collection in relation to that category or cluster of categories.

Worth to mention that '*code memos*' (Kvale and Brinkmann, 2009) were used during open and focused coding where the names of the different codes, who coded which parts of the material, the date when the coding was done, definitions of the codes used, and notes about the thoughts about the codes were recorded. The generations of codes were purely '*data driven*' than '*concept driven*'. Concept-driven coding uses codes that have been developed in advance by the researcher, either by looking at some of the material or by consulting existing

literature in the field, whereas data-driven coding implies that the researcher starts out without codes, and develops them through reading of the material.

3.3 Judging research quality

In line with Bryman and Bell (2007)'s suggestions for evaluating qualitative research, two criteria were considered: *Trustworthiness* and *Authenticity*. Main measures to increase trustworthiness of the results were: transferability (generating representative samples of literature) and dependability (creating a research logbook/black box which entails complete records of every single phase of the research such as: problems formulation; selection of samples; literature reviews; coding schedule and manual; memos of open and focused coding; and data analysis procedures). In addition, analyses of collected data were done by both authors in order to decrease subjectivity in coding of data. On the other hand, in order to increase authenticity of the results, several mixes of literature from several sources were selected and the results were discussed among the research project's stakeholders.

4. RESULTS

Systematic review and analysis of the literature led to identification of the pattern of discussed themes and challenges. This section provides a classified synthesis of identified themes and challenges.

4.1 Identified themes

Eight themes were identified. The identified themes are explained here in detail.

4.1.1 Juridical and financial regulations/restrictions/limitations

Limitations and restriction are related to policies that aim to make freight distribution sustainable by regulating access to urban areas.

- ***Time restrictions – delivery timing – vehicle access time restrictions***

These regulations – usually called *access time windows* – aim to restrict the time of collection, delivery/loading and unloading of freight in urban areas. The most common form is *night deliveries* that may reduce noise pollution, traffic congestion, vehicles fuel consumption and as a result, GHG emission of freight distribution during the daytime (Bhuiyan et al., 2010; Álvarez and de la Calle, 2011; Munuzuri et al., 2005; Angheluta and Costea, 2011). According to Álvarez and de la Calle (2011), night deliveries have reduced the fuel consumption and CO₂ emissions by 15 to 20% in some European cities. Relaxation of access time windows and their harmonization among different municipalities can result in a relief of the environmental burden and a cost decrease for the retailers, too (Quak and de Koster, 2007).

- ***Vehicle load capacity restrictions – vehicle access weight /size/capacity restrictions***

Restrictions on vehicle access weight and size are some of the most common mobility policies and legislation. The goal is to restrict the entrance to urban areas of vehicles that surpass the specified gross weight, length, width, and height in urban areas. Such restrictions may lead to the reduction of congestion, pollution, intimidation, safety concerns, vibrations and noise in urban areas especially where pedestrians and other road users are present (Anderson et al., 2005; McKinnon et al., 2010). Another reason to introduce such restrictions is the limitations in infrastructures in urban areas such as height of bridges, width of carriageways, and dimensions of city squares.

- ***Environmental zones/low emission zones/clear zones***

Environmental zones – sometimes called low emission zones or clear zones – relate to geographical areas that can be entered by vehicles meeting certain emissions criteria/standards or below a certain age. The aim is to improve air quality in urban areas by encouraging the use of less polluting engine technologies (McKinnon et al., 2010) and more modern and cleaner vehicles (Anderson et al., 2005).

- ***Financial regulations/means***

There are also some financial means that can impact the environmental sustainability of urban freight distribution. The most common ones, reflected in the literature, are congestion charging (Awasthi et al., 2011; Hensher and Puckett, 2008; Goldman and Gorham, 2006), which is also called congestion pricing or road pricing. The aim is to reduce the number of vehicles that enter specific urban areas – especially where road and parking space are scarce – increase the average speed of vehicles – because of reduction in traffic intensity – and internalize the external costs originated by traffic congestion (Munuzuri et al., 2005; Anderson et al., 2005). Toll systems (Angheluta and Costea, 2011) and taxes on vehicles are other mechanisms for reducing traffic intensity and congestion in urban areas.

4.1.2 Structural and Infrastructural

These relate to initiatives that aim to make urban freight distribution sustainable by restructuring the supply chain design or maximizing the capacity utilization of existing infrastructures.

- ***Urban Consolidation Center (UCC)***

The goal of UCC initiatives is to consolidate the freight flows from outside the city before delivery in urban areas. This will help to bundle inner-city transportation activities (Yamada and Taniguchi, 2006; van Rooijen and Quak, 2010). Browne et al. (2005) consider a wider goal of UCC by stating that “*UCC is best described as a logistics facility that is situated in relatively close proximity to the geographic area that it serves, be that a city center, an entire town or a specific site (e.g. shopping center), from which consolidated deliveries are carried out within that area*”. UCCs are also called by similar phrases (Browne et al., 2005) like urban shared use freight terminals (Dablanc, 2007), city terminals (Munuzuri et al., 2005), city distribution centers (van Rooijen and Quak, 2010), and urban freight consolidation centers (Edoardo and Danielis, 2008).

The main advantage of UCCs is reduction of traffic intensity (total number of operating vehicles) in urban areas by improving the load factor and empty running of vehicles. However, it might take more small vehicles to replace the large vehicles, which could increase the number of vehicles in the city (van Rooijen and Quak, 2010). Such initiatives can also reduce- fuel/energy consumption per ton-km, vehicle emissions and noise generation in delivering goods as well as making the area more pedestrian-friendly (Browne et al., 2005; Álvarez and de la Calle, 2011; Weber, 2003;). According to Goldman and Gorham (2006), such initiatives have reduced number of truck trips into the city and truck operating times by 70% and 48%, respectively in some German cities.

- ***Maximizing capacity utilization of existing infrastructures***

Some literature sheds light on initiatives that aim to maximize the capacity utilization of existing roads, parking places, load/unloading areas, and pedestrian/bicycle ways. “Multi-use lanes”, common use of “public and private parking lots”– mainly used for passenger vehicles – or “other reserved spaces” (taxi zones, bus lanes, motorcycle parking spaces, and parking spaces for disabled people) during certain time intervals are some of these initiatives that

adapt the use of public roads and spaces to the different freight distribution operational needs emerging during the day. “Load zone provision”, “delivery zones”, and “dynamic allocation of loading and unloading places” – reserved spaces to be used by delivery vehicles for loading or unloading freight in certain dense urban areas – as well as “temporal individual load spaces” and “short time double parking” (Munuzuri et al., 2005; Álvarez and de la Calle, 2011; Awasthi et al., 2011) are other initiatives worth mentioning. Although these initiatives may not reduce the number of vehicles during peak hours, they can reduce traffic intensity and congestion by facilitating parking, and loading/unloading operations.

• ***Underground urban goods distribution***

The aim of underground urban goods distribution initiatives is to utilize the underground links or network for distribution of goods among distribution centers around urban areas and receivers (like shops) inside the urban areas. According to Binsbergen and Bovy (2000), the concept of underground goods transportation has potential feasibility for urban distribution of food products and consumer goods. It can also reduce noise levels, improve local air pollution, and decrease energy use for propulsion.

4.1.3 Managerial

Managerial issues are related to activities that can contribute to the sustainability of urban freight distribution such as planning, control, measurement, monitoring, modeling, assessment/evaluation, cooperation/coordination/collaboration, and partnership.

Modeling activities are reflected on in several articles. These range from multi-criteria decision-making approaches for location planning for urban distribution centers under uncertainty (Awasthi et al., 2011) to peak-hour urban freight movements with limited data availability (Munuzuri et al., 2010), and CO₂ emissions for different levels of congestion and time-definitive customer demands (Figliozzi, 2011). Modeling can also be found in Gao and Sheng (2008) who take advantage of simulation methods combined with improved heuristic algorithms to solve the dynamic vehicle routing problem with time windows (DVRPTW) in real city environments. *Evaluating* activities can be found in Awasthi and Chauhan (2012) who present a hybrid approach for evaluating four city logistics initiatives: vehicle sizing restrictions, congestion charging schemes, urban distribution centers and access timing restrictions. Hensher and Puckett (2008) present a choice-modeling framework for *assessing* the influence of distance-based charges on freight transporters. Route *planning* of delivery fleets (Zeimpekis et al., 2008) and *mapping out* the pattern of goods distribution (Ljungberg and Gebresenbet, 2004) in order to reduce costs, congestion, and environmental impact are other activities of a managerial thematic character.

Cooperation, coordination, and collaboration are inseparable activities of sustainable logistics and supply chains. Urban freight distribution is not an exemption. *Partnership* between public and private sectors (McKinnon et al., 2010), inter-organizational cooperation among actors and stakeholders involved in city logistics (Petersen, 2006), cooperation in distribution channels, and coordinated goods flows are just a few examples of managerial activities.

4.1.4 Environmentally friendly modes of transportation

These initiatives relate to design and production of new green modes of transportation as well as taking advantage of inter- and co-modalities.

• ***Inter- and co-modality***

Transferring freight from urban roads to rail and marine (Dinwoodie, 2006; Pawlak and Stajniak, 2011; Goldman and Gorham, 2006) – which may have less energy intensity per ton-

km – are among the discussed activities in making urban freight distribution sustainable. Co-modality, by combining different modes together, like cargo- trams and ferries combined with electric powered trucks (Angheluta and Costea, 2011), freight busses and metro (Petersen, 2006; Amico et al., 2011), and passenger and cargo trams (Munuzuri et al., 2005) are some other initiatives. Inter- and co-modality by shifting to non-road modes of transport can reduce congestion on roads as well as costs of distribution operations.

• ***Developing environmentally friendly vehicles***

Designing, developing, and producing more environmentally friendly vehicles – with less energy and emission intensity – are inseparable parts of zero emission and eco-mobility strategies. Using electric vehicles (Álvarez and de la Calle, 2011) like electric lorries and vans (Zuccotti et al., 2011; Binsbergen and Bovy, 2000), zero emission vehicles powered by hydrogen (Rambaldi and Santiangeli, 2011), and gas and electricity powered trucks (Angheluta and Costea, 2011) can all contribute to environmentally friendly city distribution operations.

4.1.5 Technological developments

Developing clean/green/environmental technologies are permanent strategies towards sustainable development of city logistics, logistics, and supply chains. Several articles shed light on ICT as enablers of green urban freight distribution. They are also some major enablers of world-class infrastructure (Toh et al., 2009). Such technologies are also keys to integrated, connected, visible, adaptive, and intelligent supply chains. ICT can be found in today and in the future of sustainable urban freight distribution to track and trace goods and resources of supply chains and take advantage of Global Positioning Systems (GPS), route optimization, variable message panels, traffic management systems, identification tags, smart cards, computer software and hardware, emission calculators, parking monitoring tools, on-line load zone reservations (Gebresenbet et al., 2011; Zuccotti et al., 2011; Qiang and Miao, 2003; Munuzuri et al., 2005). According to Weber (2003), *“Bottom-up processes of strategic niche management with new emerging technologies have the potential to trigger regime shift towards a more sustainable supply of energy and transport services.”*

4.1.6 Emissions and Fuels economy

Developing sustainable fuels with zero emissions and without antagonistic effects somewhere else, like destroying food resources or high costs, improving engine efficiency, and controlling measures towards reduction of emissions, are long-term trends that can reduce energy and emission intensities of freight distribution in urban areas. Among the related reviewed literature, Yoshizumi et al. (1982) have studied diesel emission levels of several urban driving cycles and analyzed the effects of average speed on emissions and fuel economy by diesel trucks. Another example is Gebresenbet et al. (2011) who have studied emission estimation for an urban food delivery system.

4.1.7 Distribution services

Distribution services are complementary to sustainable physical freight distribution. Some exemplary services which can reduce transport intensity, traffic intensity as well as congestion and emissions in urban areas are: home service distribution (Álvarez and de la Calle, 2011), neighborhood drop-off points (Goldman and Gorham, 2006), use of packaging automates in the distribution process (Pawlak and Stajniak, 2011), DHL pack stations and BentoBox (Amico et al., 2011).

4.1.8 Educational

Education and change of behavior are building blocks of making and developing sustainable supply chains. Education plays an important role in informing the human resources of dimensions of sustainability as well as improving their performances.

4.2 Identified challenges

Seven challenges were identified and classified and are explained in the following subsections.

4.2.1 Decoupling

Economic growth both effects and is effected by freight distribution and transport growth. Traditionally, goods transport increases with growth in the GNP (Taniguchi and Van Der Heijden, 2000). In many urbanized European regions, the pace of growth in goods transport is about twice that of the GNP (Binsbergen and Bovy, 2000). The challenge is to decouple economic growth from an increase in urban freight mobility and environmental damage/degradation. As Afroz et al. (2011) reflect, the challenge is to develop collaborative business models to *“meet the future challenges of the growth of trade, freight movement and maintaining economic, environmental and urban sustainability.”* To achieve the EU targets (EU, 2011) is very challenging as the emissions should drastically reduce by 2020 and 2050 while the number of vehicles (Gebresenbet et al., 2011) and the population are increasing.

4.2.2 Restructuring

Dynamic restructuring of patterns of urban freight distribution has made its sustainable development challenging, too. For example, the growth of e-business/e-commerce, home deliveries, and just-in-time (JIT) trends have drastically changed the B2C (business to consumers) as well as B2B (business to business) transactions by having antagonistic effects on the environment and sustainability (see for example Abukhader, 2005 and McKinnon et al., 2010). The scenario becomes even more challenging when freight distribution in urban areas is influenced by global supply chains/networks. As Markus (2006) discusses, both “global change” and “global chain” may lead to “local pain”. (...) *“Increasing globalization and global economic integration exert constant pressure on local places to adapt to these processes.”* Adaptation to these changes and reconfiguration of freight distribution may also lead to further challenges in urban areas where the infrastructures, spaces, and resources are limited; roads and streets are narrow and compact (especially in historic and central parts of cities) (Gonzalez-Feliu and Morana, 2011; Pawlak and Stajniak, 2011; Goldman and Gorham, 2006).

4.2.3 Costs/Financial viability

A major challenge in making urban freight distribution sustainable is cost. In general, in the same time period, the average costs of freight distribution in urban areas (short distance) is higher than inter-city (long distance) freight distribution. The reasons are higher fuel consumption of vehicles due to more congestion and less average speed as well as more stops and load/unload operations in urban areas.

Corporate social responsibility – including both environmentally and socially sustainable – initiatives, activities, and strategies that may threaten economical sustainability are less likely to be continued. This is a real challenge, as many of these may be very costly, at least initially. For example, although environmentally beneficial, adding urban consolidation centers/terminals/cross-docks can result in potentially high set-up and operating costs. There is also an increase in delivery costs because of the additional stage in supply chains, potential costs associated with additional companies handling goods, and increased transaction costs

(Browne et al., 2005; Dablan, 2007; Quak and de Koster, 2007; Marcucci and Danielis, 2008; McKinnon et al., 2010; Álvarez and de la Calle, 2011). High investment costs in developing, constructing, or restructuring the infrastructure is also a challenge. For example, it is costly to build and maintain new (cargo) tramlines, underground distribution links, new fuel stations, dry ports, hubs, and intermodal terminals. It is also costly to shift the fleet to more environmentally friendly ones and develop new fossil-free fuels as well as clean/green/environmental technologies (EU, 2011; Binsbergen and Bovy, 2000; Angheluta and Costea, 2011).

4.2.4 Operationalization

Several factors make sustainable urban freight distribution operationally challenging. One is the considerable lack of knowledge and understanding of the nature of city logistics and initiatives/themes. The problems caused by freight transport and distribution in urban areas are far less well understood (Browne et al., 2005; McKinnon et al., 2010, p. 286). A comprehensive evaluation and evidence-based information of full financial, environmental, and social impacts of city logistics initiatives is lacking in the literature, too.

Another factor is the reluctance of city logistics stakeholders to accept or participate in initiatives. For example, night deliveries where the receiver must be present when the delivery is made are not always acceptable (Munuzuri, et al., 2005). There are also concerns about higher driver wages, higher reception/dispatch costs, and safety when it comes to night deliveries (Anderson et al., 2005). Another common example is the construction and operations of a UCC initiative that may be ultimately doomed to fail if those who are the potential customers refuse to participate. There are some evidence-based studies attesting that businesses with frequent, differentiated, and high-volume deliveries are less willing to use UCC services (Marcucci and Danielis, 2008) where much of the urban freight is already consolidated at the intra-company level or by parcels carriers (Browne et al., 2005; McKinnon et al., 2010). In most of such businesses, the vehicles are already fully loaded. In addition, businesses dealing with valuable goods (van Rooijen and Quak, 2010) as well as bars, restaurants, and hotels – which demand higher frequency, punctuality, and logistics quality – (Marcucci and Danielis, 2008) are more reluctant to participate. McKinnon et al. (2010) also elaborate on difficulties that may emerge for a single UCC as it may be unable to handle the wide range of goods moving in and out of an urban area, due to such factors as different handling and storage requirements. Browne et al. (2005) add that: *“A single consolidation center for an urban area is unlikely to be attractive for many suppliers’ flows due to the degree of diversion required from normal route (and may therefore negate transport savings for onward distribution).”* Obligation and compulsion can also threaten the sustainability of UCCs by making the potential customers as well as private sector unwilling to participate and/or pay (McKinnon et al., 2010).

Inefficiency in urban freight distribution is another factor that can make the operationalization of sustainable development challenging. It is fairly challenging to improve the efficiency of urban mobility while ensuring environmental quality and economic growth as well as maintaining livable communities (Figliozzi, 2011; Gebresenbet et al., 2011). Inefficiencies in urban freight transport can occur as a result of existing road layouts or traffic levels, unintended consequences of non-freight urban transport policies on freight transport operations (e.g. the introduction of bus lanes), variations in urban freight transport policy measures in different urban areas or different parts of a single urban area (McKinnon et al., 2010), and counterproductive institutional roles and procedures (Jönson och Tengström, 2005).

4.2.5 Uncertainties

Another challenge is related to uncertainties inherited in different aspects of urban freight distribution and sustainability. There are several strategic uncertainties regarding production capacities and logistics of new fossil-free fuels, design/location and capacity planning/viability of supply chain static resources (like distribution centers, UCCs, terminals, facilities) in urban areas, construction of new infrastructures, behavioral effects of congestion charging regimes, etc. (Angheluta and Costea, 2011; Marcucci and Danielis, 2008; Hensher and Puckett, 2008; Awasthi et al., 2011). There are also operational uncertainties due to unexpected/unforeseen incidents like order cancellation, delivery time changes, new customer requests, traffic congestion, road construction, flea markets, natural disasters, weather changes, accidents, and mechanical failures (adapted from Zeimpekis et al., 2008). Other uncertainties are due to the psychological reluctance of customers to buy clean technologies, as they might not be fully convinced of their practicability and chance of survival on the market (Angheluta and Costea, 2011).

Finally, yet importantly, there are uncertainties, dilemmas, and misunderstandings regarding paradoxical/contradictory/antagonistic effects of freight distribution activities/initiatives in urban areas. For example, “Lean” and “just-in-time” (JIT) may increase service levels and efficiency of freight distribution while at the same time leading to small order problems and increased less-than-truckload (LTL), empty running, costs, congestion, fuel consumption, and GHG emissions (Gebresenbet et al., 2011; McKinnon et al., 2010). There are also dilemmas in decision making for the facility location of static resources. For example, locating distribution centers close to customers’ locations may increase traffic congestion in urban areas while locating far from them may increase costs of transportation or destroy green fields (Awasthi et al., 2011; Toh et al., 2009).

4.2.6 Lack of visionary leadership

Today, there is a lack of visionary leadership in making urban freight distribution sustainable as visions and goals are vague, short-term market perspectives are in focus, and potential long-term benefits of initiatives and legislation are misunderstood (Petersen, 2006; Angheluta and Costea, 2011). This is a real challenge in the construction and development of infrastructures as they last for several decades; it takes many years to plan, build and equip them, and considerable investment will be needed (EU, 2011). In addition, there are tremendous difficulties in creating a new and innovative urban mobility culture that all stakeholders accept and follow the legislation and initiatives (Zuccotti et al., 2011; Pawlak and Stajniak, 2011). To change and shift the organizational culture is also tied to behavioral challenges, as there is a very high inertia and resistance to change. Sustainable development brings significant challenges to traditional business models – which have a clear focus on financial aspects only – and the ways that different stakeholders define their missions and strategies, and organize their work and operations (Jönson and Tengström, 2005; Goldman and Gorham, 2006; Weber, 2003; Browne et al., 2005).

4.2.7 Corporate governance

Another challenge is related to corporate governance of freight distribution in urban areas. For example, there are bureaucratic difficulties (Jönson and Tengström, 2005) and administration barriers (Angheluta and Costea, 2011) embedded in decision making where several actors at different levels, from municipality and regional to state levels, influence urban distribution. Other dimensions of the difficulty of corporate governance of urban freight distribution are variations in urban freight transport policy measures in different urban areas or different parts of a single urban area (McKinnon et al., 2010; Anderson et al., 2005), governmental policies

(Quak and Tavasszy, 2011) and rules (Dablanc, 2007) related to zoning, emissions, vehicle restrictions, and access conditions to roads and terminals. The scenario becomes even more complex when it comes to the development of sustainable and integrated/united continental or global governing bureaucracies and measures (EU, 2011).

In an analysis of barriers to urban transport sustainability, Jönson and Tengström (2005, p. 222) highlight the lack of political commitment and national policy framework: *“When the political will is lacking, the problems can be recognized, but are not deemed enough – in practice – for there to be a real change in the system in place.”* On the other hand, Dablanc (2007) elaborates on local policies and similarly concludes that in major European cities, local public policies regarding freight are scarce and out-of-date: *“Because of the impacts of freight on the urban environment, local governments are aware that they should control goods transport activities, but most do not know how” (...)* *“For most cities, existing freight policies do not appear to measure up to the important changes which have taken place in the production, distribution and consumption sectors.”*

Other challenges raised in the literature are: Poor policy integration and co-ordination, unsupportive legal or regulatory framework/ policy measures, wavering political commitment (Jönson and Tengström, 2005; van Rooijen and Quak, 2010); potential to create monopolistic situations, thus eliminating competition and perhaps leading to legal issues (Browne et al. 2005; Toh et al., 2009); and unwillingness to collaboration among producers or between large-scale and small-scale transport companies and uncertainties regarding who takes the initiative (Weber, 2003; Gebresenbet et al., 2011).

5. CONCLUDING DISCUSSION

As it is clear from the identified themes, urban freight distribution cannot become sustainable with just one activity or theme of activities. Instead, a packet of themes of activities and mixed strategies with minimal antagonistic effects on each other is required. The identified themes may help the readers to have a more holistic view on the main activities discussed in literature. Taking a holistic view while development sustainable urban freight distribution is essential in order to understand economic, environmental, and social effects of identified themes on each other and avoid sub-optimal, irrationalized, and based on intuition discussion and decision making. Taking short-term perspective and/or considering urban freight distribution in isolation from their supply chains or other aspects of urbanization will not make them sustainable. It is also important to realize that ‘one shoe does not fit all’. The packet of activities and strategies should also be adaptive as each urban area is unique. Differences among shape, size, nature, and society of urban areas have led to different types of freight distribution inside them. The urban freight distribution needs to be adjusted to the local context and user requirements as well as regulations and policies of a specific city (Gebresenbet et al., 2011). It should also be adaptive to new clean technologies and infrastructures.

5.1 Recommendation for tackling the challenges

In order to tackle the challenges, it is recommended that the complexity of such a complex socio-technical system (urban freight distribution) be harnessed, visionary leadership for transformation of this system towards sustainability be appreciated, and both top-down and bottom-up changes be considered.

Harness the complexity

Urban freight distribution is a complex socio-technical system with tremendous number of interconnected actors/stakeholders and activities which influence its sustainable development. In order to harness this complexity, these actors and activities shall be identified and classified, and their effects on sustainability of urban areas/cities (environmental protection, livable human societies, and economic profitability) shall be managed. In addition, effects of current and future business and market trends on urban freight distribution must be fully investigated. For example, the role of: globalization in distribution industries - and, vice versa, the significance of distribution in globalization – (Markus, 2006), future of ICT (Information and Communication Technologies), and clean technologies deserve full investigation.

Visionary leadership

Urban freight distribution calls for charismatic visionary leaders who may transform it towards sustainability and develop it sustainably. It is also necessary to shape a new culture of sustainable mobility among all the stakeholders where big and innovative ideas be heard, developed, and evolved. Education, information, and innovation are important factors for creation of such culture.

Top-down and bottom-up changes

Both top-down and bottom-up strategies and initiatives should be considered for transformation of complex city logistics towards sustainability. Governmental subsidies, funding, and liberalized policies and restriction are some examples of top-down ones. On the other hand, some bottom-up examples are: collaboration of local stakeholders and practitioners (like retailers, transport operators, shippers, and residents) by taking part in initiatives as well putting pressure on local and central government. Combination of bottom-up initiatives with top-down legislation may increase the chance of acceptance and operationalization of all pillars of sustainable development.

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Who Controls the Logistics Emissions? Challenges in Making Fragmented Supply Chains Environmentally Sustainable from Logistics Service Providers' Perspective

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Who controls logistics emissions?

Challenges in making fragmented supply chains environmentally sustainable from logistics service providers' perspective

Abstract

Purpose – The purpose of this article is to explore the environmental impact of Logistics Service Provider (LSP) activities in the light of increased customer attention and fragmentation of the industry. It also explores to what extent the LSPs can actually monitor the environmental impact of logistics activities in the supply chain?

Design/methodology/approach – The methodology of this paper is a literature review, a qualitative interview survey, and three case studies. A framework on sustainability challenges in supply chains derived from the literature is used to structure and analyze the findings.

Findings – Our findings reveal that despite ambitious environmental schemes communicated by several LSPs, LSPs exert very little control over the actual emissions created from their transport operations. Furthermore, it is clear from this study that any real interest in environmental solutions that impact the cost and time requirements from customers of logistics services are not yet a reality.

Research limitations/implications (if applicable) – This paper implies that LSP sustainability cannot be investigated in isolation if a company does not manage proprietary resources.

Practical implications (if applicable) – Our findings imply that environmental policies between different LSPs appear similar, but in practice differs, which stresses the importance of follow-up control by environmentally aware logistics service buyers.

Originality/value – This paper represents a novel approach as to how LSP environmental policies should be viewed.

Keywords environment, logistics, logistics service provider, LSP, supply chain, sustainability

1. INTRODUCTION

For the past decade, the largest multinational companies have published an increasing number of sustainability reports, Corporate Social Responsibility (CSR) reports, and codes of conduct (Carter and Rogers, 2008), often within their annual report or in separate sustainability reports (Porter and Kramer, 2007). Consequently, their interest in the environmental performance of their outsourced activities is being given attention. Considering the high level of outsourcing of logistics activities and the large number of emissions the logistics activities account for in the supply chain (Wu and Dunn, 1995), the environmental performance of LSPs (Logistics Service Providers) becomes both crucial and challenging to address. Rossi et al. (2013, p. 595) state “LSPs feel pressure from their customers, which is the first driver for sustainability...”. Lieb and Lieb (2010) also report on LSPs receiving increased attention from their customers on environmental initiatives (13% of LSPs receive substantial attention and 50% moderate attention). However, how this pressure or attention is transformed in practice is not clear from relevant literature, especially in the large networks of actors involved in fulfilling logistics services.

Furthermore, many firms act in ways to maximize their own profit and not to maximize supply chain performance (Narayanan and Raman, 2004). As a result, despite the excessive impact logistical activities have on the environment, dealing with environmental challenges in the logistics industry is rather immature (Lin and Ho, 2008; Isaksson and Hüge-Brodin, 2013). For example, in the literature reviews on third-party logistics (3PL) by Selviaridis and Spring (2007) as well as Marasco (2008), environmental issues are not emphasized as central themes or put forward as areas of interest for further research. Wolf and Seuring (2012) report from their study on procurement of logistics services that *“While 3PL reports an increasing interest in environmental issues, buying decisions are still made on “traditional” performance objectives, such as price, quality and timely delivery.”* Furthermore, in one of the few articles on environmentally focused research from an LSP perspective, Maas et al. (2012) conclude that environmental differentiation is only a small part in differentiating LSP offerings and practices, which Isaksson and Hüge-Brodin (2013) also confirm.

Currently, several large LSPs (3PLs), i.e., DHL, DSV and Schenker have CSR policies, but many small and medium-sized LSPs still do not (Piecyk and Björklund, 2012). In addition, very little research has been done on LSPs’ challenges as regards sustainability (Lieb and Lieb, 2010).

Considering that 3PLs typically own a terminal network but only limited transportation resources (e.g., trucks) (Klaas-Wissing and Albers, 2010), both influencing and monitoring emissions of outsourced logistics activities become difficult. Freight transportation from an LSP perspective becomes crucial to address, but fragmentation of the industry makes both studying and managing environmental performance very challenging (Sternberg et al., 2013). As shown by Sternberg et al. (2013), the road transportation market (accounting for the majority of transportation emissions) is dominated by small road haulers both in North America and in Europe; in the US small road haulers make up 75% of all road haulers (ibid). The authors (ibid.) also showed in case studies how the efficiency of logistics operations suffered from coordination difficulties between a plethora of different actors, due to a lack of clear areas of responsibility.

How are the environmentally related requirements from the buyers of logistics services perceived and handled by LSPs? How does the fragmentation of logistics services and the large number of subcontracted service providers, hauliers, and subcontractors influence the environmental work and policies of Logistics Service Providers? In other words, how are the

environmental policies of 3PLs applied in practice, and how do these companies work with their subcontracted transportation suppliers?

The purpose of this article is to explore the environmental impact of LSP activities in the light of increased customer attention and fragmentation of the industry and to explore to what extent LSPs can actually monitor the environmental impact of logistics activities in the supply chain.

In the next section, the research method is presented. It is based on a qualitative interview survey study with selected LSPs operating in the Scandinavian countries and three case studies. The case studies provide deeper insights on the results from the interview survey study. The results from the studies are presented followed by a synthesizing discussion as well as conclusions, implications, and suggested further research.

2. METHODOLOGY

In order to explore the environmental consequences of LSP activities in the light of increased customer attention and the fragmentation of the industry and to gain understanding of the different factors involved, a research design was created consisting of two empirical investigations after an initial literature review. The empirical investigations consist of one qualitative interview survey study with 10 LSPs and three in-depth case studies in order to dig deeper into the challenges found in the interview survey study.

Starting with an initial literature review, a number of relevant articles focusing LSPs and/or environmental challenges in supply chains were reviewed. Based on a recent article by Abbasi and Nilsson (2012) a framework addressing current themes and challenges was deemed applicable for the empirical investigation of environmental challenges of LSP activities from a supply chain perspective. The framework is based on a systemic review and content analysis of articles published in top-ranking journals from supply chain management, logistics, transportation, sustainability and environmental studies, and consists of five main categories of challenges in making supply chains environmentally sustainable; costs, complexity, operationalization, mindset and cultural changes, and uncertainties (see Figure 1). These five categories were used as the framework for the interview survey study. Subcategories for each of the dimensions were created, and questions formulated in order to explore the LSP perspective on sustainability challenges they are facing. In this paper the aspects and questions related to environmental challenges are reported, while the interview survey also incorporated the social aspects of sustainability.

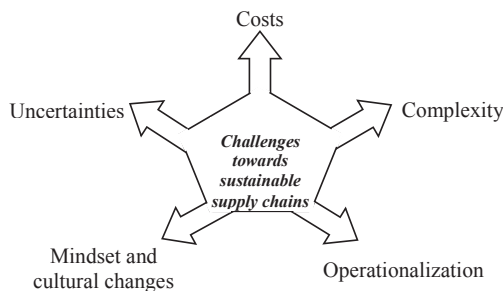


Figure 1- The five main areas of challenges facing environmentally sustainable supply chains (Abbasi and Nilsson, 2012)

2.1. Interview survey study

A sample number of 30 LSP companies (including 3PLs, various transport operators and midsized hauliers) operating on the Scandinavian market were identified and contacted for interviews. In total, 10 companies agreed to participate. The interviews were divided into two parts: the first part with open-ended questions asking about current and future activities related to environmental issues as well as company challenges. The second part was based on a survey derived from the challenges presented by Abbasi and Nilsson (2012). In line with Leeuw et al.'s (2008) guidelines for conducting a survey, the following steps were taken: design, implementation, and data analysis. After the questionnaire was designed, feedback for improvement was received from both academics and industry representatives. When answering the survey questions (a 5-degree Likert scale) the interviewees were asked to reason out loud how and why they made their choices. Their reasoning was recorded and later on transcribed for analysis. The analysis of the result involved both the qualitative reasoning and the quantitative marks given by the respondents. This research process provided insights into the difficulty of grading some of the issues addressed while other issues were much easier to assess/grade. On many occasions the interviewees first reasoned about answering with a score of 2 or 3 but after some reasoning they gave a 5 on the Likert scale or vice versa. The uncertainty and the great variety of dimensions to handle were raised in different ways at the same time as interviewees felt that some of the measures that can be made in improving environmental performance are quite obvious.

Table 1: An outline of the experts included in the study. Companies with 100 to 500 employees were classified as medium.

Interview number	Position of the interviewee(s)	Size of the company	Main transportation mode
1	Regional managing director	Medium	Rail and road
2	Regional managing director	Medium	Road
3	Regional manager	Large	All modes
4	Sustainability manager	Large	Sea
5	Environmental manager	Large	Air
6	Environmental and quality manager	Large	Rail and road
7	Managing director	Medium	Road
8	Environmental/quality manager	Large	Road (mainly), Rail
9	Managing director, environmental manager, quality manager	Small	Road
10	Environmental manager and business developer	Small	Road

2.2. Case studies

The interview survey study revealed a number of areas that are challenging for LSPs not least concerning costs and the difficulties in managing both customers and suppliers when it comes to sustainability issues. In order to understand these areas in more detail we decided to explore it further in three case studies. The case study design was chosen since it focuses on understanding the dynamics present within single settings (Eisenhardt 1989; Ellram, 1996) in order to gain a deeper insights of the phenomena being studied. Aiming to illustrate the interdependency and complexity of organisationally nested planning and control structures in supply chain transportation, the case-study approach was used.

The three cases involve two of the major LSPs operating pan-European networks and with a strong presence in the Scandinavian market, and one medium-sized LSP operating in the Nordic market. All were chosen for their environmental profiles, accessibility, and their interest in the research area. Data was gathered from the cases based on interviews, sustainability reports, websites, and internal documentation of the number, setup, and type of subcontractors involved. A convenience selection of the subcontracted haulers of the two LSPs was interviewed with the purpose of studying follow-up procedures that particularly focused on the environmental relevant aspects of their operations.

- Case A begins at the LSP where interviewee 3 is employed. In addition, three complementary short interviews with follow-up questions were conducted with two environmental managers, one on the European level and one on the Scandinavian level of the same company, and with one account manager on international level. To investigate the effects in practise, the hauler of interviewee 8 was mainly studied.
- Case B consists of an LSP (the company of I8) and an interest organization representing the Scandinavian subcontractors of the Case B LSP. The LSP and its subcontractors have an open attitude to research involvement, so extensive additional data and interview material from previous research studies were available for comparison.
- Case C focuses on one of the LSPs taking part in the survey and explores the development of environmental logistics concepts that provided their customers with lower CO_{2e} impacts as well as lower costs.

3. INTERVIEW SURVEY RESULTS

The following sections present the results of the interview survey based on the framework by Abbasi and Nilsson (2012).

A. Costs. Interviewees were asked to reflect upon the following: the costs of developing sustainability-prioritized logistical solutions (like services, infrastructures, fuels, technologies, education, and training) (A.1); the difficulties of quantifying the costs of environmental degradation (A.2); and the importance of payback for environmentally friendly/green solutions from customers or from other instances (A3).

Table 2: LSPs' opinions about challenges related to costs (Total answers (Respondents)).

<i>A.1. To develop and carry on logistical solutions where sustainability is prioritized cost _____ than development of those solutions where sustainability is less prioritized.</i>	1 <i>Much less</i>	2	3 <i>Same</i>	4	5 <i>Much more</i>
	0	3 (I1, I2, I4)	2 (I3, I9, I10)	3 (I5, I6, I8)	1 (I7)
<i>A.2. Quantifying environmental costs of operations, activities, and processes is:</i>	1 <i>Very easy</i>	2	3	4	5 <i>Very difficult</i>
	1 (I4)	1 (I5)	1 (I8, I10)	4 (I3, I6, I7, I9)	2 (I1, I2)
<i>A.3. It must financially pay to be green:</i>	1 <i>Not important</i>	2	3	4	5 <i>Very important</i>
	1 (I2)	0	3 (I4, I5, I6)	2 (I1, I3)	4 (I7, I8, I9, I10)

Although developing sustainability-prioritized logistical solutions, from LSPs' perspectives, may not necessarily cost more than non-prioritized ones, the issue of costs was interpreted in different ways. Sustainability-prioritized logistical solutions can cost less (I1, I2, and I4) or the same (I3, I9, and I10) in the long term and/or if the costs are shared among the supply chain stakeholders. The rest of the interviewees stated that even though every solution might not trigger costs, it is costly to, for example, develop new clean technologies, vehicles, and fuels; *"If you, for example, look at the second or third generation of biofuels this cost should show itself somewhere"* (I8).

Most of the interviewees agreed upon difficulties in quantifying the environmental costs of logistical operations/activities and processes. This can be due to, for example, lack of standards (I1) and differences among modes of transportation (I8). As a result, it was argued that it is difficult to include costs of environmental degradation of logistical operations/activities and processes in total costs.

That it must pay to be green is something most respondents find important or very important. I2 is the only one to have a different view, recognizing the challenge of becoming sustainable must be prioritized and that the benefits for the company are indirect and longer term. All the interviewees argued, more or less explicitly, that transportation is too cheap and the main things their customers prioritize are cost and time.

B. Complexity. In the next step, the interviewees were questioned about difficulties of diagnosis, measurement, and assessment of the environmental effects of logistical operations/activities and processes (B1 and B2 in Table 2). They were also asked if antagonistic effects and paradoxical conflicts exist in the sustainable development of their supply chains (B3 in Table 2).

The most elaborated-on environmental effect was that of CO₂e emissions. Just as they have different perceptions of difficulties in diagnosing environmental effects, LSPs also express different degrees of difficulty in measuring and assessing the environmental effects of logistical operations/activities and processes.

Table 3 - LSPs' opinions about challenges of complexity.

	1 Not difficult	2	3	4	5 Very difficult
<i>B.1. Diagnosis of environmental aspects and effects of logistical operations, activities and processes is:</i>	1 (I4)	4 (I1,I6, I7,I8)	0	2 (I3, I10)	3 (I2,I5, I9)
<i>B.2. Measurement /assessment of environmental effects of the logistical operations, activities and processes is:</i>	0	4 (I2,I4, I7,I10)	1 (I1)	3 (I3,I6, I8)	2 (I5,I9)
<i>B.3. There are paradoxes in sustainable development! (e.g. making one part sustainable may make another part unsustainable)</i>	1 Do not agree	2	3	4	5 Fully agree
	1 (I2)	0	2 (I3,I5)	3 (I4,I7, I8)	4 (I1,I6, I9,I10)

Two of the interviewees (I4 and I7) do not experience difficulties in either diagnosing or in measuring and assessing the environmental effects of logistics operations. On the other hand, I2 experienced major difficulties in diagnosing but not so much in measuring and assessing.

I8, who experiences less difficulty in diagnosing while much in measuring and assessing states: “... It is easier to know the emissions, for example, but their effects or how much damage they cause are not so easy to assess.”

Some of the interviewees shed light upon Corporate Social Responsibility (CSR) and highlighted some of its aspects like education, training, safety, and customer satisfaction, “We are not the direct employer of the drivers ... but of course we have to take responsibility for road accidents involving trucks which have our logotype ... we communicate this to our haulers. We have also training modules for drivers and interactive programs for haulers which they can access by the internet. We have a spot where our haulage companies can log into when they have a contract with us. We have, of course, direct communication with our haulers as well.” (I8)

The last category of complexity-related challenges focused on the antagonistic effects and paradoxes in making supply chains sustainable. Almost all the interviewees agree with the existence of paradoxes in sustainable development. For instance, I1 refers to carbon leakage from transportation involving electric vehicles to production of electricity. I6 explains that exports, which enable increases in GDP, may increase the demand for logistical services, transportation intensity (ton-km), and traffic intensity (vehicle-km), and as a result lead to higher environmental degradation. I8 elaborates on the dilemma concerning decreasing fill rates/resources utilization, higher service levels, and environmental degradation by stating: “There is a dilemma when it comes to ‘customer service’! We would like to offer daily departures for our customers but then we get a lower degree of utilization ... so, we have to find out what is acceptable for the customers and at the same time increase the fill rate ... And I think that our industry or line of business is a little guilty as we have been competing with daily departures and perhaps the transportation buyers may not need these services ...”.

C. Operationalization. The challenges of operationalization of sustainable development due to difficulties of interpretation and organizational inertia have previously been discussed (Abbasi and Nilsson, 2012) (C1 and C2). Table 3 summarizes the interviewees’ opinions about these challenges.

Table 4 - LSPs’ opinions about the challenges of operationalization.

	1 Not difficult	2	3	4	5 Very difficult
C.1. Interpretation of dimensions of sustainable development (triple-bottom lines) in logistical operations/ activities and processes is:	1 (I10)	2 (I4,I5)	2 (I1,I8)	2 (I2,I3,I6,I7, I9)	0
C.2. Inertia (resistance to change) in the organization against the development of environmentally sustainable operations/ activities and processes is:	0	5 (I1,I2,I4,I6, I7)	2 (I5,I10)	3 (I3,I8,I9)	0

One challenge concerning the operationalization of sustainable development is the difficulty in interpretation and integration of all its dimensions/pillars. Similarly, the majority of the interviewees experience difficulties in interpreting and implementing sustainable development in the context of logistics. I7 highlights the operationalization challenges with their subcontractors; “I usually say that we made a journey together with our haulers. [...]

Nowadays, we also have environmental demands which they have to fulfill in order to qualify as a subcontractor or hauler for us.”

Organizational inertia and resistance to change in developing environmentally sustainable operations were raised as challenges in the literature (Abbasi and Nilsson, 2012). This challenge is less often mentioned by interviewed LSPs (5 interviewees regard inertia as low and only 3 as high). However, in discussion some issues emerge, e.g. I8 perceives high inertia due to the conservativeness of the owners of the company and their fear of change, and I3 reflects on the fact that there is less inertia among younger colleagues than older ones.

D. Mindset and Cultural Changes. The interviewees were asked to reflect upon difficulties in changing the mindsets and behavior of three of their stakeholders, namely customers, decision makers, and coworkers (D1, D2, D3, D4, D5, and D6). The results are shown in Table 4.

Table 5 - LSPs’ opinions about the challenges of mindset and cultural changes.

	1 Not difficult	2	3	4	5 Very difficult
<i>D.1. Making customers aware of the dimensions of sustainable development is:</i>	0	2 (I4, I10)	2 (I5, I7)	2 (I3, I6)	4 (I1, I2, I8, I9)
<i>D.2. Changing customers’ behavior is:</i>	0	1 (I3)	2 (I4,I10)	1 (I7)	6 (I1,I2,I5,I6,I8,I9)
<i>D.3. Making decision makers aware of the dimensions of sustainable development is:</i>	1 (I1)	4 (I2,I3,I8, I9)	5 (I4,I5,I6, I7, I10)	0	0
<i>D.4. Changing decision makers’ behavior is:</i>	1 (I1)	3 (I2, 3,I8)	5 (I4,I5,I6, I7,I10)	1 (I9)	0
<i>D.5. Making coworkers aware of the dimensions of sustainable development is:</i>	2 (I1,I2)	2 (I6,I9)	4 (I4,I7, I8,I10)	2 (I3,I5)	0
<i>D.6. Changing coworkers’ behavior is:</i>	1 (I1)	2 (I3,I6)	6 (I2,I4,I7, I8,I9,I10)	1 (I5)	0

To change mindset and culture call for awareness about sustainable development and its dimensions/pillars is raised in the literature as a key factor in sustainable development. Just as they have major difficulties in interpretation and implementation of sustainable development, LSPs have the same feeling for making their customers aware of what sustainability development means and the dimensions it has; *“We have customers of all sizes ... the bigger ones are well aware and to some extent even push us. However, the majority are not well aware or at least not willing to change their buying patterns”* (I8).

Although it is fairly difficult to increase sustainability awareness of customers, it is even more difficult to change their behavior according to the interviewees. Concerning their customers I6 states that *“They are very good at placing demands on us. And they tell us what they think we should do although they do not do it themselves. They put pressure just on us.”* As raised several times during the interviews, time and cost are prioritized by customers and when more sustainable alternatives are presented that either cost a little bit more or are less time-accurate these alternatives are often omitted in the process.

The interviewees had different perceptions when it came to sustainability awareness as well as changing the behavior of both decision makers and organizational coworkers. The increase in awareness and change of behavior of decisionmakers and coworkers as regards sustainability was as difficult and challenging as other changes in their organizations. Consequently, it was regarded to be more of a normal management challenge than specific to sustainability.

E. Uncertainties. Uncertainties about governmental regulations and policies (E1) as well as long-term development (E2) are reported in Table 5.

Table 6 - LSPs' opinions about the challenges of uncertainties.

<i>E.1. Uncertainties about the degree and nature of governmental regulations and policies are:</i>	1 Very low	2	3	4	5 Very high
	0	2 (15,110)	4 (14,16, 17,19)	2 (13,18)	2 (11,12)
<i>E.2. Uncertainty about long-term development is:</i>	1 Not challenging	2	3	4	5 Very challenging
	0	1 (15)	2 (16,19)	4 (13,14, 17,110)	3 (11,12,18)

The LSPs interviewed are unaware of, and uncertain about, future regulations, policies, and legislations formulated by governments and policy makers. They are also very uncertain about sustainability-related strategies formulated by supply chain stakeholders as well as customers' behavior and future demands.

4. Case studies

The interview survey revealed, among other things, that two main themes – customer priorities and the fragmented industry (large LSPs and small haulers) – are challenging for sustainable development. In order to further explore why and how the two themes are influencing logistics service operations in practice and especially the challenge of making supply chains sustainable we decided to dig deeper into the themes in three case studies.

The 3PLs rarely own or govern any trucks but instead buy transportation and other logistics services from haulers (Stefansson, 2006, Sternberg et al., 2013). One of the 3PLs interviewed was in the process of selling off their proprietary fleet (150 trucks) in order to be more flexible and competitive. Some of the haulers report that the requirements from 3PLs have increased in terms of certificates and follow-up questionnaires. Consequently, these case studies will elaborate on how the environmental policies of large LSPs are applied in practice and how these companies are working with their subcontracted transportation suppliers.

Case A consists of a 3PL (the company of I3) and one of their thousands of subcontractors, a hauler (represented by I7 in the interview survey). I7's trucks are profiled with I3's logo and colors. Manager I3 states: "We work really hard with measurements and calculations", and "we are well ahead in the holistic perspective". The 3PL assist their customers to a great extent in setting up various environmental performance measurements processes, e.g. CO₂ reporting. The claims from the 3PL were followed up with I7.

Table 7: Case A - summarizing perspectives on environmental policy and follow-up

	LSP	Subcontracted hauler
Environmental policy	Runs an extensive environmental program and has an ambitious CSR policy.	No environmental policy.
Reporting	Produces detailed environmental reports for customers. Supervising environmental reporting.	Produces pro forma reports for the LSP, sometimes under supervision from the LSP.
Sample environmental activities	Central organization pushing sustainable vehicles (e.g. gas-fueled trucks) to subcontractors.	No activities dedicated to the environment.

I7 told the authors about when the LSP called the hauler and wanted them to purchase environmentally friendly vehicles. As of today they mostly use Euro3 trucks and state: “They tell us to drive environmentally friendly vehicles, but in the end all they really care about is the lowest price”¹. The LSP generally pays their subcontracted haulers a fixed price based on either the line operated or the actual distance/weight of an assignment.

In addition to the two interviewees, an additional interviewee (sales manager) of the LSP was contacted. When asked about how the environmental program of the LSP is carried out, he explains: “Our environmental program is very ambitious, but the main goal is for it to be selling. When the goods are moved by our subcontractors, we actually don’t know how they do it.”

4.1. Case B (I7)

The majority of the trucks belonging to the member companies are painted with the logo and colors of the LSP (I8). “They are not our trucks, but they are painted with our logotype and we have to take responsibility”(I8). When asked about whether it should be financially beneficial to be green, I8 comments: “If you look at individual/small haulage companies, it is not fair it should be those that carry the burden ...”.

Table 8: Case B - summarizing perspectives on environmental policy and follow-up

	LSP	Subcontracted hauler
Environmental policy	Runs an environmental program and has an ambitious CSR policy.	Obligated to apply the environmental policy of the LSP.
Reporting	Produces detailed environmental reports for customers. Supervising environmental reporting.	Produces detailed reports for the LSP, actively monitored and supervised by the haulers’ interest organization.
Sample environmental activities	Training programs for subcontracted haulers.	Activities are agreed on between the LSP and the interest organization.

“We do work together in most questions and share most of the objectives for the future”, says one of the managers of the interest organization. The annual follow-up survey the LSP and the interest organization carry out jointly contains various questions on driver training (e.g., details on the percentage of drivers with eco-driving or dangerous goods training), driver

¹ During the interviews, the interviewed hauler was close to bankruptcy.

social conditions (e.g., union agreements and contracts), and truck specifications (e.g., engine types).

An additional interviewee from the LSP, working with environmental calculations explains: “Sometimes we just used standard aggregate values, but whenever possible we used the audits on the fleets from the subcontractors involved in moving a particular customer’s goods... the methods we use could hardly be called scientific, but at least we try. In tenders, sometimes customers would ask us to hand in information on the expected environmental impact and we would calculate it based on the local subcontractors’ fleets, but we have no clue as to how our competitors calculated.”

This LSP operates mainly based on revenue-sharing contracts with most of their subcontracted haulers. Given the high level of commitment and in-depth collaboration with their subcontractors, we asked a market manager of the same LSP for his opinion about offering logistics services with a, compared to competitors, relatively higher level of environmental and social responsibility. He answers: “We are increasingly facing difficulties in competing; in the south of Sweden we are unable to sell any full truck loads, because the customers are not prepared to pay for our responsible service.”

4.2. Case C

The third case (the company of I1) is based on previous joint research studies together with follow-up studies of actual outcomes and reflections. Being an LSP focusing on environmental solutions, one of the central services they provide for their customers is the coordination of deliveries to stores by intermodal transportation (freight train and last-mile truck service). The goods being handled are mainly fast-moving consumer goods sold in the retail stores where the LSP focus is on delivery operations, i.e. the pickup, loading, distribution, unloading, and return flow of products in the Swedish and/or Nordic region. Based on advanced planning and visualization tools the company developed different alternatives for their customers that explicitly provide environmentally friendly alternatives together with competitive time, quality, and cost setups.

One of their large customers which the company had provided with logistics services for several years, was in the procurement process for a coming period where the environmental aspects were highlighted as very important. The company responded with different solutions, all incorporating environmental priorities.

Table 9: Case C – Summary of a suggested delivery setups presented to the 3PL customer.

	Current setup (deliveries M,T,W)	Suggested setup (deliveries M,W,T)
Deliveries	56	56
Pallets	120	120
Truck delivery distance (KM)	9558	6599
Trucks needed	40	24

Table 9 illustrates one of the suggestions, combining train and truck, where the company coordinates the deliveries with other customers in one region in Sweden, and instead of having deliveries on Mondays, Tuesdays, and Wednesdays it has deliveries on Mondays, Wednesdays, and Thursdays. The trade-off is that the deliveries cannot be as time- accurate as before, as well as more costly administration (planning, etc.). The suggested solution lowers

transportation distance by 31% in the delivery stage and thus also the environmental impact in terms of CO_{2e}. Including the first stage transportation by train, the solution in total showed even greater reduction of CO_{2e} compared to road transportation all the way. Furthermore, due to fewer trucks needed, i.e. improved fill rates, the areas where the stores are located have total fewer trucks driving around, which also is beneficial for traffic and people in the same area.

Nonetheless, the customer decided to procure the logistics services from another 3PL, only using road transportation solutions, with the motivation that the competitor was both less costly and higher delivery time precision. Consequently, while the importance of environmental solutions was raised, at the end of the day it was all about cost and time. Or, as the manager at the LSP company expressed it: “customer behaviors today are the opposite of what is needed” in order to reach the targets set for CO_{2e} reductions. He continues by arguing that: “it is not the more environmentally friendly solutions, but the less environmentally friendly solutions that should cost the most.”

4.3. Synthesis

Having policies is one thing, acting on them is another. The interview study and the case studies confirmed that, from an LSP perspective, a majority of buyers of logistics services focus on service quality and price – not on sustainability.

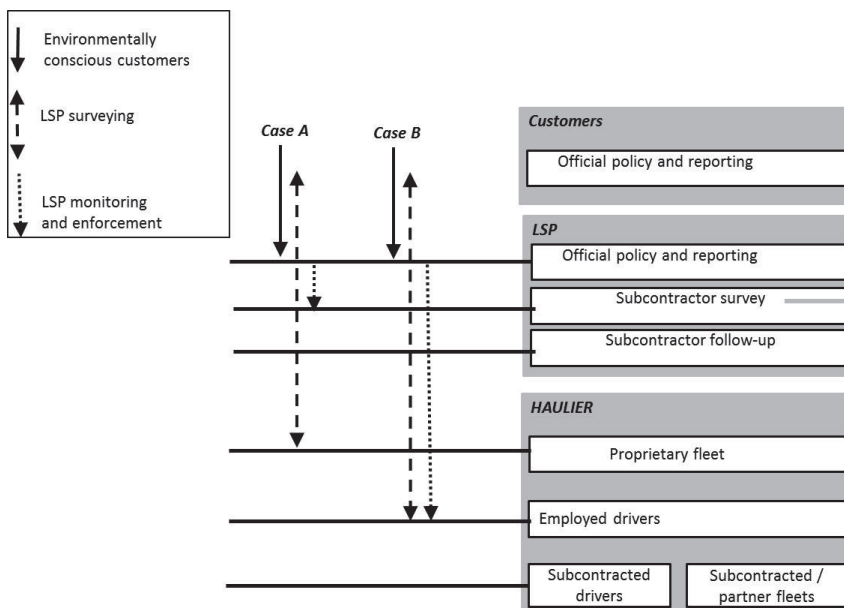


Figure 2: An illustration of the difference between LSP policy and practice. Some customers actually do not reflect over the environment at all, which means they are not depicted in the figure.

The cases revealed a great difference between how two LSPs (Case A and Case B), with similar CSR and environmental policies enforce and monitor their subcontractors differently. This difference in actual practice might have major implications on the validity of environmental or sustainability reports. As shown in the literature, the fragmented industry means that many haulers are subcontractors to other haulers. We found no evidence that what

are called subhaulers are involved in the environmental monitoring of LSPs, as illustrated in Figure 2.

Furthermore, as highlighted in Case C, one major reason for the lack of actual monitoring and follow-up of the environmental performance of haulers and other subcontractors from 3PLs is the lack of real interest from customers. As one representative from the 3PL in Case B expresses it: “I have never been involved in a customer asking for any environmental reports in the procurement process...”

5. CONCLUDING DISCUSSION

Overall, it can be concluded from the interview survey that the issues of sustainability are complex, involve a great deal of uncertainty, and are challenging to operationalize; all of which are also raised and discussed in the relevant literature. However, for the specific context of logistics services there are some interesting aspects that need further exploration. One is how problematic the current business models are, where all pillars of sustainable development are more or less sacrificed for short-term financial sustainability, especially due to the customer’s single focus on time and cost when selecting logistics service suppliers. Consequently, the hunt for ever less costly activities at the same time as the margins in the industry are very low, lead to operational fix solutions rather than strategic directions and innovations that, in the long term, lead to sustainable development. As reported in literature (Oke, 2007; Wagner, 2008) innovation focus and the share of innovators are low in the logistics industry. Furthermore, when innovation activities are carried out by LSPs the focus is most often on proactive cost improvement and proactive performance improvement in order to generate customer loyalty (Wallenburg, 2009). The dominating cost and efficiency focus has led to an earning-without-paying perspective in more than half of the LSPs interviewed. From this perspective, it is acceptable to make a profit without paying attention or money to environmental degradation or social vulnerability. Consequently, one of the most environmentally impacting industries is under cost and efficiency pressure from its customers at the same time as the level of innovation is low. As a result, as already concluded by Wu and Dunn (1995, p. 34) “Logistics has been a missing link in providing green products and services to the consumer”, logistics seems still to be the missing link and a non-prioritized area in supply chains.

The fragmentation of the logistics industry today makes coordination and overall development difficult at the same time as the major drivers for most LSPs have been to deliver less costly alternatives and more accurate deliveries at the expense of their own long-term development.

5.1. Managerial implications

In this paper we have illustrated the complexity involved when large logistics service providers are trying to monitor hundreds of domestic suppliers. The majority of the activities in physical distribution are not carried out by the LSPs themselves. Supply chain managers looking for sustainable or “green” logistics services need to look further than LSP reports in order to ensure the degree of sustainability promised by logistics service providers and they also need to scrutinize how LSPs are performing follow-ups. Furthermore, as it is clear from this study that any real interest from customers of logistics services is not yet a reality, policy makers and senior managers need to address the issues of more environmentally friendly solutions if the goals needed and changes set by the EU and others should be reached.

5.2. Future research

While this research has investigated how environmental policies are put into practice, we have not addressed the social aspects of the LSPs' CSR policies. Considering the fragmentation in the industry and the low transparency and follow-up of environmental policies, social sustainability in the transportation industry might show similar characteristics.

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Appendix I

Interview Guide of the Research Study 2 (RS2)

Interviewers: Maisam Abbasi and Fredrik Nilsson

1.1. Information collection during the interviews

Background Information

Gender:

Years of experience:

Department:

Position:

Main tasks / functional job:

1.1.1. Current sustainability-related issues

The aim of this section is to:

- Define aspects of sustainable development from interviewees' perspective;
- Diagnose 3PL's sustainability-related operations & activities;
- Analyze operations of 3PL's supply chains.

1) How do you deal with/define sustainable development? *[In this case, the interviewers and interviewees can match their definitions, perceptions, etc. – Lead to delete of misunderstanding]*

2) How do you deal with/define sustainable development for a TPL/ goods transport sector? *[Finding themes of sustainable development for goods transport industry]*

3) Supply chain related questions: *Actors that they collaborate with, modes of transport that they use, information about 'fill-rate' and 'resources utilization'*

1.1.2. Future sustainability-related issues (Till 2020 & 2050)

The aim of this section is to:

- Diagnose and analyze 3PL's future sustainability-related strategies, operations & activities;

1) What have they planned/ what strategies do they have for sustainable development till 2020 & 2050? *[Ask if they have shorter or longer vision than 2020]*

1.1.3. Challenges of sustainable developing

The aim of this section is to:

- Diagnose current as well as probable future challenges for sustainable development;
- Diagnose remedies for challenges.

1) What were the difficulties, barriers ... for sustainable development till today?

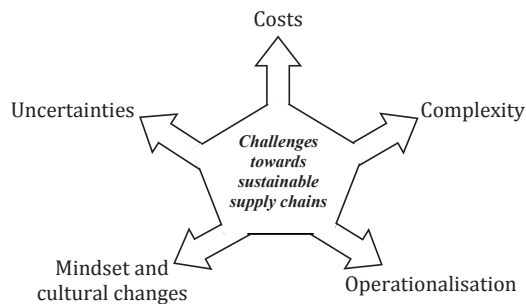
- 2) What difficulties, barriers... do you predict/expect till 2020 & 2050? [*Ask if they have shorter or longer vision than 2020*]
- 3) What do you suggest for mitigation/elimination of challenges?

1.1.4. Complementary questions / survey

The aim of this section is to:

- Compare theoretical findings of first article with what happens in reality/practice.

Results of a comprehensive literature review on ‘challenges of developing sustainable supply chains’ revealed five main categories of challenges, namely: *Costs, Complexity, Operationalisation, Mindset & Cultural changes, and Uncertainties*. How do you assess relevance of these challenges for your organization?



A. Costs

A.1. To develop and carry on logistical solutions where sustainability is prioritized cost _____ than to develop and carry on solutions where sustainability is less prioritized.

1
Much less
 2
 3
Same
 4
 5
Much more

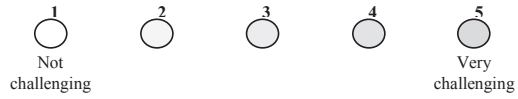
A.2. Quantifying environmental costs of processes/ activities is:

1
Very easy
 2
 3
 4
 5
Very difficult

A.3. It must financially pay to be green:

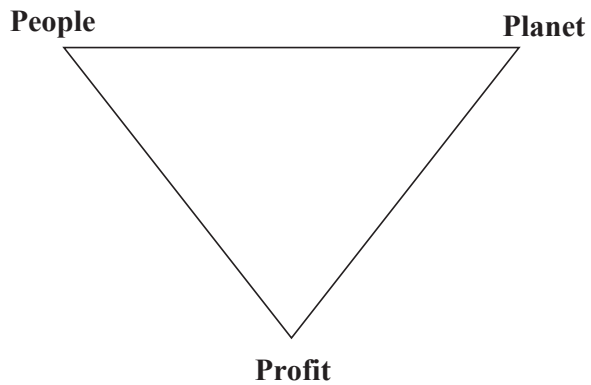
1
Not important
 2
 3
 4
 5
Very important

E.2. Uncertainty in long-term development is:



Appendix

Where does the work of your organization regarding *sustainable development* fit in the picture below?



Appendix II

Codification of the Central Challenges

<p>Shifting the values</p>	<ul style="list-style-type: none"> • Increasing financial costs in reducing negative environmental impacts (RS1) • Higher average costs of freight distribution in urban areas (short distance) than inter-city (long distance) freight distribution (RS4) • High set-up and total costs of city logistics initiatives especially in the short term (RS4) • High investment costs in developing, constructing, or restricting the infrastructure (RS4) • Restructuring of urban distribution due to globalization (global- change and chain) (RS4) • It must financially pay to be green (RS1) • Unequal weighting of social aspects, in compare to economic aspects, of sustainability (RS2) • Exclusion of social degradation costs in the total costs (RS2) • LSPs customers usually look at transport as a non-value activity which must be fulfilled with lowest time and price (RS3) • Low sustainability interest of the customers (RS3) • Low united sustainability interests inside LSPs (especially the global ones) (RS3) • Changing the business models (RS2)
<p>Difficulties of operationalization</p>	<ul style="list-style-type: none"> • Interpretation of dimensions of sustainable development in operations/processes/activities (RS1) • Interpretation of the Brundtland Commission definition in concrete operational terms (RS2) • Considerable lack of knowledge in understanding what city logistics and its initiatives/themes are (RS4) • Making customers aware of dimensions of sustainable development (RS1) • Making decision-makers aware of dimensions of sustainable development (RS1) • Making co-workers aware of dimensions of sustainable development (RS1) • Diagnose of environmental aspects/effects of operations/processes/activities (RS1) • Diagnose of social aspects/effects of operations/processes/activities (RS1) • Inadequate and asymmetric knowledge about different aspects of social sustainability (RS2) • Low attention to social sustainability in the entire supply chain (RS2) • Inertia against development of environmentally sustainable operations/processes/activities (RS1) • Inertia against development of socially sustainable operations/processes/activities (RS1) • Organization inertia (<i>due to different cultural backgrounds, values, norms, expectations, mental models, cognitive perceptions, legal frameworks, governing styles</i>) (RS2) • Inertia and resistance to change (RS4) • Change of mind-sets/culture/values on international-, national-, and organizational levels (RS1) • Change of customers' behaviour/mind-sets/culture/values (RS1) • Change of decision-makers' behaviour/mind-sets/culture/values (RS1) • Change of co-workers' behaviour/mind-sets/culture/values (RS1) • Changing the employees' and customers' attitude (RS2) • Lack of strategic thinking or persistence from management (RS2) • Difficulties in change and adaptation in favour of sustainability (RS3) • Vague vision and goals (RS4) • Short-term market perspectives in focus (RS4) • Lack of consensus or misalignment between behavior or practice and sustainability visions and goals (RS2) • Uncertainties to the degree and nature of governmental regulations and policies (RS1) • Uncertainty in long-term development (RS1) • Uncertainties in consumers' behaviour and demands (RS1) • Uncertainties in competitive advantages and strategies formulated by stakeholders (RS1) • Uncertainties about future fossil-free fuels and infrastructural changes for their production (RS3) • Uncertainties about future changes in transport infrastructure (RS3) • Uncertainty in legislations, regulations, and long-term strategies (RS3) • Strategic uncertainties (RS4) • Operational uncertainties (RS4)

	<ul style="list-style-type: none"> • Uncertainties due to psychological reluctance of customers to buy clean technologies (RS4) • Uncertainties due to antagonistic effects of city logistics initiatives in urban areas (RS4)
Dealing with complexity	<ul style="list-style-type: none"> • Measurement/assessment of environmental effects of operations/processes/activities (RS1) • Measurement/assessment of social effects of operations/processes/activities (RS1) • Difficulties in measurement and assessment of environmental externalities (RS3) • Different standards, methods, and platforms for measuring GHG emissions or assessing environmental impacts (RS3) • Quantifying environmental costs of operations/processes/activities (RS1) • Changes at different stages of development (RS2) • Subjectivity in meaning, scope, and degree of responsibilities (RS2) • Lack of a meaningful indicator or unified labels (RS2) • Difficulties in defining the boundaries and scales of description of tiers and stakeholders of supply chains (RS2) • Conflicts of a paradoxical character in sustainable development of supply chains (RS1) • Antagonistic effects of distribution trends on environment and sustainability (RS4) • Evade of responsibilities by transferring to/sourcing from places or stakeholders with looser regulations and standards (RS2) • Decoupling economic growth from freight distribution and transport growth (RS4) • Restrictions in delivery times, diverse load and unload (pick and delivery) operations (RS3) • Geographical positions (RS3) • Imbalances due to globalization, exports, and free trade (RS3)
Difficulties of corporate-governance	<ul style="list-style-type: none"> • Difficulty of cooperative sustainable development due to fragmented nature of logistics industry (RS3) • Difficulties in auditing and controlling due to fragmentation (RS2) • Lack of accountability, credibility, and independency of certifiers (RS2) • Difficulties in adaptation to a wide range of corporate codes of conduct, standards, certificates, and labels (RS2) • Reluctance of city logistics stakeholders to accept or participate in initiatives (RS4) • Heterogeneity regarding sustainability practices between and within industries (RS2) • Different customers' demand in different markets and industries (RS3) • Lack of sustainability-related policy or legislation (RS2) • Inefficiencies in urban freight distribution (RS4) • Creating a new and novel sustainability urban mobility culture (RS4) • Bureaucratic difficulties and administration barriers (RS4) • Decision making by several actors from municipality and regional to state levels (RS4) • Variations in policy measures as well as governmental policies and rules in different urban areas (RS4) • Lack of political commitment (RS4) • Scarce and out-of-date national and local policy frameworks regarding freight distribution (RS4)
SMEs difficulties	<ul style="list-style-type: none"> • Difficulties and uncertainties regarding the benefits of upgrading to new sustainability standards and codes of conduct (RS2) • Lack of knowledge, skills, time, enforcement, financial and human resources in responding to requirements and regulations (RS2) • Corporate governance (RS4)

