

THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

Purchasing process for freight transport services  
and influence on CO<sub>2</sub> emissions

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# **Purchasing process for freight transport services and influence on CO<sub>2</sub> emissions**

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## **ABSTRACT**

Companies purchasing freight transport services may through the purchasing process restrict or create opportunities for how transport service providers deliver the transport service. The purpose of this thesis is to explore how the configuration of the purchasing process for freight transport services can influence the reduction of CO<sub>2</sub> emissions.

This thesis is a compilation of three papers based on empirical data, collected mainly through interviews in three multiple-case studies.

The results include descriptions of the purchasing process for freight transport services. Influence of the contextual dimensions purchase task, importance, and service type on the purchasing process for freight transport is discussed, and eight different types of contexts and their implications for the configuration of the purchasing process are presented. Relationships between the purchasing process for freight transport and logistical variables, related to CO<sub>2</sub> emissions, are identified. In particular, time requirements and information sharing are highlighted as important underlying aspects of the relationships. Different configurations of the purchasing process for freight transport services facilitate or hinder consideration of such aspects.

The results lead to increased understanding of how contextual variables influence the configuration of the purchasing process. The results also contribute to theory on reducing negative effects of freight transport on the environment, by connecting practices to logistical variables that are related to CO<sub>2</sub> emissions, combining a purchasing process model with an existing framework that depicts the relationship between logistics and environmental effects. The results can be used by companies purchasing freight transport to support discussions aiming to reduce CO<sub>2</sub> emissions.

**Key words:** Freight transport, Purchasing process, Transport buyer, Context, Shipper, Sustainability



## List of appended papers

### Paper I:

Rogerson S., Andersson, D. and Johansson, M I. (2013) "*Influence of context on the purchasing process for freight transport services*".

Manuscript, submitted to *International Journal of Logistics Research and Applications*, January 2013.

An earlier version of this paper was published in the Proceedings of the 20th Annual IPSERA Conference, 10-13 April 2011, Maastricht.

### Paper II:

Rogerson S., Andersson, D. and Johansson, M I. (2012) "*Sustainable freight transport purchasing*". Proceedings of the 21th Annual IPSERA Conference, 1-4 April 2012, Naples.

### Paper III:

Rogerson S. (2012) "*Connecting ordering of freight transport to logistical variables related to CO<sub>2</sub> emissions*", Proceedings of the LRN Conference, 5-7 September 2012, Cranfield.

## The researcher's contribution to the papers

PAPER	FIRST AUTHOR	SECOND AUTHORS	RESPONSIBILITIES
I	Sara Rogerson	Dan Andersson and Mats I Johansson	The paper planning was done jointly by all three authors. The first author was responsible for the data collection in six of seven cases (data for the seventh case was collected by a fourth researcher). For the first version submitted to the IPSERA conference, the writing was shared between all authors, with the first author mainly responsible for sections related to case descriptions, analysis and results. For the reworked version, the first author did the larger part of the writing, developing drafts for all sections that were then discussed and improved jointly between all authors. The analysis model was developed jointly, where after the analysis was conducted by the first author and discussed between all authors to arrive at the final analysis and conclusions.
II	Sara Rogerson	Dan Andersson and Mats I Johansson	The paper planning was done jointly by all three authors. The first author was responsible for the data collection. The first author did the larger part of the writing, developing drafts for all sections that were then discussed and improved jointly. The analysis was conducted by the first author and discussed between all authors to arrive at the final analysis and conclusions.
III	Sara Rogerson	(Sole author)	

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# 1 Introduction

This section presents the background of the research. The research focuses on how the purchasing process for freight transport services can influence emissions from such transport. The first section explains the importance of reducing CO<sub>2</sub> emissions from transport. Thereafter the relevance of researching purchasing of freight transport services is discussed and issues related to environmental consideration in purchasing such services are highlighted. This leads to the formulation of the purpose, where after the research question are presented.

## 1.1 Importance of reducing CO<sub>2</sub> emissions from the freight transport industry

This research centres on the purchasing of freight transport services, particularly on how companies can consider environmental issues when purchasing such services. The purchasing companies may influence how these services are delivered by the companies that provide freight transport services, thereby influencing adverse environmental effects, such as CO<sub>2</sub> emissions.

In 1987, the Brundtland Commission defined sustainable development as ‘meeting the needs of the present without compromising the ability of future generations to meet their own needs’ (Brundtland, 1987). In the sustainable development concept, environment is one dimension. The past two decades have seen an increase in the general awareness of problems related to climate change. Globally adopted commitments, such as the Kyoto Protocol, affect countries located within the EU in terms of how environmental policies are formulated and implemented, in order to stabilise or reduce emissions of greenhouse gases. In line with public interest in climate change, green logistics research presently focuses on the global effects of pollution on the environment (McKinnon, 2010).

Transport, especially road freight, imposes a considerably negative effect on the environment. Wu and Dunn (1995) state that in a logistics system, transport is the largest threat to the environment. In 2010, the transport sector of Sweden accounted for 39% of CO<sub>2</sub> emissions (Swedish Environmental Protection Agency, 2012). Also, the growth rate of greenhouse gas emissions is higher in the transport sector than in other industries. Given these problems, the transport industry has been receiving considerable attention by authorities and the public. A white paper published by the European Commission (2011) discusses resource-efficient transport systems and reduction measures for carbon emissions from the transport industry. Freight transport is linked to economic development and as the GDP in the EU increases, so does the amount of transported goods (European Commission, 2011). We need to counter the negative effects from transport of goods by implementing measures for reducing emissions from this sector.

The target of the EU in minimising greenhouse gas emissions from the transport sector is a reduction of 20% by 2030 relative to 2008 levels (European Commission, 2011). Individual countries have also set targets for emission

reductions. The Swedish government aims to reduce greenhouse gas emissions by 40% in 2020 relative to 1990 levels (Regeringskansliet, 2009). Achieving the aforementioned goals may lead to policy measures that are specific to freight transport.

In response to the above-mentioned issues, environmental perspectives have become more important to companies as they conduct business. Various factors motivate companies to pursue environmental protection-related policies. Murphy et al. (1995) indicate that such factors include compliance with government regulations, control over environment-related costs, satisfaction of societal expectations, minimisation of liability from potential lawsuits, acquisition of profit opportunities, keeping pace with competitors, meeting customer requirements, and being good citizens. In more recent articles motivations are similar to those mentioned above, where the most commonly proposed argument for the relevance of environmental consideration is legislation (for example Murphy and Poist, 2003; Bala et al., 2008), followed by pressure from customers (for example Kovács, 2008; Seuring and Müller, 2008) and the government. Several articles also indicate negative publicity (for example Golicic et al., 2010) and competitive advantage (for example Markley and Davis, 2007) as important arguments.

Companies paying increasing attention to CO<sub>2</sub> emission reduction in the freight transport sector is an expected trend because of the rising awareness of the sector's negative environmental effects and the possibility of governments enacting more stringent environmental regulations.

## **1.2 Purchasing freight transport services**

Many companies currently outsource all or part of their freight transport needs to third-party providers. Lammgård (2007) states that more than 95% of the manufacturing companies in Sweden purchase freight transport services from a provider. The question then is, what can companies that purchase such services do to reduce CO<sub>2</sub> emissions from the freight transport industry? Providing an answer to this question is relevant given that many enterprises are looking for guidance on how to take environmental issues into account when purchasing transport services (Björklund, 2005).

The purchase of services differs from that of goods (Jackson et al., 1995). The purchasing process for business services is more complex (Fitzsimmons et al., 1998) due to the characteristics of the service, for example that services are less tangible. It can affect the time spent at each stage of the purchasing process, the level of details involved in each stage, the number and type of disciplines involved in the process, and the information exchange between buyer and supplier (Axelsson and Wynstra, 2002).

According to Holter et al. (2008), few studies have touched upon the transport purchasing process. Literature in this field often covers transport modes and carrier selection decisions. Over the years, several surveys have been carried out on selection criteria for shippers (Pedersen and Gray, 1998; Matear and Gray, 1993; Whyte, 1993). The results indicate that service and cost are the most important criteria for selecting shipping companies.

Three literature reviews (Meixell and Norbis, 2008; Marasco, 2008; Selviaridis and Spring, 2007) have included the development process of third-party logistics and the decision process for transport choices or purchasing frameworks. Few articles cover the entire purchasing process for freight transport. Several articles highlight a particular stage of the purchasing process, such as select supplier or contract agreement. Studies that provide a broader view of the process generally offer more wide-ranging perspectives, including those on logistics alliance or logistics services.

Björklund (2005) provides the most detailed account of the purchasing process for freight transport services, with the author providing recommendations for companies on purchasing environmentally preferable transport services. However, the thesis does not clearly explain the effect of these practices on CO<sub>2</sub> emission reduction or the conditions in which such practices are suitable. Organisations differ in that they operate in various environments; thus, certain practices may be suitable or unsuitable, depending on company, industry, or market characteristics. Clarifying these issues will result in more effective guidance on how environmental considerations can be incorporated into the purchasing process.

An impediment to the effective integration of business and environmental concerns is that enterprises lack knowledge on the transport services that they purchase (Santén and Arvidsson, 2011). Variations in responsibility suggest that the purchasing process and corresponding decision making is non-transparent to management, and therefore receive less attention when a company addresses environmental issues. Different people may be in charge of purchasing transport services. Gentry and Farris (1992) find that the responsibility for inbound transport decisions is often shared between the purchasing and the distribution departments. Responsibilities for inbound and outbound transports are frequently handled by different divisions (Drewes Nielsen et al., 2003). Due to involving many people, including environmental considerations in the purchasing process necessitates more extensive employee training. On one hand, that responsibility for purchasing freight transport can be handled by logistics staff or shared between purchasing and logistics is an indication that logistics expertise is important in purchasing freight transport services. On the other hand, that only logistics staff make the decision suggests low purchasing expertise when purchasing freight transport. Lack of coordination in shipments can translate to increased demand for transport.

Wu and Dunn (1995) noted that some companies that adopt green purchasing in general also began applying green purchasing when purchasing transport services. However, today, enterprises continue to be inconsistent in their consideration of environmental issues in the purchase of freight transport services. Wolf and Seuring (2010) note that although enterprises send questionnaires to third-party providers regarding environmental performance, the follow-up of responses to such questionnaires remains uncertain. The authors also find a contradiction: companies purchasing freight transport services identify purchasing as part of their environmental strategies, but third-party providers state that they receive no environment-related requirements from

buyers. Isaksson (2012) noted that transport buyers from different industries exert various levels of pressure on transport service providers with regard to formulating or implementing green solutions.

One solution to greening the freight transport service is for transport service providers to offer more environmentally preferable service options. Several recent studies offer a logistics service provider perspective on environmental work, for example Isaksson (2012), Maack (2012) and Martinsen (2011). Santén and Arvidsson (2011) find that companies purchasing freight transport services view third-party providers as passive with regard to offering green solutions. A strategy for resolving passivity is for enterprises to set explicitly stated requirements on transport service providers. Björklund (2005) finds that approximately 50% of companies purchasing freight transport services include environmental requirements in a written contract. Santén and Arvidsson (2011), however, indicate that transport service providers prefer a more open discussion regarding the best transport solutions over dictated requirements. Given these mixed results, the influence on CO<sub>2</sub> emissions of stipulating requirements on transport service providers remains unclear.

Companies purchasing freight transport services often enter into frame agreements with transport service providers. The initial stages of the purchasing process determine how such agreements are reached (for example whether requirements are included in the contract). The influence of different activities in the purchasing process on CO<sub>2</sub> emissions is unclear.

The process by which contract agreements are reached and what properties of the service are agreed can either restrict or create opportunities for how transport service providers deliver services at reduced CO<sub>2</sub> emissions. For example, requirements may restrict route planning or vehicle utilisation. Companies can achieve improved and realistic goal setting in relation to environmental considerations in purchasing freight transport services by comprehensively understanding the practices that influence CO<sub>2</sub> emissions and the strategies for enhancing the potential of transport service providers to contribute to emission reduction.

### **1.3 Purpose**

As previously discussed, it is of interest to reduce CO<sub>2</sub> emissions from transport. While some companies express an interest in environmental consideration when purchasing freight transport services, others remain inconsistent in their consideration of environmental issues. Companies purchasing freight transport services may through the purchasing process, for example by requirements, restrict or create opportunities for how transport service providers design the delivered transport service. However, it is not clear from existing research how practices in the purchasing process influence CO<sub>2</sub> emissions from freight transport. For example, the influence of specifying requirements on transport service providers is unclear. Neither is it clear in what conditions certain purchasing practices are suitable. Also, the activities involved in the purchasing process occur in a specific context, indicating that the conditions that determine the applicability of activities aimed at CO<sub>2</sub> emission reduction are likely to differ.



In light of this, the purpose of this research is **to explore how the configuration of the purchasing process for freight transport services can influence the reduction of CO<sub>2</sub> emissions.**

To achieve the research goal, three research questions have been formulated, which are grounded on the issues discussed in Section 1.2.

#### **1.4 Research questions**

The configurations of the purchasing process for freight transport services, i.e. how the process is composed and what activities occur in the process, can differ between companies. This difference is attributed to the specific contexts in which the process occurs and the consequent adaptations that organisations must employ to ensure concordance between their needs and the contexts. Adaptation to context is frequently discussed in the literature. Companies adapt purchasing to changing environments (Kraljic, 1983); different purchasing processes are needed, depending on whether small or large-scale purchases are made (Parikh and Joshi, 2005); specific logistics strategies are preferred, depending on situation (Persson, 1991); different environments drive companies to set different goals and initiatives, as well as identify inappropriate approaches (Fisher, 1997); appropriate global supply chain strategies are contingent on market characteristics (Christopher and Towill, 2002); and supply chains are context specific (Godsell et al., 2011).

As stated in Section 1.2, the purchasing practices that are suitable to a given set of conditions are unclear. If the purchasing process is influenced by context, then certain green purchasing practices may either be suitable or unsuitable for a given context. A specific context provides the frame for how the purchasing process is carried out. Understanding contexts is therefore crucial to understanding the purchasing process, i.e. why the process is operated in a specific manner and how it is influenced by context.

Björklund (2011) supports the aforementioned statements, arguing that a high environmental performance in purchasing freight transport services necessitates knowledge on context (business environment). Context can drive but also hinder environmental performance. Björklund (2011) provides 54 contingency factors that act as hindrances to, drivers of, or enablers of green purchasing of transport services. It does not clarify the manner by which such factors influence the configuration of the purchasing process.

Björklund (2005) also relates the issue of differing purchasing practices to whether companies regard certain contingency factors as supportive or obstructive of environmental performance. It is pointed out that purchasing situations and actions are better understood through further analysis of the links between practices and contexts.

As shown in Björklund (2005) and Björklund (2011), many contextual factors affect the purchase of freight transport services. According to the organisational buying behaviour model (OBB) (Johnston and Lewin, 1996), purchase characteristics influence the buying process. However, little research is carried

out on purchase characteristics related to the purchasing process for freight transport services. This gap translates to the potential to enhance our understanding of the influence of purchase characteristics on freight transport purchasing; i.e. in what way the purchasing process is influenced and by what contextual factors.

In this regard, the first research question is formulated as follows:

***RQ 1: How can contextual factors influence the configuration of the purchasing process for companies purchasing freight transport services?***

To examine how the purchasing process for freight transport services can influence the reduction of CO<sub>2</sub> emissions, two other research questions are formulated connecting the purchasing process for freight transport services to CO<sub>2</sub> emissions.

As explained in Section 1.2, companies that purchase transport services enter into contract agreements with transport service providers. In the initial stages of the purchasing process (the first three stages according to van Weele, 1994), the service is specified, transport service providers are selected, and a contract is agreed. The process by which contract agreements are reached and what properties of the service are agreed can either restrict or create opportunities for how transport service providers deliver freight transport services, thereby resulting in either more or less CO<sub>2</sub> emissions. Companies purchasing freight transport services can place requirements aiming at environment-friendly delivery, but the effects of such requirements are unclear; they do not necessarily exert a positive influence on CO<sub>2</sub> emission reduction. Santén and Arvidsson (2011) indicate that transport service providers sometimes regard requirements as excessively stringent, thereby limiting the options for service delivery (for example planning of consolidation). Different activities in the purchasing process may also affect the service delivery although in what way activities influence the service delivery, for example planning of the transport service by transport providing companies, is unclear.

Piecyk and McKinnon (2010) present a framework that shows the relationship between logistical variables and CO<sub>2</sub> emissions. The logistical variables in the framework are modal split, handling factor, average length of haul, lading factor, empty running, fuel efficiency, and carbon intensity of fuel. Relating the purchasing process for freight transport services to these logistical variables would clarify the influence of process activities and requirements on how transport services are delivered. Given that the logistical variables are related to CO<sub>2</sub> emissions, the relationship between the purchasing process for freight transport services and the logistical variables indicates the potential to influence CO<sub>2</sub> emissions.

To provide guidance regarding how companies can incorporate environmental issues in purchasing decisions, and to elucidate the influence of purchasing practices on CO<sub>2</sub> emissions, the second research question intends to clarify the relationship between the initial stages of the purchasing process (up to contract

agreement) and the logistical variables related to CO<sub>2</sub> emissions from the freight transport sector.

***RQ 2: How can a shipper's initial stages of the purchasing process for freight transport services influence the logistical variables related to CO<sub>2</sub> emissions?***

The later stages of the purchasing process are the post-contractual stages, which cover ordering, expediting, and evaluation. After contract agreement, transport orders are placed in accordance with the provisions in the contract. The literature devoted specifically to the ordering process for freight transport services is limited. Bagchi and Virum (1998) include post-contractual issues in a framework for logistics alliances, and Selviaridis and Spring (2010) describe the ongoing service exchange between a company and its logistics service provider when the company purchases logistics services (i.e. more services than transport). Holter et al. (2008) discuss the ordering of freight transport services, but restrict their analysis to a single case. None of the aforementioned studies link the ordering process with the environmental performance of freight transport service providers. Furthermore, research on the post-contractual freight purchasing process is often of a quantitative nature, with focus on decision support systems (for example Kuo and Soflarsky, 2003; Caputo et al., 2005). In addition, the characteristics of purchasing services, for example, that a service is often produced in interaction between buyer and seller; i.e. customers can participate in the production of the service, means that the post-contractual stages are important for realising the service agreed upon by both parties.

The contract serves as the framework for the ordering of freight transport services. At this stage, customers can further specify shipment-specific requirements. In this way, details of the transport order can limit the planning options available to transport service providers, thereby resulting in less efficient transport operations in terms of environmental performance. Although the intended level of environmental consideration is established in the contract, determining whether the aims are achieved is possible only after the ordering stage.

With regard to how different activities in the purchasing process influence service delivery, Sanchez-Rodrigues et al. (2009) indicate that from a transport service provider's perspective, knowledge of actual volume to transport can enhance efficient planning by transport service providers. Another example from this perspective is that some providers observe that companies purchasing freight transport services place orders at increasingly later periods whilst requiring earlier delivery (Santén and Arvidsson, 2011). Such practice also decreases the time allotted for planning.

In addition to the contract agreement, ordering influences the outcome of a service, but the influence of ordering practices on CO<sub>2</sub> emissions are unclear. Therefore, understanding shippers' daily processes for service orders provides insights on how environmental issues can be included in purchasing decisions on freight transport services. Therefore, the third research question considers how the freight transport ordering process is linked to the logistical variables that are related to CO<sub>2</sub> emissions from the freight transport industry.

***RQ 3: How can a shipper's freight transport ordering process influence the logistical variables related to CO<sub>2</sub> emissions?***

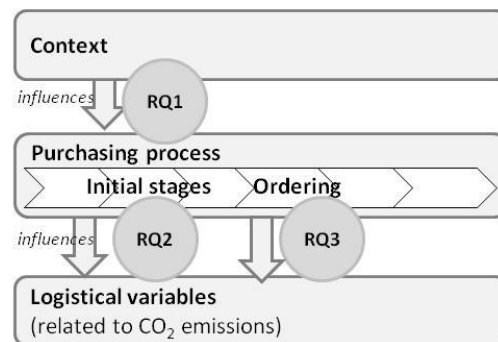
## 1.5 Scope

This research is conducted from the perspective of companies purchasing freight transport services (i.e. shippers). The purchasing process for freight transport services occurs at a company purchasing transport services. Freight transport is required for the movement of goods either from a supplier to a company purchasing freight transport services (supply) or from the company purchasing freight transport services to its customers (distribution). In this thesis both the supply and distribution side are included and the company purchasing transport services can be either the supplier or receiver of goods.

The company that purchases transport services essentially buys service delivery from sender to recipient by one or more transport service providers. In service delivery, therefore, the relationship between the purchasing company and the transport service provider is a significant factor.

Which transport service is purchased also depends on supplier or customer requirements, such as delivery time and quantity. The relationship with suppliers and customers is outside the scope of this thesis. This also excludes that requirements can originate with suppliers or customers.

Within a company, internal stakeholders may interact with the purchasing process, it will be investigated which internal stakeholders influence the purchasing process of transport services. Products manufactured or handled by the company are of interest because these are the goods transported.



*Figure 1: Positioning of research questions with regard to the purchasing process and CO<sub>2</sub> emissions*

Figure 1 illustrates how the three research questions are positioned with regard to the purchasing process and CO<sub>2</sub> emissions. The purchasing process is influenced by the business context in which the company operates. This context comprises the characteristics of freight transport service purchasing. RQ 1 is designed to examine the influence of contextual factors on the initial stages of the purchasing process. RQ 2 looks into the influence of the initial stages of the purchasing process for freight transport services on the logistical variables related to CO<sub>2</sub> emissions. RQ 3 is intended to analyse the influence of the ordering stage of the purchasing process on the logistical variables related to CO<sub>2</sub> emissions, in which orders are placed in accordance with the provisions in

agreements. The logistical variables are related to transport service delivery, particularly on how it is carried out. Piecyk and McKinnon (2010) identify the relationship between logistical variables and CO<sub>2</sub> emissions.

RQ 2 and RQ 3 revolve around the activities in the purchasing process that potentially contribute to the reduction of CO<sub>2</sub> emissions from the freight transport industry, as well as in what manner this contribution is achieved (i.e. which logistical variables are influenced by the purchasing process). RQ 1 is key to determining how environmental considerations can be applied to context-specific cases, i.e. what activities are suitable given the nature of the transport purchasing process and understanding the scope of green purchasing practices in specific cases.

In RQ 1 and RQ 2 the focus is on the three first stages of the purchasing process, according to van Weele (1994), i.e. ‘define specification’; ‘select supplier’; and ‘contract agreement’. This part of the purchasing process is in this thesis called ‘Initial stages of the purchasing process’. In RQ 3 the focus is on the first stage of the post-contractual phases, i.e. ‘ordering’. This means that the later stages of the purchasing process, i.e. ‘expediting’ and ‘evaluation’ according to van Weele (1994), are outside the scope of this thesis.

## **1.6 Outline of the thesis**

This is a compilation thesis consisting of the main text and three appended papers. Below follows a brief overview of the chapters included in the thesis and their main contents.

Chapter 1 (Introduction) presents the background of the research. The purpose and research questions are motivated and formulated.

Chapter 2 (Frame of reference) motivates selection of theoretical points of departure (models used) and describes the selected models.

Chapter 3 (Methodology) describes the research design of this study, outlining the methods used.

Chapter 4 (Results) summarises the results for the research questions, which are derived from each respective appended paper.

Chapter 5 (Discussion) discusses how the main findings contribute to the purpose of the thesis, how they relate to results of other studies and implications of results. The results of the three studies are also combined and discussed.

Chapter 6 (Conclusions and further research) presents the conclusions of this thesis and gives suggestions for further research.



## 2 Frame of reference

This section discusses the motivation for selecting relevant theoretical points of departure (for example models used to respond to the research questions). It describes the selected models on whose bases the arguments in the discussion section are put forward. Figure 2 shows the frame of reference in relation to the research questions. The first section describes the theoretical points of departure for what is meant by the ‘purchasing process’, a central concept in this thesis. The second section describes the choices made in relation to context. The third section describes a framework which links logistical variables to CO<sub>2</sub> emissions. Purchasing of freight transport services is introduced in section 1.2.

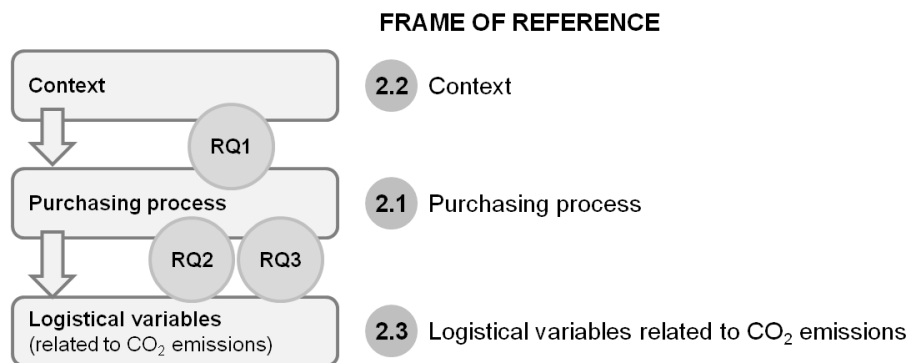


Figure 2: Frame of reference in relation to research questions

### 2.1 Purchasing process

Given that the purpose of this thesis and the research questions revolve around the purchasing process for freight transport services, an important point of departure is what constitutes such a process.

The purchasing process is generally described as a sequential and rational decision process that involves several consecutive stages. Van Weele (1994) uses the stages in Figure 3 to show how different purchasing activities are related to one another. Note that the figure shows a simplified model. Purchasing research has considerably been directed towards the purchase of goods, but the process model is also applicable to the purchase of services. Axelsson and Wynstra (2002) state that the different stages of the process are affected by the characteristics of the service being purchased. This research assumes the applicability of the general purchasing process model to the purchase of freight transport services.

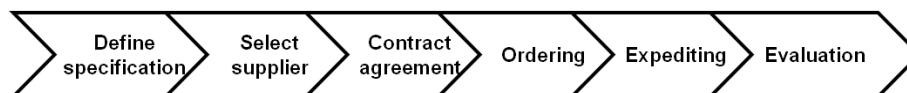


Figure 3: Purchasing process (van Weele, 1994)

Because differences may exist, however, analysing the literature on the purchase of freight transport services is a worthwhile endeavour. The limited research on this subject matter is addressed by first reviewing the literature on the purchase of logistics services. Purchasing logistics services is more complex than purchasing freight transport services, but the latter can fall under logistics

services; thus, the two realms are related. The literature on the purchase of logistics services is used to provide more detailed descriptions of the activities that take place in different stages of the purchasing process.

In their literature review of third-party logistics (3PL), Selviaridis and Spring (2007) identify three main frameworks for purchasing logistics services. Sink and Langley (1997) provide a five-stage model for selecting 3PL providers. The five stages are identifying the need to outsource, developing alternatives, evaluating and selecting suppliers, implementing services, and providing ongoing service assessment. Bagchi and Virum (1998) include post-contractual issues in logistics alliance formation. The study of Andersson and Norrman (2002), who describe and compare the purchasing processes for advanced and basic logistics services (including contract signing); Figure 4, is particularly relevant to transport because freight exchange purchases typify basic logistics services. Andersson and Norrman (2002) indicate a process that extends up to the contracting stage.



Figure 4: Purchasing process covering stages up to contract signing (Andersson and Norrman, 2002)

For the purchase of freight transport services, Björklund (2005) developed a process model of purchasing practices for environmentally preferable transport services. On the basis of a literature review, the author designed the process stages of the model (Figure 5). In Björklund (2005), the last three stages of the model by van Weele (1994) are summarised as post-choice management.

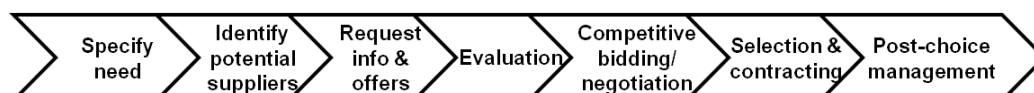


Figure 5: The purchasing process based on Björklund (2005, pp. 114–115)

The process models developed by Björklund (2005) and Andersson and Norrman (2002) show more details on the different process stages compared to the general process model by van Weele (1994). The more specific models for purchasing freight transport services fit within the general process model, unless more details are needed. Van Weele's model presents the advantage of a more in-depth description of post-contractual management. When decisions are of a general nature, van Weele's process model is appropriate, but when more details on the initial stages of the purchasing process up to contract signing are required, Björklund's process model is the suitable choice.

That rationally arriving at optimal decisions is based on carefully evaluating available alternatives is an easy assumption to make. Simon (1997), however, argues that any individual encounters substantial difficulty in achieving a high degree of objective rationality because of the excessive volume of information needed and number of alternatives available for decision making. To cope with



this complexity, an individual creates a simplified model of actual situations. This bounded rationality indicates that individuals are confronted with limitations in the decision making process. Through routines and constraints on decision making, organisations influence these individual limitations (March and Simon, 1958). In this research, a simplified decision-making model is used bearing in mind that in the real world, decisions and the steps in decision making are not as rational and consecutive as that depicted in the model.

## **2.2 Context**

This section presents the argument for the importance of the context in which the purchasing of freight transport services takes place. It defines context and the choices made in relation to context.

This research aims to elucidate the configuration of the purchasing process, assuming that this configuration differs, depending on the context in which the process takes place. This assumption is reflected in RQ 1. The assumption that an organisation adapts to the environment in which it exists is based on contingency theory (see Lawrence and Lorsch, 1967). The assumption indicates that developing general principles that apply to all organisations over time and in different locations is difficult to achieve. Another assumption of contingency theory is that the best-suited organisational form is one that adapts to environments; i.e. different types of organisations are needed for different environments.

The underlying idea, therefore, is that the manner by which the purchasing process for freight transport services is carried out differs between companies. Understanding these differences and the factors that they depend on is significant in comprehending why certain activities work to a greater or lesser extent, or why these are unsuitable, depending on circumstances.

These underlying assumptions, as well as achieving the research aims and providing answers to the research questions, require the definition of context.

Many studies discuss the factors that influence purchasing work (for example Gadde and Håkansson, (1993, 1998); van Weele, 1994). Environments consist of many contextual variables (for example the 54 contingency factors that influence the environmental purchasing of transportation services, provided by Björklund, 2011).

A framework that includes many external and internal factors is presented by Johnston and Lewin (1996), who describe three models on organizational buying behaviour (OBB) in their study (Sheth, 1973; Webster Jr and Wind, 1972; Robinson et al., 1967). A simplified representation of the constructs that can influence organisational buying behaviour is presented in Figure 6. In the centre are the process stages surrounded by different characteristics that can influence the behaviour. The model includes the effects from (1) environmental factors, such as physical, political, economic, legal, technological, and cultural characteristics, as well as suppliers and competitors; (2) organisational characteristics, such as size, structure, rewards, tasks, and goals; and (3) buyer characteristics, such as education, experience, personality, and motivation. (4)

purchase characteristics, such as product type, buying task, and perceived risk, (5) seller characteristics, including evaluation criteria for price and quality, (6) group characteristics, such as size, experiences, leadership, and authority, (7) informational characteristics, such as source and type of information, as well as (8) conflict negotiation characteristics, including the use of cooperative and bargaining methods (Johnston and Lewin, 1996).

The Johnston and Lewin (1996) model is relevant to this thesis because it includes process stages. Although the types and number of stages slightly differ from those in van Weele's (1994) model, it is still suitable for analysing the configuration of the purchasing process.

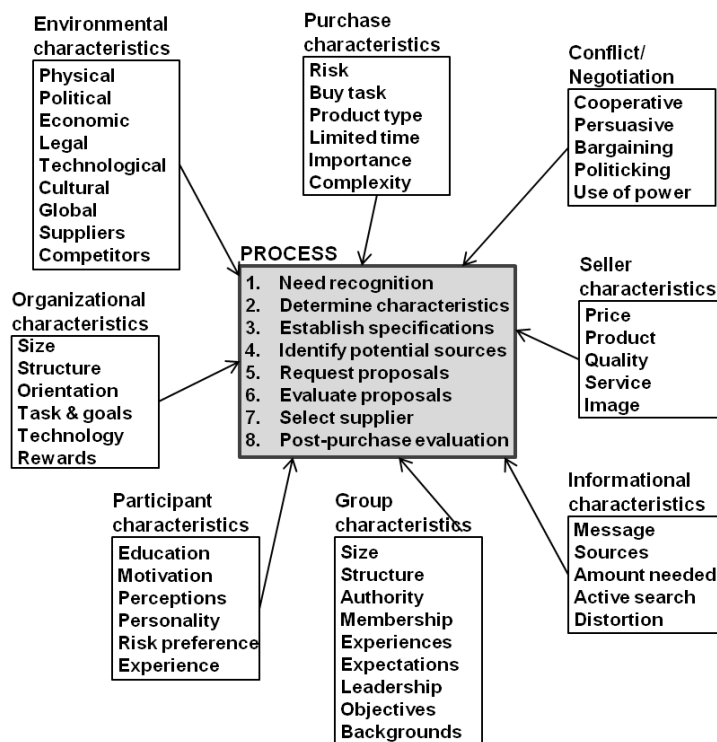


Figure 6: Integrating the constructs of organisational buying behaviour (adapted from Johnston and Lewin, 1996)

In-depth analysis to answer RQ 1 necessitates selecting a few constructs and these are derived from the purchase characteristics in the OBB model. The choices of specific contextual dimensions are based on arguments that selected dimensions are important, and of relevance to the purchasing process for freight transport services. Buy task, in this thesis called purchase task, is included based on the use of portfolio models (for example Kraljic, 1983) as a basis for classifying purchases, setting purchasing strategy, and in other ways supporting management decisions. Importance is included for example based on Persson (1991) arguing that an appropriate logistics strategy is influenced by the importance of service. Product type, below called service type, is included based on arguments about logistical factors that affect companies' demand for road transport (McKinnon and Woodburn 1996) as well as Fisher's (1997) arguments regarding the relationship between product type and supply chain strategy. The three contextual dimensions are further disaggregated into variables, more

precisely defining the dimensions. For more details, the reader is referred to appended paper 1.

Webster and Wind (1972) distinguish between task variables, which are related to the tasks, responsibilities, and competencies of individuals, and non-task variables, which are related to the personalities of the individuals involved in purchasing decisions. The approach chosen in the aforementioned study is of a task-oriented rather than a non-task-oriented nature. Despite not studying psychological factors, such factors can influence decision-making in the purchasing process.

### **2.3 Logistical variables related to CO<sub>2</sub> emissions**

This section describes the framework presented by Piecyk and McKinnon (2010), which links logistical variables to CO<sub>2</sub> emissions. The motivation for its application in the current research is also discussed.

This research centres on reducing CO<sub>2</sub> emissions; thus, the manner by which logistical activities are related to CO<sub>2</sub> emissions is of interest.

Existing literature suggests that logistical decisions influence the negative effects on the environment. Wu and Dunn (1995) present examples of many decisions in the value chain, where logistics managers make decisions that reflect environmental responsibility. Eng-Larsson et al. (2012) provide a framework that decomposes CO<sub>2</sub> emissions into several factors, including transport intensity and traffic intensity. A framework that includes many relevant variables and maps the complex relationship between logistical activity and environmental effects is that developed by McKinnon (2010). This framework has been used by other researchers, such as Sanchez-Rodrigues et al. (2010), in which supply chain uncertainty is linked to the sustainability of transport operations, and Piecyk and McKinnon (2010), who discuss the relationships between logistics-related decisions and CO<sub>2</sub> emissions.

Given that the relationships between logistical activities and environmental performance are complex, and that existing frameworks are applicable to such relationships, this thesis does not cover the complex associations between logistical activities and CO<sub>2</sub> emissions. Instead an existing framework is selected. The relevance of the selected framework is motivated below.

A framework that clearly connects logistics to CO<sub>2</sub> emissions is presented in Piecyk and McKinnon (2010; Figure 7). It is grounded on a transportation perspective, includes many relevant logistical variables, and shows the manner by which these variables are related to CO<sub>2</sub> emissions. The individual logistical variables included in the framework have been used by other researchers, for example in McKinnon and Ge (2006), which describes empty running, and in McKinnon (2006), which discusses lading factor. The framework contents are therefore considered well-established and relevant to research on freight transport services.

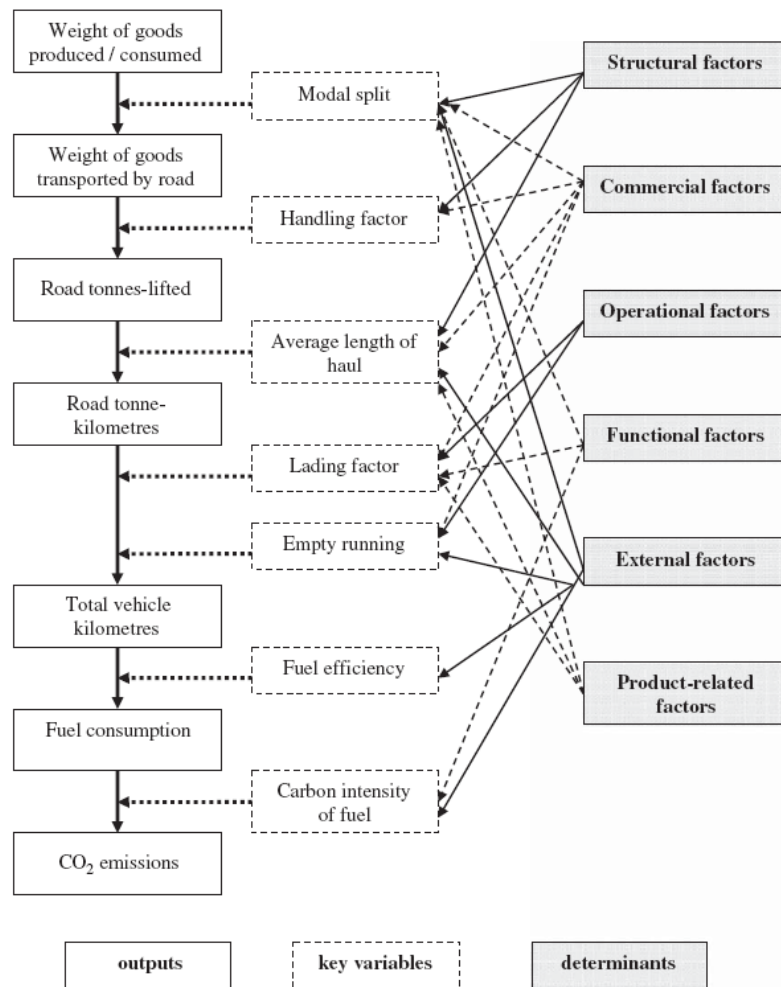


Figure 7: Relationship amongst logistical variables, determinants, and environmental impact (CO<sub>2</sub> emissions) (Piecnyk and McKinnon, 2010)

The framework illustrates the relationships between the weight of goods produced/consumed and the environmental effects of the freight transport sector in the form of CO<sub>2</sub> emissions through seven key (logistical) variables, also called key ratios of interest for reducing CO<sub>2</sub> emissions. The seven variables are: modal split; handling factor; average length of haul; lading factor; empty running; fuel efficiency; and carbon intensity of fuel. Modal split pertains to the proportion of goods carried by different transport modes. Handling factor is a rough measurement of the number of times products are loaded on vehicles, reflecting multiple links in a supply chain. Average length of haul refers to the mean length of each link in a supply chain. Lading factor and empty running are measurements of vehicle use, with empty running pertaining to vehicle movement without load and lading factor referring to load volume evaluated against maximum carrying capacity. Fuel efficiency depends primarily on vehicle characteristics, driving behaviour, and traffic conditions. Carbon intensity of fuel concerns the type of fuel used and how much CO<sub>2</sub> is emitted by a specific fuel type (McKinnon, 2010).

Previous research exists on issues that can be sorted according to the logistical variables. For modal choice, for example Eng-Larsson and Kohn (2012); transshipment points which relates to handling factor, for example Kellner and

Igl (2012); lading factor or fill rate, for example Santén and Arvidsson (2011) or McKinnon (2006); empty running, for example McKinnon and Ge (2006); fuel efficiency, for example Arvidsson (2011) and type of fuel, for example Santén and Arvidsson (2011).

The framework used in this thesis is a version of the framework presented in McKinnon (2010), which has several versions. Elements can be found in McKinnon (2007a) and McKinnon (2007b).

The version of Piecyk and McKinnon (2010) is selected because of its clear focus on the influence of the freight transport industry on CO<sub>2</sub> emissions, as well as the inclusion of influence from logistics-related decisions. In this framework, the decisions that affect transport service purchase are made at different levels (for example Aronsson and Brodin, 2006; Stank and Goldsby, 2000). Logistical factors that influence road freight demand in a company can be related to four different levels of decision-making, in which logistics managers impose a more considerable effect on the two lower levels (McKinnon, 1998; McKinnon and Woodburn, 1996). These four levels are:

- |   |                     |
|---|---------------------|
| 1. Structure of the logistics system    | structural factors  |
| 2. Pattern of sourcing and distribution | commercial factors  |
| 3. Scheduling of product flow           | operational factors |
| 4. Management of transport resources    | functional factors  |

Piecyk and McKinnon (2010) denotes these logistics-related decisions ‘determinants’, and these are considered in the framework along with external factors (for example regulations) and product-related factors. The authors show that the six factors (structural, commercial, operational, functional, external, and product-related) have complex relationships with the key logistical variables.

Structural factors determine the number, location and capacity of factories and warehouses, including for example centralisation or decentralisation of production or inventory, and relocation to other countries. Commercial factors are related to sourcing and distribution strategies and include practices such as global or localised sourcing, subcontracting, online retailing, and return flows for recycling. Operational factors affect the scheduling of product flow and include for example order lead times, frequency of deliveries, and delivery time windows. Functional factors relate to the management of transport resources and include practices such as use of vehicle routing systems, backloading of vehicles, and use of vans for deliveries. External factors include for example fuel prices, use of alternative fuels, and congestion charging. Product-related factors is related to product and packaging design. (Piecyk and McKinnon, 2010)

Similar to how the determinants are linked to the key logistical variables, in this thesis the decisions, activities, and practices in the purchasing process are linked to the key logistical variables.

## **2.4 Positioning research questions with regards to selected models**

The application of the theoretical points of departure, i.e. models, described in the frame of reference, is shown in Figure 8. In RQ 1 the influence of the

selected contextual dimensions purchase task, importance (of purchasing freight transport services to the organisation, for example relative size of costs), and service type, on the initial stages of the purchasing process are examined. In RQ 2, the influence of activities in the process stages of ‘define specification’, ‘select supplier’ and ‘contract agreement’ on logistical variables is examined. In RQ 3, the influence of activities in the process stage of ordering on logistics variables is examined. Piecyk and McKinnon (2010) identifies the relationship between logistical variables and CO<sub>2</sub> emissions.

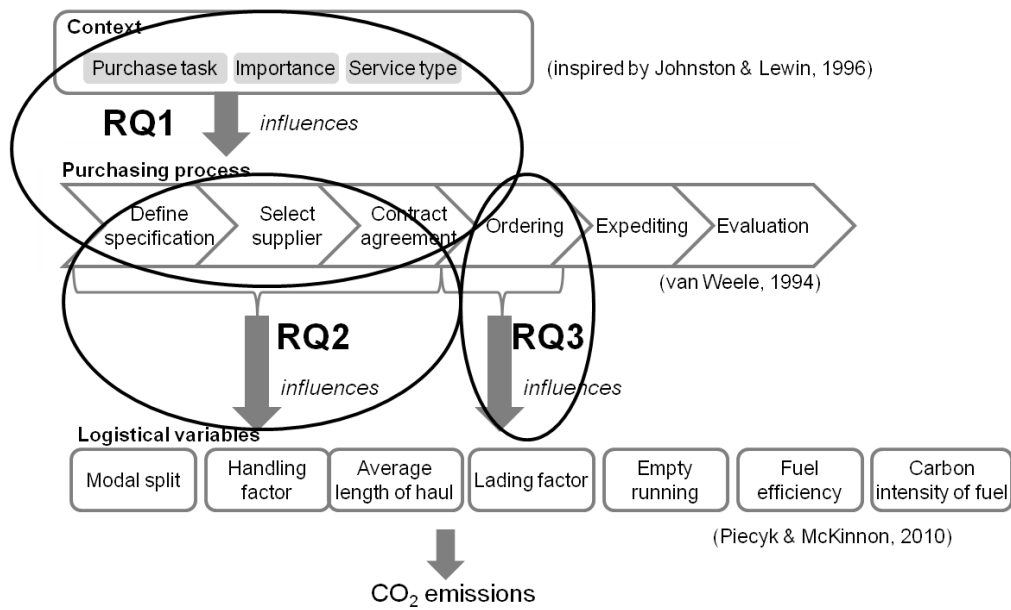


Figure 8: Developed framework, showing scope of research questions

### 3 Methodology

This chapter describes the research design of this study. It outlines the methods that were used to answer the research questions, and also examines the systems of data collection, data analysis and validity testing used for each case study.

Figure 9 below illustrates the link between the research questions, studies and the resulting papers. Each study is designed to address one research question, and each study results in one paper. These research questions were selected to contribute to the purpose of this research:

- RQ 1: How can contextual factors influence the configuration of the purchasing process for companies purchasing freight transport services?
- RQ 2: How can a shipper's initial stages of the purchasing process for freight transport services influence the logistical variables related to CO<sub>2</sub> emissions?
- RQ 3: How can a shipper's freight transport ordering process influence the logistical variables related to CO<sub>2</sub> emissions?

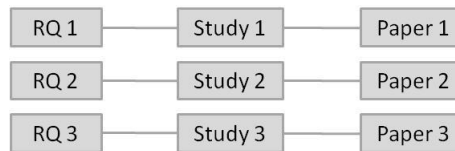


Figure 9: Link between the research questions, studies and papers

#### 3.1 Research process

Initiated in February 2009, this research is part of the project “Integrated logistics development for sustainability and competitiveness”. Within the project sustainable transport solutions are studied from the perspective of different actors involved, where this research takes the perspective of the companies purchasing freight transport services.

The development of the first study was an important step in understanding the research area, due to the limited existing literature on the purchasing process for freight transport services. Study 1 was planned and the first round of data collected in Quarter One of 2010, before a period of maternity leave. Upon return, a second round of data was collected and a working paper submitted and presented at the IPSERA conference in April 2011.

Throughout the whole research process, it was clear that environmental considerations should be central to the work. The researcher was influenced through the supervision of a student thesis during the Spring of 2011, where operational freight transport purchasing was explored. There appeared to be some potential for expansion of existing research in the field.

This early work provided a preliminary understanding (Flick, 2009) that developed during the research process. Specific research questions were evaluated and reformulated throughout. The first set of questions were

formulated in November 2009 and reformulated several times during the research process.

The second study was planned from November 2011 and carried out in early 2012; resulting in a working paper presented at the IPSERA conference in April 2012. The third study was planned in March-April 2012 and carried out in May 2012; resulting in a conference paper at the LRN conference in September 2012.

At this point, the conference paper based on the first study was reassessed for submission to a journal. The theoretical framework was reworked based on suggestions from the conference, as well as additional literature research. One more case was added and the analysis redone, resulting in a paper aimed at the International Journal of Logistics Research and Applications, submitted early 2013.

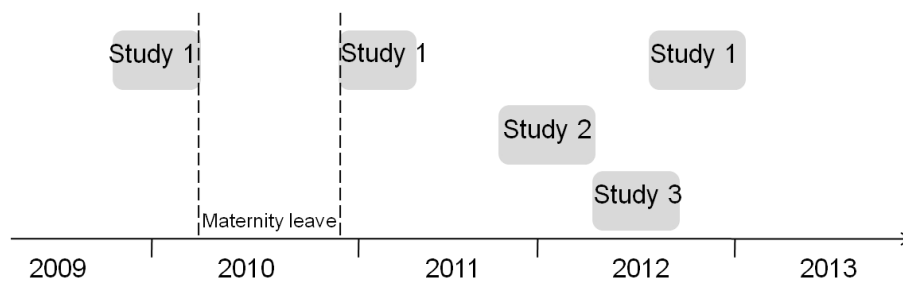


Figure 10: Research process

### 3.2 Research design

Table 1 below summarises the research questions, evidence needed and research design, in an effort to fully examine each study. It also provides an overview of the methods, case selection and data collection used in each of the three studies.

Ragin's (1994) definition of research design describes it as a plan for collecting and analysing evidence in order to answer research questions. Flick (2009) describes several components of a research design, and writes that during the research process choices will be made during different stages of the process. The starting point here has been the purpose and the research questions needed to contribute to that purpose. The other components of the research design should fit with the research questions, allowing for ability to answer them with the resources available. This is opposed to views, such as Maxwell (2005), that research questions are the result of the research design rather than the starting point.

Within each of the studies, the methodological choice has been considered based on the research question and how it could be answered.



Table 1: Overview of research studies

	STUDY ONE	STUDY TWO	STUDY THREE
Research questions	RQ 1: How can contextual factors influence the configuration of the purchasing process for companies purchasing freight transport services?	RQ 2: How can a shipper's initial stages of the purchasing process for freight transport services influence the logistical variables related to CO <sub>2</sub> emissions?	RQ 3: How can a shipper's freight transport ordering process influence the logistical variables related to CO <sub>2</sub> emissions?
Empirical data	<p>Cases: purchasing processes</p> <p>Process descriptions: steps, activities, time, people involved, and collaboration with transport service provider.</p> <p>Description of contextual variables for each case.</p>	<p>Cases: purchasing processes (up to contracting).</p> <p>Processes descriptions: steps, activities, time, people involved, and collaboration with transport service provider.</p> <p>Perception of environmental work.</p> <p>Transport service provider's description of interaction with transport buyer, and perceived influence on environmental work.</p>	<p>Cases: ordering processes (according to agreed contracts).</p> <p>Process descriptions: steps, activities, time, people involved, and collaboration with transport service provider.</p> <p>Perception of environmental work.</p> <p>System or people input to the ordering process.</p>
Research design	<p>Multiple-case studies, with contrasting contexts.</p> <p>Semi-structured interviews.</p> <p>Analysis: emerging pattern, systematisation and rich descriptions.</p>	<p>Multiple-case studies, contrasting processes.</p> <p>Semi-structured interviews.</p> <p>Data triangulation: buyer and provider.</p> <p>Analysis: emerging pattern, systematisation and rich descriptions.</p>	<p>Multiple-case studies, contrasting processes.</p> <p>Semi-structured interviews.</p> <p>Method triangulation: semi-structured interviews, and observations.</p> <p>Analysis: emerging pattern, systematisation and rich descriptions.</p>
Methods	<p>Multiple-case study: seven cases.</p> <p>Case: transport buying companies.</p>	<p>Multiple-case study: three cases.</p> <p>Case: specific purchasing process.</p>	<p>Multiple-case study: five cases.</p> <p>Case: ordering process.</p>
Case selection	<p>Cases where companies regularly purchase freight transport services, and experience variation in company size and goods flow characteristics.</p> <p>People responsible for purchasing freight transport at transport buying companies.</p>	<p>Cases experiencing variation in company size, repetitive goods flow, degree of specification, and volumes purchased.</p> <p>People responsible for purchasing freight transport at transport buying companies and their partners at transport providing companies.</p>	<p>Companies purchasing transport services, with more than one contracted service provider, experiencing variation in degree of freedom for provider selection.</p> <p>People working with ordering freight transport at transport buying companies.</p>
Data collection	Semi-structured interviews, documents.	Semi-structured interviews, documents.	Semi-structured interviews, observations.

### **3.2.1 Study One**

Initially, the first research question was concerned with what logistics context factors influence the purchasing process. At that point, a survey was considered as fitting to answer the question. However, as the research question evolved into how the purchasing process is influenced by specific factors, deeper understanding of each situation was required. A case study was then chosen as the most relevant method. According to Yin (2009), case studies are relevant for 'how' or 'why' questions, and when an in-depth description is sought. In-depth description is considered necessary because of the scarcity of earlier research on the specific topic of the transport purchasing process. In order to be able to categorise results, a multiple-case approach was selected for Study One to examine the differences between contexts of the purchasing process. Dubois and Gadde (2002) write that in-depth case studies are the best way to understand the interaction between a phenomenon and its context. In Study One, it is the connections between the context and the purchasing process that is explored. Dubois and Araujo (2007) argue that the case-study method is well-suited for constructing, adapting, extending and refining theories. Since Study One is about adding incrementally to existing knowledge, this seems to fit well.

Critics of case-study research mention the problems with rich detail. Eisenhardt (1989) discusses that the overwhelming volume of data might result in theory that is rich in detail, but which is overly complex. Easton (1998) states that studies can end up saying very little about very much. The challenge is to select what to describe and structure it in an appropriate way, so that the reader can follow the reasoning.

In Study One, existing theory informed an initial framework, which then guided the explorative data collection. The proposed final framework was based on the conceptual model, but enriched by data from the cases.

### **3.2.2 Study Two**

Research Question Two is interested in what happens in the purchasing process and how this can be connected to CO<sub>2</sub> emissions. To answer the question, an in-depth understanding of one or several situation-specific purchasing process is of interest. A survey would most likely have acquired very general responses regarding procedures, whereas a case can dig deeper into the specific situation. The case study was then chosen as the most relevant method. As mentioned earlier, case studies are relevant for 'how' or 'why' questions, and when an in-depth description is sought (Yin, 2009). It would have been possible to do a single case study, but a multiple-case study was selected to find more approaches that influence CO<sub>2</sub> emissions in the purchasing process. The cases were not selected to be similar or to be compared, but instead to contribute through different aspects.

Part of the methodological choice in Study Two, was to include interviews with the transport service provider to get the perspective both from the transport buyer and transport service provider. The transport service provider is well placed to provide information on how the service delivery, including planning, is affected by the transport buying company.

In Study Two, a conceptual framework was created based on existing literature, which then guided the explorative data collection.

### **3.2.3 Study Three**

Research Question Three examines what happens in the transport ordering process and how this can be connected to CO<sub>2</sub> emissions. In-depth description was considered necessary because of the scarcity of earlier research on the topic. The methodological choice in Study Three was also guided by methods used in Study Two. The reason for this was the intention to later be able to combine the two results (which look at different stages of the purchasing process). In order to do this, a similar methodological approach would be preferable. Case study was then chosen as the most relevant method. Similarly to Study Two, it would have been possible to do a single case study, but a multiple-case study was selected to find more approaches that influence CO<sub>2</sub> emissions in the purchasing process. Also, here, the cases were selected to contribute different elements.

As opposed to Kuo and Soflarsky (2003) and Caputo et al. (2005), Study Three is of a qualitative nature. The use of case studies supplements the existing material with a focus on specific situations, describing more cases than Holter et al. (2008).

Part of the methodological choice in Study Three was to include observations. The reason behind this was partly because of the limited early descriptions of the order process, and partly to avoid general descriptions of what activities that took place.

## **3.3 Research methods**

### **3.3.1 Study One**

#### **3.3.1.1 Literature search**

Research began with searches of existing literature to find relevant texts on freight transport purchasing. Search strings of “purchasing”, “purchasing process” or “freight transport purchasing” were combined with “business services”, “process characteristics” or “contextual factors”, in the databases of Google Scholar, ABI/Inform and Science Direct. Moreover, “contingency theory” was combined with “purchasing”, “purchasing process” or “logistics” in the ABI/Inform database. In addition, reference lists cited within relevant articles were reviewed for potential leads.

Due to the lack of research on the purchasing process for freight transport services, literature on the purchasing process of logistics services, i.e. more complex settings than pure transport, was studied. To provide background knowledge on the field, general purchasing process and the purchasing process of services were also explored.

The literature review led to the construction of a theoretical frame to guide the case study.

### 3.3.1.2 Case selection

Six small and medium-sized companies were initially selected for inclusion in the study. In addition, a seventh company, being much larger, was selected to add variance to the group. The initial criteria for case selection were company size, sourcing transport services, and regularity of purchased transport. A municipality in Sweden provided a list of companies matching these criteria, as well as contact details. The ambition was to include companies differing in regard to the contextual dimensions identified from theory, in order to be able to study their influence on the freight purchasing process. In practice, this information was in general not available prior to the data collection from the case companies. Therefore, a first round of interviews gathered data on the contextual factors to ensure the relevance of including the companies. Table 2 describes the basic background data of the seven case companies.

In order to carry out an information-oriented selection (Flyvbjerg, 2006) or purposive sampling (Flick, 2009) cases must fulfil the demands of the study. Dubois and Araujo (2007) write that the relevance of a case may not be known before the study, but becomes apparent during the research. Flyvbjerg (2006) argues that cases can start out as one type and end up as another. In Study One, cases that differed from the previously studied context dimensions were sought. In practice, finding and deciding on relevant context factors took place at the same time as arranging interviews. The studied cases do not provide the maximum variation described as opposite end points of a scale, but they differ sufficiently for each to motivate inclusion in the study. To some degree, it is also a case selection of convenience in order to get access to companies and people willing to provide the required detail of information.

*Table 2: General characteristics of the case companies*

Case	No of employees	Turnover (MEUR)	In/outbound transport
1. Lab	400	20	Inbound transport
2. Mail order, IT	40	25	Outbound transport
3. Manufacturer, Industrial equipment	24	5	Outbound transport
4. Manufacturer, Retail commodity	40	6	Inbound and outbound transport
5. Manufacturer, Machinery	80	40	Inbound and outbound transport
6. Manufacturer, Food	55	30	Outbound transport
7. Manufacturer, Personal care	50 000	10 000	Outbound transport

### 3.3.1.3 Data collection

A first round of approximately two-hour face-to-face semi-structured interviews were carried out in 2010 with the people responsible for purchasing freight transport services at six transport buying companies (purchasing and/or logistics managers). See Table 3 for more information about the respondents.

The main focus of these interviews was on the business context in general, as well as the specific factors of the conceptual model. A general description of the purchasing process and what took place was also covered.

*Table 3: Respondents at the case companies*

Case	Respondents	Interviewer
1. Lab	Purchasing manager + Logistics manager	Sara
2. Mail order, IT	Logistics manager	Sara
3. Manufacturer, Industrial equipment	Purchasing and production director + Production manager	Sara
4. Manufacturer, Retail commodity	Logistics manager	Sara
5. Manufacturer, Machinery	Purchasing manager	Sara
6. Manufacturer, Food	Purchasing manager	Sara
7. Manufacturer, Personal care	Regional Logistics Business representative + Environmental specialist	Christina Wolf

A second round of follow up semi-structured interviews was carried out in 2011 by phone with the same respondents, lasting 30-40 minutes and focusing on the purchasing process.

Both rounds of interviews were audio recorded and transcribed word for word. Where questions arose, the respondents were contacted again for further questions and confirmations to ensure accurate understanding of the responses.

For the seventh case (the personal care manufacturing company), the data was collected by another researcher (Christina Wolf) during meetings, email communication and phone interviews with the regional logistics business representative, as well as the environmental specialist. Interview protocols based on the notes were sent to the respondents for verification. The interviews resulted in a report describing the case company and the purchasing practices.

### **3.3.2 Study Two**

#### **3.3.2.1 Literature search**

A literature study was used to identify purchasing activities feeding into an interview guide. In February 2012, a key word search was run in the Scopus, ABI Inform and Web of Science databases for combinations of the search strings “logistic\*” or “freight transport” or “transport” and “purchasing process”. A second literature search was conducted for literature: (a) mentioning any of the key logistical variables; and (b) linking the purchasing process to environmental impact, for example green practices when purchasing services. Apart from key word searches, a large part of the literature found was identified through snowballing, i.e. references mentioned in other articles.

#### **3.3.2.2 Case selection**

The processes studied were selected to display varied types of purchasing processes, for example different activities taking place within the processes. What is purchased differs significantly between the cases, as can be seen in Table 4; varying in type of shipments, geographical spread, transport modes and direction of transport. These differences were assumed to affect the purchasing process, resulting in three different cases that can illustrate in what way activities in the purchasing process are connected to logistical variables and thereby to CO<sub>2</sub> emissions. As described earlier, it may be difficult to know prior to data collection if there is variation between cases. This was handled by selecting companies of which the researcher had prior knowledge from Study

One. A benefit of this was reliable access to people willing to provide the required detail of information.

The cases consist of a purchasing process up to contract, either the latest that has been carried out or a process carried out within two years. If more than one purchasing process was described by the transport buying company, the selection for inclusion was based on achieving a variety in shipment characteristics.

*Table 4: Shipment characteristics of the cases*

Case	Type of shipments	Geographical spread	Transport modes	In/outbound transport
A. Manufacturer, Retail Commodity	Container	China to Sweden	Ship + truck	Inbound
B. Manufacturer, Machinery	Smaller shipments, express service	Worldwide, mainly Europe	Truck + air	Inbound + outbound
C. Manufacturer, Food	Part truck loads (pallets)	Sweden	Truck + rail	Outbound

### 3.3.2.3 Data collection

To begin with, one to two-hour long semi-structured interviews were carried out with purchasing or logistics managers, who were directly involved in transport service provider selection at three transport buying companies. During each interview the activities of the specific purchasing process for freight transport services were described; from defining specification to contract agreement. In addition, where possible, documents used in the process, for example evaluation matrices, requests for quotations, and contracts, were examined.

To complement the description of the three purchasing processes, the sales person at the transport service providing companies responsible for respective case was also interviewed. The main focus of the 30-40 minute long semi-structured interviews with the three transport service providers was to collect their views of the influence of the purchasing process on transport operations and environmental performance. At these interviews, the respondents were shown a list of key logistical variables to prompt suggestions. The views of the sales representatives were used as an important input for drawing the connections between the purchasing process and logistical variables. Table 5 below lists the respondents for Study Two.

*Table 5: Respondents at the case companies*

Case	Shipper respondents	Transport service provider respondents	Interviewer
A	Logistics manager	Sales rep (account manager)	Sara
B	Purchasing manager	Key Account Manager + Corporate Responsibility Manager	Sara
C	Purchasing manager	Sales rep (account manager)	Sara

### 3.3.3 Study Three

An explorative multiple-case study of five routine freight transport ordering processes was carried out.

#### 3.3.3.1 Literature search

A literature search was conducted to find articles describing the freight transport ordering process by shippers. Key word search combinations of “logistic\*”,

“purchasing process”, “freight transport”, “freight, transport management”, “buy” and “shipper” were performed in the ABI/Inform Global and Scopus databases during March 2012. Also, the search strings “traffic manager” and “freight transport” were used in the ProQuest database in March 2012. Few relevant articles were found. It is possible that there are other keywords that should be used when searching.

### 3.3.3.2 Case selection

The case processes studied were selected to explore the transport ordering process.

*Table 6: Characteristics of the cases*

Case	Type of shipments	Recipients	Shipment size	Destinations	Transport modes
A. Manufacturer, Machinery	Spare parts distribution	Industrial customers/ Sister companies	Parcels /pallets Less than full loads	Global	Mainly air or road
B. Manufacturer, Power and automation	Distribution of manufactured products	Industrial customers	Palletised goods; Less than full loads	Global	Mainly road and sea
C. Manufacturer, Paper	Distribution of customised manufactured products	Industrial customers – electrical industry	Reels + pallets; Less than full loads + Full loads	Outside Europe	Mainly sea
D. Manufacturer, Paper	Distribution of customised manufactured products	Industrial customers – steel, printing and textile industries	Reels + pallets; Full loads + less than full loads	Global	Sea and road
E. Manufacturer, Paper	Distribution of customised manufactured products	Industrial customers – furniture industry	Palletised goods; Less than full loads + Full loads	Global	Sea and road

All cases concern outbound transportation from manufacturing companies, in order to see similarities in the input from other functions in the company. All cases were selected to have more than one frame agreement with a transport service provider. Case B was selected due to its degree of freedom surrounding the transport ordering function. Cases C, D and E are different locations within the same company. Table 6 shows the characteristics of the cases.

### 3.3.3.3 Data collection

Semi-structured interviews with the transport ordering staff at Swedish companies purchasing transport services lasted for approximately two hours and included observations on how transport orders were placed. During the interviews, the respondents were asked to describe the process, as well as how related internal processes affect the process. After the interviews, a protocol was written based on the notes and audio recording.

For three of the cases, the data collection was carried out by students, during their thesis work in the Spring of 2011, which was supervised by the researcher.

The same interview guide was not used as for case A and B. The students structured the descriptions according to steps in the order process and presented them in a report. These process descriptions were restructured by the author of this thesis in March 2012, according to the same structure as for cases A and B. The resulting protocol was sent back to the respondents for confirmation. A few follow-up questions were answered by phone.

*Table 7: Respondents at the case companies*

Case	Respondents	Interviewer
A. Manufacturer, Machinery	Transport order staff	Sara
B. Manufacturer, Power and automation	Supply Manager + Order staff	Sara
C. Manufacturer, Paper	Logistics manager	Students
D. Manufacturer, Paper	Transport order staff	Students
E. Manufacturer, Paper	Transport order staff	Students

### 3.4 Analysis

The different steps of analysis in the described studies are shown in Table 8. The figure is inspired by the serpentine of Creswell (2007), an iterative process that develops one step at a time, with two additions of early analysis. The figure can be read as follows. A first round of analysis takes place during the preparation, for example framework to be used, what to include in the interview, deciding the focus. A second round of analysis takes place during the interview, depending on how flexible the interview guide is. What threads are followed? Certain things are followed up on while others are given less attention. Is the interviewee allowed to reflect on certain answers? Third, the analysis continues with the managing of data, for example how the data is structured. Fourth, the analysis continues with reading and reflecting on the collected data. Fifth, the next stage of analysis consists of describing, classifying and interpreting the data. Finally, the data is visualised and represented in tables, matrices, and frameworks.

*Table 8: Steps in analysis (inspired by Creswell, 2007).*

STEPS OF ANALYSIS	STUDY 1	STUDY 2	STUDY 3
Preparation	Interview guide, literature study	Literature study, interview guide	Literature study, interview guide
Data collection	Interviews	Interviews	Interviews, observations
Data managing	Structuring content	Structuring content	Structuring content
Reading, reflecting	Highlighting comments, notes	Highlighting comments, notes	Highlighting comments, notes
Describing, classifying, interpreting	Sorting, comparisons	Grouping, comparisons	Grouping comparisons
Representing, visualising	Illustrations (purchasing process), tables, framework	Framework	Illustration (ordering process), tables, framework

#### 3.4.1 Study One

In Study One, the literature review shaped the framework of what contextual dimensions and variables to include in the interview guide. The interviews, which were semi-structured, varied in focus between cases in order to follow interesting threads that appeared during questioning. The usable content of the



transcribed interviews was structured according to what parts of the text concerned specific variables of contextual dimensions and descriptions of the purchasing process. The case information for the seventh case was structured similarly, in close cooperation with the researcher who had collected the data. Reading and reflection of the transcribed interviews was carried out, highlighting words, phrases or sections that appeared relevant, and writing notes of interesting issues in the text. Visual representations of the results in the form of tables were drawn.

Two important steps of analysis is within-case and cross-case, in an attempt to recognise patterns (Eisenhardt, 1989). First, a within-case was carried out. The purchasing process and the contextual variables in each case were described. This was followed by considering, case by case, how the purchasing process may be influenced by the contextual variables. Tables were drawn with variables on one side and purchasing process activities on the other side, to visualise the connections identified.

Second, a cross-case analysis was carried out, reflecting what patterns emerged from the within-case analyses and how the cases differed. Here, tables that showed the purchasing process as well as contextual variables for all cases were used. The results of the within-case analysis were also used to examine what connections had been found. The connections identified between process and context were sorted according to stages, and within that sorted according to contextual dimensions and variables.

Third, the implications identified on the purchasing process from contextual dimensions were listed. The contextual dimensions were combined into eight different types of context, with implications on the purchasing process. A visual representation of the eight types of contexts was presented.

### **3.4.2 Study Two**

The interview guide was quite detailed, and based on existing literature on methods and strategies for specification, selection and contracting. However, the respondents viewed the processes as less complicated, and the questions were modified to reflect the answers from the respondents. The interviews were mainly structured with requests for process description, and followed up with questions during the dialogue. Towards the end of the interviews, the respondents were shown the conceptual framework and asked for reflections regarding possible connections. The interview guide for the transport service provider was more focused on implications on CO<sub>2</sub> emissions.

After each interview, a protocol was written based on the notes and audio recording. For the transport buying respondent, this protocol was structured according to the steps of the purchasing process, as described by the respondents. For the transport providing respondents, the protocol was similarly structured, but the focus of the protocol was on the implications identified on the logistical variables.

At the same time, existing literature was re-examined, according to different steps in the purchasing process and according to key logistical variables.

A within-case analysis was carried out on the empirical evidence. Findings in the cases were checked against existing literature to see if earlier observations were confirmed. The combination resulted in a list of observations where links were drawn. This was expressed in tables connecting purchasing process steps with logistical variables. A visual representation of the connections was also drawn up on a case by case basis, as well as a compilation of all the different connections found. The cross-case analysis consisted of grouping the ways the connections could be achieved and the reasons underlying the connections.

### **3.4.3 Study Three**

Although an interview guide was developed, the interviews were quite flexible, allowing for the respondent to describe his/her work with follow-up questions inserted where suitable. In addition, many questions were based on observing the respondent perform a transport order process.

Based on the student thesis from 2011, a visualisation of the process was drawn up. The data collected was structured according to (1) the order of the activities taken; (2) input from internal processes and functions; and (3) the degree of freedom for the transport ordering function.

The first analysis described the process of ordering freight transport based on findings from the five cases. The data was first structured according to the order of activities taken. Next, the data was grouped into process stages. Thereafter, the process was expressed through a figure. Finally, a general process description was written up.

In the second analysis, the connections from the ordering process to logistical variables were considered. The detailed case process descriptions were examined, highlighting aspects that could be related to logistical variables. However, it is difficult to comment on the consequences on the service delivery based only on interviews with shippers. For that reason, literature searches for logistical variables and/or transport operations were conducted, and the literature found was explored for associations to shippers ordering of transport, for example remarks regarding constraints or activities. Findings in cases and literature were combined to a list of tasks and issues. The cases were then structured according to the tasks and issues in a table. A figure visualised the connections identified from the transport ordering process to the logistical variables and the aspects underlying these connections.

As a third analysis, the case descriptions were structured according to the degree of freedom from the transport ordering function, i.e. what opportunities there were for the person ordering transport to act on or affect the transport ordering process (and through that the logistical variables). Information input required for the transport ordering function was analysed in each case. The information input was then linked to the aspects in the transport ordering process underlying the influence on the logistical variables, grouping the data by process stage and identified aspects, first in tables and then illustrated in a figure.

### **3.5 Research quality**

The discipline of logistics has a history of positivistic ideals, but has moved towards more interpretivist-inspired qualitative methods (Halldorsson and Aastrup, 2003). Since this research uses qualitative methods, it is of interest to consider quality criteria that are more suitable to that type of research. The following section connects this research to four aspects of trustworthiness.

#### **3.5.1 Credibility**

Credibility matches internal validity in quantitative research, and concerns the truth-value of the research (Halldorsson and Aastrup, 2003). If there is no single objective reality, then credibility is about a correspondence between what is described by the researcher and how respondents present their reality. Respondent validation becomes important, where respondents can correct the reality as constructed by the researcher (Halldorsson and Aastrup, 2003).

In Study One, the respondents verified the researcher's understanding of their answers by reading and commenting on summaries of their purchasing process. Where anything was unclear, it was discussed in further detail. The second round of interviews provided an opportunity to clarify statements from the first round. In three of the cases, the illustration of the purchasing process was verified with the respondents at a follow-up meeting.

Another technique to increase credibility is triangulation (Bryman and Bell, 2007). Croom (2009) mentions different types of triangulation: methods, data, investigator, and theory. In Study Two, data triangulation was used by studying different perspectives. Both transport buyers and transport service providers were interviewed and asked to describe the purchasing process. In Study Three, method triangulation was used through both interviewing and observing to acquire a fuller description through multiple sources of evidence.

#### **3.5.2 Transferability**

Transferability matches external validity in quantitative research (Bryman and Bell, 2007) and questions if the research can be applied to the general world, in another context or in the same context but at a different point in time. According to Erlandson et al. (1993) and Guba and Lincoln (1989), it is the reader that determines if there is transferability, i.e. enough similarity between the context that is described in an article and the context the reader would like to apply ideas to. For this reason, it is important to describe the context and provide detailed accounts of the interrelationships and intricacies of studied context. According to Eisenhardt and Graebner (2007), the case-study method emphasises the context in which the study takes place. Thus, the use of the case-study method in all three studies supports transferability.

In Study One, the contexts of the cases was very thoroughly documented and described, while both Study Two and Study Three include detailed descriptions of the processes to allow the reader to compare them to other situations or see dissimilarities.

### **3.5.3 Dependability**

Dependability matches reliability in quantitative research (Bryman and Bell, 2007). While reliability is concerned with stability of data, in qualitative research dependability is more concerned with trackable variance (Halldorsson and Aastrup, 2003); change can be positive, meaning better insights (Erlandson et al., 1993). It is important to document the logic of process and method decisions (Guba and Lincoln, 1989). On the negative side, auditing such a large amount of documentation is very demanding (Bryman and Bell, 2007).

For all studies, interview guide development has been documented, as has case selection, and which contacts have been made and when. The different stages of analysis have been described in detail in section 3.5 to show the process.

### **3.5.4 Confirmability**

Confirmability matches objectivity in quantitative research (Bryman and Bell, 2007). However, in qualitative research the researcher who selects and uses the research method(s) cannot be separated from it completely, and thus there is no complete objectivity, free of bias and values (Erlandson et al., 1993). Therefore it is important to be able to track data (Guba and Lincoln, 1989) to confirm findings through interpretations made.

To provide a chain of evidence, recordings of interviews and case protocols have been kept together with documents regarding case selection and analysis stages. In all studies, the researcher discussed the progress with two supervisors; for example discussing interpretations in the analysis. Validation has also been sought through peer review at conference presentations and research seminars.

## 4 Results

This section summarises the results, which are derived from the answers of the research questions in the three appended papers. As previously stated, each research question corresponds to one of the papers. Table 9 presents an overview of the three papers and the main findings.

*Table 9: Overview of the three papers*

	PAPER 1	PAPER 2	PAPER 3
Paper title	Influence of context on the purchasing process for freight transport services.	Sustainable freight transport purchasing.	Connecting ordering of freight transport to logistical variables related to CO <sub>2</sub> emissions.
Published as	Working paper for IPSERA Conference, April 2011. Reworked 2012.	Working paper for IPSERA Conference, April 2012.	Paper for LRN Conference, September 2012.
Research question	RQ 1: How can contextual factors influence the configuration of the purchasing process for companies purchasing freight transport services?	RQ 2: How can a shipper's initial stages of the purchasing process for freight transport services influence the logistical variables related to CO <sub>2</sub> emissions?	RQ 3: How can a shipper's freight transport ordering process influence the logistical variables related to CO <sub>2</sub> emissions?
Research studies	Study 1: Context.	Study 2: Purchasing process up to contract agreement.	Study 3: Ordering process.
Main findings	<p>Description of purchasing process for freight transport services.</p> <p>Three types of purchasing processes found.</p> <p>Influence of contextual factors (purchase situation, relationship, and service type) on purchasing process.</p> <p>Eight different types of contexts are suggested.</p>	<p>Identified the relationships between the initial stages of the purchasing process for freight transport services and logistical variables.</p> <p>Importance of environmental and other aspects (particularly, time requirements) in considering the use of green purchasing practices.</p>	<p>Detailed process description of the freight transport ordering process.</p> <p>Identified the relationships between the freight transport ordering process and logistical variables.</p> <p>Potential to influence logistical variables through actions and decisions in the transport ordering process depends, to a large degree, on input from other processes.</p>

### 4.1 Context and configuration of the purchasing process

The first research question was formulated as follows:

***RQ 1: How can contextual factors influence the configuration of the purchasing process for companies purchasing freight transport services?***

A conceptual model was developed suggesting influence on the purchasing process for freight transport services from the contextual dimensions 'purchase task', 'importance' (of purchasing freight transport services to the organisation, for example relative size of costs) and 'service type'. These contextual

dimensions can be disaggregated into contextual variables, defining the dimensions in the context of purchasing freight transport services. See Figure 11 for a list of the contextual variables and the scales for each variable. By influence is meant that activities in the purchasing process were performed differently depending on the contextual variables, for example spending much time or not on specification of the service.

PURCHASE TASK		
Rebuy -----	<i>Purchasing situation</i>	----- New task
Single (only transport) -----	<i>No of services</i>	----- Multiple (warehouse etc)
Standard -----	<i>Type of service</i>	----- Dedicated
Competitive bidding -----	<i>Supplier strategy for transport purchase</i>	----- Reduce no of suppliers
Few -----	<i>No of suppliers</i>	----- Many
Arm's length -----	<i>Supplier relationship approach</i>	----- Partnership
IMPORTANCE		
Low -----	<i>Transport cost</i>	----- High
Small -----	<i>Unique driver</i>	----- Large
SERVICE TYPE		
Local (domestic) -----	<i>Location of recipients/senders</i>	----- Global
Few -----	<i>No of locations</i>	----- Many
Repetitive -----	<i>Variation in locations</i>	----- Changing
Full load -----	<i>Size/volume/weight of shipment</i>	----- Small – part load
Repetitive -----	<i>Variation in size/volume/weight</i>	----- Changing
Functional -----	<i>Innovativeness of product</i>	----- Innovative
Only industrial -----	<i>Type of recipients/senders</i>	----- Many (consumer+public+industrial)

Figure 11: Contextual variables that define the studied contextual dimensions, together with indications of the scales for each variable

The results of study 1 show that differences in the context do affect the purchasing process for freight transport services. Different stages of the purchasing process are influenced by different contextual variables, as can be seen in Table 10.

Table 10: Contextual dimensions that influence different stages of the purchasing process

DEFINE SPECIFICATION	SELECT SUPPLIER	CONTRACT AGREEMENT
<i>Purchase task</i>	<i>Purchase task</i>	<i>Purchase task</i>
Purchasing situation	Supplier relationship approach	Supplier strategy
No of services		Supplier relationship approach
Type of service		Purchasing situation
	<i>Importance</i>	No of services
<i>Importance</i>	Transport cost	
Transport cost		<i>Service type</i>
Unique driver		Variation in locations
	<i>Service type</i>	Size of shipments
<i>Service type</i>	Locations of recipients/senders	
Variation in locations	Number of locations	
Variation in size of shipments	Variation in locations	
	Type of recipients/senders	

More time or detail in the first stage of the purchasing process, ‘define specification’, can be an effect of a new *purchasing situation*, purchasing a *dedicated service*, or purchasing *multiple services*. The observations were inconclusive regarding the influence of the contextual dimensions ‘importance’ on the first stage of the purchasing process, since how much time was spent in the specification stage in the cases did not concur with importance of purchasing

freight transport services. The contextual dimension *service type* shows a clear influence on the first stage of the purchasing process, 'define specification'. Frequently, *changing destinations* meant that it was more difficult to specify the service in detail. *Variation in shipment size* can make it difficult to specify the requirements in advance.

Many contextual variables, the *service type* variables in particular, also influence the second stage of the purchasing process, i.e. the 'select supplier' stage.

Personal contact during the second stage of the purchasing process, 'select supplier', can be connected to the *supplier relationship* approach. Evaluation of potential providers as opposed to comparing the offers was also related to the *supplier relationship* approach. In most of the cases studied, shortlisting of potential transport service providers in the 'select supplier' stage was also related to the *supplier relationship* approach.

Regarding influence of the contextual dimensions 'importance' on the 'select supplier' stage, the perceived high *cost of transport* for low value products makes it important to compare offers from transport service providers.

*Location of recipients and senders* were found to influence the selection of transport service providers: both *locations* and the *number of locations*. It is difficult to compare offers regarding *many global destinations* as opposed to *repetitive full loads to few destinations*. The *type of recipients* can limit the number of potential providers in the second stage of the purchasing process, 'select supplier'. Inconclusive evidence also suggested a relationship between the *type of recipients/senders*, for example being nearer to the end consumer, and the inclusion of environmental considerations in the selection stage.

In the third stage of the purchasing process, 'contract agreement', mainly purchase task variables influence the process. The *purchasing situation* influences the 'contract agreement' stage where a new task purchasing situation resulted in comprehensive contracting. The *number of services* purchased was found to influence the 'contract agreement' stage, where purchasing additional services resulted in detailed contracting. Observations in the cases showed that the *supplier strategy* as well as the *supplier relationship* approach influenced both negotiation, for example on-going negotiations, and contracting, for example level of detail as well as goal setting. Difficulties in specifying the service due to *variation in destinations* or customer requirements resulted in less detailed contracting. *Shipment size* was found to influence the content of negotiations.

A proposed framework is presented based on patterns found in the seven cases. The influence on the purchasing process is mapped for how complicated the service type is in combination with how complicated the purchase situation is (for example new task or rebuy situation) and how close the intended relationship with the transport service provider will be. These mappings result in eight types of contexts, and the different types of contexts result in different configurations of the freight purchasing process. Specifics for the configuration

of the purchasing process for each type of context are presented in Figure 12. For more details regarding the framework, see appended paper 1.

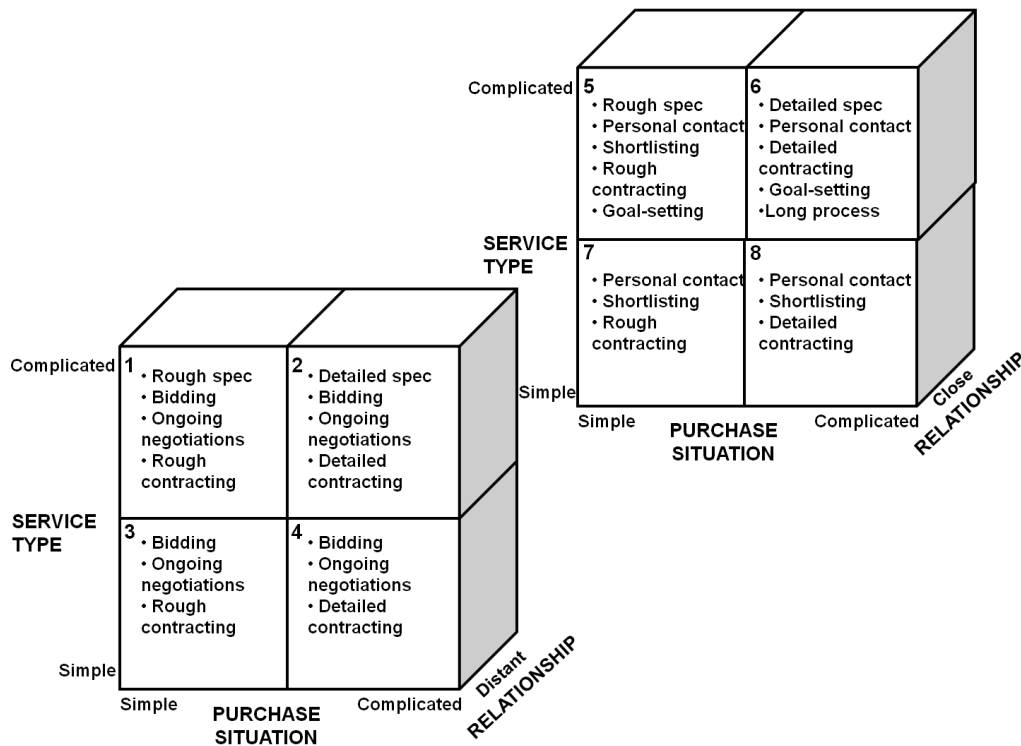


Figure 12: Eight types of contexts and specifics for the purchasing process in each context

To use this framework, companies have to assess which variables of the contextual dimensions are particularly relevant to them, and describe their context in order to map the type of context that corresponds to the company. The proposed framework can offer guidance on the configuration of the purchasing process, provided different contextual dimensions.

In addition, before examining relationships, the configuration of the purchasing process was described. Three types of purchasing processes for freight transport services have been identified. Five of the seven cases could be said to have a similar structure in their purchasing process. Within those five cases, there are differences on a more detailed level, for example which stages are emphasised as important, time spent as well as level of detail in different stages.

Two cases differ more significantly from the rest: The Machinery Manufacturing Company, because a frequently changing transport pattern leads to frequent renegotiations with the transport service provider, and the IT Mail Order Company, because the process consists of benchmarking with a new transport service provider and then inviting the current transport service provider to make a counter offer.



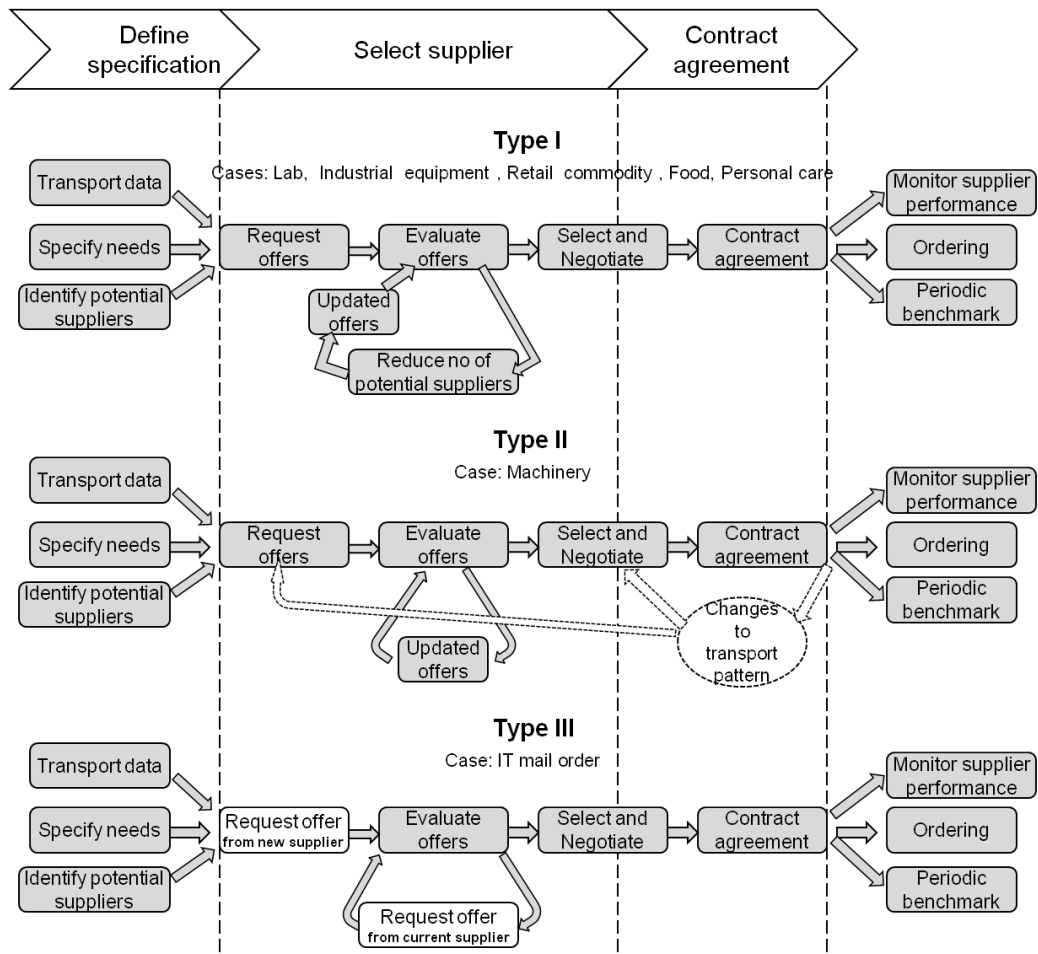


Figure 13: Three types of purchasing processes identified in the cases

## 4.2 Initial stages of the purchasing process linked to logistical variables

The second research question was formulated as follows:

***RQ 2: How can a shipper's initial stages of the purchasing process for freight transport services influence the logistical variables related to CO<sub>2</sub> emissions?***

In the results in appended paper 2, a conceptual model that combines a purchasing process model with a framework of the relationship between logistics and environmental effects is presented. Based on a multiple-case study of three purchasing processes, the relationships between the purchasing processes for freight transport services and logistical variables are identified. Figure 14 depicts the connections found in the cases. By connection is meant influence from the purchasing process on the logistical variables, either in a negative or positive direction, for example if average length of haul can become shorter or longer. The connections identified primarily occur in the first stage of the purchasing process, where needs are specified. A few of the identified connections occur in the 'select supplier' stage, and one connection takes place in the 'contract agreement' stage.

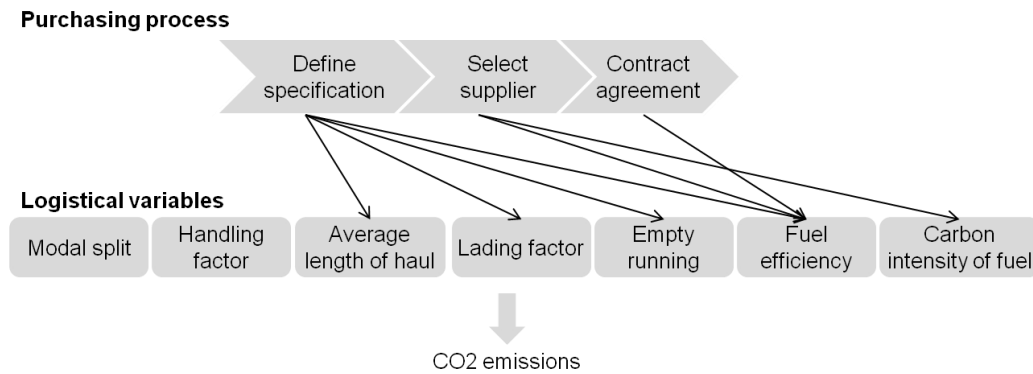


Figure 14: Identified relationships between the purchasing process and logistical variables

In all three cases, the ‘define specification’ stage exhibits a relationship with the logistical variable *average length of haul*, but the reasons for such a relationship differ for each case. In cases A, B and C, the relationships are driven by a requirement for low cost, a requirement for late pickup, and specified time windows for delivery, respectively. Companies purchasing freight transport services and companies providing freight transport services discuss *length of haul* less frequently than *lading factor* and *fuel efficiency*.

The reasons underlying the relationship between the ‘define specification’ stage and the logistical variable *lading factor* also differ. In cases B due to scheduled pickups, delivery precision, and volume while in case C due to time window. Because case A concerns containers filled by the companies purchasing freight transport services, the scope is insufficient to exert influence on *lading factor*. Understanding the relationship between requirements and *lading factor* can improve the collaborative relationship of buyers and providers, specifically with regard to discussing the consequences of requirements on *lading factor*, as well as the measures that can be taken to improve this factor.

The ‘define specification’ stage and the logistical variable *empty running* also exhibit a relationship in cases A and C because of a requirement for low cost and specified time windows for delivery, respectively.

The logistical variable *fuel efficiency* is influenced in three purchasing stages: ‘define specification’, ‘select supplier’ and ‘contract agreement’. In case A, requirements for lead-time in the ‘define specification’ stage potentially influence the logistical variable *fuel efficiency*. In case C, specific requirements are specified in the ‘define specification’ stage regarding vehicle type (euro classes) and driving style (eco-driving training); the same variables are used in a questionnaire in the ‘select supplier’ stage, and specific criteria are used for evaluating transport service providers. Verbal agreements (part of ‘contract agreement’) also cover vehicle type and driving style.

Finally, the ‘select supplier’ stage and the logistical variable *carbon intensity of fuel* exhibit a relationship in case C because the questionnaire submitted by all of the providers touches on the use of alternative fuels.

In summary, three different ways of working influence the logistical variables:

- Specifying requirements that create the conditions imposed on transport service providers' solutions.
- Use of evaluation criteria that ask for specific information or assign weight to environmental aspects.
- Use of verbal agreements, which include aspects that affect the logistical variables.

The aspects through which companies purchasing freight transport services influence the logistical variables include cost, time, environment, availability and volume. These aspects and their relationships with the corresponding logistical variables are shown in Figure 15.

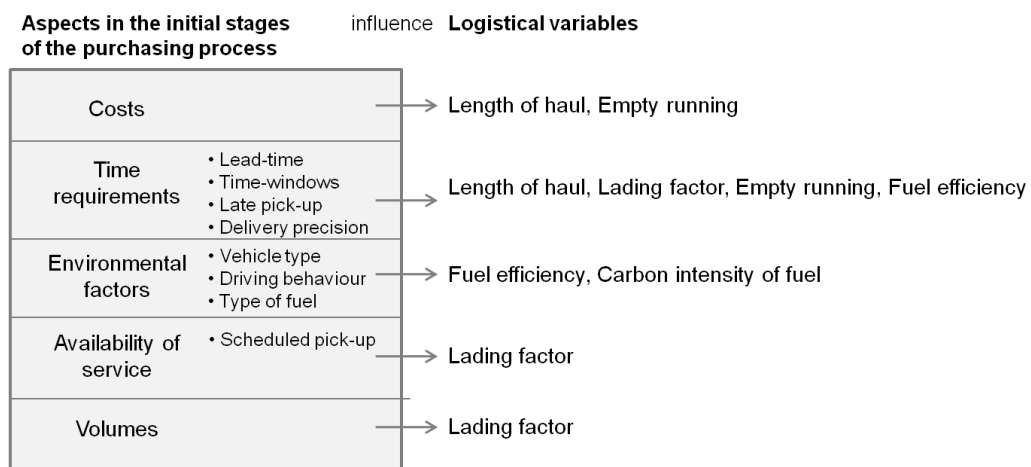


Figure 15: Aspects in the initial stages of the purchasing process and their relationships with the logistical variables

This study shows that the important considerations with regard to the potential CO<sub>2</sub> emissions from the freight transport sector are (1) the environmental requirements set by buyers, such as vehicle type and training on eco-driving, and (2) other requirements, particularly time requirements, including lead-time, time window, late pickup and delivery precision.

### 4.3 Ordering process linked to logistical variables

The third research question was formulated as follows:

***RQ 3: How can a shipper's freight transport ordering process influence the logistical variables related to CO<sub>2</sub> emissions?***

In appended paper 3, relationships between the freight transport ordering process and the logistical variables are identified in five cases. Figure 16 summarises these relationships.

Overall, the most clearly identified relationship is that between the transport ordering process and *lading factor*. The relationships with *lading factor* are found in all cases and in three phases: 'plan transport', 'calculate space' and 'select provider'. In addition, related literature shows possible connections

between the transport ordering process and *average length of haul* and *empty running*. An influence on *modal split* is also found.

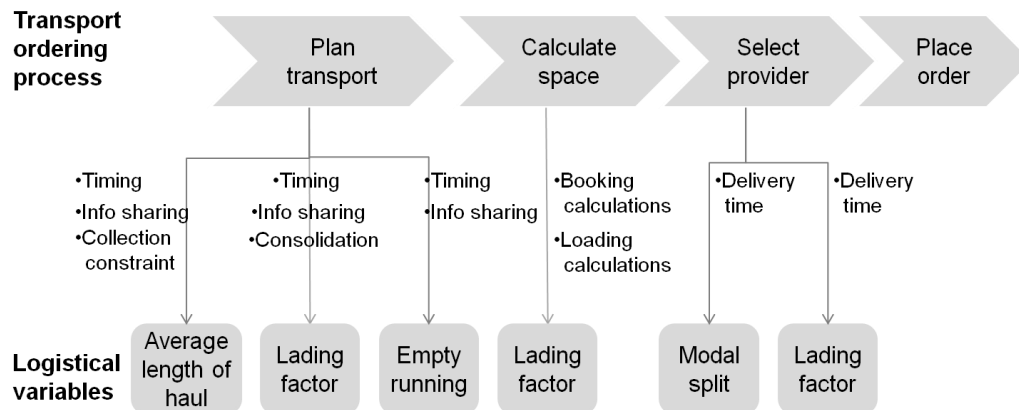


Figure 16: Connections from the transport ordering process to logistical variables

The aspects behind the relationships between the ordering process and the logistical variables are: timing of booking, timing of information sharing, type of information shared, requirements made on collection or delivery times, consolidation work and calculations of required space, as well as how efficiently this space is used (loaded).

In most of the cases studied, the transport is ordered when the product is ready for collection. The timing of ordering can influence the logistical variable *average length of haul*, since products that are not ready for collection when the transport service provider arrives can mean inefficiencies for the transport service provider. Alternatively, bad quality products can lead to return flows.

In two of the cases, shipments are sometimes consolidated. Consolidating to send larger volumes less often could influence the logistical variable *lading factor*. However, the actual *lading factor* depends on the carrier's ability to consolidate shipments from several shippers.

In two of the cases studied, information regarding goods waiting to be consolidated was not shared with the transport service provider and *ordering of transport* took place as late as possible. Information sharing as well as the timing of information sharing can influence the logistical variables *lading factor* and *empty running*.

In one of the cases, information about the actual volume for daily scheduled collection is only communicated if it is outside a pre-agreed range. If that volume is larger or smaller than expected, it can result in extra distance for the vehicle, meaning that information sharing can influence the logistical variable *average length of haul*.

In three of the studied cases, collection times are sometimes specified. Collection constraints might influence how transport service providers can plan the route, and thus the logistical variable *average length of haul*.

Estimations by the ordering function can lead to ordering more or less than needed, and thus can influence the logistical variable *loading factor*. The utilisation of ordered space, i.e. the logistical variable *loading factor*, could be influenced by how the goods were arranged in the space.

Often, the delivery time determined which particular service was selected and which mode could be used. Thus, the delivery time influences the logistical variable *modal split*. Urgent deliveries limit the possibility to consolidate shipments and thus may negatively influence the logistical variable *loading factor*.

In addition, findings in the cases show that the potential for ordering-related actions and decisions to influence the logistical variables, and thereby to reduce CO<sub>2</sub> emissions, to a large extent depends on input from other processes. This result indicates that communication between different functions is important.

As shown in Figure 17, in the studied cases, information input into the freight transport ordering process is necessary from many internal processes, from customers and from joint purchasing agreements with other companies. In particular, input from sales and production processes create the time frame in which the transport ordering process takes place. With such input, urgency and availability are important.

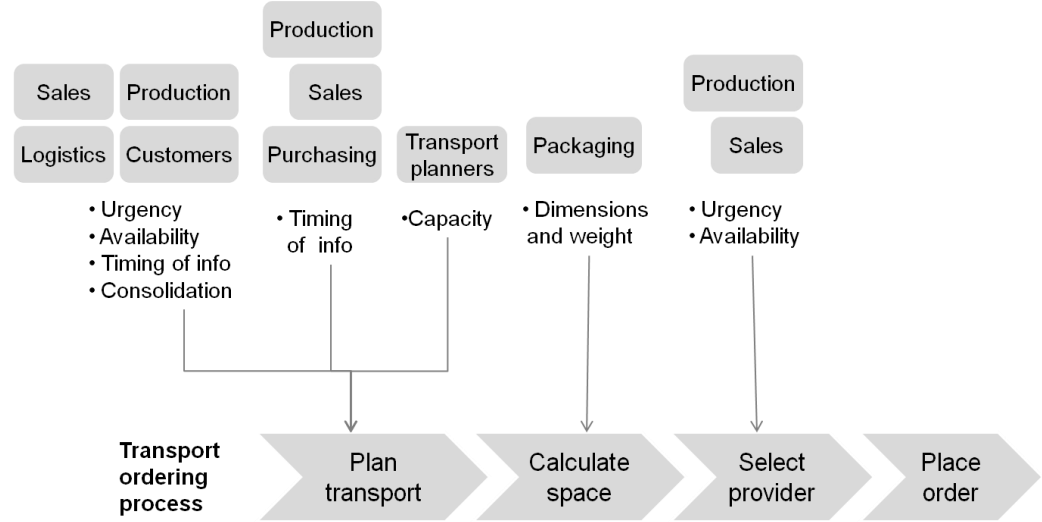


Figure 17: Information input into the transport ordering process from other disciplines

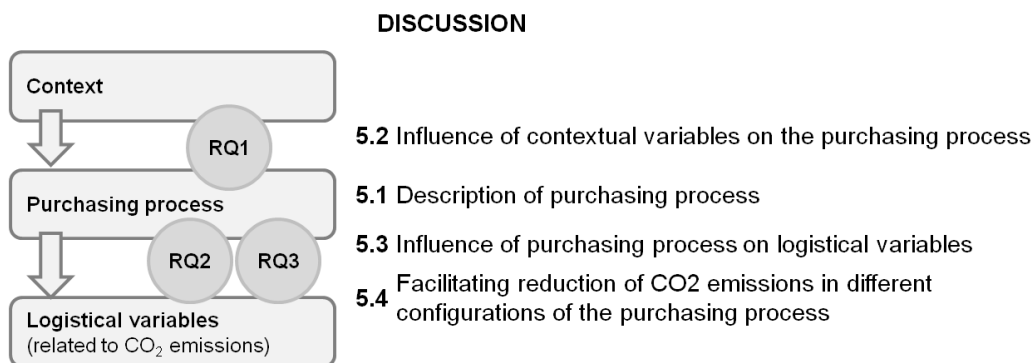
An example of how the potential of the transport ordering process to influence logistical variables depends on input from other processes relates to the timing of the information. The timing of the information input into the ordering process, including information on transport requirements from production processes, shipping and delivery schedules and sales processes, can influence the timing of the ordering and information sharing with the service providers. This influence, in turn, affects opportunities for transport service providers to plan vehicle use and routing, and therefore, influences *loading factor*, *empty running*, and *average length of haul*.



## 5 Discussion

This section is divided into subsections which discuss contributions in relation to the purpose of this thesis. Subsections 5.1-5.3 start with the main findings, followed by how these findings contribute to the purpose of the thesis, i.e. to explore how the configuration of the purchasing process for freight transport services can influence the reduction of CO<sub>2</sub> emissions. The findings are discussed in relation to theory, i.e. the results of other studies and the implications of the results are explored.

Figure 18 below provides an overview of the topics in each subsection. First, as a step on the way to answering the research questions, the purchasing process was described (subsection 5.1). Second, paper 1 explored the influence of contextual variables on the purchasing process (subsection 5.2). Third, research questions 2 and 3 and the corresponding papers explored how the purchasing process can influence logistical variables related to CO<sub>2</sub> emissions, which is discussed in 5.3. In 5.4, findings from all three papers are examined together to discuss how the influence on logistical variables can be facilitated or hindered depending on the configuration of the purchasing process.



*Figure 18: Overview of the Discussion sections in relation to the research questions, where 5.2 corresponds to RQ 1, 5.3 combines findings related to RQ 2 and 3 and 5.4 combines findings related to all three RQs.*

### 5.1 Description of the purchasing process for freight transport services

As steps on the way to answering the research questions, the results presented in paper 1, 2 and 3 include descriptions of the purchasing process for freight transport services. First, descriptions of the initial stages of the purchasing process (up to contracting) for different cases are presented. Second, a detailed process description of the freight transport ordering process is presented. Third, three types of purchasing processes are identified. The descriptions contribute to the purpose of the thesis by increasing understanding of the different configurations of the purchasing process for freight transport services that exist, including which activities take place during the process.

All papers include detailed descriptions of the purchasing processes of the case studies. For example, the process descriptions of the initial stages of the

purchasing process cover why the process is initiated; what requirements are formulated in the specification; the level of detail of the specification sent to potential transport service providers; how providers are identified; how offers are evaluated (for example use of an evaluation matrix and important selection criteria); how negotiations are carried out; agreements in the contract; and how follow up with transport service providers is managed in the post-contractual stages. For more details, see case descriptions in appended paper 1 or 2. The order process descriptions cover the following: when planning of transport is initiated; how the transport is planned; calculation of required space; selection of transport service provider; and timing of placing the transport order. For more details on the order process, see process descriptions in appended paper 3.

Understanding what takes place during the purchasing process is a starting point in identifying connections with the logistical variables (which will be discussed in section 5.3). This, in turn, is a step towards understanding how to reduce CO<sub>2</sub> emissions. Thus, the descriptions of the purchasing process are used to understand what activities take place during the purchasing process and to analyse which activities during the purchasing process can potentially influence logistical variables.

It is clear from the descriptions of the purchasing processes that loops are very important in the process. For example, a loop back to specification of needs could be introduced when offers from providers are evaluated. If there is a dialogue regarding implications of the requirements in the Request for Quotation (RfQ), it is possible that requirements can be reconsidered by the transport buyer. Another possibility is that requirements can be jointly discussed between the transport buyer and the provider. These discussions should explore which solutions are possible in order to deliver according to needs rather than dictating requirements.

Three different types of purchasing processes are identified (see Figure 13), all of which fit within the general process model of consecutive steps outlined by van Weele (1994), but are more detailed with regards to the stages. The descriptions of purchasing processes are also in agreement with the process descriptions put forth by Björklund (2005), but provide more information regarding the process stages during the post-contractual stages.

The findings offer descriptions of how specifying, selecting, contracting and ordering are applied for purchasing of freight transport services, which adds to the body of research on purchasing of freight transport. The findings also add to the research conducted by Andersson and Norrman (2002) by offering descriptions of more situations in which basic services are purchased.

Compared to the studies conducted by Björklund (2005) and Andersson and Norrman (2002), which focus on the process stages up to contracting, the descriptions of the ordering process in this thesis add richer descriptions of the ordering stage of the purchasing process.

In conclusion, the descriptions of the purchasing processes in this thesis do not contradict previous findings. Rather, the descriptions add more case studies that



address a broader variety of situations. As described in the Introduction, the literature on the ordering process stage is limited for freight transport. The descriptions of the ordering process in study 3 provide increased knowledge of this process stage.

The descriptions of the purchasing process for freight transport services in this thesis contribute to the literature by increasing knowledge of freight transport purchasing at small- and medium-sized companies. To a great extent, the smaller companies studied do not appear to have adopted green practices in the purchasing process.

## **5.2 Influence of contextual variables on the purchasing process**

In response to research question 1, influence of contextual variables on the purchasing process was found. Eight different types of contexts were ascertained (see section 4.1 or appended paper 1), and resulting different configurations of the purchasing process for freight transport services presented. Knowledge of the influence of contextual factors on the configuration of the purchasing process increases understanding of why the configuration of the purchasing process differs. The findings are a step towards increased knowledge regarding the configuration of the purchasing process in different contexts, thereby contributing to the purpose of this thesis by explaining why different configurations exist and describing how the configurations vary. This knowledge increases understanding of important contextual variables that influence which activities are carried out. It also shows how these activities are carried out in the different stages of the purchasing process at companies purchasing transport services, and can be used as a guide for determining which configuration of the purchasing process is suitable, provided certain types of contexts.

Portfolio models, for example the model by Kraljic (1983), can be used to understand and support management of supplier relationships. However, Olsen and Ellram (1997) argue that portfolio models do not provide any support in how to differentiate the management of products within one and the same quadrant of the model. The proposed framework (see section 4.1) helps to distinguish companies that are not differentiated in the Kraljic (1983) portfolio model, categorising them by differences in the context and showing the configuration of the purchasing process in eight different types of context.

As mentioned in the Introduction, it is not clear in what conditions certain practices are suitable. Understanding why the configuration of the purchasing process differs is a step towards understanding if certain configurations are more suitable for facilitating reduction of CO<sub>2</sub> emissions. An example of how the configuration of the purchasing process differs depending on the context is that the specification sent to transport service providers is either detailed or rough, depending on the context. A second example is that goals, such as Key Performance Indicators, might or might not be included in the contract, depending on the context. A third example is that personal contact with transport service providers might or might not be emphasised during the process, depending on the context. For information regarding which types of contexts see

Figure 12. How such differences in the configuration of the purchasing process could affect the potential to influence CO<sub>2</sub> emissions is discussed in section 5.4.

Study 1 uses a different methodological approach than Björklund (2005) and Björklund (2011) and explores a few contextual variables in-depth through case studies, in contrast to many factors examined through a survey. Also, this thesis focuses on the way the purchasing process is influenced by the context, which is not explained by Björklund (2011) or Holter et al. (2008). Compared to Björklund (2005) and Björklund (2011), the findings of this study are not focused on green purchasing practices and thus have broader applicability.

The study applies the following three variables from the organizational buying behaviour model (Johnston and Lewin, 1996) to the freight transport purchasing context: buy task, product type and importance (of purchase). Further, the study defines what is meant by the variables in this context and shows how the contextual dimensions can influence the different stages of the purchasing process. The descriptions of what is meant by the variables can be used to describe contexts for companies purchasing freight transport services. Descriptions of how the different stages of the purchasing process are influenced by the context increases understanding of the reasons why purchasing processes differ.

### **5.3 Influence of purchasing process on logistical variables related to CO<sub>2</sub> emissions**

In response to research questions 2 and 3, a key contribution is the identified connections between the purchasing process for freight transport services and the logistical variables; the aspects underlying such connections are identified as well. For more information, see sections 4.2 and 4.3 or appended papers 2 and 3. The findings contribute to the purpose of this thesis by presenting and discussing the potential influence of the purchasing process for freight transport services on CO<sub>2</sub> emissions, since the logistical variables are related to CO<sub>2</sub> emissions.

The findings show that practices in the purchasing process for freight transport services, both in the initial stages of the process leading up to a contract agreement and when ordering freight transport, can influence several logistical variables that are related to CO<sub>2</sub> emissions. Figure 19 combines the identified connections from the purchasing process to the logistical variables (from Figure 14 and Figure 16 in the results section). The aspects underlying the connections are listed in Figure 20, and will be discussed later in this section. See sections 4.2 and 4.3 or appended papers 2 and 3 for specifics regarding each connection.

The results indicate that many of the companies in the studied cases generally spend a short time during the first stage (the 'define specification' stage). Since many connections were identified between this first process stage and logistical variables, it seems important to ensure that sufficient resources, including time, are spent in this stage, for example understanding the needs underlying stated requirements. It is recommended that companies purchasing freight transport services properly analyse requirements and the consequences of requirements on logistical variables, preferably in discussion with potential transport service

providers. The discussions could also include alternative transport solutions, if offered by the transport service providers.

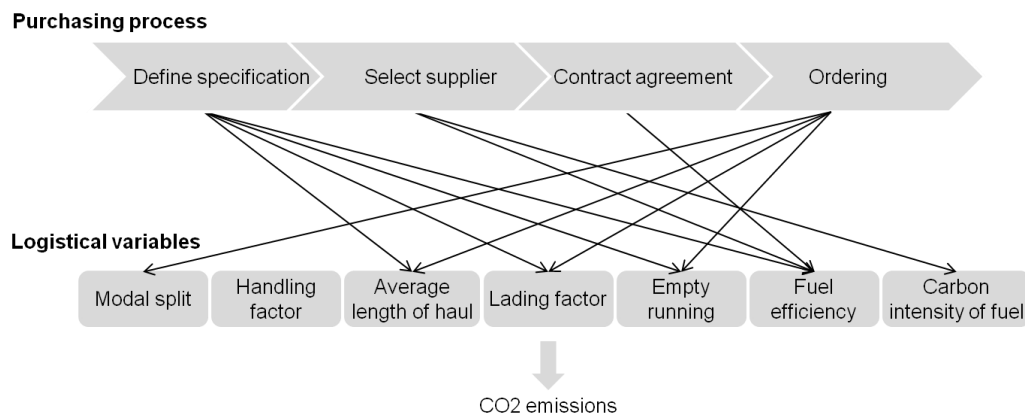


Figure 19: Identified relationships between the purchasing process and the logistical variables (combining the findings from papers 2 and 3).

In the studied cases, the purchasing functions of companies when purchasing transport services typically do not consider the environmental consequences of their activities and requirements. Furthermore, the transport service providers in the cases do not engage buyers in a discussion of the environmental consequences for the transport operations, for example, discussions regarding how specified requirements regarding delivery time windows might influence length of haul.

As mentioned in the Introduction, companies purchasing transport services perceive transport service providers as being passive with regard to offering green solutions (Santén and Arvidsson, 2011), which can result in purchasing companies stipulating requirements also regarding how to deliver the service. At the same time, in order to provide a more efficient and environmentally preferable transport, transport service providers would prefer less dictated requirements (Santén and Arvidsson, 2011). The findings show that in many of the studied cases, both the companies purchasing transport services and the transport service providers are passive in pursuing environmental goals. It is suggested in this thesis that stipulating requirements restricts how service providers design the service delivery and can have a negative effect on logistical variables. For fruitful discussions regarding consequences for logistical variables, both the companies purchasing freight transport as well as the transport service providers have to take a more active role in pursuing environmental goals.

The model in Figure 19 can be used in the specific circumstances of a company to discuss how the purchasing process for freight transport services is related to negative environmental effects. Further, it can be used in discussions between buyers and service providers, or between general managers and purchasing function regarding how to mitigate the negative effects purchasing freight transport services has on the environment. Companies that purchase such services should evaluate the aforementioned relationships, the factors that determine such relationships and how different logistical variables are affected.

Identifying the relationships can facilitate goal setting with respect to improving environmental performance.

Though these findings are based on case studies, they are also, to a large degree, based on results in previous literature. It is the perspective applied in this thesis that is new. Figure 19 structures information from the perspective of the company purchasing freight transport services, linking decisions and actions to the logistical variables. Previous research is often presented per logistical variable, for example the lading factor (see section 2.3 in the Frame of reference).

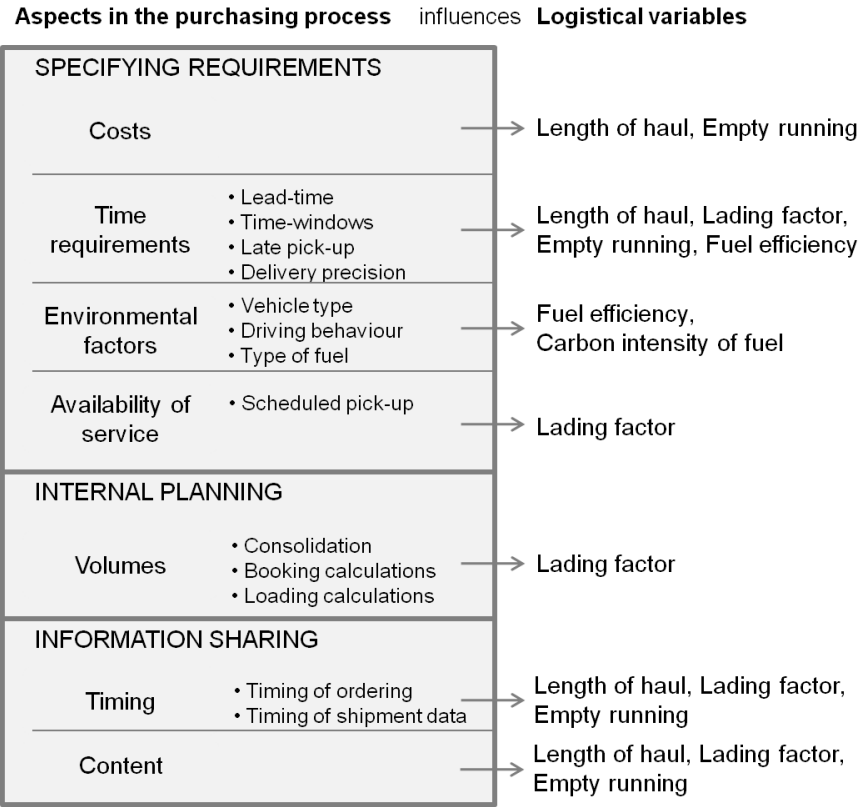
The perspective of companies purchasing freight transport services makes it clearer that practices at companies purchasing freight transport can have consequences on the logistical variables, and which logistical variables may be affected by different practices. Having this knowledge, companies purchasing transport can implement practices aimed at reducing CO<sub>2</sub> emissions. Additionally, this perspective offers a deeper understanding of the ways in which CO<sub>2</sub> emissions can be reduced. However, how logistical variables are actually influenced in each case needs to be discussed with the transport service provider(s). Such discussion is necessary to understand the actual implications on the specific service delivery and to reduce the risk of suboptimisation due to only considering one company at a time.

The findings regarding the connections between the purchasing process for freight transport services and logistical variables adds to the findings of Björklund (2005), in which green practices are described when purchasing freight transport, for example environmental requirements and environmental selection criteria, by showing the influence on logistical variables which are related to CO<sub>2</sub> emissions. The findings of this thesis are a step towards showing the impact of practices in the purchasing process for freight transport services on CO<sub>2</sub> emissions.

While Björklund (2005) describes practices such as transport buying companies placing requirements on the transport service providers, it is here argued that green practices, although they can push transport service providers to perform a transport that minimises CO<sub>2</sub> emissions, can also create limitations for transport service providers which make it more difficult to minimise CO<sub>2</sub> emissions. This means that increased understanding of the implications of requirements for CO<sub>2</sub> emissions are of interest both as an area for further research and for companies purchasing freight transport services.

An important finding when answering the second research question was that beyond just environmental factors, other requirements, especially time requirements, can potentially influence logistical variables. For more information, see section 4.2 or appended paper 2. Before discussing the implications of this finding, findings from studies 2 and 3 regarding the aspects identified to influence the logistical variables are combined in Figure 20. For more details regarding each study, see section 4.2 and 4.3 or appended papers 2 and 3.

In Figure 20 below, aspects identified to influence the logistical variables are sorted into the following three categories: requirements placed on the transport service provider; internal planning issues; and cooperation with the transport service provider. As already pointed out, Figure 20 shows that other factors beyond just environmental factors are important to consider when using green purchasing practices.



*Figure 20: Three categories of aspects and their relationships with the logistical variables.*

The first category in Figure 20 is specifying requirements, where costs, time and availability are listed in addition to environmental requirements. This relates both to what requirements are specified and to how they are specified, i.e. the process of specifying requirements, use of requirements as selection criteria, and inclusion of requirements in contracts or verbal agreements. The content of the requirements made by the company purchasing freight transport services can potentially affect the transport service provider in their work and affect the following logistical variables: length of haul, lading factor, empty running, fuel efficiency, and carbon intensity of fuel. Time requirements were found to be especially important to consider. The requirements belonging to the first stage of the purchasing process (specification of needs) can also be applied to the selection stage when evaluating providers as well as to the contracting stage by detailing requirements in the contract agreement (not observed in the cases included here). The list of requirements in Figure 20 should be used by companies purchasing freight transport to discuss with the transport service providers requirements and their actual influence on the logistical variables. For such requirements, companies purchasing freight transport services can also

consider how use of selection criteria and inclusion of requirements in contracts or verbal agreements, may influence the logistical variables.

The second category is internal planning. This concerns planning at companies purchasing freight transport services regarding volume to transport, including how often shipments are sent, for example consolidating by collecting goods to the same destinations, planning how much space is needed, i.e. optimising booking calculations, and how the space is utilised, i.e. optimising loading to fill the space that has been ordered. This section of Figure 20 can be used to discuss how transport buyers can internally influence the lading factor, which is related to CO<sub>2</sub> emissions. The findings correspond with the loading efficiency and booking efficiency dimensions of fill rate as described by Santén (2012). Although the internal planning category mainly focuses on the ordering stage of the purchasing process, it is possible to include a consideration of consolidation in the specification stage as well.

The third category is information sharing. In addition to the content of information shared, for example regarding how much is ready to ship and when, the process of information sharing, for example the timing of information sharing is also found to be important. This is based on findings regarding the order stage of the purchasing process. Examples of such findings are as follows: information sharing at an early stage is important for improving planning for transport operators, thereby influencing the lading factor and empty running; and incorrect information regarding how much to ship leads to extra length of haul. However, increased information sharing in the 'define specification' stage and the 'select supplier' stage could also be helpful.

The combination of results from study 2 and 3 strengthens the finding that not only environmental factors (see Figure 20), but also other factors, such as time requirements and information sharing, are important to consider when using green purchasing practices. Aspects that companies may not have thought of have been found to hinder the transport service providers wishing to minimise CO<sub>2</sub> emissions. This finding adds to the findings of Björklund (2005) by suggesting additional issues that transport buying companies should consider in order to purchase environmentally preferable transport. Furthermore, this finding also contributes to the purpose of this thesis by identifying the concrete aspects in the purchasing process for freight transport services that can influence the logistical variables that are related to CO<sub>2</sub> emissions.

The studies use the framework by Piecyk and McKinnon (2010) to connect the purchasing process for freight transport services to the logistical variables. Piecyk and McKinnon (2010) noted connections between operational factors (including order lead-times, delivery time windows, frequency of deliveries, use of JIT and variability of order size) and the logistical variables lading factor and empty running. The findings in this thesis found additional connections between the purchasing process, for similar reasons, and the logistical variables average length of haul, modal split, and fuel efficiency.

The findings regarding different aspects that can influence the logistical variables are important for further research regarding green freight transport

purchasing practices. These findings can also be considered in research regarding the individual logistical variables, for example, in providing input regarding the shipper's perspective to research on intermodal solutions.

The implications of the findings illustrated in Figure 20 are that it is important to foster increased communication and interaction between the transport buying company and the transport providing company. Companies that actively consider environmental factors in the purchasing process should also strive to reduce the potential environmental impact of non-environmental requirements. Sharing information about the implications of requirements, for example regarding time or availability of service, can take place during the purchasing process, creating more of a loop in the purchasing process than was observed in the cases studied here. This loop, in turn, can encourage discussions that lead to new proposals regarding what is required from the transport-buying side and new suggestions for solutions from the transport-providing side.

As identified in the Introduction to this thesis, there are contradictions regarding which actor drives the question of environmental consideration when purchasing freight transport. Regardless of which actor leads the question, the findings regarding aspects in the purchasing process that can influence the logistical variables can help both parties discuss the influence on logistical variables and hopefully find a common language when setting targets for reducing CO<sub>2</sub> emissions.

#### **5.4 Facilitating reduction of CO<sub>2</sub> emissions in different configurations of the purchasing process**

The following section combines the findings from all three studies to discuss how different configurations of the purchasing process facilitate or hinder effective consideration of the aspects influencing the logistical variables. Using the three categories of aspects listed in section 5.3, this relates to: facilitating the effective specification of requirements, effective internal planning, and effective information sharing, all effective in terms of reducing CO<sub>2</sub> emissions.

The different configurations of the purchasing process were identified for different types of contexts in study 1, and the categories of aspects influencing the logistical variables were identified in studies 2 and 3. These findings are combined in Table 11 to present how configurations of the purchasing process facilitate or hinder effective consideration of the aspects.

Starting with the first category of aspects, *specifying requirements*, it has already been discussed that transport buyers need to understand that requirements can influence the logistical variables. Discussions should be held with transport service providers regarding the actual effects of requirements on the logistical variables.

In type 1 and type 5 contexts, the purchasing process consists of a less detailed specification as well as less detailed contracting. The less detailed specification and contracting leads to more flexibility for the transport service provider, thus potentially enabling the transport service provider to plan and implement the transport without many restrictions, which has a positive effect on the logistics

variables. This could be negated, however, by last minute requirements from the transport buyer, including urgent shipments or late information sharing regarding shipments.

*Table 11: How configurations of the purchasing process facilitate or hinder effective specification of requirements, effective internal planning, and effective information sharing, effective in terms of reducing CO<sub>2</sub> emissions.*

Context	Details of configuration of purchasing process	Categories of aspects with potential to influence logistical variables		
		SPECIFYING REQUIREMENTS	INTERNAL PLANNING	INFORMATION SHARING
1	Rough specification, Ongoing negotiations, Less detailed contracting	(+) Freedom for transport service provider (-) Late requirements or information to transport service providers	(-) Difficult to standardize booking and loading calculations.	(+) Negotiations could be used to discuss effects on logistical variables (-) Culture for discussions
2	Detailed specification, Detailed contracting, Ongoing negotiations	(-) Limitations for transport service provider	(-) Difficult to consolidate.	(+) Negotiations could be used to discuss effects on logistical variables (-) Culture for discussions
3	Ongoing negotiations			(+) Negotiations could be used to discuss effects on logistical variables (-) Culture for discussions
4	Ongoing negotiations			(+) Negotiations could be used to discuss effects on logistical variables (-) Culture for discussions
5	Rough specification, Personal contact with provider, Less detailed contracting, Use of goals in contract	(+) Freedom for transport service provider (+) Goals formulated in cooperation with transport service provider (-) Late requirements or information to transport service providers	(-) Difficult to standardize booking and loading calculations.	(+) Discussions regarding consequences of requirements (+) Culture of information sharing (+) Goals formulated in cooperation with transport service provider
6	Detailed specification, Personal contact with provider, Detailed contracting, Use of goals in contract	(-) Limitations for transport service provider (+) Potentially agree on details, positive for transport service provider. (+) Goals formulated in cooperation with transport service provider	(-) Difficult to consolidate.	(+) Discussions regarding consequences of requirements (+) Culture of information sharing (+) Goals formulated in cooperation with transport service provider
7	Personal contact with provider			(+) Good foundation for information sharing (+) Discussions regarding consequences of requirements
8	Personal contact with provider			(+) Good foundation for information sharing (+) Discussions regarding consequences of requirements



On the other hand, in context types 2 and 6, the purchasing process consists of a more detailed specification as well as contracting. That requirements are specified in detail can create limitations for the transport service provider's work to operationalise the transport, which has a negative effect on the logistics variables. It becomes even more important for the transport buyer and the transport service provider to discuss the implications of requirements for logistical variables.

In context type 6, personal contact with the transport service provider is important which creates better conditions for a discussion regarding the implications of requirements for logistical variables. Such personal contact can also have a positive effect on the logistics variables. If discussions take place and agreements are made based on known influences on the logistical variables, a detailed contract may be favourable for the transport service provider who would then know what to plan for, which could have a positive effect on the logistics variables.

In context type 5 and 6, it is possible to include goals in the contract. These goals, if formulated in cooperation with the transport service provider, could include goals referring to the logistical variables, for example reducing the lading factor or average length of haul, which is seen as a positive effect on logistics variables.

Regarding the second category of aspects, *internal planning*, it has already been discussed that transport buyers can internally plan consolidation of shipments, how much space is ordered and how that space is utilised in order to influence the logistical variables. In both context types 2 and 6, although detailed specifications are used, many locations, varying locations, and/or varying size of shipments can make it difficult for the transport buyer to plan consolidation, which has a negative effect on the logistics variables. However, planning is also affected in context types 1 and 5. With rough specifications, variety means that planning how much space is ordered and how to best utilise that space is not repetitive and less likely to be standardised, which has a negative effect on the logistics variables. Internal information sharing between disciplines becomes important, including the timing of information sharing, to try to increase time for planning.

Finally, for the third category of aspects, *information sharing*, the importance of information sharing between the transport buyer and the provider has already been discussed. Looking at the contextual dimensions, maintaining a close relationship is of particular interest for cooperation between transport buyer and transport service provider and creates better conditions for information sharing. In context types 5, 6, 7 and 8, personal contact with the transport service provider during the purchasing process is emphasized. This personal contact can create a good foundation for information sharing both leading up to a contract agreement and during the contract period. For example, the importance of loops and discussing consequences of requirements, as previously discussed, may occur more frequently when there is close personal contact and cooperation

between the transport buyer and the provider. This can have a positive effect on logistics variables.

In context type 5 and 6, use of goals in the contract can occur. The goals can be developed in cooperation between the transport buyer and the provider. Furthermore, if there is a culture of information sharing already established during the early stages of the purchasing process, this can lead to further cooperation on goals and further information sharing during the contract period, which can have a positive effect on potentially reducing CO<sub>2</sub> emissions. As mentioned earlier, the goals could be formulated in cooperation with the transport service provider, and refer to the logistical variables.

In context types 1, 2, 3 and 4, ongoing negotiations are used in the purchasing process. These ongoing negotiations could be used to achieve the loop previously discussed where discussions regarding influence of requirements on logistical variables can lead to reformulation of requirements and further discussions regarding influence on logistical variables, which would have a positive effect on the logistics variables. However, the question is if a distant relationship approach creates the right culture for having these types of discussions rather than just negotiations regarding costs.

Combining the results from all three studies is of interest for contributing to the purpose of this thesis by discussing how the configuration of the purchasing process for freight transport services can influence the logistical variables. It also describes how configurations of the purchasing process facilitate or hinder work to reduce CO<sub>2</sub> emissions, suggesting which configurations of the purchasing process are more favourable than others.

Understanding how the configuration of the purchasing process in a given context can facilitate or hinder consideration of aspects influencing the logistical variables is useful for guiding how environmental considerations can be applied in a context-specific case. The discussion above is a step towards addressing the gap identified in the introduction regarding how suitable green purchasing practices are in a given context. The list in Table 11 can be used to guide which goals are realistic for companies purchasing freight transport aiming at reducing CO<sub>2</sub> emissions. For example, goals relating to information sharing are more suitable or not depending on the configuration of the purchasing process.

## 6 Conclusions and Further research

This section presents the conclusions of this thesis and suggests areas for further research.

### 6.1 Conclusions

Reducing CO<sub>2</sub> emissions from transport is necessary for achieving sustainable development. Companies purchasing freight transport services are in the purchasing process for freight transport services restricting and creating opportunities for how the transport service providers may design the delivered transport service, for example by specifying requirements. However, it is not clear from previous research how practises in the purchasing process can influence CO<sub>2</sub> emissions from freight transport. The activities involved in the purchasing process occur in a specific context, indicating that the conditions that determine the applicability of CO<sub>2</sub> emission reduction measures are likely to differ. Therefore, the purpose of this thesis was to explore how the configuration of the purchasing process for freight transport services can influence the reduction of CO<sub>2</sub> emissions.

The first research question examined the influence of three contextual factors on the configuration of the purchasing process: purchase task, importance (of purchasing freight transport services to the organisation) and service type. The second research question connected the initial stages of the purchasing process to logistical variables related to CO<sub>2</sub> emissions from the freight transport sector. The third research question considered how the freight transport ordering process, i.e. the part of the purchasing process after contracting, is linked to the same logistical variables.

The findings are based on empirical data, collected mainly through interviews in three multiple-case studies. Case studies were chosen as the most relevant method to suit the research questions, providing deep understanding of each situation. This was required due to the scarcity of earlier research on the transport purchasing process.

The results include descriptions of the purchasing process for freight transport services, with focus on the first four stages, i.e. 'define specification', 'select supplier', 'contract agreement' and 'ordering'. Three types of purchasing processes are identified in study 1. The influence of 'purchase task', 'importance' (of purchasing freight transport services to the organisation) and 'service type' on the purchasing process was established, and eight different types of context as well as the implications for the configuration of the purchasing process in each context presented. The results combine a purchasing process model, based on van Weele (1994), with a framework that depicts the relationship between logistics and environmental effects (Piecyk and McKinnon, 2010). Relationships between the purchasing process for freight transport and logistical variables, related to CO<sub>2</sub> emissions, are found for all four stages of the process that were studied. The underlying aspects of the relationships consist of three categories. In particular, time requirements and information sharing are highlighted as important aspects. Finally, the potential to influence logistical

variables when purchasing freight transport depends on input from other processes.

The knowledge gained by the findings in this thesis contributes to research on reducing the environmental impact of freight transport services, and supports researchers as well as companies that aim to reduce CO<sub>2</sub> emissions from freight transport activities.

Increased understanding of the purchasing process for freight transport services, and why as well as how the purchasing process influences reduction of CO<sub>2</sub> emissions, can guide companies on how to implement environmental considerations. Awareness of the influence of the purchasing process on CO<sub>2</sub> emissions can over time and combined with an increased focus on environmental sustainability help buyers and sellers design practises intended to minimise negative effects on the environment. The results of this thesis can support discussions about reducing CO<sub>2</sub> emissions by companies purchasing freight transport, both internally and with transport service providers.

This thesis also provides a step toward understanding how different configurations of the purchasing process facilitate or hinder consideration of the aspects influencing the logistical variables; thus, it provides a step toward understanding the applicability of different measures aimed at reducing CO<sub>2</sub> emissions depending on the different contexts and configurations of the purchasing process for freight transport services.

## **6.2 Suggestions for further research**

A limitation of the research is that the proposed framework regarding types of contexts and their influence on the configuration of the purchasing process is only based on seven cases that do not fully cover the eight types of context. Further research could develop the framework, identifying differences in the configuration of the purchasing process for contexts that were not found in the case studies.

A second limitation of the results presented in this thesis is that the actual CO<sub>2</sub> emissions are not measured or known. Instead, the connections from the purchasing process to logistical variables are simplified to show the potential to influence the logistical variables, whether in a negative or positive direction. In order to understand the actual effects of the decisions and practises in the purchasing process for freight transport services on the carriers' transport solutions in each case, the transport service provider's perspective is necessary, since the transport service providers and transport operators can offer further insights on how the service delivery, including planning, is affected by interactions with the companies purchasing transport services. The transport service provider and transport operator would need to be included in the studies in order to measure the actual CO<sub>2</sub> emissions of particular shipments.

Another reason to focus on both the companies purchasing the transport service and the companies providing the service is grounded in the idea that interaction means that both parties affect the outcome. There is potential for interaction when the transport service provider and shipper communicate about which

alternatives are available and the consequences of applying the different alternatives. Adding loops to the purchasing process has been discussed in this thesis. This would require interaction between transport buyers and transport service providers that was not seen in the studied cases. It is plausible that information on estimated CO<sub>2</sub> emissions could be provided by the transport service providers, for example into a selection tool used by shippers when ordering transport (similar to what was seen for cost and lead-time). This would allow the transport order function to include environmental considerations.

Also, in the studies included in this thesis, it was ignored if specified requirements originated with customers, for example regarding time windows. Further research could involve more actors, potentially exploring the interactions between senders, transport service providers, transport operators and recipients (a quadratic relationship) regarding reduction of CO<sub>2</sub> emissions from freight transport.

A finding that is not discussed in any detail is that the potential to influence logistical variables in the ordering process to a large degree depends on input from other processes, for example regarding production plans and when the transport is needed (for more details see section 4.3 or appended paper 3). Information from other parts of the organisation has to be considered when companies purchasing freight transport services want to apply environmental concerns. Although some actions aimed at reduction of CO<sub>2</sub> emission can be identified in the purchasing process for freight transport services, companies purchasing freight transport services should consider freight transport also on a strategic level. Further research could explore a more strategic approach to reducing CO<sub>2</sub> emissions from freight transport. When setting environmental goals that relate to the purchasing of freight transport, managers have to recognize that routines regarding information sharing may have to be changed elsewhere in the company in order to be able to improve conditions for the process and to be able to realise a greener outcome of the transport service (for example increasing coordination between production and logistics to improve the planning of shipments).

The findings reveal that input is required during the process of ordering freight transport, which is likely also true for the initial stages of the purchasing process, leading up to a contract agreement. Input required during the initial stages of the purchasing process could be explored further in order to facilitate discussions regarding routines in companies purchasing freight transport (for example how information is shared between departments).

Most of the studied cases offer descriptions of purchasing processes for freight transport services, and the activities in such processes, not including environmental consideration. Further research could compare the cases with low environmental consideration when purchasing freight transport (included in this thesis) with cases in which environmental consideration exists.

There are other factors that could be explored for their influence over freight transport purchasing. One potential issue to examine is organisational characteristics. As was mentioned in the introduction, numerous people in

different departments may be responsible for the purchasing of freight transport services. This was also observed in the studied cases. It would be possible to explore the implications of the degree of professionalism in the purchasing of freight transport services on the purchasing process.

The findings in this thesis are not generalized beyond the context of purchasing freight transport services. The applicability to other types of services is not discussed. To discover applicability of this research on purchasing of other services, further research could try to categorise the purchasing of freight transport services in comparison to the purchasing of other services (for example complexity of what is sourced) in an attempt to reveal similarities.

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