THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

# Environmental concerns when purchasing freight transport

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# ABSTRACT

Companies that purchase freight transport (shippers) influence the conditions for how transport providers can execute the transport, which in turn influences $CO_2$ emissions. The conditions can be influenced both by shippers' purchasing processes for freight transport and when shippers prepare goods for delivery. For shippers to make appropriate decisions aimed at reducing the $CO_2$ emissions from their transport, clarification of such influences on the conditions are necessary. The purpose of this thesis is to clarify how shippers can influence $CO_2$ emissions from the freight transport they purchase.

This thesis is a compilation of seven papers, six of which are based on empirical data from five multiple-case studies. The data collection mainly consisted of semi-structured interviews with shippers' logistics, transport, and purchasing managers, as well as with staff in operational positions; one study also conducted interviews with transport providers. The seventh paper reports on a structured literature review of load factor. Together these studies answer four research questions.

The first research question is concerned with how contextual factors influence shippers' freight-transport-purchasing processes. The results describe the purchasing process in contexts that vary in service type, purchase situation, and relationship.

The second research question examines how shippers' freight-transport-purchasing processes influence various logistical variables (mode of transport used, handling factor, length of haul, load factor, empty running, fuel efficiency, and carbon in fuel). The causes of different influences on logistical variables (such as specified time requirements) are clarified by answering this question.

The third research question concerns how shippers can identify and evaluate opportunities to increase their load factors. Achieving high load factors is a matter of balancing required and available capacity at the packaging, shipping, and vehicle levels. A framework of opportunities describes how these capacities can be increased, decreased, and reallocated, thus allowing for the identification and comparison of relevant opportunities.

The fourth research question is concerned with how shippers' internal coordination may enable high load factor. The use of coordination mechanisms is described in situations that differ in terms of dependence between activities, number of activities, and the need for intra- or interfunctional coordination.

The results contribute to green-logistics research in terms of improving load factor and the purchasing of freight transport. Different research streams and perspectives – especially in terms of purchasing, transport, and coordination – have been combined in this thesis. The results contribute to improving the environmental performance of freight transport by clarifying shippers' influence on the $CO_2$ emissions of the transport they purchase via descriptions of the shippers' influence over logistical variables (including load factor) that in turn influence $CO_2$ emissions.

**Keywords**: Freight transport, Purchasing process, Load factor, Coordination, Shipper, Green logistics

# List of appended papers

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

## Paper I

Rogerson, S., Andersson, D., and Johansson, M. I. (2014) Influence of context on the purchasing process for freight transport services. *International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management*, Vol. 17 No. 3, pp. 232-248.

An earlier version of this paper was published in the Proceedings of the 20th Annual International Purchasing and Supply Education and Research Association (IPSERA) Conference, 10–13 April 2011, Maastricht, the Netherlands.

## Paper II

Rogerson, S. (2016) Environmental transport performance: influence of purchasing processes.

Submitted to an international journal within the field of logistics in July 2016.

An earlier version of this paper was published as:
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, Italy.

## Paper III

Santén, V., and Rogerson, S. (2016) Achieving transport efficiency through increased load factor: a literature review of measurement and influencing factors.

Submitted to an international journal within the field of logistics in February 2016.

An earlier version of this paper was published as:
Santén, V., and Rogerson, S. (2014) Influencing load factor in transport operations: a literature review. In *Enterprise in Logistics Research: Matching the Needs of Industry with Academia. Proceedings of the 19th Annual Logistics Research Network (LRN) Conference*, 3–5 September 2014, Huddersfield, United Kingdom.

## Paper IV

Santén, V., and Rogerson, S. (2016) Shippers' transport efficiency: a model for measuring load factor.

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An earlier version of this paper was published as:
Rogerson, S., and Santén, V. (2015) Shippers' transport efficiency: the balance between required and available capacity. In *Resource Efficiency and Sustainability in Logistics and Supply Chain Management. Proceedings of the 20th Annual Logistics Research Network (LRN) Conference*, 9–11 September 2015, Derby, United Kingdom.

## Paper V

Rogerson, S., and Santén, V. (2015) Shippers' opportunities to increase the load factor: managing imbalances between required and available capacity.

Submitted to an international journal within the field of logistics in December 2015.

## Paper VI

Rogerson, S., and Sallnäs, U. (2016) Internal coordination to enable high load factor.

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## Paper VII

Rogerson, S. (2012) Connecting ordering of freight transport to logistical variables related to $CO_2$ emissions. *Proceedings of the 17th Annual Logistics Research Network (LRN) Conference*, 5–7 September 2012, Cranfield, United Kingdom.

## The researcher's contributions to the papers

| PAPER | FIRST AUTHOR | OTHER 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 conference version of the paper, 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 and developed drafts for all sections, which were then discussed and improved jointly between all authors. The analysis model was developed jointly. The analysis was conducted by the first author and was discussed between all authors to arrive at the final analysis and conclusions. |
| II | Sara Rogerson | | (Sole author.) The author conducted the data collection and analysis as well as the writing.<br>In an earlier conference version, the paper planning was conducted jointly with Dan Andersson and Mats Johansson. The first author then did the larger part of the writing and developed drafts for all sections, which 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 | Vendela Santén | Sara Rogerson | For this paper the first author (Vendela Santén) had the main responsibility for the paper, doing the writing and analysing the data. The second author (Sara Rogerson) provided input on the paper planning. The data collection and the first-stage analysis were conducted jointly by the two authors. |
| IV | Vendela Santén | Sara Rogerson | For this paper the responsibility was shared equally between the two authors. The paper planning was conducted jointly. The conceptual model was developed jointly by the authors: the first author had the initial idea, and both authors jointly developed the idea into the final framework. The data collection and writing of the paper were performed by both authors. |
| V | Sara Rogerson | Vendela Santén | For this paper the responsibility was shared equally between the two authors. The paper planning was conducted jointly. The conceptual model was developed jointly by both authors: the first author had the initial idea of adding increase versus reallocation of capacity; and both authors jointly developed the idea into the final framework. The empirical data was collected by both authors in two of the cases, while the second author collected the data in the third case. The analysis and writing were performed jointly by both authors. |

| PAPER | FIRST AUTHOR | OTHER AUTHORS | RESPONSIBILITIES |
|---|---|---|---|
| VI | Sara Rogerson | Uni Sallnäs | The first author had the main responsibility for this paper. The paper planning was done jointly by the authors. Although the writing was performed by both authors, the first author did the larger part of the writing. The first author had the main responsibility for the data collection and collected the data in two of the cases. In the third case, the data was collected jointly between the authors. The analysis was done jointly, but the first author took the main responsibility, specifically for the analysis of interdependencies. The model was developed jointly. |
| VII | Sara Rogerson | | (Sole author.) |

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# 1 Introduction

This thesis focusses on the ways in which companies that manufacture and distribute products (hereafter 'shippers') can provide conditions for efficient transport and in doing so limit their $CO_2$ emissions: for example by enabling high utilisation of transport capacity. Such conditions can result from shippers' requirements. The background and general motivation for this thesis are described below, followed by to the purpose of this thesis, after which the main research problem is examined and defined by four research questions.

## 1.1 Background

Transportation is necessary for products and materials to be available to consumers and companies. Transporting goods from suppliers to manufacturers, and again from manufacturers to shops, creates a chain between supplier and consumer. While moving the goods to the places they are needed, this transportation unfortunately causes negative effects to the natural environment. Examples of such negative effects include greenhouse gas (GHG) emissions, other polluting emissions, energy use, noise, accidents, and traffic congestion (Wu and Dunn, 1995; Behrends, 2011; McKinnon, 2015a). Of these effects, greenhouse gas emissions, in particular carbon dioxide ($CO_2$), has received attention due to the problem of global warming and the fact that transport contributes considerably to $CO_2$ emissions amounts. To provide an idea of the extent to which freight transport contributes to $CO_2$ emissions, 11 percent of total greenhouse gas emissions ($CO_2$ equivalents) in Sweden in 2011 were emitted by light and heavy trucks and buses (Swedish Environmental Protection Agency, 2012). This attention to reducing $CO_2$ emissions from transport can be found in a variety of goals formulated both in the European Union and by the Swedish government. The European Union target is a reduction of 20 percent of greenhouse gas emissions by 2030 (relative to 2008 levels) from transport, which also includes personal transportation (European Commission, 2011). Similarly, the goal in Sweden is to reduce greenhouse gas emissions by 40 percent in 2020 relative to 1990 levels (Regeringskansliet, 2009). These goals may lead to policies or legislation that will have a direct impact on shippers.

From the discussion above, the emphasis on reducing $CO_2$ emissions from society at large is clear, but the environmental perspective has also become important for companies to consider. Various factors motivate companies (including shippers) to pay attention to environmental issues. Already Murphy et al. (1995) had identified several of these factors, including compliance with regulations, control over environment-related costs, satisfaction of societal expectations, minimisation of liability from potential lawsuits, acquisition of profit opportunities, the ability to keep pace with competitors, the meeting of customer requirements, and the desire to be good citizens. These factors are consistent with the literature review that Seuring and Müller (2008) conducted, which listed five motives for sustainable supply chains: regulations, response to stakeholders, competitive advantage, customer demands, and reputation loss. Two commonly stated motivations for companies that pay attention to environmental issues include legislation (e.g. Murphy and Poist, 2003; Bala et al., 2008) and pressure from customers (e.g. Kovács, 2008). More recent articles have put forward similar

motivations but have also stated the importance of negative publicity (Golicic et al., 2010).

Given that companies are now paying attention to environmental perspectives in general, it is likely that they also pay attention to $CO_2$ emissions from freight transport in particular. Companies need to take the rising awareness at the societal level of the need to reduce $CO_2$ emissions from freight transport into account. In addition to policies and legislation, customers may expect low $CO_2$ emissions from freight transport. Companies in the freight-transport business, such as logistics-service providers (DHL, for example), have already set ambitious targets to reduce their transport-related emissions (McKinnon and Piecyk, 2012). Shippers that purchase freight transport will not be able to ignore the need to reduce $CO_2$ emissions from freight transport in the near future.

## 1.2 Problem area: Shippers' roles in reducing $CO_2$ emissions

Because shippers need to transport goods and are likely to increase their attention to reductions in $CO_2$ emissions from freight transport, it is worth discussing their roles and possibilities in this respect. Several areas for improvement have been identified in the literature. Wu and Dunn (1995), for example, provide various examples of decisions that are made along the value chain where the logistics manager can influence the company's environmental impact. The decisions the authors list for inbound and outbound logistics include network design, inventory decisions, packaging, consolidation, mode selection, carrier selection, warehousing, backhaul management (i.e. transport on return journeys), and materials handling. Piecyk and McKinnon (2010) identify five categories of decisions that influence the environmental performance of freight transport: structural factors (for example centralisation of production), commercial factors (for example global sourcing), operational factors (for example order lead times), functional factors (for example vehicle routing systems), and product-related factors (for example the use of shelf-ready packaging). Shippers can thus influence the environmental performance of their freight transport in numerous areas.

Although many areas and decisions have been identified in the literature that shippers that aim to reduce $CO_2$ emissions from their freight transport can use, more detailed descriptions are needed. In their literature review of environmental sustainability from the perspective of companies involved in logistics and transportation, for example, Marchet et al. (2014) found little research that addressed in a detailed manner environmental sustainability from a logistics and transportation perspective. Details are needed to provide an increased understanding of actions that shippers can take to reduce $CO_2$ emissions and to provide guidance to shippers that are beginning to turn their attention to $CO_2$ reductions from their freight transport.

Any detailed guidance to shippers must take into account the fact that shippers purchase freight transport from transport providers. While the areas for improvement and decisions mentioned above can be linked to influence on the environment, when shippers purchase freight transport, the responsibility of these decisions varies among different actors: some of the decisions will be the responsibility of the shipper, while others will be the responsibility of the transport

provider; for still others the responsibility will be shared. For example, many operational decisions often are made by the transport provider, such as transport routing and the type of vehicles to use. Transport providers have implemented various environmental practices to respond to such decisions, including the use of alternative fuels, fleet modernisation, speed reductions, and the use of information technology (IT) tools to minimise length of haul (Colicchia et al., 2013).

It should be noted, though, that the approach to green issues among these transport providers ranges from being proactive to not making green issues a priority (Evangelista, 2014). In the latter case, shippers might choose to push transport providers to implement environmental practices, for example by stating such requirements in the purchasing process, for example concerning the type of vehicles that should be used. Since the responsibility of decisions that result in reduced $CO_2$ emissions varies, shippers need to understand the decisions in which they can influence environmental performance when purchasing freight transport.

In order to increase understanding and to offer further details about shippers' roles and their possibilities of reducing $CO_2$ emissions, decisions that are the responsibility of the shipper when purchasing freight transport can be structured into (1) purchasing decisions and (2) decisions that form the boundaries within which the transport provider can perform the transport and implement its environmental practices.

Purchasing-related decisions that shippers make in which they can influence the green performance of their freight transport refer to transport-provider selection, as mentioned in Wu and Dunn (1995). For example, depending on which transport provider is selected, the distance that is driven can differ due to different network structures. Another example is that transport providers use fleets of vehicles of different ages, which influences their fuel consumption and emissions. Also, because shippers and transport providers come to agreements when freight transport is purchased, these agreements may influence the green performance of transport. Björklund (2005) provides several recommendations for shippers when purchasing environmentally preferable freight transport, but the effects on $CO_2$ emissions can be further clarified: specifically how shippers' decisions influence the execution of the freight transport.

The second category, decisions that form boundaries, refers to how the transport provider works within the limits set by the shipper. Examples of such decisions – provided in Roth and Kåberger (2002) and inspired by McKinnon and Woodburn (1996) – include the structure of the logistics system and the pattern of sourcing and distribution. An example of a boundary is when certain properties of the goods that the transport provider picks up may prevent loading a full vehicle. Another example is when goods must be delivered at specific times, which may also prevent trucks from being fully loaded (Arvidsson et al., 2013). Santén and Arvidsson (2011) provide further examples of how shippers can improve the conditions for their transport providers; they note that transport providers sometimes complain that shippers' requirements are excessively stringent, thereby limiting the options for service delivery, for example regarding the consolidation of goods. Due to limitations such as these, Isaksson (2012) noted that shippers can serve as barriers to the 'greening' of transport providers. Some of the decisions that form the boundaries are part of the agreements between

shippers and providers when transport is purchased (for example, delivery times, delivery frequency, and the volume of goods).

It is therefore crucial to understand more about these agreements that are agreed upon during the freight-transport-purchasing process, as well as the conditions that are created for the transport in the daily process of preparing goods for deliveries. When purchasing freight transport, shippers thus create various boundaries that the transport is performed within. Further clarification is required regarding which boundaries are created, how they are created in the freight-transport-purchasing process and goods-delivery preparation, and how these boundaries influence the execution of the freight transport.

In sum, in light of the importance of reducing $CO_2$ emissions and the fact that shippers have a role to play in that reduction, further clarification of how shippers can reduce $CO_2$ emissions for the freight transport they purchase is needed. If shippers are to make decisions that reduce $CO_2$ emissions from freight transport, a structured presentation of how they set conditions for execution of freight transport and the effects of such conditions would be helpful. Therefore, the purpose of this research is *to clarify how shippers can influence $CO_2$ emissions from the freight transport they purchase*.

## 1.3 Research questions

Four research questions have been formulated within the broad scope indicated in the purpose above. These questions are briefly presented below, illustrated in Figure 1, and are further presented in sub-sections 1.3.1 and 1.3.2. The research focusses on shippers' internal processes (i.e. where decisions are made): specifically the processes of freight-transport purchasing and goods-delivery preparation. In the freight-transport-purchasing process, the agreement with the transport provider is included. The first research question examines how the freight-transport-purchasing process differs with context. The second research question examines the influence of the freight-transport-purchasing process on seven logistical variables that are related to $CO_2$ emissions. Because the field's general understanding of how shippers' freight-transport-purchasing processes influence logistical variables is low, it is necessary to explain the mechanisms that connect activities in the process to various logistical variables. Increasing the knowledge regarding influence of the freight-transport-purchasing process on logistical variables is a step towards clarifying the influence on $CO_2$ emissions.

The third and fourth research questions go into detail on one of these logistical variables, namely load factor. For goods-delivery preparation, there is already an understanding that load factor should and can be improved. What is less clear is which actions should be performed to improve load factor and how to perform those actions. It is therefore of interest to investigate in more detail the goods-delivery-preparation process and its influence on load factor. The third research question focusses on how opportunities to increase load factor can be identified and evaluated, while the fourth research question focusses on how shippers can coordinate internally to enable high load factor.

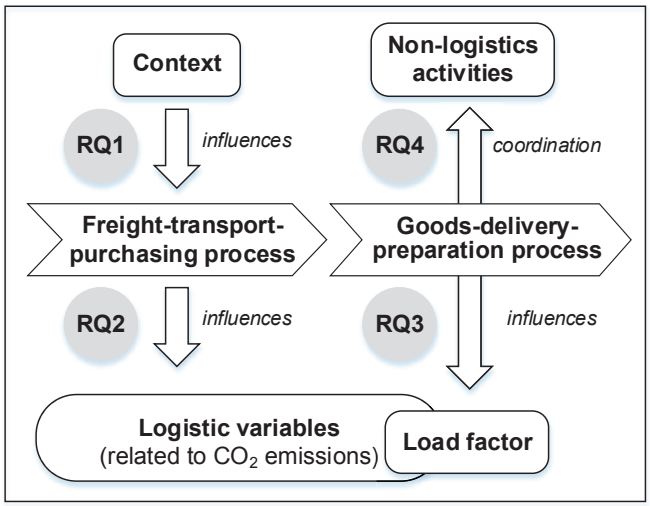


*Figure 1: Positioning of the research questions*

### 1.3.1 Shippers' freight-transport-purchasing process

When purchasing freight transport, the transport is performed in accordance with agreements between the shippers and the companies that provide the transport (hereafter 'transport providers'). These agreements are reached through a purchasing process in which the service is specified, transport providers are selected, and agreement on a contract is reached. One step towards understanding how shippers can influence $CO_2$ emissions from the freight transport they purchase is to investigate which activities are performed in the purchasing process, although how these activities are performed may differ, depending on the context in which they are performed.

Holter et al. (2008) state that little research had been conducted that addressed the freight-transport-purchasing process. Instead, literature on the purchase of freight transport often covers transport-mode and carrier-selection decisions. For example, Pedersen and Gray (1998), Matear and Gray (1993), and Whyte (1993) found that service and cost are important selection criteria for shippers.

Three literature reviews have described articles that cover purchasing processes or purchasing frameworks: the third-party logistics-development process (Marasco, 2008), the carrier-selection decision process (Meixell and Norbis, 2008), and frameworks for purchasing logistics services (Selviaridis and Spring, 2007). The articles identified in these literature reviews, however, often focus on logistics services, which is a wider field than freight transport. For this reason, the findings in these articles are not automatically valid for the freight-transport purchasing process. This is supported in the work by Andersson and Norrman (2002), which describes several differences between purchasing processes for advanced logistics services and for the one-time purchase of freight transport.

The articles that have been written thus far on freight-transport-purchasing activities often highlight a particular stage of the purchasing process, such as the selection-of-supplier stage or the contract-agreement stage, and thus do not cover the entire freight-transport-purchasing process. One exception is Björklund (2005), which provides a detailed account of the freight-transport-purchasing

process. In addition, Holter et al. (2008) mapped the freight-transport-purchasing process in a single case.

Because specific contexts provide the framework for how the purchasing process will be carried out, understanding contexts is crucial to understanding how activities are performed in the purchasing process. In line with this line of thought, Björklund (2011) argues that a high level of environmental performance in purchasing freight transport requires knowledge of context. In addition, Björklund (2005; 2011) describe that context can hinder or support environmental performance when purchasing freight transport. Adaptation to context is frequently discussed in the literature; for example, that companies adapt their purchasing behaviours to changing environments (Kraljic, 1983) and that different purchasing processes will be most suitable, depending on whether small-scale or large-scale purchases are being made (Parikh and Joshi, 2005).

Although (Björklund, 2005; 2011) show that many contextual factors influence the purchase of freight transport, the manner in which such factors influence the purchasing process has yet to be clarified. In Björklund (2005) the author points out that purchasing situations would be better understood through further analysis of the links between practices and contexts. The descriptions of the purchasing process in Björklund (2005) and Holter et al. (2008) could be added to by explaining how purchasing processes differ with context. Therefore, a research question (RQ) is formulated as follows:

*RQ1: How do contextual factors influence shippers' freight-transport-purchasing processes?*

Many shippers currently seek guidance on how to take environmental issues into account when purchasing freight transport (Björklund, 2005). To build on the work of Björklund (2005) – which provides recommendations for shippers on the purchasing of environmentally preferable freight transport – it is useful to explain the relationship between the purchasing process and $CO_2$ emissions, since this can clarify for shippers how their decisions or actions are linked to $CO_2$ emissions. The mechanisms involved in these links to $CO_2$ emissions, including causes of influence of the shippers' purchasing processes for freight transport on $CO_2$ emissions, could be clarified further.

Two issues where the mechanisms behind the influence of the purchasing process on $CO_2$ emissions can be clarified are the effects of shippers' requirements and the effects of 'green' purchasing practices. In the specification stage of the freight-transport-purchasing process, shippers can place requirements regarding environmental aspects in the service delivery. However, the effects on $CO_2$ emissions of specific requirements are still unclear, these requirements do not necessarily exert a positive influence on $CO_2$-emissions reductions. Previous research has mentioned several practices of shippers that consider environmental aspects, including specifying that the transport provider must have environmental certification, prioritising environmental criteria in the selection of the transport provider, and including written agreements on the measurement of environmental performance; see, for example, Björklund (2005), Wolf and Seuring (2010), and Björklund and Forslund (2013). Although the use of such practices has been described in the literature, it is less clear how these practices are connected to $CO_2$

emissions or in what way they influence the service delivery (i.e. the freight transport that is executed).

Piecyk and McKinnon (2010) relate seven key logistical variables to $CO_2$ emissions; these logistical variables can thereby be used as indicators of $CO_2$ emissions. The logistical variables are mode used, handling factor, length of haul, load factor, empty running, fuel efficiency, and carbon in fuel.

Given that the logistical variables are related to $CO_2$ emissions, influence on these logistical variables thereby indicates the potential to influence $CO_2$ emissions. Relating shippers' purchasing processes for freight transport to the logistical variables would clarify the influence of process activities, shippers' requirements, and agreements between the shippers and transport providers on how freight transport will be performed. Clarifying how the shipper's freight-transport-purchasing process can influence the logistical variables is a step towards clarifying the implications of the purchasing process on $CO_2$ emissions; this would then support shippers that aim to reduce their emissions. A second research question is therefore formulated as follows:

*RQ2: How may shippers' freight-transport-purchasing processes influence logistical variables?*

### 1.3.2 Enabling high load factor

Among the various logistical variables, load factor was selected for further examination in this thesis because achieving a high load factor is important in reducing both costs and the negative effects from freight transport on the environment (Kamakaté and Schipper, 2009; Bø and Hammervoll, 2010). The load factor is the ratio of actual load carried to the maximum load that could have been carried in a load unit, such as a vehicle (McKinnon and Ge, 2004; McKinnon, 2010a). Although load factor has received some attention in the literature, it is seldom described in detail. Both Transportstyrelsen et al. (2011) and Pahlén and Börjesson (2012) state that little research have focussed on load factor. In particular, little research addresses details about shippers' roles in achieving high load factors. One article that does is Lumsden et al. (1999), which describes how changes in the distribution network improved the vehicle load factor from 52 to 70 percent. While there appears to be potential for improving load factor, more research is needed to understand how exactly this might be achieved.

Specifically, opportunities for shippers to enable high load factor when delivering goods could be clarified. When delivering to customers, shippers perform several activities to prepare their goods for transport: for example, transport planning, picking, packing, and staging the goods for loading (Croxton, 2003). In such activities, shippers may take actions or make decisions that will influence the load factor. For example, shippers may pack boxes that contain a lot of air or they may consolidate goods in different ways. Such activities, and the properties of the items to be transported, provide the conditions for efficient freight transport.

Earlier literature has related several areas in which decisions by shippers – for example decisions regarding handling systems (McKinnon, 2010b), packaging (Pålsson et al., 2013), loading of pallets (Santén, 2012), and shipment consolidation (Ülkü, 2012) – may influence load factor. A few articles have

offered details on specific decisions: for example, how packaging can increase load factor. Other articles, for example Aronsson and Brodin (2006), have provided suggestions that cover multiple decisions that shippers might make to increase load factor. To these two types of articles can be added the topic of how different decisions in which shippers can influence load factor relate to one another and when certain decisions are suitable.

Relating the areas or decisions that influence load factor by comparing actions and assessing their appropriateness in specific situations would help shippers to identify and select those actions that would improve their load factor. A structured way of describing load factor would help shippers identify their problematic areas with regards to achieving high load factor and could be used to evaluate the effects of opportunities for increasing load factor. A third research question is thus formulated as follows:

*RQ3: How can shippers identify and evaluate opportunities to increase their load factors?*

The relationship between logistical activities and other activities in the company (for example purchasing or sales) is very relevant to load factor (McKinnon, 2010b). Other functions in the company can make decisions or perform activities in such a way that logistics managers become restricted in their ways of achieving transport efficiency. Constraints caused by other functions in the company influence vehicle utilisation (McKinnon, 2015b). To inhibit such constraints, planning for manufacturing and logistics can be integrated, which may support efforts to dispatch full truckloads (Piecyk, 2010). One such constraint is poor coordination of purchasing, sales, and logistics (McKinnon, 2015b). This aspect is concerned with that inbound and outbound freight transports may be handled by different parts of the organisation (Drewes Nielsen et al., 2003), which can result in the company missing potential opportunities for backloading (McKinnon, 2015b). Manufacturers and retailers believe that better internal coordination can help transport managers achieve improved load factors (Piecyk, 2010). Taking these findings into consideration, the relationship between shippers' internal coordination and load factor can be further explored, specifically by clarifying the activities that need to be coordinated and the means of performing the coordination. A fourth research question is thus formulated as follows:

*RQ4: How may shippers' internal coordination enable high load factor?*

The remainder of this thesis describes how these research questions are addressed by conducting a literature review and five multiple case studies, where the main data was collected through semi-structured interviews. The findings are presented in the Results chapter (Chapter 4). The findings are then discussed in relation to other research, one another, and practical use in Chapter 5, 'Discussion'.

## 1.4 Scope

This research was conducted from the perspective of shippers (see Figure 2). Both the supply of goods (to the focal company from its suppliers) and distribution of goods (from the focal company to its customers) are included. The shipper can be the sender or the recipient of goods; when the shipper is the sender, the customer

orders goods from the shipper. When the shipper is the recipient, the shipper orders goods from suppliers.

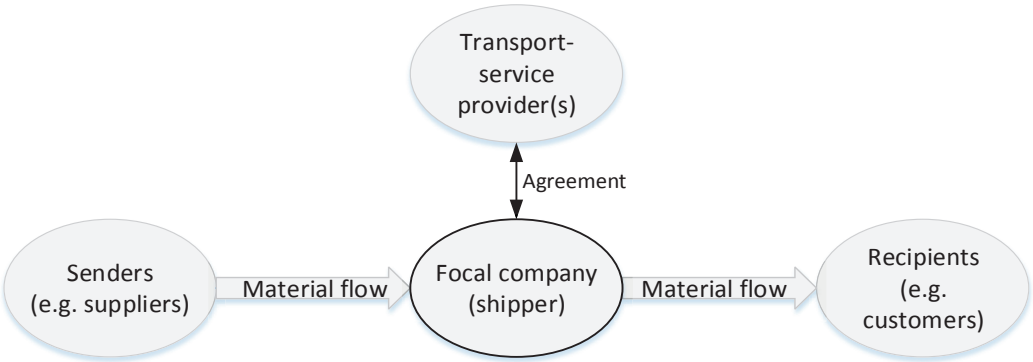


*Figure 2: Focal company (shipper) as recipient from suppliers, as sender to customers, and as purchaser of freight transport from transport provider(s).*

Although this research does not address which actions transport providers can take to reduce emissions, the agreement with the transport provider is nevertheless included in the study. The shipper makes transport agreements with transport providers, who then perform the transport of goods or in turn arrange for transport operators to perform the transport. This thesis only looks at the transport providers as actors that perform the transport; it does not differentiate if those transport providers are transport operators (companies that own their own vehicles), third-party logistics providers (those that assign the transport to transport operators), or other types of actors. Nor does this thesis differentiate if the transport provider offers more services than transport. (One exception is Study I / Paper I, where the scope of the service that is purchased may include more than transport.)

This research focusses on the activities that are performed when purchasing and ordering transport and when preparing goods for delivery: that is, the purchasing process and the goods-delivery-preparation process. The 'purchasing process' in this thesis refers to the activities of defining specifications, selecting suppliers, agreeing on contracts, and ordering transport. The 'goods-delivery-preparation process' in this thesis refers to planning transportation and to picking, packing, staging goods for loading, and loading. Further descriptions of what constitutes each process are found in Chapter 2, 'Frame of reference'. These activities take place at an operational level: that is, daily activities to order transport and send goods. The activities also take place at a tactical level, which refers to planning and deciding how the daily activities should be performed and agreeing on transport contracts that are valid for more than one year. Because the purchasing and goods-delivery-preparation processes occur at the tactical and operational levels, any issues at a strategic level where shippers might influence emissions (such as warehouse locations) lie outside the scope of this thesis.

Externally, the relationship with suppliers and customers is outside the scope of this thesis; this also excludes the fact that requirements on the transport can originate with suppliers or customers. For example, which transport service is purchased will depend on agreements with suppliers or customers regarding delivery times and quantities. In addition, in cases where the transport provider assigns the transport to transport operators, the transport operators are outside the scope of this thesis.

## 1.5 Outline of the thesis

This compilation thesis includes a cover paper, consisting of six chapters, and seven appended papers. An overview is presented in Figure 3. Interview guides, as well as the literature searches that were performed, are presented as a series of appendices. The cover paper is structured as follows:

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

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

Chapter 3 (Methodology) describes the research design of this study and outlines the methods that are used.

Chapter 4 (Results) summarises the results related to the research questions, which were derived from the appended papers.

Chapter 5 (Discussion) discusses the ways in which the main findings contribute to the purpose of the thesis, how these findings relate to the results of other studies, and the implications of these findings. The results of the studies are also combined and discussed. Influence of context on logistical variables via the freight-transport-purchasing process is discussed, connecting RQ1 and RQ2. The connection between the freight-transport-purchasing process and the goods-delivery-preparation process is also discussed.

Chapter 6 (Conclusions) presents the conclusions of this thesis.

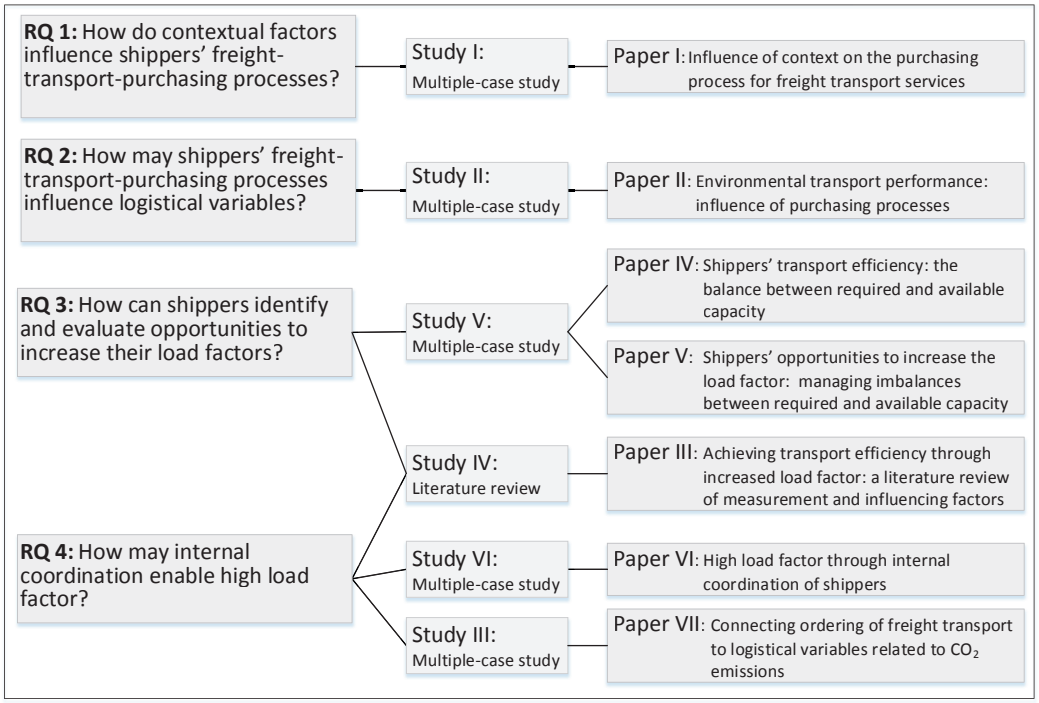


*Figure 3: Overview of research questions, studies and appended papers*

# 2 Frame of reference

This section presents earlier research that is relevant to the focus of this thesis. The sub-sections are structured as outlined in Figure 4. Section 2.1 describes the stages of the freight-transport-purchasing process, which are used in the results of research questions (RQs) 1 and 2. Section 2.2 defines the context as used to address RQ1. Section 2.3 discusses the motivation behind selecting the framework in Piecyk and McKinnon (2010), which is used to address RQ2. Section 2.4 describes the activities of the goods-delivery-preparation process, which are used to address RQs 3 and 4. Section 2.5 describes the literature on load factor used to address RQs 3 and 4. Section 2.6 describes the coordination literature used to address RQ4.

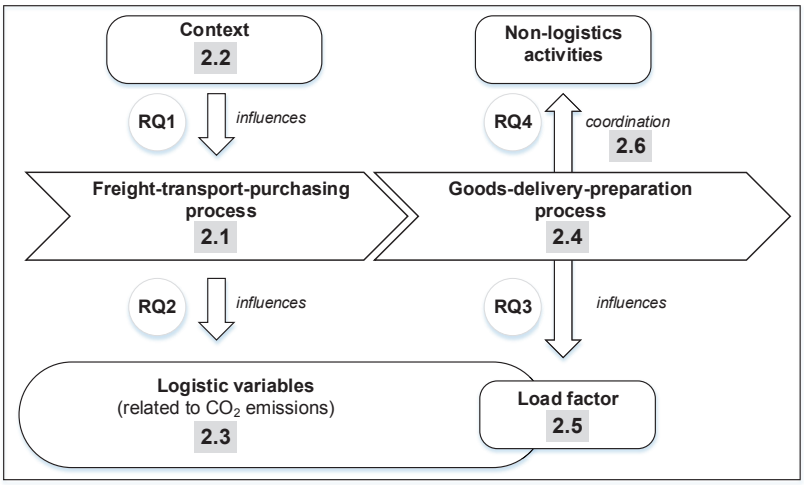


*Figure 4: Areas of focus in this thesis and the 'Frame of reference' chapter sections*

## 2.1 Purchasing of freight transport

### 2.1.1 Freight-transport-purchasing process

This sub-section describes the components of the freight-transport-purchasing process, which are then used to address RQs 1 and 2. It presents the specific purchasing-process model that is used, based mainly on the purchasing-process models developed by van Weele (1994) and Björklund (2005).

To address RQs 1 and 2, it was first necessary to define the freight-transport-purchasing process. A general purchasing-process model – that by van Weele (1994) – serves as the starting point. The purchasing process is generally described as a sequential and rational decision process that involves several consecutive stages. Van Weele (1994) uses the stages listed in Figure 5, which include *define specification*, *select supplier*, *contract agreement*, *ordering*, *expediting*, and *evaluation*, to show how different purchasing activities are related to one another. This model is applicable to the purchase of both goods and services. Axelsson and Wynstra (2002) describe van Weele's (1994) *define specification*, *select supplier*, and *contract agreement* stages in more detail for buying business services.

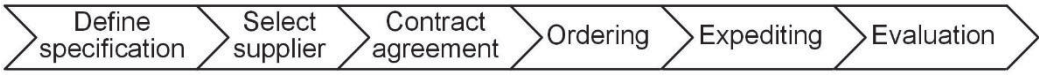


*Figure 5: Purchasing process (van Weele, 1994)*

For the purchase of freight transport, Björklund (2005) presents a process model of purchasing practices for environmentally preferable freight transport (Figure 6) based on a literature review. Björklund (2005) provides more details on the second stage (*select supplier*) in van Weele's model (1994), while summarising the last three stages of the model as one stage: *post-choice management*. The focus on the earlier stages of the purchasing process in Björklund (2005) mirrors the focus in Axelsson and Wynstra (2002).


*Figure 6: The purchasing-process stages based on Björklund (2005, pp. 114–115)*

Because the model described in Björklund (2005) does not disagree with the process stages according to van Weele (1994) but rather provides more details on the stages, this thesis uses van Weele's (1994) process stages (*define specification*, *select supplier*, and *contract agreement*) to describe the freight-transport-purchasing process on a broad level, while each process stage is further described by several activities (Figure 7). The activities described in Figure 7 were also inspired by the purchasing-process model for freight transport described in Holter et al. (2008) as well as by the purchasing processes for basic and advanced logistics services described in Andersson and Norrman (2002).

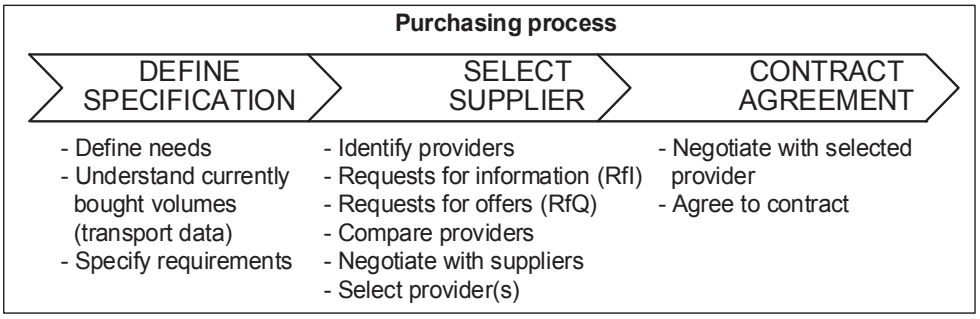


*Figure 7: Activities in stages of the purchasing process (Paper II)*

The *define specification* stage consists of specifying needs, understanding currently bought volumes (transport data) and defining requirements. Understanding currently bought volume is mentioned in Andersson and Norrman (2002) while Holter et al. (2008) states that transport data is an important input to the tender. This thesis makes a distinction between defining needs and requirements: 'defining needs' means identifying what is needed, while 'specifying requirements' means stating what is required from the transport provider.

The *select supplier* stage consists of identifying potential providers, requesting information from providers, requesting offers from providers, comparing providers (which includes reducing the number of potential providers), negotiating with providers (which includes asking for updated offers), and selecting one or several providers. This thesis makes a distinction between the 'requests for information' and 'requests for offers' activities, to offer more detail; this distinction was also made in Andersson and Norrman (2002). While the 'comparing providers' activity is equivalent to the *evaluation* stage in Björklund

(2005), the former is used in this study, since the *evaluation* stage has a different meaning in van Weele's (1994) process model.

The *contract agreement* stage consists of negotiating with selected provider(s) and agreeing to the details in the contract. To provide more details, negotiation has been included here as an activity in the *contract agreement* stage. This is in agreement with Andersson and Norrman (2002), who mention contracting and negotiating as concurrent activities.

Of importance to the definition of the purchasing-process model in this thesis is the understanding that although the model shows sequential activities, this is a simplification. Because the model is simplified, it does not show that some activities (such as 'identify providers') in the *select supplier* stage may start before all activities in the *define specification* stage have been completed. To show that negotiation can take place in both the *select supplier* stage and the *define specification* stage, the detailed list of activities includes 'negotiate with suppliers' (in *select supplier*) and 'negotiate with selected supplier' (in *contract agreement*). Further, loops exist between activities. For example, in the *select supplier* stage, 'comparison of providers' is followed by 'negotiation with suppliers' and then a new 'comparison of providers'. Another loop between activities might concern the way the specification is derived. Van der Valk and Rozemeijer (2009) argue that companies that are purchasing services should use interaction with suppliers to develop a detailed specification before moving on to the *select supplier* stage.

While the process stages *define specification*, *select supplier*, and *contract agreement* are of a tactical nature, in routine situations the ordering of transport generally occurs at an operational level. 'Frame' contracts are often used when purchasing transport (Lammgård, 2007). Following the process stages *define specification*, *select supplier*, and *contract agreement*, frame contracts with one or several transport providers are agreed upon. These frame contracts are agreed upon for specific lengths. According to a survey of Swedish companies engaged in purchasing transport, the duration of the largest contract was two years on average; companies that purchased transport had contracts that spanned longer than one year, with eight transport providers on average (Andersson et al., 2016). During the contract period, transport can be ordered from the contracted transport provider. The operational ordering of transport can be performed by different people than those who are involved in the *define specification*, *select supplier*, and *contract agreement* stages.

While the purchasing-process model (Figure 7) used in this study is based on the literature (as explained in this sub-section), it has also evolved during the collection of empirical data.

### 2.1.2 Environmental ambitions when purchasing freight transport

Martinsen (2014) presents a framework that describes the different environmental ambitions of the actors involved and notes that environmental activities will differ depending on these environmental ambitions. This framework is used in the Discussion chapter of this thesis (Chapter 5) to explain how the results of RQ2 can be used, depending on environmental ambitions.

Martinsen (2014) categorises relationships between shippers and logistics-service providers into four categories depending on the environmental ambition of each actor (Figure 8). There are situations where both shipper and logistics-service provider have high environmental ambitions, situations where the shipper has a higher environmental ambition than the logistics-service provider, situations where the logistics-service provider has a higher environmental ambition than the shipper, and situations where both shipper and logistics-service provider have low environmental ambitions.

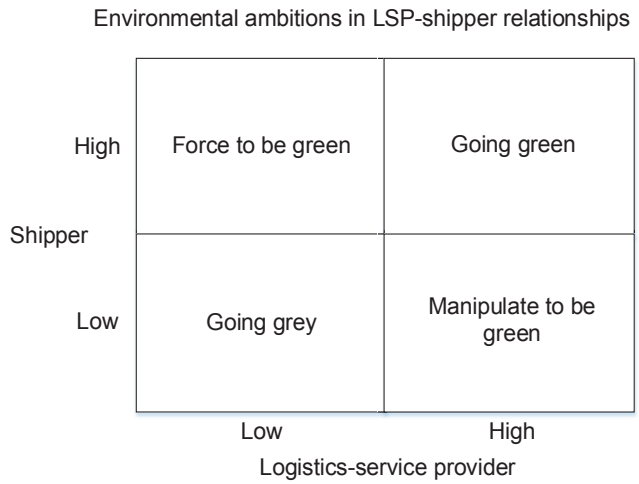


*Figure 8: Categorisation of logistics-service providers (LSPs) – shipper relationships based on environmental ambitions (Martinsen, 2014)*

## 2.2 Contextual variables influencing the purchasing process

This section defines the context of the purchasing process, which is relevant to RQ1, and discusses the motivation behind the selection of the contextual variables addressed in RQ1.

Organisations differ depending on their environments, which in this thesis translates into the fact that the freight-transport-purchasing process will differ depending on contextual factors. Earlier research has discussed many factors that influence purchasing: both purchasing in general and the purchasing of freight transport specifically. For example, Gadde and Håkansson (1998) and van Weele (1994) discuss several factors that influence purchasing. Specific to the purchasing of freight transport, Björklund (2011) analyses fifty-four factors that influence the environmental purchasing of freight transport, covering a wide range of factors in the following categories: management, measurement/reward system, employees, product characteristics, owners, image, purchasing function, resources of the company, customers, carriers, competitors, product suppliers, transport manufacturers, and government and authority. In Björklund (2005), the author identified from the literature more than two hundred factors that can facilitate or hinder environmentally preferable purchasing practices of freight transport. Although authors have identified many factors as relevant for the purchasing of freight transport, capturing how context influences the purchasing process in detail necessitates the selection of a few contextual factors to study.

The selection of the contextual dimensions (purchase task, importance, and service type) are based on arguments that selected dimensions are of relevance to

the freight-transport-purchasing process. All three contextual dimensions selected for the current study were derived from the purchase characteristics in the organisational buying behaviour (OBB) model in the work of Johnston and Lewin (1996), who describe three OBB models: those by Sheth (1973), Webster Jr and Wind (1972), and Robinson et al. (1967). The framework presented in Johnston and Lewin (1996) was considered for the present work, since that framework includes purchasing-process stages. One reason for the interest in purchase characteristics in the present study was the statement in Axelsson and Wynstra (2002) that the characteristics of the service that is being purchased will influence the different stages of the process. In order to answer RQ1, this entailed learning which service characteristics influence the freight-transport-purchasing process as well as learning how the purchasing-process stages are influenced by the service characteristics.

The contextual dimension 'purchase task', which in Johnston and Lewin (1996) is denoted as 'buy task', is selected in the current study to describe the task or situation of purchasing freight transport. The type of situation – for example, if it is a new purchase or a rebuy – can influence decisions and may be seen in the portfolio models that are used for classifying purchases and for supporting management decisions (Kraljic, 1983). The contextual dimension 'importance' was selected based on Persson (1991), who argued that an appropriate logistics strategy will be influenced by the importance of the service, and to include the strategic importance of the purchase. The contextual dimension 'service type', or what Johnston and Lewin (1996) called product type, was selected to describe what is purchased. 'Service type' was selected for this study, since the material-flow characteristics of the freight transport that is purchased may influence the requirements of the service and how the service is described. Material-flow characteristics (such as locations) are described in McKinnon and Woodburn (1996) as influencing companies' demand for road freight transport. The company's demand corresponds to what freight transport is purchased.

The three contextual dimensions (purchase task, importance, and service type) are further disaggregated into variables in the current study, specifically defining the dimensions (Table 1). For more details, the reader is referred to Paper I.

*Table 1: Contextual dimensions and variables studied (Rogerson et al., 2014)*

| **Contextual dimensions** | **Contextual variables** | **Values for each contextual variable** |
|---|---|---|
| Purchase task | Purchasing situation | Rebuy/new task |
| | Number of services | Single (only transport)/multiple (warehouse etc.) |
| | Level of customisation | Low/high |
| | Supplier strategy for transport purchase | Competitive bidding/reduce number of suppliers |
| | Supplier relationship approach | 'Arms-length'/partnership |
| Importance | Transport cost | Low/high |
| | Unique driver | Small/large |
| Service type | Location of recipients/senders | Local (domestic)/global |
| | Number of locations | Few/many |
| | Variation in locations | Repetitive/changing |
| | Size of shipments | Full load/small – part load |
| | Variation in size of shipments | Repetitive/changing |
| | Type of product | Functional/innovative |
| | Type of recipients/senders | Industrial/consumer + industrial + public |

## 2.3 Logistical variables related to $CO_2$ emissions

This section explains and justifies the use of the logistical variables presented in Piecyk and McKinnon (2010) as indicators of $CO_2$ emissions. The framework is used when addressing RQ2 and is referred to in the Discussion chapter (Chapter 5).

Given that frameworks that cover the relationships between logistical activities and environmental performance exist in earlier literature, an existing framework was selected in this thesis. The framework that was selected (which will be described below) relates a number of logistical variables to $CO_2$ emissions. Since the logistical variables have already been related to $CO_2$ emissions in previous research, in this thesis the influence on the logistical variables is studied; this influence then indicates the potential to influence $CO_2$ emissions. In this way the scope of this study is narrowed to describing how shippers can influence specific logistical variables.

Before selecting the framework to use in this thesis, two frameworks were considered: that in Piecyk and McKinnon (2010) and that in Eng-Larsson et al. (2012). Both frameworks include relevant variables and map the relationship between freight transport and $CO_2$ emissions.

The framework selected for use in this thesis is the one presented in Piecyk and McKinnon (2010). The primary reasons for selecting this framework are that the logistical variables are relatively easy to grasp with a brief explanation and because it shows in a relatively simple manner that these variables are related to $CO_2$ emissions. Both are important for developing a model that both shippers and transport providers can easily grasp. The components of the framework (i.e. the individual logistical variables) are useful for describing how the freight transport is executed, thus making these variables understandable to transport providers.

The framework presented in Piecyk and McKinnon (2010) shows the relationships between the weight of goods produced/consumed and freight-related $CO_2$ emissions through seven key logistical variables, also called key ratios. The seven variables include modal split, handling factor, average length of haul, lading factor, empty running, fuel efficiency, and carbon intensity of the fuel. The logistical variables as presented in Piecyk and McKinnon (2010) are further elaborated upon in McKinnon (2015a). ‘Modal split’ pertains to the proportion of goods carried by different transport modes; ‘handling factor’ is a rough measurement of the number of times that products are loaded onto vehicles, thus 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 the former referring to load volume evaluated against maximum carrying capacity and the latter pertaining to vehicle movement without load. ‘Fuel efficiency’ primarily depends on vehicle characteristics, driving behaviour, and traffic conditions. ‘Carbon intensity of fuel’ concerns the type of fuel that is used and how much $CO_2$ is emitted by specific fuel types. A few of the variables have been renamed for the purposes of this thesis: ‘mode used’ instead of ‘modal split’, ‘length of haul’ instead of ‘average length of haul’, ‘load factor’ instead of ‘lading factor’, and ‘carbon in fuel’ instead of ‘carbon intensity of fuel’.

Several versions exist of the framework presented in Piecyk and McKinnon (2010): both earlier, using some elements of the later framework (McKinnon, 2007b; McKinnon, 2007a; McKinnon, 2008), and later, with additional elements (McKinnon, 2015a). The decision to use the version in Piecyk and McKinnon (2010) in this thesis was made because that framework clearly expresses the link to $CO_2$ emissions and was presented in an academic journal paper. Piecyk and McKinnon (2010) also link the logistical variables to logistics-related decisions (which they call 'determinants'), and the framework has additional components and thus was more relevant compared to earlier versions. Another factor in the decision is that the components added in later versions – for example, 'other externalities' and the change of 'fuel consumption' to 'energy consumption' – were not deemed necessary for application in this thesis due to its focus on $CO_2$ emissions and freight transport.

## 2.4 Goods-delivery preparation

This section defines the goods-delivery-preparation process, and the activities of that process that are studied in this thesis, to address load factor (RQs 3 and 4).

In this thesis, the goods-delivery-preparation process, which is the preparation of products into shipments for delivery, consists of five activities: planning transportation, picking, packing, staging the goods for loading, and loading.

The first four activities are based on two sub-processes of the order-fulfilment process described in Croxton et al. (2001) and Croxton (2003): filling the order and processing the order. The sub-processes of 'filling the order' consist of the activities picking, packing, and staging the goods for loading (Croxton et al., 2001; Croxton, 2003), which in Croxton (2001) is called the 'order picking' stage. The sub-process of 'processing the order' consists of the activity 'planning the transportation'.

As the fifth activity, 'loading' is added in this thesis. Loading is included in the goods-delivery-preparation process for two reasons: loading takes place before the vehicle or container leaves the shipper's premises and loading has a clear influence on load factor. The loading of vehicles, however, is often not performed by the shippers' personnel. Therefore, loading is included in this thesis in terms of changes shippers can make to planning of loading and the loading process in order to improve their load factor.

To explain where the goods-delivery-preparation process fits into other company processes, the process is related to the order-fulfilment process. Order fulfilment within a supplying company starts when customer orders are received and ends when products are delivered (Zhang et al., 2010). As Croxton (2003, p. 20) states, the process of order fulfilment includes those 'activities necessary to define customer requirements, design the logistics network and fill customer orders'. Espino-Rodríguez and Rodríguez-Díaz (2014) present thirteen activities in the order-fulfilment process (Table 2); of these, the goods-delivery-preparation process described in this thesis relates to the stage 'preparation of the order', and it also includes the loading in the stage 'shipment of the consignment'. Croxton (2003) describes both a strategic and an operational order-fulfilment process. The operational order-fulfilment process defines specific steps to manage customer

orders, where Croxton (2003) describes seven sub-processes of the operational order-fulfilment process. The goods-delivery-preparation process described in this thesis relates to the stage 'fill order', which includes picking, packing and staging the goods for loading, and also to the stage 'process order', in terms of planning order flow and transportation. Table 2 illustrates how the goods-delivery preparation activities (in bold) are part of the order-fulfilment process.

*Table 2: Goods-delivery-preparation activities (in bold) in relation to the order-fulfilment process*

| **Activities in the order-fulfilment process (from Espino-Rodríguez and Rodríguez-Díaz, 2014)** | **Activities in the order-fulfilment process (from Croxton, 2003)** |
|---|---|
| 1. Receipt of order | STRATEGIC ORDER-FULFILMENT PROCESS |
| 2. Customer control | 1. Review marketing strategy, supply-chain structure, and customer-service goals |
| 3. Receipt of the order in the warehouse | 2. Define requirements for order fulfilment |
| 4. Stock control | 3. Evaluate logistics network |
| 5. Production order | 4. Define plan for order fulfilment |
| 6. Manufacturing | 5. Develop framework of metrics |
| 7. Transfer to the factory warehouse | |
| 8. Storage | |
| **9. Preparation of the order** | OPERATIONAL ORDER-FULFILMENT PROCESS |
| 10. Control of delivery note and invoicing | 1. Generate and communicate order |
| **11. Shipment of consignment** | 2. Enter order |
| 12. Transport | **3. Process order** |
| 13. Merchandising (placing the products at the point of sale) | 4. Handle documentation |
| | **5. Fill order** |
| | 6. Deliver order |
| | 7. Perform post-delivery activities and measure performance |

## 2.5 Load factor

This section defines load factor and describes the relevant literature on the subject; these definitions and descriptions help to address RQs 3 and 4, since these two questions are concerned with ways to increase load factor.

As noted earlier, the load factor is the ratio of actual load carried to the maximum load that can be carried in a load unit, such as a vehicle (McKinnon and Ge, 2004; McKinnon, 2010a).

A structured literature review of load factor was conducted in Study IV and was reported on in Paper III. In order to address RQs 3 and 4, it is relevant to determine the ways in which shippers can achieve high load factors and how they can measure load factor. Problems in these areas lead to the development of several frameworks that are presented in the Results Chapter.

Some of the decisions shippers can take that influence load factor, described in earlier research, include logistics structures, order and delivery, packaging and loading, transport operations, and consolidation (Table 3). At a more detailed level, within 'order and delivery', decisions related to delivery frequency will influence load factor; within 'packaging and loading', packaging systems will influence load factor; within 'transport operations', routing decisions will influence load factor; and within 'consolidation', both 'shipment consolidation', pooling of vehicles' and 'sharing warehouses and factories' will influence load factor. Descriptions about decisions that are relevant in goods-delivery

preparation have been used in this thesis to identify actions that shippers can take to achieve high load factor.

*Table 3: Decisions shippers can take that will influence load factor*

| Decision areas | Statements in the literature | Articles |
|---|---|---|
| Logistics structure | The number and location of senders, recipients, and terminals influence load factor. | Aronsson and Brodin (2006); Kohn and Brodin (2008); Lumsden et al. (1999) |
| Order and delivery | Decisions about the frequency of deliveries influence load factor. | Schöneberg et al. (2011) |
| Packaging and loading | Load factor was higher in a one-way packaging system compared to a returnable packaging system. | Pålsson et al. (2013) |
| Transport operations | Decisions on routing increase load factor. | Treitl et al. (2014) |
| Consolidation | Shipment consolidation, which consists of combining several small shipments within the same vehicle, is positively related to load factor. | Ülkü (2012) |
| | Load factor can be increased by pooling vehicles and sharing factory sites. | Christensen (1996) |
| | Pooling warehouses and routing shipments between supply chains can improve load factor. | Pan et al. (2014) |

One issue dealt with in this thesis is how shippers should measure load factor, but measuring load factor has not been standardised. Measurement is problematic for many reasons, including what measure to use, the definition of 'maximum load', measuring at several levels, when to measure, access to data, and differences between transport modes.

Related to the 'what to measure' question, McKinnon (2010a) suggests five measures of a truck's load factor : weight-based, volumetric, tonne-kilometre, deck-area coverage, and level of empty running. Pahlén and Börjesson (2012) suggest using several measures. For example, the load factor is high when measuring the deck-area coverage but is low when measuring the volume.

Maximum load will also differ depending on what measure is used. For example, maximum load is reached when the deck area is covered, even if there is empty space above the goods. Alternatively maximum load can be measured according to maximum weight (McKinnon, 2010a). In order to achieve a more efficient use of the vehicle in terms of both volume and weight, high and low-density goods can be combined (Santén, 2012) or an upper deck can be inserted in vehicles (McKinnon and Campbell, 1997). The maximum load may also be influenced by the need for space to perform loading and unloading efficiently (Pahlén and Börjesson, 2012).

Measuring load factor on many levels, as Samuelsson and Tilanus (1997) suggested, addresses the problem that a vehicle can be full of empty boxes or a ship full of empty containers. If several levels are measured – boxes, containers, trucks, and ships – then those empty spaces become more visible.

For the 'when to measure' question, if a truck makes several stops during a trip, the load factor will differ during its journey (McKinnon and Ge, 2004; Arvidsson, 2013). In addition, access to data can be challenging, since several actors are involved (shipper, forwarder, and transport operator); it can also be difficult to obtain the exact details from transport operators (Santén, 2013).

Finally, load factor is measured in different ways for different modes of transport. Road transport measures utilisation inside vehicles, for example, while rail and sea transport measure the number of 'twenty-foot equivalent units'(TEUs) (Styhre, 2010; Woodburn, 2013). This means that different system levels are measured.

## 2.6 Coordination

This section defines what is meant by the term 'internal coordination' in this thesis and describes and explains the typologies used when addressing RQ4: 'dependencies' in Thompson (1967) and 'coordination mechanisms' in Glouberman and Mintzberg (2001). This section also presents coordination-related research that is later drawn upon in the Discussion chapter (Chapter 5).

### 2.6.1 Internal coordination between logistics and other activities

The term 'internal coordination' in this thesis covers both coordination between logistics activities and coordination between logistics and non-logistics activities. The coordination between activities is related to two of the three dimensions of coordination in supply-chain management discussed in Ballou et al. (2000), namely intra- and interfunctional coordination. Intrafunctional coordination refers to activities within one function of a firm; in this thesis this refers to coordination between logistics activities. Interfunctional coordination, which means working together across functions to achieve common company goals (Min, 2001), refers in this thesis to coordination between logistics and non-logistics activities. Although this thesis focusses on the activities that need to be coordinated rather than on the organisation of the activities (i.e. which department performs the activities), intrafunctional versus interfunctional differences (in terms of sharing the same manager or goals) are nevertheless discussed in Paper VI, which provides the results of RQ4. In this thesis, the aim of the coordination studied is to achieve high load factor. As such, it differs from earlier research on internal coordination between logistics and other functions. van Hoek et al. (2008) note in their review of academic literature that relatively few papers address the alignment of logistics with other functional areas, and that most of the research that has been conducted on this area focusses on coordination between logistics and sales/marketing functions.

Kahn and Mentzer (1996) presented a model (Figure 9) that describes different levels of interaction and collaboration between departments, depending on situational characteristics. By 'interaction' they mean communication, while 'collaboration' refers to common goals. This model is used in the Discussion chapter (Chapter 5) of this thesis to discuss (1) the idea that certain purchase characteristics (refer to Table 1) will result in the need for a high level of interaction or collaboration between activities and (2) the use of different coordination mechanisms, depending on the situation.

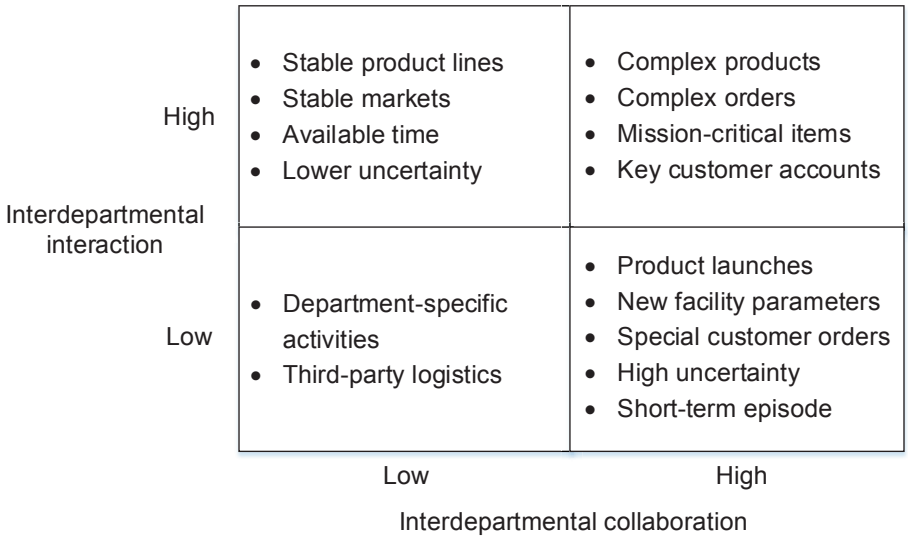


*Figure 9: Interaction and collaboration between departments in different situations (Kahn and Mentzer, 1996)*

### 2.6.2 Dependencies between activities

In order to examine internal coordination (RQ4), the typology of dependencies, as detailed in Thompson (1967), is used in this thesis to describe task dependencies between activities.

*Table 4: Thompson's (1967) types of interdependencies*

| Interdependence type | Description |
|---|---|
| Sequential | When the output of one part becomes the input of another and 'the order of that interdependence can be specified' (Thompson, 1967, p. 54) |
| Reciprocal | When 'outputs of each become inputs for the others' and 'each unit posing contingency for the other' (Thompson, 1967, p. 55); when two related activities must change at the same time in order to work (Håkansson and Persson, 2004). |
| Pooled | When 'each part renders a discrete contribution to the whole and each is supported by the whole' (Thompson, 1967, p. 54); when two activities are related to a third activity or share a common resource (Håkansson and Persson, 2004). |

The typology of dependencies in Thompson (1967), see Table 4, was selected for use in this thesis since it is useful in explaining the need for coordination in the cases that were studied. It is also relatively simple, well established and has previously been applied in logistics and supply-chain management, which in itself indicates the usefulness of this method of describing interdependencies. Sandberg and Bildsten (2011) note in their comparison of frameworks of dependencies that most dependencies can be traced back to Thompson (1967). Van de Ven et al. (1976) add one more type to Thompson's typology, for example, and two of the four types of dependencies in Malone and Crowston (1994) correspond to those in Thompson (Table 5).

*Table 5: Relating other typologies of task dependencies to that in Thompson (1967)*

| Type of dependencies | | | |
|---|---|---|---|
| *Thompson (1967)* | *Van de Ven et al. (1976)* | *Malone and Crowston (1994)* | *Malone et al. (1999)* |
| Pooled | Pooled | Shared resources | Sharing |
| Sequential | Sequential | Producer-consumer | Flow |
| Reciprocal | Reciprocal | | |
| | Team arrangements | Simultaneity constraints | |
| | | Task-subtask | Fit |

### 2.6.3 Coordination mechanisms

The typology of coordination mechanisms as described in Glouberman and Mintzberg (2001) is used in this thesis to describe how coordination can be performed to enable high load factor. Glouberman and Mintzberg (2001) describe six coordination mechanisms: mutual adjustment and direct supervision, as well as four types of standardisation (standardisation of work, standardisation of output, standardisation of skills and knowledge, and standardisation of norms). The coordination mechanisms are also described in Mintzberg (1979), although it does not include the standardisation of norms. The six coordination mechanisms are described in Table 6.

*Table 6: Coordination mechanisms (Mintzberg, 1979; Glouberman and Mintzberg, 2001)*

| Coordination mechanism | Description | When to coordinate? |
|---|---|---|
| Mutual adjustment | When people adapt to one another. Uses informal communication. Used by the doers of activities to coordinate. | During work |
| Direct supervision | When an individual not doing the work (e.g. a manager) dictates how the work should be done to the people performing the work, for example by issuing instructions and monitoring the work. | During work |
| Standardisation of work | When the contents of the work are stipulated (e.g. as procedures or instructions), which those performing the work need to follow. The design of the work is coordinated. | Before work |
| Standardisation of output | When the result of the work is standardised: for example, stipulating a certain performance level or dimension. The way that the output is achieved is not stipulated. The coordination is focussed at the interface between activities. | Before work |
| Standardisation of skills and knowledge | When the doers are standardised regarding skills and knowledge to perform the work: for example, standardised training about how to perform the work. People know what to expect from one another due to standardised skills or knowledge; since people know what to expect, they coordinate automatically. | Before work |
| Standardisation of norms | When people share common values and beliefs. Since they share expectations of goals, they coordinate automatically. | Before work |

The typology of coordination described in Glouberman and Mintzberg (2001) was selected for use in this thesis since – according to Sandberg and Bildsten (2011) – it is comprehensive, and also because it has been applied to logistics, for example by Martinsen (2014).

Different types of coordination mechanisms have been described in the literature as corresponding to different types of interdependence. Most organisations use all of the coordination mechanisms (Glouberman and Mintzberg, 2001), but some mechanisms may be more suitable than others in certain situations. Table 7 presents examples of situations where different authors have suggested different types of coordination. For example, the coordination mechanism ‘mutual adjustment’ is suitable in both very simple and very complex situations (Mintzberg, 1979). In complex situations, for example, it is difficult to plan in advance, and thus the knowledge develops during the work; this means that the people performing the work have to adapt to one another, and they use mutual adjustment as a result. According to Thompson (1967), mutual adjustment is suitable for reciprocal interdependencies. Another example is the coordination mechanism ‘standardisation of work’, which is suitable for simple and routine

tasks (Mintzberg, 1979), situations that can be anticipated in advance (Galbraith, 1973), and activities with low task uncertainty (Van de Ven et al., 1976).

*Table 7: Use of coordination mechanisms depending on situation*

| **Coordination mechanisms** | **Situations when coordination mechanisms are suitable** | | | |
|---|---|---|---|---|
| | *Mintzberg (1979)* | *Thompson (1967)* | *Galbraith (1973)* | *Van de Ven et al. (1976)* |
| Mutual adjustment | Simple situations with few people, or very complex situations | Reciprocal interdependence | n/a | n/a |
| Direct supervision | More people | Sequential interdependence | Unanticipated situations | Not too large unit size |
| Standardisation... | | | | |
| … of work | Simple and routine tasks | Pooled interdependence | Situations that can be anticipated in advance | Low task uncertainty, low work-flow interdependence |
| … of output | Complicated tasks | | | n/a |
| … of skills and knowledge | More complicated tasks | | High task uncertainty | n/a |
| … of norms | n/a | | High task uncertainty | n/a |

## 2.7 Summary of areas in focus

Based on the descriptions above, this chapter has provided more details on the areas in focus in this thesis (Figure 10). To summarise, the context examined in RQ1 consist of purchase task, importance, and service type. The freight-transport-purchasing process consists of the stages of *define specification*, *select supplier*, and *contract agreement*. The logistical variables include mode used, handling factor, length of haul, load factor, empty running, fuel efficiency, and carbon in fuel. The activities studied in goods-delivery preparation include planning of transport, picking, packing, staging of goods for loading, and loading. Coordination between logistics activities and non-logistics activities is needed to achieve high load factor; this is examined in terms of the dependencies and coordination mechanisms.

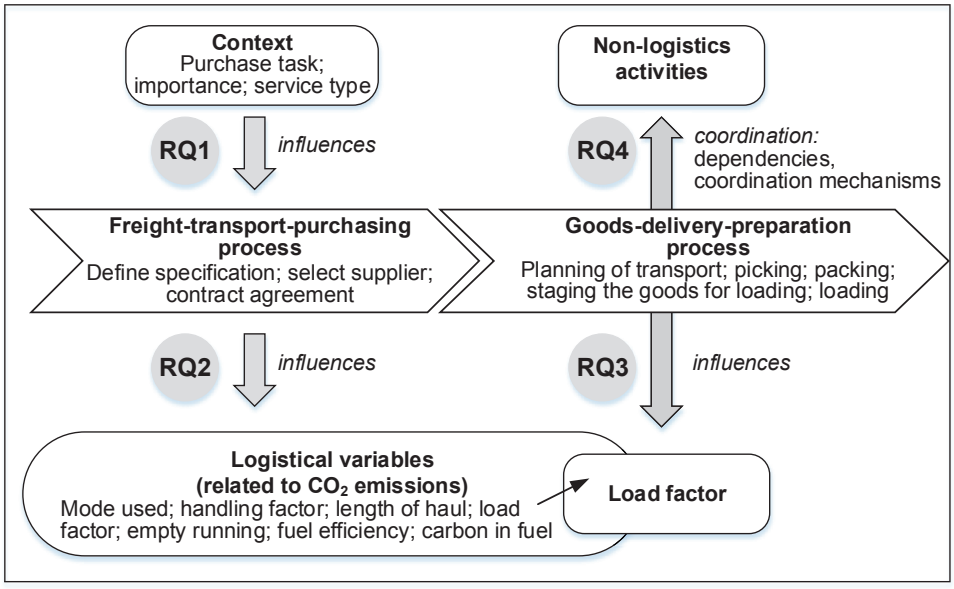


*Figure 10: A more detailed version of the areas of focus in this thesis*

# 3 Methodology

This chapter describes the research design of this thesis; it outlines the methods that were used to answer the four research questions and examines the data collection, data analysis, and research quality.

Figure 11 illustrates the link between the four research questions, the six studies, and the resulting seven papers. Study I was designed to answer RQ1, and the findings are reported in Paper I. Study II was designed to answer RQ2, and the findings are reported in Paper II. Study V was designed to answer RQ3, and the findings are reported in papers IV and V. Study VI was designed to answer RQ4, and the findings are reported in Paper VI. Study IV (the literature review) provided input to RQs 3 and 4, and the findings are reported in Paper III. Finally, Study III, which examined the influence of the ordering of freight transport on the various logistical variables, provided input to RQ4; the findings are reported in Paper VII.

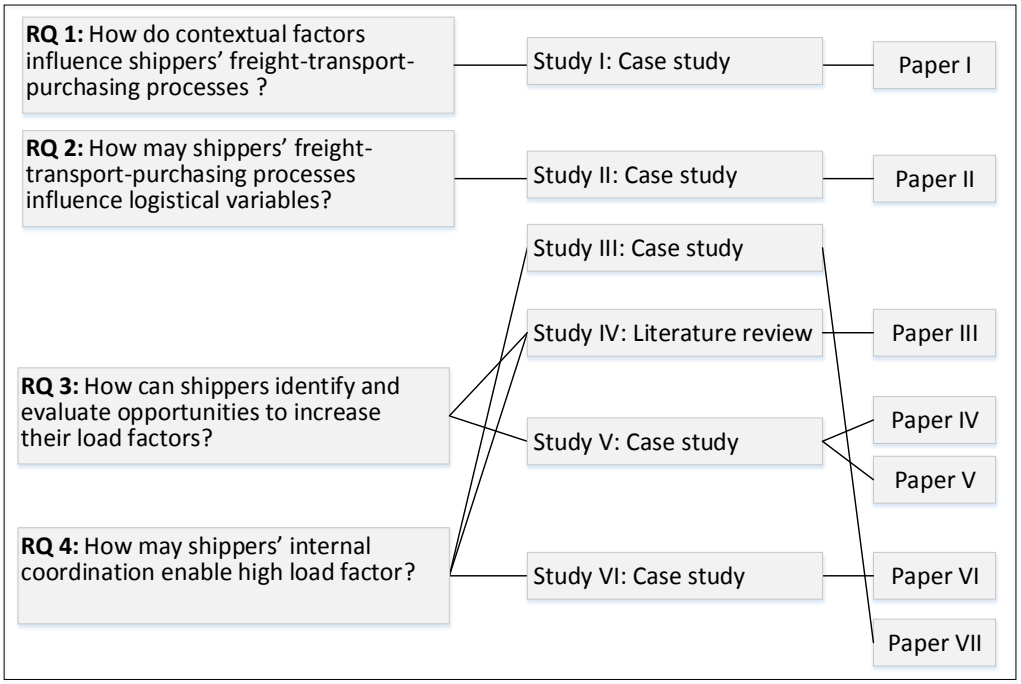


*Figure 11: Links between the four research questions, six studies, and seven papers (sorted by studies)*

## 3.1 Research process

Initiated in February 2009, this research has been conducted as part of two research projects: 'Integrated logistics development for sustainability and competitiveness' (before the licentiate level) and 'Increased transport efficiency through better utilisation of loading capacity' (after the licentiate level). In the first project, sustainable freight-transport solutions were studied from the perspective of the different actors involved; the author of this thesis examined the perspective of the companies that purchase freight transport (i.e. shippers). In the second project, load factor was studied from the shippers' perspective.

The first study was an important step in understanding the research area due to the limited existing literature on the freight-transport-purchasing process. Study I was

planned and the first round of data collected in the first quarter of 2010 before a period of parental leave. Upon the author's return, a second round of data was collected and a working paper was presented at the International Purchasing and Supply Education and Research Association (IPSERA) conference held in Maastricht, the Netherlands, in April 2011.

Throughout the research process, it was clear that environmental considerations would be central to the work. During the spring of 2011, the author, through the supervision of a student thesis on operational freight-transport purchasing, found the potential to expand on the existing research in the field.

This early work provided a preliminary understanding of the field that was then developed during the research process. Specific research questions were evaluated and reformulated throughout the process. The first set of questions was formulated in November 2009 and then reformulated several times during the research process.

Study II was planned in November 2011 and conducted in early 2012, resulting in a working paper presented at the IPSERA conference held in Naples, Italy, in April 2012. Study III was planned from March to April 2012 and was conducted in May 2012. The resulting paper was presented at the Logistics Research Network (LRN) conference held in Cranfield, the United Kingdom, in September 2012 (Paper VII).

At this point, the conference paper based on Study I was reassessed for submission to a journal. The theoretical framework was reworked based on suggestions from the conference and additional literature research. One more case was added, and the analysis was reworked. The resulting paper (Paper I) was submitted to the *International Journal of Logistics Research and Applications*; it was accepted in the autumn of 2013.

Upon return from a second parental leave, the conference paper based on Study II was reworked, featuring a more detailed analysis of earlier literature. In January 2014, Study IV (a literature review on load factor) was initiated, which resulted in a conference paper presented at the LRN conference in September 2014 held in Huddersfield, the United Kingdom. In the spring of 2014, Study V was initiated and carried out from the autumn of 2014 to the autumn of 2015. Study V resulted in two papers – one conference paper (Paper IV) presented at the LRN conference in September 2015 (held in Derby, the United Kingdom) and one paper submitted in December 2015 to an international journal (Paper V). Study VI was planned during the autumn of 2014 and conducted throughout 2015. A conference paper was presented at the same LRN conference in September 2015; after further analysis, the article was later rewritten and submitted to the *International Journal of Logistics Management*; it was accepted in September 2016 (Paper VI).

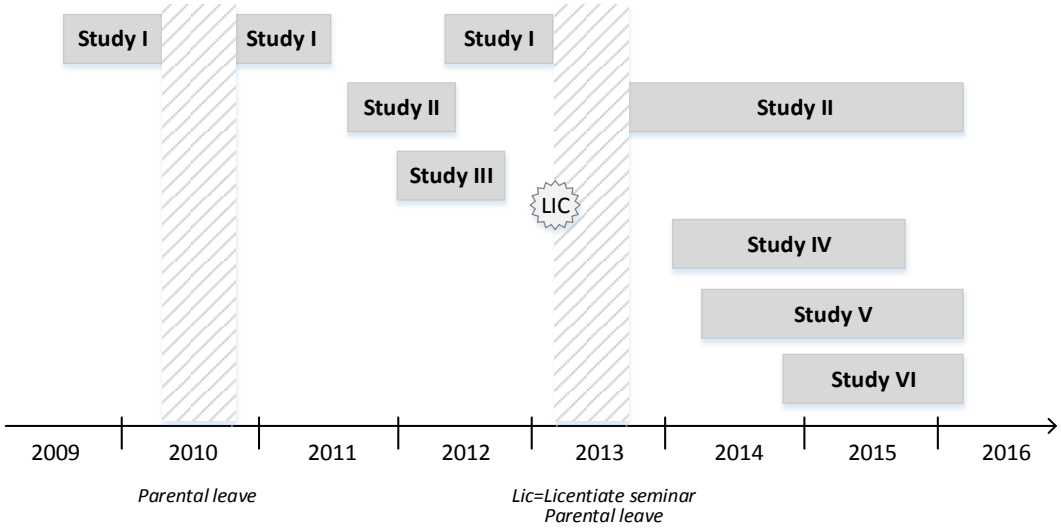


*Figure 12: Research process*

## 3.2 Research design

Table 8 provides an overview of the studies, summarising the methods, case selection, data collection, and analyses used in each.

The starting point of this thesis has been the purpose of study, as well as the research questions that were formulated to contribute to that purpose; the research design is thus a plan for collecting and analysing evidence in order to answer the research questions, see, for example, Ragin (1994). Other components of the research design, such as methods, theoretical frame, and the selection of empirical material, should ideally fit with the research questions, thus allowing for the ability to answer the questions with the resources available. Within each of the studies, the particular methodological choice was considered based on the respective research question and how it could be answered.

### 3.2.1 Research question 1: Design of Study I

RQ1 was initially concerned with examining which logistics-context factors influence the purchasing process. While the survey method was at first considered to be a suitable method for answering the question, as the research question started to evolve into discerning how the freight-transport-purchasing process is influenced by specific factors, it became necessary to acquire a deeper understanding of each situation; a case study was thus chosen as the most relevant method.

According to Yin (2009), case studies are relevant for answering 'how' or 'why' questions and for situations where the researcher seeks an in-depth description. An in-depth description was considered to be necessary in Study I due to the scarcity of earlier research on the freight-transport-purchasing process. A multiple-case-study approach was selected to examine the differences between contexts of the purchasing process. In order to answer the research question, it was necessary to study cases that provided variation in the contextual variables that were selected for the study. See sub-section 3.4.2 for a description of the sampling of cases. Dubois and Gadde (2002) argue that in-depth case studies are the best way to understand the interactions between a phenomenon and its context;

reflecting this idea, Study I examined how specific contextual variables influenced the freight-transport-purchasing process. Dubois and Araujo (2007) argue that the case-study method is well suited for constructing, adapting, extending, and refining theories. Since Study I incrementally adds to existing knowledge, this method is appropriate for its purposes.

*Table 8: Overview of the research studies*

| Study | Literature review? | Multiple-case study? | No. of cases | Case selection | Data required | Semi-structured interviews? | Documents? | Observations? |
|---|---|---|---|---|---|---|---|---|
| I | | Y | 7 | Case: shippers<br>Cases with varying contexts (variation in company size and goods-flow characteristics) | Process descriptions (steps, activities, time, people involved, and collaboration with transport provider); description of contextual variables<br>Respondents: Purchasing/logistics manager | Y | Y | |
| II | | Y | 3 | Case: specific purchasing process<br>Cases with contrasting processes | Processes descriptions (steps, activities, time, people involved, and collaboration with transport provider); transport provider's perceived influence on environmental work<br>Data triangulation: Buyer & provider (dyad)<br>Respondents: Shipper: Logistics / purchasing manager. Transport provider: Account manager (salesperson) | Y | Y | |
| III | | Y | 5 | Case: specific transport ordering process<br>Cases with contrasting processes | Process descriptions (steps, activities, time, people involved and collaboration with transport provider); input to the ordering process<br>Respondents: Transport order staff | Y | | Y |
| IV | Y | | | Broad search: 'Summon' tool using many 'search strings' (see section 3.4.1 for details) | Journal articles mentioning areas that influence load factor | | | |
| V | | Y | 3 | Case: specific goods flow<br>Intensity sampling: Cases with changes to increase the load factor either recently undertaken or to be implemented in the near future | Required and available capacity at several load-factor levels; actions performed to improve load factor; context (constraints, enablers)<br>Respondents: Logistics/transport manager, transport-planning manager, transport-order manager, transport-operating manager, packaging manager, purchasing manager, project manager | Y | Y | Y |
| VI | | Y | 3 | Case: shippers<br>Intensity sampling: Cases that fulfil the two criteria of (1) performing actions to improve load factor and (2) interaction between logistics and other activities | Actions performed to achieve high load factor, process descriptions (activities), interdependencies between activities, interactions between activities<br>Respondents: Logistics/transport manager | Y | Y | |

Critics of case-study research have discussed its problems with providing overly rich detail. Eisenhardt (1989), for example, argues that the overwhelming volume of data might result in a theory that is rich in detail but is overly complex, while Easton (1998) states that this method says very little about too many topics. The challenge is to select what to describe and then to structure the descriptions in such a way that the reader will be able to follow the reasoning. A conceptual framework was used in the current study to focus the data analysis in order to avoid these issues. Existing theory informed the initial framework used in Study I, which then was used to guide the data collection. The study provided more detailed understanding compared to the initial framework, specifically on what it meant for the purchasing process that the contextual variables had certain values, and which aspects of the purchasing process were influenced by which contextual variables. The proposed final framework was developed from the conceptual model and was enriched by data from the cases.

### 3.2.2 Research question 2: Design of Study II

RQ2 relates to how shippers' freight-transport-purchasing processes influence logistical variables. To answer this question, it was necessary to acquire an in-depth understanding of situation-specific purchasing processes. A survey would most likely have acquired very general responses about procedures, whereas a case study examines a specific situation more thoroughly; the case-study approach was thus chosen as the most appropriate method. As mentioned earlier, case studies are relevant for answering 'how' and 'why' questions and when the researcher seeks in-depth descriptions (Yin, 2009). To provide a detailed understanding of 'how' shippers' purchasing processes may influence logistical variables, a multiple case-study with few cases was selected, since more than one case should be able to shed light on different influences. The purposive sampling of cases is described in sub-section 3.4.2.

Part of the methodological choice in Study II was to include interviews with the transport provider in order to obtain the perspectives of both the shipper and the transport provider. The transport provider was well placed to provide information about the ways in which the shipper influenced the planning and delivery of the freight transport.

A conceptual framework was created in Study II based on the existing literature, which then guided the data-collection process. The study then provided more details in terms of which purchasing activities influence logistical variables, which logistical variables were influenced by which activities, the causes of that influence, and how the decisions by transport providers were influenced.

### 3.2.3 Research question 3: Design of studies IV and V

RQ3 examines how shippers identify and evaluate opportunities to increase their load factors. Conducting Study IV (a structured literature review) was necessary to gain an overview of the literature on load factor from a shipper's perspective. Study V was designed based upon the findings from Study IV (the literature review) that were related to those areas that would be of interest for shippers to address to influence their load factor. The case-study method was considered appropriate because it could provide detailed descriptions about the ways that

shippers can increase load factor and to be able to understand and explain why those changes were performed. A multiple-case-study design with few cases was selected in order to gain a deep and detailed understanding of the phenomenon in the contexts that were studied: the fewer the number of cases, the greater the opportunity for depth of observation (Voss et al., 2002). It was important to investigate the cases deeply, since detailed understandings of 'how' were sought in this study. Each case provided examples in different contexts that illuminated different aspects of the topic under consideration. The sampling of cases is described in sub-section 3.4.2.

Early in the data-collection process, the focus was on shippers' actions for improving load factor in the areas of transport planning, packaging, and loading. The structuring of the data and the resultant conceptual models were developed during the course of the study. Because Study IV revealed that a single definition of load factor did not yet exist, it was necessary in Study V to establish a common definition of load factor from a shipper's perspective; this definition was then presented in Paper IV. Study IV also illuminated two facts: earlier research on load factor was scattered, and it was difficult for shippers to gain an overview of what they could do to improve load factor. It became apparent that an overview of actions that companies could take would be useful. This overview built upon the definition that had already been developed in the study. In hindsight it may have been possible to create the framework presented in Paper V based on the literature review, but for the researchers, the understanding gained from immersing themselves in the rich empirical data allowed them to categorise actions into the framework.

Study V was performed as part of the project 'Increased transport efficiency through better utilisation of loading capacity' and made use of the partner companies in the project. These companies had expressed an interest in load factor as a topic and were interested in improvements to load factor. The project format, which included several workshops, enabled the researchers to test and discuss the results with representatives from the various companies.

### 3.2.4 Research question 4: Design of studies III and VI

RQ4 examines how shippers' internal coordination may enable high load factor. While Study III investigates activities in the freight-transport-ordering process and how this can be connected to various logistical variables, Study VI focusses solely on the influence on the logistical variable 'load factor'. Study VI was designed following the finding from Study III that other functions determine the conditions under which the ordering of freight transport could influence load factor. Study VI also took into account the fact that Study IV (the literature review) had determined that little research had so far addressed the areas of packaging and loading in relation to load factor. While Study VI aimed to include purchasing, ordering, and goods-delivery-preparation activities, during the course of the study the goods-delivery-preparation activities were prioritised based on the respondents' actions for achieving high load factor.

In Study III, an in-depth description was considered necessary because of the limited earlier research on the topic (i.e. the ordering of freight transport). Study III was of a qualitative nature, which differed from those of Kuo and Soflarsky

(2003) and Caputo et al. (2005), who studied decisions-support systems for ordering freight transport. The use of case studies provides a focus on specific situations. The use of multiple cases provides descriptions of additional contexts compared to the work of Holter et al. (2008).

The methodological choice in Study III was guided by the methods that were used in Study II, because the intention was to later combine the two results in order to examine different stages in the purchasing process. A similar methodological approach was preferable for doing this, so a case-study approach was appropriate. The multiple-case-study method was selected in order to examine the different influences of the freight-transport-ordering process on logistical variables.

In Study III the initial framework, which guided the data collection, connected information input, transport-ordering processes, and logistical variables. Given the limited amount of earlier research on the freight-transport-ordering process, the study first needed to study what activities were taken within that process, and thereafter how the process influenced logistical variables. As a result more details could be added to the framework during the study.

A multiple-case-study method was used in Study VI to gain a detailed understanding of how shippers work towards achieving higher load factors. Few detailed examples of internal coordination to enable high load factor are provided in earlier research. RQ4 is about 'how' coordination may enable high load factor and it was necessary to acquire in-depth descriptions in order to understand why and how interactions between activities took place. A multiple-case study was conducted to address how shippers coordinate internally in order to achieve high load factors. Three cases were selected to gain detailed understandings of 'how' they did this. The purposive sampling of cases is described in section 3.4.2. The different cases illuminated different aspects of coordination, for example by providing examples of coordination between different activities and the use of different coordination mechanisms.

## 3.3 Companies and contexts studied

The cases in the different studies were sometimes found in the same companies. An overview of the cases in each study and in which companies these cases were found is presented in Table 9. A total of thirteen companies (a–m in Table 9) were studied. To allow the reader to recognise the cases from the appended papers, the names of the cases in each study in Table 9 correspond to the names used in the appended papers.

*Table 9: The thirteen companies studied (a–m) with respective case names in each study*

| | Studies | | | | |
|---|---|---|---|---|---|
| | **I** | **II** | **III** | **V** | **VI** |
| a | Lab | | | | |
| b | IT mail order | | | | |
| c | Industrial equipment manufacturing | | | | |
| d | Retail commodity manufacturing | Retail commodity | | | |
| e | Machinery manufacturing | Machinery | A | | |
| f | Food manufacturing | Food | | | |
| g | Personal care manufacturing | | | | |
| h | | | B | Project delivery | |
| i | | | C, D, E | | A |
| j | | | | | B |
| k | | | | | C |
| l | | | | Distribution round | |
| m | | | | Fast response | |

Company e (machinery manufacturing) was included in three studies; even so, Study III focussed on different respondents than did studies I and II. Company h was included in studies III and V, but since it is a large company, the studies were on areas that were geographically separate from one another, they were separate in the types of products that were examined, and they had separate respondents. Three cases from Company i were used in Study III, but the cases that were studied were different goods flows for different products at different sites. Because Study III inspired Study VI, investigations within Company i were continued. It is also worth noting that two food distributors were studied (companies k and l) and although they may sound similar in the descriptions in the papers, they are in fact different companies.

Including the same companies in several studies provided prior knowledge before the data-collection process began. This meant that when interviewing respondents about the ordering process in Study III, the interviewer was aware of what the purchasing process looked like as well as the context of the company; the interviews were thus able to go straight to the main topic. The interviewer was also able to ask the respondents about connections to previous knowledge (i.e. context and processes).

A variety of contexts were studied: both inbound and outbound transport and several modes of transport. The companies that were studied were mainly manufacturers and wholesalers/distributors of varying sizes. Several transport services and types of load units were also studied. To provide details on what was covered in each study Table 10 lists different aspects that were included in the studies. This table may be used by readers to assess whether the results are transferable to particular situations.

*Table 10: Aspects included in the studies*

| | **Research Questions** | **1** | **2** | **3** | | **4** | |
|---|---|---|---|---|---|---|---|
| | **Papers** | **I** | **II** | **IV, V** | **III** | **VI** | **VII** |
| | **Studies** | **I** | **II** | **V** | **IV** | **VI** | **III** |
| Direction of transport | Inbound | x | x | | x | x | |
| | Outbound | x | x | x | x | x | x |
| Transport modes | Road | x | x | x | x | x | x |
| | Sea | x | x | | x | x | x |
| | Rail | x | x | | x | | |
| | Air | x | x | | x | | x |
| Geographical spread (location of senders/recipients) | International | x | x | x | x | x | x |
| | National/Domestic | x | x | x | x | x | |
| Type of companies | Manufacturer | x | x | x | x | x | x |
| | Wholesaler/Distributor | x | | x | x | x | |
| | Lab | x | | | | | |
| Company size | Small to medium | x | x | | x | | |
| | Medium to large | x | | x | x | x | x |
| Load units transported | Container | x | x | | x | x | x |
| | Pallets | x | x | x | x | x | x |
| | Sacks | x | | | | | |
| | Reels | x | | | | x | x |
| | Boxes | x | | x | x | | |
| | Small (e.g. parcels) | x | x | | x | | x |
| | Single products | x | | x | | | |
| Process | Freight-transport purchasing | x | x | | x | | x |
| | Goods-delivery preparation | | | x | x | x | |
| Logistical variables | Mode used | | x | | | | x |
| | Handling factor | | x | | | | x |
| | Length of haul | | x | | | | x |
| | Load factor | | x | x | x | x | x |
| | Empty running | | x | | x | | x |
| | Fuel efficiency | | x | | | | x |
| | Carbon in fuel | | x | | | | x |
| Decision-making level | Tactical | x | x | x | x | x | |
| | Operational | | | x | x | x | x |
| Transport service | Express | x | x | | x | | |
| | Parcel | x | | | x | | |
| | LTL* via terminal | x | x | x | x | | x |
| | LTL* not via terminal | x | x | x | x | x | |
| | FTL/FCL** | x | x | x | x | x | x |
| | Dedicated transport | x | | | x | x | |

* LTL = less-than-full truckload; ** FTL/ FCL = full truckload / full container load

## 3.4 Research methods

This section provides an overview of the studies in terms of the literature search, case selection, and data collection. Similarities and differences in the methods are also discussed.

### 3.4.1 Literature searches

Literature searches were performed for all of the studies, combining different 'search strings' (i.e. the words that are used in searches) in different databases; a list is provided in Appendix II. The literature searches were used to increase the researcher's knowledge of the study topics, to construct theoretical frameworks (e.g. in studies I and V), to develop categories for analysis (e.g. the coordination mechanisms in Study VI), to map earlier findings (e.g. the suggested influences in Study II and the influencing areas in Study IV), to provide input to models (e.g. the inclusion of the reallocation of capacity in the framework of opportunities in Study V), and to relate the findings to those found in earlier research.

One difficulty the researcher encountered was in identifying the relevant keywords. This was handled by using many alternative search terms, such as when searching for literature on logistical variables in Study II and load factor in Study IV. For Study IV, the search terms were discussed with other researchers in the logistics and transportation field; they were also tested using the search tools. Further, snowballing (i.e. checking reference lists cited within relevant articles for potential leads) was used in each study to find additional relevant literature.

The searches were performed using both broad search tools (Google Scholar, Summon) and specific databases (ABI/Inform, Science Direct, Web of Science, and ProQuest). Broad search tools were used to ensure that sources were not missed. The use of broad search tools, however, made it difficult to narrow down the search results. In addition, the search tool Summon was inconsistent in the use of full-text searching across different databases; this meant that full-text searches were performed in some databases, while in others the abstracts were searched. The tool provided limited information on the differences between searches in different databases. Specific databases were used for advanced searches: for example, to search for specific search terms. These specific databases made it possible to perform full-text searches while allowing different ways of narrowing down the search results to find the relevant articles. The search tool used depended both on the search terms and on the desired outcome of the search. When the desired outcome was to gain as complete a picture as possible, for example, a broad search tool was selected (as was the case with Study IV); alternatively, both specific databases and broad search tools were used (as in Study II). When the researcher were trying to find relevant literature to position each study, the use of broad search tools proved to be faster than searching several databases.

In order to gain a thorough understanding of previous research on load factor, a structured literature review was performed (in Study IV) that was more comprehensive than the other literature searches. The process of this literature review is described in Table 11. The literature review in Study IV followed the first four stages in the research process of a literature review, as described by Cooper (1998): problem formulation, data collection, data evaluation, and

analysis and interpretation. The literature review only included journal articles, although other sources, such as reports, are also relevant for load factor.

*Table 11: Overview of the literature-review process (Study IV/Paper III)*

| Process stages | Description of activities |
|---|---|
| Problem formulation | Preparing a draft of a coding sheet to collect information from the reviewed articles |
| Data collection | – Defining search tools, search terms, timing, and limitations of the search<br>– Using the ProQuest Summon search tool (provided by the university library)<br>– Search limited to scholarly journals<br>– Search conducted between March and June 2014<br>– After excluding duplicates, the final search results included 603 articles |
| Data evaluation | – Excluding articles outside the focus of the study based on reading abstracts, 205 articles remained<br>– Specifically for Paper III, articles with a low focus on load factor were excluded, leaving 67 articles<br>– Adding 9 articles after searches in a specific journal that had been identified as being missing resulted in 76 articles for Paper III and 214 articles in total |
| Analysis and interpretation | Collecting data from the articles in the coding sheet (an Excel file); classifications in the coding sheet are described in Paper III |

### 3.4.2 Case selection

Table 12 provides an overview of case selection in the case studies; Study IV (the literature review) is excluded.

**Case definition**

The cases consisted of companies in studies I and VI, while in the remaining studies the cases were more narrowly defined into specific processes or goods flows. These narrower definitions allowed for exact descriptions rather than broad descriptions: for example encompassing different practices in different processes. In order to avoid such broad descriptions in Study VI (which featured companies as the cases), the questions were focussed on specific actions for achieving high load factors. One might argue that this focus on specific actions means that these cases should be referred to as 'sub-cases'; but because not all of the data collected focussed on the specific action – the process descriptions were for the companies, for example – the cases are thus described as 'companies'. One might also argue that the processes studied constituted the cases; but not all data was particular to individual processes – the use of the coordination mechanism 'standardisation of norms', for example – the cases are thus described as 'companies'.

**Sampling of cases**

In order to select cases based on specific criteria, an information-oriented selection (Flyvbjerg, 2006), or purposive sampling Flick (2009), cases must fulfil the demands of the study. Dubois and Araujo (2007) state that the relevance of a case may not be known before the study but that it becomes apparent during the research. Flyvbjerg (2006) argues that cases can begin as one type and end up as another. In Study I, cases that differed from one another in terms of contextual dimensions were sought. In practice, finding and choosing relevant contextual factors took place at the same time that interviews were being arranged.

The sampling conducted in studies I and II was inspired by the goal of achieving maximal variation (i.e. to find cases that varied), which is a sampling strategy

mentioned by Flick (2009). Studying cases that varied fit with research questions 1 and 2, which were concerned with identifying influences. In order to study how contextual factors influence shippers' purchasing processes in Study I, the underlying proposition was that purchasing processes would differ due to contextual factors; thus, it was important to study cases where differences between contextual factors were apparent. Study II examined how shippers' purchasing processes influenced various logistical variables, with the underlying proposition that logistical variables are influenced by decisions and actions in the purchasing process; in this study, it was important to examine cases in which different decisions, actions, and influences appeared. In Study I, several contextual dimensions varied between the cases (as opposed to varying in only one parameter). Although varying several parameters produced findings on more contextual variables, this also made the analysis more complicated.

Little was known ahead of time about the ordering of freight transport, so cases were sought in Study III that could illuminate descriptions of the ordering process for manufacturing companies that order outbound transport. Variation in the degree of freedom for the freight-transport-ordering function was identified as potentially being of interest in order to include situations that showed different dependencies between the freight-transport-ordering function and other activities.

Cases were selected for high intensity in studies V and VI. In Study V, the cases were considered to have high intensity because of their changes to load factor, the existence of imbalances between required and available capacity, and the high focus on load factor in the companies (for example, resources were allocated to improve load factor). The cases in Study VI were selected for their high intensity in terms of actions that were performed to achieve high load factors and the interactions between functions that took place to do so. According to Patton (2002) 'intensity sampling' involves the selection of information-rich cases that exhibit the phenomenon of interest intensely.

The development of the sampling strategy during the course of the studies was such that the early studies – which were broader and needed to describe how purchasing processes were performed – required cases that would provide differences; variation was thus suitable for these earlier studies. In contrast, the later studies (which focussed on change) required cases where this change would be featured to a high degree.

The criteria for case selection are described in Table 12 in two steps: qualifiers and selection criteria. 'Qualifiers' are defined as the basic criteria that must be met to be considered for inclusion. These qualifiers concerned the scope of the thesis and of the studies: for example, that companies should purchase freight transport (studies I and II) and that road transport was used (Study V). These qualifiers ensured that the topics that were studied were relevant within the cases: for example, freight transport was purchased regularly (Study I) and knowledge of the purchasing process was relatively recent (Study II). The selection criteria depended on the sampling strategy (variation, or intensity); thus, the criteria should be varied (studies I and II), and the criteria should be intense (studies V and VI).

*Table 12: Overview of case selection*

| Studies | Case | Sampling | Selection criteria |
|---|---|---|---|
| **I** | Companies | Variation | Qualifier: Purchasing freight transport regularly<br>Variation: Contextual dimensions |
| **II** | Specific freight-transport-purchasing processes | Variation | Qualifier: Process carried out within two years; small- or medium-sized company purchasing freight transport regularly<br>Variation: Type of shipment, geographical spread, transport modes, direction of transport |
| **III** | Freight-transport-ordering processes | Variation | Qualifier: More than one transport provider contracted, manufacturing companies, outbound transport<br>Variation: Degree of freedom for the freight-transport-ordering function |
| **V** | Specific goods flows | Intensity | Qualifier: Outbound freight transport, road transport<br>Intensity: Changes to load factor recently undertaken (or to be implemented in the near future), imbalances between required and available capacities, high focus on load factor, consolidation important, different item characteristics |
| **VI** | Companies | Intensity | Qualifier: Outbound freight transport, purchasing freight transport<br>Intensity: Performing actions to achieve high load factor, interaction between logistics and other functions |

### 3.4.3 Data collection

Table 13 provides an overview of the data collection in the case studies; as such, the literature review in Study IV is excluded here also.

**Data-collection methods and sources**

All of the studies used semi-structured interviews. The interview guides, which were developed to examine the research questions, were quite detailed for all studies except for Study VI. These guides ensured that all of the intended aspects were covered (rather than strictly being followed in terms of the order of questions). The questions were quite open in nature and were intended to prompt the respondents, who then spoke freely. An example of such an open question would be one in which a respondent was asked how he or she booked freight transport (Study III). The interviewers then followed up with questions, steering the direction of the conversation as well as ensuring that the respondents did not veer off-topic. This interview approach resulted in detailed descriptions from the respondents and allowed for the interviewers to pursue intriguing threads in each case. Rather than being structured during the interviews, the data was structured after the interviews. In Study V, the use of broader questions allowed the interviewers to capture aspects that otherwise may have been missed and that contributed to developing the model. Interview guides are provided in appendices III–VIII.

Several rounds of interviews were performed in three of the studies: two rounds were performed in studies I and VI, while multiple rounds were performed in Study V. The conducting of several rounds of interviews was useful for (1) following up on data that had been gathered in earlier interviews, (2) verifying that the data from the previous interviews had been understood correctly, and (3) asking any additional questions about topics that had arisen during the analyses. In studies II and III, the analyses did not prompt any new questions that would necessitate a second round of interviews.

Over time the interviewer's knowledge of the study topics increased, and it became possible to probe more deeply and more quickly during the interviews. In Study I it was necessary to gain an understanding of the study topic, while in studies V and VI the interviews were able to go into much greater detail; in these studies the interviewers were able to ask questions that they would not have been able to ask had they lacked a thorough understanding of the study topic. In Study V this understanding was developed over the course of several interviews, digging deeply into details, while in Study VI much of the understanding that had been gained from earlier studies resulted in the researcher asking detailed follow-up questions during the interviews.

Direct observation was used in two of the studies in order to better understand how activities were performed (Study V); and to complement the descriptions in the interviews in those situations where respondents found it difficult to describe their work (Study III). The observations provided increased and detailed understanding and prompted questions that would not have surfaced otherwise.

Study V differed from the others in that (1) several sources of data were used (e.g. study visits, company databases, and documents) in addition to interviews, (2) subjects with many different roles were interviewed, and (3) multiple rounds of interviews were performed. The depth of the study was important for the development of the models – the load-factor model, the framework of opportunities, and approaches for identifying opportunities to increase load factor – as these models required a deep understanding of the topic. Interviewing several respondents at several points in time offered different points of view to confirm the interviewers' understanding of the topics and to follow up on questions from earlier interviews.

Secondary data was used in one of the studies (Study I) to provide additional material. In Study I, a case study was used as a seventh case; the data collection had been performed by another researcher and was verified by interviewing the researcher who had collected the data and asking her to confirm the data. Also, in Study III, data gathered for a bachelor's thesis that was supervised by the author of this thesis complemented the data collected in the interviews and was used as three cases. The data had been collected by students; and when the author of this thesis decided to use the data in Study III, the data was restructured and sent to the original respondents for verification. The data was also discussed with the respondents.

**Sampling of respondents**

Respondents who were knowledgeable about the topics covered in the interviews were selected (see Table 14 and Table 15). In some of the studies, the organisations were small and only a few people worked with the issues studied in this thesis. In the coordination study (Study VI), additional people in both logistics and non-logistics staff could have been interviewed (such as those in operational roles or order-processing staff). Adding more people would have provided data triangulation on the ways in which the coordination was performed. Although the researchers considered interviewing additional people during the design of the study, they instead decided to focus on the perspective of the logistics function. As a result, the findings in Study VI are from a logistics manager's perspective.

*Table 13: Overview of data collection in the case studies*

| Study | Method of collection | Other sources of data | Data collected | Interview guide |
|---|---|---|---|---|
| **I** | Semi-structured interviews: Two rounds<br>Face-to-face, 2 hours, phone, 30–40 minutes | Report by other researcher, which was followed up by interviewing the other researcher | Business context in general<br>Specific contextual factors of conceptual model<br>General description of purchasing process | Detailed (many specific questions) |
| **II** | Semi-structured interviews:<br>With shipper: Face-to-face, 1–2 hours<br>With transport provider: Face-to-face, 30–40 minutes plus one corporate-responsibility manager by phone, 30 minutes | Documents: Evaluation matrices, request for quotations, contracts | Activities of specific purchasing process, influence of purchasing process on transport operations, environmental-performance and logistical variables | Detailed (many specific questions) |
| **III** | Semi-structured interviews<br>face-to-face, 2 hours<br>Observations of work performed | Data (process descriptions) collected (interviews) by students for bachelor's thesis<br>Follow-up phone interview with respondents | Activities in the freight-transport-ordering process<br>Influence of other internal processes<br>Restructuring data collected by students | Detailed (many specific questions) |
| **V** | Semi-structured interviews: Multiple rounds<br>Observations of packing on pallets and loading on vehicles | Initial study visits<br>Internal company databases: Data on goods transported, capacity used<br>Documents: Transport plans, loading plans, drawings<br>Data collected in third case by co-author thoroughly discussed between co-authors | Each subsequent interview delved deeper: Overview of company; changes undertaken to achieve high load factor; specific transport flow and changes made to achieve high load factor (how load factor was influenced, implementation details, specific changes made, order of changes made, reasons for changes, enablers and barriers of changes, staff involved); process descriptions of planning transport; packing, loading, and delivery<br>Data to be able to calculate load factor | Detailed (many specific questions) |
| **VI** | Semi-structured interviews: Two rounds<br>Face-to-face, 2 hours, phone, 35–55 minutes | Documents: Work descriptions, instructions | Actions taken to achieve high load factor, interaction between activities (logistics and non-logistics), process descriptions of order fulfilment and supply of material | General (few topics) |

*Table 13 (cont.)*

| Study | Respondents | Records of data | Respondent validation | Collected by |
|---|---|---|---|---|
| **I** | Employees responsible for purchasing freight transport (purchasing and logistics managers) | Audio recorded<br>Transcribed verbatim | Texts from interview protocols sent to respondents for validation | Sara Rogerson (6 cases)<br>Christina Wolf (1 case) |
| **II** | Shipper: Purchasing or logistics managers (directly involved in selecting transport providers)<br>Transport provider: Account manager (salesperson) and, in one case, corporate-responsibility manager | Audio recorded<br>Interview protocols: detailed notes | Texts from interviews sent to respondents for validation | Sara Rogerson |
| **III** | Transport-ordering staff | Audio recorded<br>Interview protocols: detailed notes | Texts from interviews and figures derived from interview material sent to respondents for verification<br>Data collected by students was restructured and sent to respondents for verification | Sara Rogerson (2 cases plus follow-up interviews in the remaining cases)<br>Bachelor's students (3 cases, supervised by Sara Rogerson) |
| **V** | Logistics or transport managers, transport-planning manager, transport-order manager, transport-operating manager, supplier manager, project manager, packaging manager | Audio recorded (some interviews)<br>Interview protocols: detailed notes after each interview | Numbers verified with respondents<br>Frameworks and descriptions presented to respondents<br>Questions and validation of points from earlier interviews at subsequent interviews | Sara Rogerson jointly with Vendela Santén (2 cases)<br>Vendela Santén (1 case) |
| **VI** | Logistics or transport managers | Audio recorded<br>Transcribed | Text, tables, and figures prepared for the paper sent to respondents and discussed with them in the second interview<br>Quotes confirmed by respondents | Sara Rogerson (2 cases first round plus all cases second round)<br>Sara Rogerson jointly with Uni Sallnäs (1 case first round) |

*Table 14: Respondents at the case companies in Studies I, II, III, and VI*

| Study | Case | Respondents | Interviewer(s) |
|---|---|---|---|
| I | 1. Lab | Purchasing manager, logistics manager | Sara Rogerson |
| | 2. Mail order, IT | Logistics manager, managing director | Sara Rogerson |
| | 3. Manufacturer, industrial equipment | Purchasing and production director, production manager | Sara Rogerson |
| | 4. Manufacturer, retail commodity | Logistics manager | Sara Rogerson |
| | 5. Manufacturer, machinery | Purchasing manager | Sara Rogerson |
| | 6. Manufacturer, food | Purchasing manager, transport-order staff | Sara Rogerson |
| | 7. Manufacturer, personal care | Regional logistics business representative, environmental specialist | Christina Wolf |
| II | A | *Shipper respondent*: Logistics manager<br>*Transport-provider respondent:*<br>Sales rep. (account manager) | Sara Rogerson |
| | B | *Shipper respondent:* Purchasing manager<br>*Transport-provider respondents:*<br>Key account manager, corporate-responsibility manager | Sara Rogerson |
| | C | *Shipper respondent:* Purchasing manager<br>*Transport-provider respondent:*<br>Sales rep. (account manager) | Sara Rogerson |
| III | A. Manufacturer, machinery | Transport-order staff | Sara Rogerson |
| | B. Manufacturer, power and automation | Supply manager, transport-order staff | Sara Rogerson |
| | C. Manufacturer, paper | Logistics manager | Students |
| | D. Manufacturer, paper | Transport-order staff | Students |
| | E. Manufacturer, paper | Transport-order staff | Students |
| VI | Manufacturer, paper | Logistics manager | Sara Rogerson |
| | Manufacturer, sanitary goods | Transport manager | Sara Rogerson |
| | Retailer, food | Logistics manager | Sara Rogerson + Uni Sallnäs |

*Table 15: Interaction in Study V*

| | Date | Type of interaction | Duration (approx.) | Respondents/participants from the case company | Researchers |
|---|---|---|---|---|---|
| **Case Distribution Round** | 30 January 2014 | Workshop | 5 hours | Logistics manager | Sara Rogerson, Vendela Santén, Mats Johansson, Dan Andersson, Magnus Blinge |
| | 13 August 2014 | Interview, site visit | 2 hours | Logistics manager | Sara Rogerson, Vendela Santén, Kristina Liljestrand |
| | 12 September 2014 | Interview | 2 hours | Transport-planning manager | Sara Rogerson, Vendela Santén |
| | 16 October 2014 | Interview | 3 hours | Transport-planning manager | Sara Rogerson, Vendela Santén |
| | 2 December 2014 | Phone interview | 1.5 hours | Transport-planning manager | Sara Rogerson, Vendela Santén |
| | 13 January 2015 | Interview | 2 hours | Transport-planning manager, Transport-order manager | Sara Rogerson, Vendela Santén |
| | 22 January 2015 | Workshop | 5 hours | Logistics manager, transport-planning manager | Sara Rogerson, Vendela Santén, Kristina Liljestrand, Mats Johansson, Dan Andersson, Magnus Blinge |
| | 12 February 2015 | Observation & site visit | 3 hours | Transport-operating manager | Sara Rogerson, Vendela Santén |
| | | Phone interview | 1 hour | Transport-planning manager | Sara Rogerson, Vendela Santén |
| | 21 August 2015 | Workshop | 5 hours | Logistics manager | Sara Rogerson, Vendela Santén, Kristina Liljestrand, Mats Johansson, Dan Andersson, Magnus Blinge |
| **Case Project Delivery** | 30 January 2014 | Workshop | 5 hours | Transportation and logistics manager for northern Europe | Sara Rogerson, Vendela Santén, Mats Johansson, Dan Andersson, Magnus Blinge |
| | 26 August 2014 | Interview, site visit | 5 hours | Transportation and logistics manager for northern Europe, global packaging category manager, supply manager, project manager | Sara Rogerson, Vendela Santén, Kristina Liljestrand |
| | 29 September 2014 | Phone meeting | 20 min | Project manager, supply manager | Sara Rogerson, Vendela Santén, Kristina Liljestrand |
| | 17 November 2014 | Phone meeting | 20 min | Project manager, supply manager | Sara Rogerson, Vendela Santén, Kristina Liljestrand |
| | 22 January 2015 | Workshop | 5 hours | Supply manager, project manager, supply manager transport logistics | Sara Rogerson, Vendela Santén, Kristina Liljestrand, Mats Johansson, Dan Andersson, Magnus Blinge |
| | 2 March 2015 | Interviews | 5 hours | Project manager, transportation and logistics manager for northern Europe | Sara Rogerson, Vendela Santén |
| | 3 March 2015 | Interviews, site visit | 4 hours | Supply manager, transportation and logistics manager for northern Europe | Sara Rogerson, Vendela Santén |
| | 24 June 2015 | Phone interview | 45 min | Project manager | Sara Rogerson, Vendela Santén |
| | 21 August 2015 | Follow-up interview | 30 min | Project manager, supply manager | Sara Rogerson, Vendela Santén |
| | 21 August 2015 | Workshop | 5 hours | Supply manager, project manager, transportation and logistics manager for northern Europe | Sara Rogerson, Vendela Santén, Kristina Liljestrand, Mats Johansson, Dan Andersson, Magnus Blinge |

## 3.5 Analysis

The different steps of analysis in the studies are shown in Table 16. The table is inspired by the 'serpentine' model described by Creswell (2007):, an iterative process that develops one step at a time, with two additions of early analyses. The table can be read as follows. A first round of analysis takes place during the preparation: for example, the framework to be used, what to include in the interview, and choosing the focus. A second round of analysis then takes place during the data collection depending on how flexible the data collection is, for example how flexible the interview guide is. At this stage, certain threads are followed up on while others are given less attention, and the interviewee may or may not be allowed to reflect on certain answers. Third, the analysis continues with management of the data (for example, how the data is structured). Fourth, the analysis involves reading and reflecting on the collected data. Fifth, the data is described, classified, and interpreted. In this thesis, the data is described both within-case and cross-case, based on the idea that two important analysis steps are within-case and cross-case (Eisenhardt, 1989), in an attempt to recognise patterns. Finally, the data is visualised and represented in tables, matrices, and frameworks.

Table 16 provides an overview of the analyses of the studies in this thesis, while more details are provided for each step of the analyses in Table 17 and Table 18.

*Table 16: Steps in the analyses, inspired by Creswell (2007)*

| **Steps of analysis** | **Study I** | **Study II** | **Study III** | **Study IV** | **Study V** | **Study VI** |
|---|---|---|---|---|---|---|
| *Preparation* | | | | | | |
| Literature review | X | X | X | | X | X |
| Interview guide | X | X | X | | | |
| Conceptual framework | | X | X | | | X |
| Coding sheet | | | | X | | |
| *Data collection* | | | | | | |
| Interviews | X | X | X | | X | X |
| Observations | | | X | | X | |
| Database search | | | | X | | |
| *Data managing* | | | | | | |
| Structuring content | X | X | X | | | X |
| Eliminating data | | | | X | | |
| *Reading, reflecting* | | | | | | |
| Highlighting comments | X | X | X | | | X |
| Notes | X | X | X | | | X |
| *Describing, classifying, interpreting* | | | | | | |
| Sorting | X | | | X | | X |
| Comparisons | X | X | X | | | |
| Grouping | | X | X | | X | X |
| Classifying in coding sheet | | | | X | | |
| *Representing, visualising* | | | | | | |
| Illustrations | X | | X | | X | X |
| Tables | X | | X | X | X | X |
| Framework | X | X | X | | X | X |

*Table 17: Overview of the early steps in the analysis (inspired by Creswell, 2007)*

| Study | Preparation | Data collection | Data managing | Reading, reflecting |
|---|---|---|---|---|
| **I** | Literature review shaped the conceptual framework and the interview guide | Interviewer followed intriguing threads that appeared during questioning | Data was structured according to specific variables of contextual dimensions and descriptions of the purchasing process | Highlighting words, phrases, or sections that appeared relevant<br>Making notes of intriguing issues |
| **II** | The literature shaped a conceptual framework and two interview guides with slightly different emphases | Questions were modified during the interviews, since respondents viewed the processes as less complicated than the interview guide<br>Towards the end of the interviews, the respondents were shown the conceptual framework and asked for their reflections | Data was structured according to the steps of the purchasing process<br>For the transport provider, interview data was also structured according to logistical variables | Re-examining existing literature<br>Highlighting aspects in the process descriptions that related to logistical variables<br>Highlighting aspects regarding logistical variables related to purchasing activities/decisions |
| **III** | The literature shaped a conceptual framework and an interview guide | Interviews allowed for the respondents to describe their work; questions were based on observing the respondents perform a freight-transport-order process<br>In the second round of interviews, topics that had been brought up in the other cases were discussed with the respondents | Data was structured according to (1) the order of the activities, (2) input from internal processes and functions, and (3) the degree of freedom for the freight-transport-ordering function | Highlighting aspects in process descriptions that could be related to logistical variables |
| **IV** | Coding sheet for collecting information from the reviewed articles prepared<br>Search tool, search terms, timing, and limitations of the search defined | Using the ProQuest Summon search tool | Excluding duplicates, articles outside the focus of the study, articles with a low focus on load factor | Highlighting relevant text in articles |
| **V** | Findings from Study IV shaped an initial framework and the first interview guide | Each interview led to new insights that provided input to the interview guide for the following interview | | |
| **VI** | The literature shaped an analysis model<br>Previous knowledge (from studies III and V) shaped interview guide | Interviewer followed intriguing threads that emerged during questioning | Data was structured according to which activities interacted (e.g. logistics and sales) | Highlighting text relevant to actions to achieve high load factor<br>Summarising ways coordination mechanisms were used |

*Table 18: Overview of later steps in the analysis (inspired by Creswell, 2007)*

| ***Study*** | ***Describing, classifying, interpreting: within-case*** | ***Describing, classifying, interpreting: cross-case*** | ***Representing, visualising*** |
|---|---|---|---|
| *I* | Describing purchasing process and contextual variables in each case<br>Describing how the contextual variables influenced the purchasing process | Sorting findings according to process stages; within this, sorted according to contextual variables<br>Sorting findings on purchasing process according to 8 types of contexts by combining the contextual variables | Tables were drawn with variables on one side and purchasing-process activities on the other side to visualise the influence<br>A framework of 8 contexts was drawn up |
| *II* | 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 that connected purchasing-process steps with logistical variables | Sorting findings according to process stages and according to logistical variables<br>Grouping the causes of the influences | A visual representation of the influence was drawn up on a case-by-case basis<br>A compilation of different influences was created<br>Tables for visualising the influence were prepared |
| *III* | Described the process of ordering freight transport. Data was structured according to the degree of freedom from the freight-transport ordering-function. Information input required for the freight-transport-ordering function was analysed in each case. The information input was linked to the aspects in the freight-transport-ordering process underlying the influence on the logistical variables. Data was grouped by process stage and identified aspects, first in tables and then illustrated in figures | Grouping data into process stages<br>Findings in cases and literature were combined and structured according to tasks and issues | A visualisation of the process was drawn<br>A figure visualised the connections identified from the freight-transport-ordering process to the logistical variables and the aspects underlying these connections<br>A table listing tasks and issues was created |
| *IV* | Collecting data from the articles in the coding sheet (Excel file)<br>Classifications in the coding sheet are described in Paper III | Grouping articles | Tables prepared to present data |
| V | Detailed descriptions of how changes were performed<br>A new framework was developed in which the data was structured.<br>Imbalance between required and available capacity was calculated before and after changes using quantitative data from internal databases, interviews and observations.<br>Changes were sorted according to the framework (load factor model) and interpreted as managing imbalances between required and available capacities.<br>Interpretations were discussed with the respondents. | The load factor model and framework of opportunities were used to structure the data.<br>The identified changes were sorted according to the framework by considering 1) had required or available capacity been changed, 2) how had the capacity been changed (for example consolidation method) and 3) whether capacity increased, decreased or reallocated.<br>The categories were evaluated against the literature. | Data was presented in two frameworks (load factor model and framework of opportunities). |

*For Study VI see next page.*

*Table 18 (cont.)*

| *Study* | *Describing, classifying, interpreting: within-case* | *Describing, classifying, interpreting: cross-case* | *Representing, visualising* |
|---|---|---|---|
| *VI* | Mapping use of coordination mechanisms and interdependencies in each case | Sorting different ways the coordination mechanisms were used<br><br>Categorising the use of coordination mechanisms in a matrix according to sequential or reciprocal interdependence, intra- or interfunctional coordination, and dyadic or multiple activities<br><br>Comparing empirical findings with the literature to find explanations for different approaches to coordination | A table was prepared to display which coordination mechanisms were used in the interface between activities and actions to achieve high load factor<br><br>Another table was prepared to display (per action to achieve high load factor) the type of interdependence and the activities involved<br><br>A matrix presents the data |

## 3.6 Research quality

The discipline of logistics has a history of positivistic ideals but has moved towards more qualitative methods (Halldorsson and Aastrup, 2003). Since the research in this thesis uses qualitative methods, it is important to consider quality criteria that are suitable to that type of research. The following section relates this research to four aspects of trustworthiness: credibility, transferability, dependability, and confirmability.

### 3.6.1 Credibility

Credibility is related to the truth value of the research (Halldorsson and Aastrup, 2003). Credibility means a correspondence between what the researcher describes and how the respondents present their reality. Respondent validation is important; respondents should be able to correct the reality as constructed by the researcher (Halldorsson and Aastrup, 2003).

Two types of respondent validation were used in this thesis: (1) case representatives commented on case protocols, and (2) respondents were asked for clarification in later interviews. The respondents were asked to read and comment on case protocols (for example, summaries of specific topics) in order to verify the interviewers' understanding of their answers. Clarification was sought in later interviews, at which point questions or statements were discussed (studies I, V, and VI).

Nearly all of the interviews were audio recorded; in this way, the interviewer could be more engaged in the interview and did not need to take notes of everything that was said. Detailed notes were taken during the few interviews that were not audio recorded. In those instances where two interviewers conducted the interviews, the responsibility for taking notes or asking questions alternated between the interviewers.

The audio recordings were transcribed in Study I (Paper I) and Study VI (Paper VI). Transcribing was useful when revisiting the data to find new aspects and using quotes from the respondents. Transcribing is time consuming, however, and in the other studies, very detailed interview protocols were created instead. First, the interview protocols were created according to what had been said during the interview; the data was then restructured as part of the analysis.

Another technique to increase the credibility of the findings is triangulation (Bryman and Bell, 2007). Croom (2009) describes four types of triangulation: methods, data, investigator, and theory. Data triangulation was used in Study II (Paper II) by interviewing both the companies that purchase freight transport and the transport providers about the purchasing process. The two types of actors provided different perspectives on the purchasing process. Method triangulation was used in studies II, III, V, and VI (papers II, VII, IV, V, and VI) to acquire descriptions through multiple sources of evidence, for example, using observation in addition to semi-structured interviews, as in Study III (Paper VII) and Study V (papers IV and V). The collection of documents in Study II (Paper II), Study V (papers IV and V), and Study VI (Paper VI) increased the researchers' understanding and confirmed the data gathered in the interviews. Investigator triangulation was used in Study V (papers IV and V) and Study VI (Paper VI), in both of which two researchers jointly performed the data collection and analysis.

An important insight from Study I (Paper I) was that the respondents' descriptions covered many different ways of working, which made it difficult to draw solid conclusions. Based on this insight, it became necessary to understand the specific situations where what the respondents talked about would be valid. The respondents were therefore probed several times during the interviews to explain in more detail as well as to explain under which circumstances their descriptions were true and if what they described would be different in other situations. The studies were designed to investigate cases that were specific rather than general (for example, specific processes or specific flows).

### 3.6.2 Transferability

'Transferability' in qualitative research may be matched with 'external validity' in quantitative research (Bryman and Bell, 2007) and questions whether 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 who 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 to provide detailed accounts of the interrelationships and intricacies of the context that have been examined. 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 supports transferability.

The studies examined in this research provide detailed descriptions to allow the reader to compare the studies to other situations and to spot any dissimilarities. In Study I (Paper I), for example, details were provided on the contexts of the cases and the processes involved, in Study II (Paper II) and Study III (Paper VII) the detail was on processes; in Study V (papers IV and V) it was on the imbalances and the changes that were performed; and in Study VI (Paper VI) the detail was on actions, interdependencies, and coordination.

The results of studies II, III, V, and VI (papers II, VII, IV, V, and VI) have been presented to companies followed by discussions with the company representatives about the usefulness of the results. This provided an opportunity to move beyond

the specific context of the cases that were studied and to gather insights from people who work in a wide range of contexts.

The application of the load-factor model (Figure 19) has been discussed with other researchers and deemed relevant for application in companies in a British context.

### 3.6.3 Dependability

'Dependability' in qualitative research may be matched with 'reliability' in quantitative research (Bryman and Bell, 2007). While reliability is concerned with the stability of data, in qualitative research dependability is more concerned with trackable variance (Halldorsson and Aastrup, 2003). It is important to document the logic of decisions (Guba and Lincoln, 1989). For all of the studies conducted for this thesis, records were kept of which contacts were made and when; see Table 15 for an example). Interview guides are provided in the appendix. Case selection is described in this chapter as well as in the papers. The different stages of analysis were described earlier to show the process (in section 3.5).

### 3.6.4 Confirmability

'Confirmability' in qualitative research may be matched with 'objectivity' in quantitative research (Bryman and Bell, 2007). In qualitative research, however, the researcher who selects and uses the research method (or methods) cannot be separated from that method completely; thus there can be no complete objectivity, free of bias and values (Erlandson et al., 1993). It is therefore crucial to be able to track one's data (Guba and Lincoln, 1989) in order to confirm the findings derived from the researcher's interpretations. To be able to track data for this research, recordings of the interviews and case protocols were stored with the documents about the case selection and stages of the analyses. This makes it possible to go back to the empirical data.

In order to confirm that the logical inferences and interpretations in this research made sense with others (Marshall and Rossman, 2006), the inferences and interpretations in the analysis of data were discussed with other people. The author discussed the progress in all of the studies with two supervisors, for example discussing interpretations in the analysis. For the studies where the papers were co-authored, the analyses were discussed between the co-authors. Further, the author presented results to other researchers at seminars, workshops, and conferences, which allowed for feedback on the analyses. Earlier versions of papers I and II were presented as work-in-progress papers at IPSERA conferences. Earlier versions of papers III, IV, and VI, and the current version of Paper VII, were presented at LRN conferences. Work-in-progress versions of papers III and IV were presented at Sustainable Logistics Winter (SLOW) symposia 2014 and 2015. A work-in-progress version of Paper III was also presented at the Swedish transportation research conference 2014. Feedback from the presentations was then taken into consideration for further development of the papers. In addition, the author presented the study results to companies at workshops – both with companies where data had been collected and with other companies – which allowed for feedback on interpretations in the analysis.

# 4 Results

This section presents the results from this thesis, structured according to the research questions that were formulated in Chapter 1.

Because the results originate with the appended papers, this chapter starts with an overview of the links between findings in the papers and the results according to the research questions (Figure 13), as well as an overview of how the findings in each paper help to answer each research question (Table 19), each sub-section then addresses one research question.

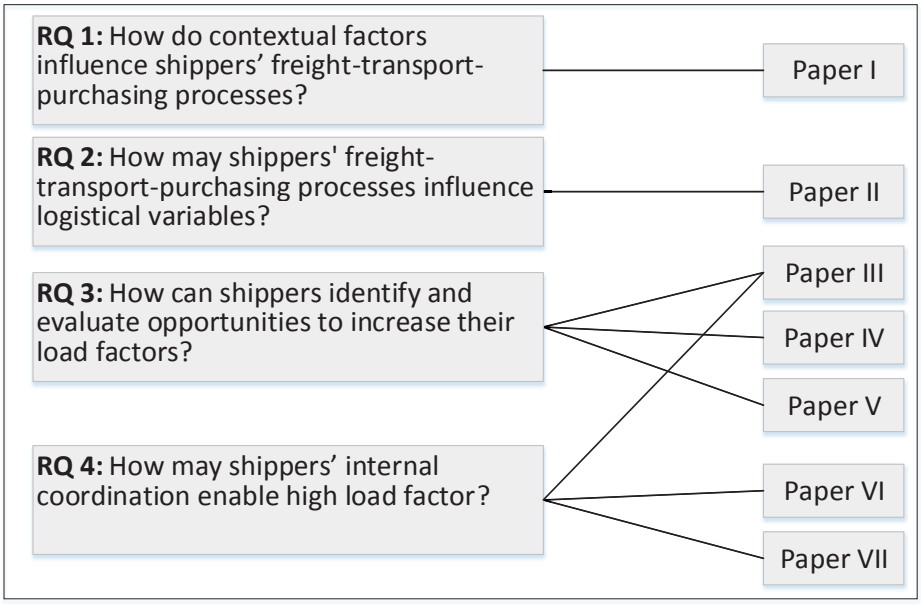


*Figure 13: Links between the four research questions and the seven appended papers*

Paper I provides insights that help to answer RQ1: specifically, with a framework that describes the purchasing process in eight contexts. Paper II, which identifies purchasing activities that influence logistical variables, helps to answer RQ2. Three papers (papers III, IV, and V) help to answer RQ3. Paper IV provides a conceptual model that can be used to describe or measure load factor as a way of helping to evaluate what the load factor is, while Paper V provides a framework that categorises opportunities for shippers to influence load factor; this framework can be used to identify and compare actions to improve load factor. Paper III, by describing the factors that influence load factor, provides input on actions that help to improve load factor. Finally, three papers (papers III, VI, and VII) help to answer RQ4. Paper VI provides the main contribution to answering the research question by providing insights into the need for coordination due to various interdependencies between activities; it also examines how these activities are coordinated in terms of coordination mechanisms. Paper VII describes how the influence of freight-transport ordering on the load factor depends on other internal processes. Paper III, by describing areas in which shippers could work to improve load factor, is a step towards understanding the need for coordination.

Figure 14 shows how the research questions are positioned in relation to one another.

*Table 19: Summary of the main findings in each paper that help to answer the RQs*

| | |
|---|---|
| **RQ1:** How do contextual factors influence shippers' freight-transport-purchasing processes? | **Paper I**:<br>• The configurations of the freight-transport purchasing process differ depending on service type, purchase situation, and relationship. Specifics of the freight-transport-purchasing process are presented in eight contexts.<br>• The influence of contextual variables on the stages of the purchasing process (define specification, select supplier, and contract agreement) is described. |
| **RQ2:** How may shippers' freight-transport-purchasing processes influence logistical variables? | **Paper II**:<br>• Logistical variables are influenced when specifying requirements, selecting transport providers, and agreeing on contracts.<br>• The influence of freight-transport-purchasing processes on logistical variables has many causes, for example specific requirements on time.<br>• Logistical variables are influenced by constraints or opportunities related to transport providers' decisions. |
| **RQ3:** How can shippers identify and evaluate opportunities to increase their load factors? | **Paper IV**:<br>• Load factor is defined as the required capacity versus available capacity on several load-factor levels.<br>• 'Required capacity' is determined by order details, item characteristics, number of items, and the consolidation of items, while 'available capacity' is determined by the type and number of load units.<br>**Paper V**:<br>• Opportunities for shippers to influence load factor can be structured according to increasing, decreasing, or reallocating required or available capacity.<br>• A four-step approach is suggested for shippers to identify suitable actions to increase their load factors.<br>**Paper III**:<br>• According to the literature, the following factors can influence load factor: network design, demand fluctuations, delivery frequency, just-in-time deliveries, delivery windows, customer-service agreements, order lead time, night-time deliveries, load-unit selection, packaging systems, route planning, vehicle selection, backhaul, and consolidation. Actions shippers can take to achieve high load factor are related to these factors. |
| **RQ4:** How may shippers' internal coordination enable high load factor? | **Paper VI**:<br>• Coordination is needed due to sequential and reciprocal interdependencies between activities.<br>• Different coordination mechanisms will be used depending on type of inter-dependence, whether the coordination is interfunctional or intrafunctional, and if the coordination is dyadic or between multiple activities.<br>**Paper VII**:<br>• Information input to the freight-transport-ordering process is necessary from many internal processes.<br>• Various relationships exist between the ordering of freight transport (*plan transport*, *calculate space*, and *select provider*) and load factor.<br>**Paper III**:<br>• According to the literature, shippers can influence load factor in the following areas: logistics structures, order and delivery, packaging and loading, and transport operations. |

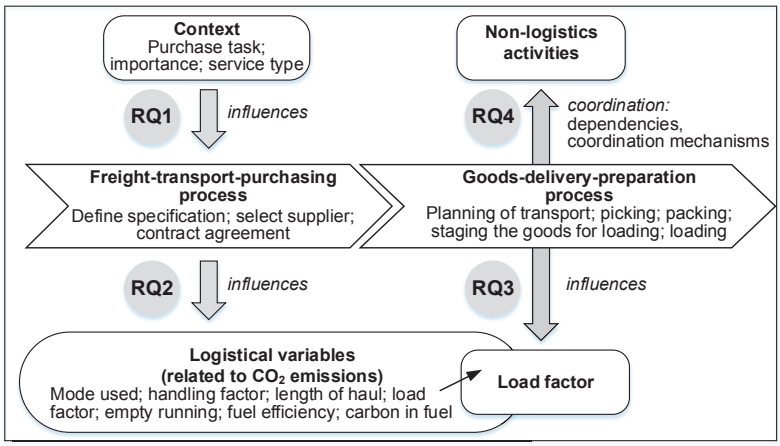


*Figure 14: Research questions answered in this chapter*

## 4.1 Influence of context on shippers' purchasing processes

### 4.1.1 Overview of findings for answering RQ1

The first research question (RQ1) was stated as: *How do contextual factors influence shippers' freight-transport-purchasing processes?* As illustrated in Figure 13, this question is addressed by the findings presented in Paper I. In this sub-section, the research question is answered by showing (1) differences in the stages of the purchasing process due to contextual variables (Figure 15) and (2) differences in the configuration of the purchasing process in eight contexts.

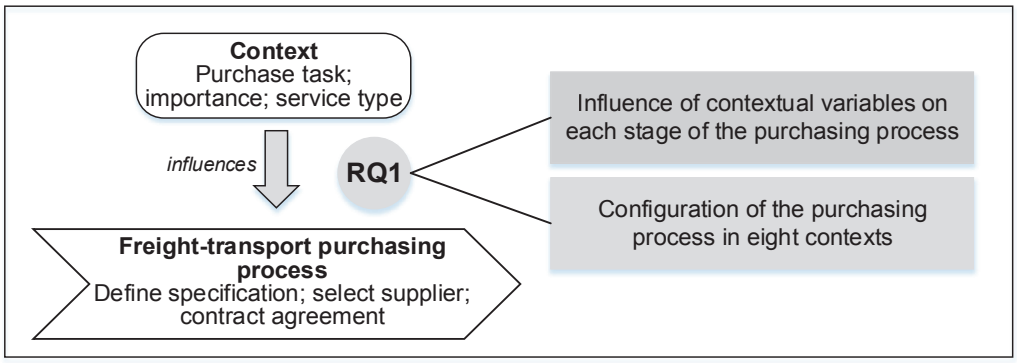


*Figure 15: Findings that answer RQ1*

The influence of the contextual variables on the purchasing process concerns differences in specification, selection, negotiation, and contracting (see Table 20). For 'specification', differences were found regarding time spent specifying and the level of detail in specification. For 'selection', differences were found in the number of transport providers, the use of contact that is personal in nature, the use of 'shortlisting', and the ways in which the evaluation of transport providers and offers was conducted. For 'negotiation' the study found differences in the content of negotiations and the use of ongoing negotiations. For 'contracting' there were differences in the level of detail in contracting and the use of goal setting in contracts. More details on the differences in the purchasing process are described in sub-section 4.1.2.

A framework is presented in Figure 16 (in sub-section 4.1.3) that suggests specifics of the purchasing process in eight contexts that differ in service type, purchase situation, and relationship. Differences in specification, selection, negotiations, and contracting are presented in the contexts: for example showing in what contexts the specification is rough or detailed, or in what context goal setting in contracts is used. More details on the framework with eight contexts are described in sub-section 4.1.3.

### 4.1.2 Influence of contextual variables on each stage of the purchasing process

The three stages of the purchasing process – *define specification*, *select supplier*, and *contract agreement* – are influenced by different contextual variables (Table 20). The table is based on the findings from seven cases. The contextual variables are details of the contextual dimensions ('purchase task', 'importance', and 'service type') described in section 2.2; for more details, see Paper I, which presents the influences on three stages of the purchasing process.

*Table 20: Contextual variables and their influence on different stages of the purchasing process*

| Contextual variables | Influence on stages of the freight-transport-purchasing process | | |
|---|---|---|---|
| | **Define-specification stage** | **Select-supplier stage** | **Contract-agreement stage** |
| **Purchasing situation: *New task*** | More time or detail in specification | | Comprehensive contracting |
| **Number of services: *Many*** | | | Detailed contracting |
| **Level of customisation: *Customised*** | | | |
| **Supplier strategy** | | | Negotiations (e.g. ongoing negotiations); contracting (e.g. level of detail and goal setting) |
| **Supplier relationship approach** | | Personal contact during selection; evaluation of potential providers vs comparing offers; shortlisting of potential transport providers | |
| **Transport cost: *High*** | | Important to compare offers from transport providers | |
| **Location of recipients/senders: *Global*** | | Difficult to compare offers | |
| **Number of locations of recipients / senders: *Many*** | | | |
| **Variation in locations of recipients / senders: *High*** | Difficult to specify service in detail | | Less detailed contracting |
| **Size of shipments** | | | Content of negotiations |
| **Variation in size of shipments: *High*** | Difficult to specify requirements in advance | | |
| **Type of recipients / senders** | | Can limit the number of potential transport providers | |

The first stage of the purchasing process, *define specification*, can be influenced by the contextual variables 'purchasing situation', 'number of services', 'level of customisation', 'variation in locations', and 'variation in shipment size'. The second stage, *select supplier*, can also be influenced by a variety of contextual variables: 'supplier relationship approach', 'transport costs', 'locations of recipients/ senders', 'number of locations', 'variation in locations', and 'type of recipients/ senders'. The third stage, *contract agreement*, can be influenced by the contextual variables 'purchasing situation', 'number of services', 'supplier strategy', 'supplier relationship approach', 'variation in locations of recipients/senders', and 'size of shipments'.

### 4.1.3 Configuration of the purchasing process, depending on service type, purchase situation, and relationship

Figure 16 shows the configuration of the freight-transport-purchasing process in eight different contexts. The framework in Figure 16 was developed based on patterns identified in seven cases. The influence on the purchasing process is described in terms of practices: specification (rough or detailed), the use of bidding, the use of shortlisting, the importance of personal contact, the use of

ongoing negotiations, the use of rough or detailed contracting, the use of goal setting, and the amount of time spent from the *define specification* to *contract agreement* stages. Specification is performed in the *define specification* process stage. Bidding, shortlisting, and using personal contact as criteria take place in the *select supplier* process stage. Ongoing negotiations, contracting, and goal setting take place in the *contract agreement* process stage. Goals may be followed up in the *evaluation* process stage.

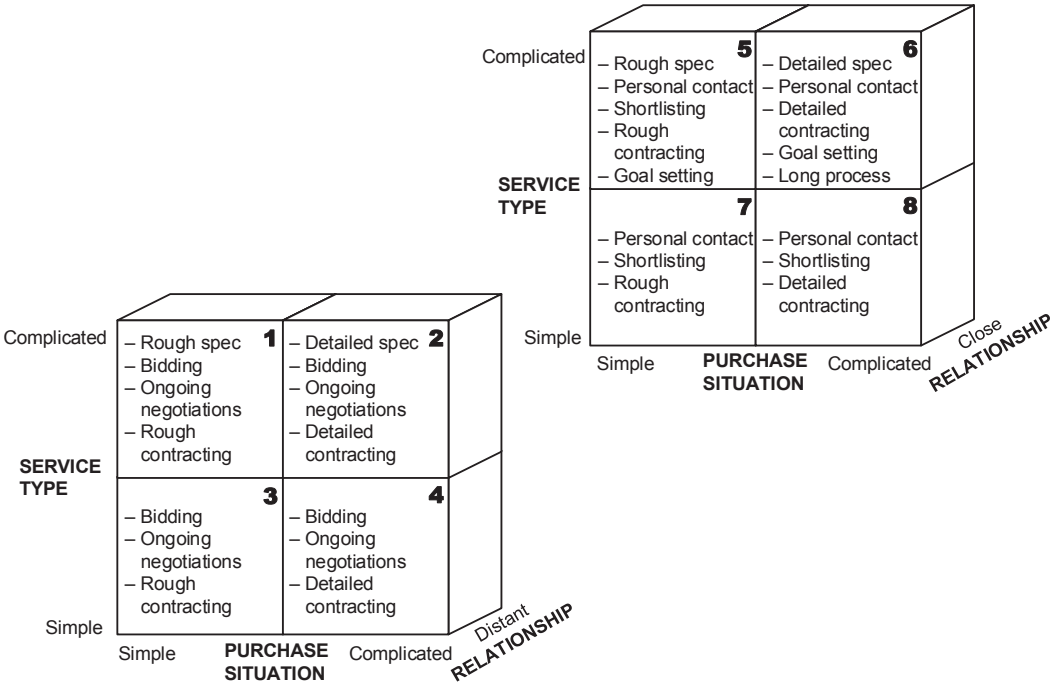


*Figure 16: Eight types of contexts and the specifics of the purchasing process in each context (Rogerson et al., 2014)*

The configuration of the purchasing process is shown in the framework in eight contexts, which are combinations of (1) how complicated the service type is, (2) how complicated the purchase situation is, and (3) the closeness of the intended relationship with the transport provider. For more details on the contextual dimensions, see Table 21.

*Table 21: Contextual dimensions of the purchasing-process framework*

| **Service type:** | **Simple** | **Complicated** |
|---|---|---|
| Locations of recipients/senders: | Local | Global |
| Number of locations of recipients/senders: | Few | Many |
| Variation of locations of recipients/senders: | Low | High |
| Size of shipments: | Full-load | Part-load |
| Variation in size of shipments: | Low | High |
| Type of recipients/senders: | One | Many (industrial, consumer, public) |
| **Purchase situation:** | **Simple** | **Complicated** |
| Purchasing situation: | Rebuy | New task |
| Number of services: | Single (transport) | Multiple |
| **Relationship:** | **Distant** | **Close** |
| Supplier relationship approach: | Arm's-length approach | Partnership approach |
| Supplier strategy: | Competitive bidding | Reducing the number of suppliers |

The specification is likely to be rough in contexts where a complicated service type is combined with a simple purchase situation (contexts 1 and 5 in Figure 16). In a context that also has a close relationship approach (context 5 in Figure 16), the transport provider can be invited to offer solutions or may be trusted to provide a suitable solution to the rough description of the requirements. The specification is likely to be detailed in contexts where a complicated service type is combined with a complicated purchase situation (contexts 2 and 6 in Figure 16). In a context that also has a distant relationship (context 2 in Figure 16), the shipper is likely to attempt to have detailed requirements or control how the transport provider delivers the solution.

All contexts that have a complicated purchase situation (contexts 2, 4, 6, and 8 in Figure 16) include detailed contracting, which can be explained by the greater efforts that are made when first contracting a new transport provider and when there is more that must be agreed on when purchasing multiple services.

Personal contact is important, and a relationship with few transport providers is built in contexts with close relationships (contexts 5–8 in Figure 16). Few providers are likely to be invited to make offers in a context with a close relationship, a complicated service type, and a complicated purchase situation (context 6 in Figure 16), since it is more difficult to compare the offers in such a situation.

In contexts that feature both a complicated service type and a close relationship (contexts 5 and 6 in Figure 16), contracts will likely include goals, which are followed up on in the *evaluation* stage.

## 4.2 Influence of shippers' purchasing process on logistical variables

### 4.2.1 Overview of findings for answering RQ2

The second research question (RQ2) was stated as: *How may shippers' freight-transport-purchasing processes influence logistics variables?* As illustrated in Figure 13, the question is addressed by the findings presented in Paper II. In this sub-section the research question is answered in terms of (1) activities in the purchasing process that influence logistical variables, (2) causes of the influence, and (3) effects on logistical variables (Figure 17).

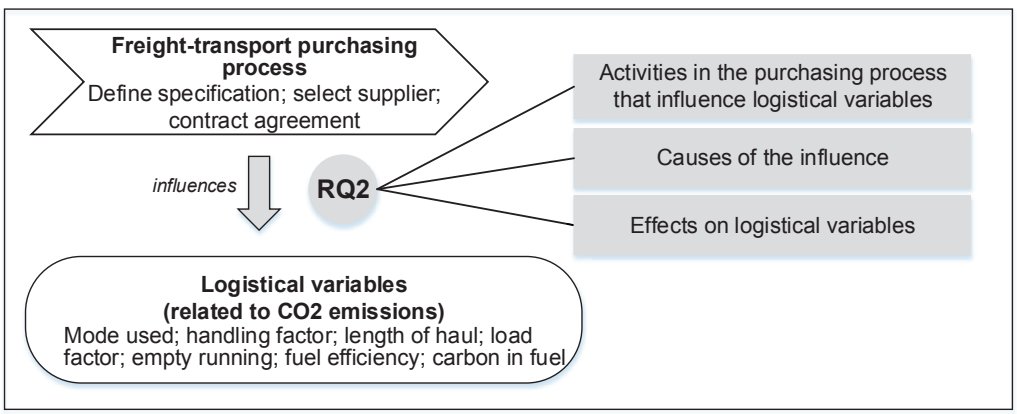


*Figure 17: Findings that answer RQ2*

Several purchasing activities influence logistical variables: specifying requirements; comparing providers; using supplier questionnaires, selection criteria, order qualifiers, and performance metrics; and deciding scope of contract. For more details see section 4.2.2. Several causes of the influence of the purchasing process on logistical variables were found; the main causes were the different requirements that were specified, for example on time. Other causes of the influence included length of agreement, contract type, and the transport provider's network structure. For more details see section 4.2.3. Several effects on logistical variables were found: restrictions on routing, opportunities for consolidation, and return loads; influence on delivery frequency, and influence on dimensioning of vehicle size, as well as improving opportunities to use several modes of transport, use fuel with less carbon content, and encouraging fuel-efficient driving. For more details see section 4.2.4.

### 4.2.2 Activities in the purchasing process that influence logistical variables

Table 22 displays the influence of activities in the different stages of the purchasing process (*define specification*, *select supplier*, and *contract agreement*) on specific logistical variables.

*Table 22: Influence of stages of the purchasing process on logistical variables (Lit. = the literature)*

| | | PURCHASING PROCESS | | |
|---|---|---|---|---|
| | | ***DEFINE SPECIFICATION STAGE*** | ***SELECT SUPPLIER STAGE*** | ***CONTRACT AGREEMENT STAGE*** |
| **LOGISTICAL VARIABLES** | ***MODE USED*** | Specifying requirements on:<br>• Time (Lit.)<br>• Method of transport (Case) | | |
| | ***HANDLING FACTOR*** | | Using comparison of providers:<br>• Network structure (Lit.) | |
| | ***LENGTH OF HAUL*** | Specifying requirements on:<br>• Time (Case, Lit.)<br>• Method of transport (Case)<br>• Route (Lit.) | Using comparison of providers:<br>• Network structure (Lit.)<br>Using order qualifier:<br>• Method of transport (Case)<br>• Time (Case) | |
| | ***LOAD FACTOR*** | Specifying requirements on:<br>• Time (Case, Lit.)<br>• Shipment size (Case, Lit.)<br>• Customisation (Lit.) | Using comparison of providers:<br>• Network structure (Lit.)<br>Using order qualifier:<br>• Shipment size (Case) | Deciding:<br>• Scope of contract (Lit.) |
| | ***EMPTY RUNNING*** | Specifying requirements on:<br>• Time (Case, Lit.)<br>• Method of transport (Case)<br>• Customisation (Lit.) | Using order qualifier:<br>• Method of transport (Case) | |
| | ***FUEL EFFICIENCY*** | Specifying requirements on:<br>• Time (Lit.)<br>• Driving behaviour (Case, Lit.)<br>• Vehicle (Lit.) | Using supplier questionnaire and selection criteria covering:<br>• Driving behaviour (Case, Lit.) | Using performance metrics regarding:<br>• Vehicle (Lit.) |
| | ***CARBON IN FUEL*** | Specifying requirements on:<br>• Fuel (Lit.) | Using supplier questionnaire and selection criteria covering:<br>• Fuel (Case, Lit.) | Using performance metrics regarding:<br>• Fuel (Lit.) |

At a more detailed level than the process stages, seven activities were found to influence the logistical variables: specifying requirements, deciding based on comparisons between providers, using supplier questionnaires, using selection

criteria, using order qualifiers, using performance metrics, and deciding the scope of contracts. More details on the influence of these activities may be found in Table 23.

*Table 23: Activities in the purchasing process that influence logistical variables, causes of the influence, and influence on transport providers' decisions*

| STAGE / **Purchasing-process activities** | **Causes of influence** | **Influence on transport providers' decisions** | **Logistical variables** |
|---|---|---|---|
| DEFINE SPECIFICATION | | | |
| **Specifying requirements** | Time, Method of transport, Driving behaviour, Fuel, Route, Vehicles, Shipment size, Customisation | Restrict routing, Determine delivery frequency, Over-dimension vehicle size, Reduce opportunities to consolidate, Reduce opportunities to find load for return journey, Provide opportunity / restrict use of several modes of transport, Encourage fuel-efficient driving, Improve use of fuel with less carbon content | Mode used, Length of haul, Load factor, Empty running, Fuel efficiency, Carbon in fuel |
| SELECT SUPPLIER | | | |
| **Comparing providers** | Network structure of providers | Influences if provider is selected or not | Handling factor, Load factor |
| **Using supplier questionnaire** | Driving behaviour, Fuel | Encourage fuel-efficient driving, Improve use of fuel with less carbon content | Fuel efficiency, Carbon in fuel |
| **Using selection criteria** | Driving behaviour, Fuel | Encourage fuel-efficient driving, Improve use of fuel with less carbon content | Fuel efficiency, Carbon in fuel |
| **Using order qualifier** | Time, Method of transport, Shipment size | Restrict routing, Over-dimension vehicle size | Length of haul, Load factor, Empty running |
| CONTRACT AGREEMENT | | | |
| **Deciding scope of contract** | Length of agreement, Contract type | Less transported than paid for (could be sold to other shipper), Take (or not take) responsibility for optimising load factor | Load factor |
| **Using performance metrics** | Vehicle, Fuel | Encourage use of more fuel-efficient vehicles. Improve use of fuel with less carbon content | Fuel efficiency, Carbon in fuel |

### 4.2.3 Causes of the influence on logistical variables

From a purchasing-process perspective, three types of causes of influence on the logistical variables were found: specific requirements, the transport providers' network structures, and the scope of contracts. A specific requirement, once it was defined, could be specified by the purchaser towards the transport provider, for example in requests for information and offers. The specific requirement can be used in supplier questionnaires or as order qualifiers or translated into selection criteria when selecting a transport provider. The requirements can also be translated into performance metrics or indicators that are agreed upon in the contract. The specific requirements cause most of the influence on the logistical variables, both in the cases that were examined and in the literature. Requirements that may influence logistical variables can be categorised into time, method of transport, driving behaviour, fuel, route, vehicles, shipment size, and customisation. (See Table 24 for a list of individual requirements in each category.) 'Network structure' can be further detailed into node location and client concentration. The contract scope can be further detailed into agreement length and contract type.

*Table 24: Requirements that can influence the logistical variables*

| Categories of requirements | Specific requirements |
|---|---|
| **Time** | Time windows, late collection, delivery precision, transit time, frequency of delivery, specific time for delivery, flexibility in departure, nominated delivery day, delivery before certain time, time restrictions linked to congestion |
| **Method of transport** | Multiple drop, mode of transport |
| **Driving behaviour** | Eco-driving |
| **Fuel** | Alternative fuel usage (fuels that result in preferable environmental performance compared to conventional diesel) |
| **Route** | Route specified |
| **Vehicles** | Vehicle, engine, tyres |
| **Shipment size** | Scheduled collection, size, variation in volume |
| **Customisation** | Specialised vehicles or equipment, dedicated shipments, co-loading restrictions |

### 4.2.4 Effects on logistical variables

All of the logistical variables can be influenced by the purchasing process (see Table 22). From the transport provider's perspective, the shippers' purchasing processes influence the providers' decisions: restricting routing, determining delivery frequency, influencing vehicle size, reducing opportunities to consolidate, reducing opportunities for finding loads for the return journey, encouraging fuel-efficient driving behaviour, and increasing the use of fuel with less carbon content. Table 25 provides details on the decisions in the transport providers' planning and execution of freight transport in the cases that were examined in Paper II that are influenced by shippers' freight-transport-purchasing processes.

*Table 25: Influence on transport providers' decisions and changes made to their plans and execution*

| Influence of shippers' purchasing processes on transport providers' decisions | Detailed effects on transport providers' decisions | Logistical variables influenced |
|---|---|---|
| Influences and restrictions on routing | Adapt route and order of locations to collect, Adapt route and order of locations for delivery, Use multiple-drop transport | Length of haul, Empty running |
| Determine delivery frequency | Deliver daily, with multiple drop rounds | Load factor |
| Influence on vehicle size | Use vehicles with 'extra' available capacity | Load factor |
| Reduce opportunities to consolidate | Consolidate based on time for deliveries and order of deliveries | Load factor |
| Reduce opportunities for finding loads for the return journey | Load for return journey restricted to late pick-up | Empty running |
| Improve opportunities to use several modes of transport | Train transport selected for long-distance transport | Mode used |
| Encouraging fuel-efficient driving behaviour | Educate drivers in eco-driving | Fuel efficiency |
| Improve use of fuel with less carbon content | Use a larger share of alternative fuels | Carbon in fuel |

## 4.3 Evaluating shippers' opportunities to increase load factor

### 4.3.1 Overview of findings for answering RQ3

The third research question (RQ3) was stated as: *How can shippers identify and evaluate opportunities to increase their load factors?* As illustrated in Figure 13,

this question is addressed by the findings presented in papers III, IV, and V. In this sub-section, the research question is answered by presenting three frameworks that evaluate load factor in different ways: (1) evaluating load factor in terms of imbalances between required and available capacity on several load-factor levels, (2) identifying opportunities to increase the load factor, and (3) by providing an approach to guiding the selection of a suitable action (or actions) to increase load factor (Figure 18). By using all three frameworks, shippers can evaluate which opportunities for increasing their load factor are suitable in their particular situation.

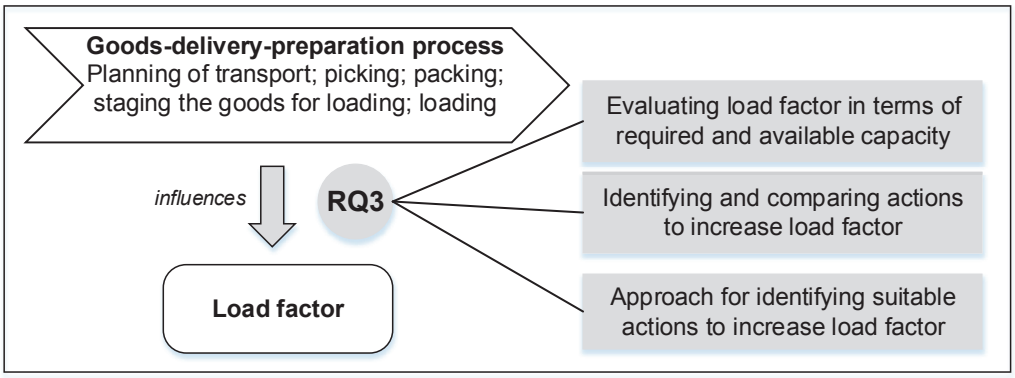


*Figure 18: Findings that answer RQ3*

To evaluate existing load factor, a load-factor model (Figure 19) is presented, where load factor is described as the imbalance between required and available capacities on several load-factor levels, namely packaging, shipping, vehicle, and fleet levels. Shippers can measure their load factor on each load-factor level as well as overall. The load-factor model is described in more detail in sub-section 4.3.2.

This thesis presents two frameworks to support shippers in identifying actions that can increase load factor in ways that are suitable to their particular situations: the framework of opportunities to achieve a high load factor and an approach for shippers to identify suitable opportunities to increase their load factors.

A framework of opportunities for achieving high load factor (Figure 20) provides an overview of several means to achieve high load factor. The opportunities are structured according to changes to required and available capacities as well as according to the increase, reduction, or reallocation of capacities. In order to change *required capacity*, shippers can change the number of items, item characteristics, and consolidation; to change *available capacity*, they can change number of units and type of units. The framework helps shippers to identify suitable actions depending on what they need to change. For example, the various means of achieving the reallocation of required capacity are listed. The framework also helps shippers compare different actions they can take to achieve high load factor in terms of those actions' effects on required and available capacities. The framework of opportunities is described in more detail in sub-section 4.3.3.

Further, an approach for identifying suitable opportunities to increase load factors is presented, consisting of four steps: calculate existing load factor, identify areas to change, identify aspects to change, and calculate effects. The existing load

factor can be calculated by using the load-factor model (Figure 19); areas that are relevant to change can be identified based on the load-factor calculation. The relevant aspects to be changed can then be identified by using the framework of opportunities to achieve high load factor (Figure 20). Finally, the effects of planned changes can be calculated using the load-factor model (Figure 19). The approach is described in more detail in sub-section 4.3.4.

### 4.3.2 Evaluating load factor: imbalances between required and available capacity

The load-factor model in Figure 19 (presented in Paper IV) can be used to describe any imbalances between required and available capacities that exist in shippers' systems; it may help logistics managers to understand the load-factor levels (for example, packaging or vehicles) in which their required and available capacities are imbalanced.

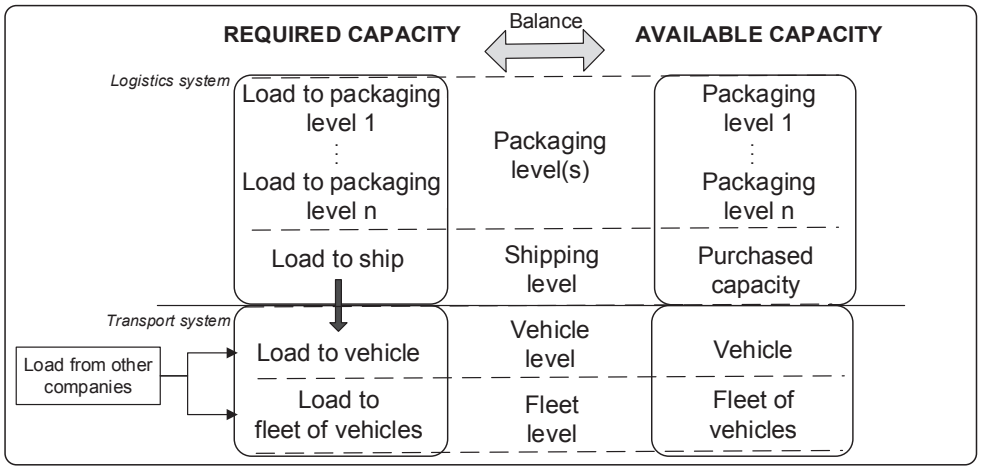


*Figure 19: The load-factor model (from Paper IV)*

The load-factor model (Figure 19) structures the load factor from a shipper's perspective on several load-factor levels: the packaging, shipping, vehicle, and fleet levels. At the packaging level, the required capacity consists of the load to pack, while available capacity consists of the packaging for the load. Several packaging levels are possible; for example, products loaded in a box and boxes loaded on a pallet. At the shipping level, the required capacity consists of the load to ship (i.e. goods to leave the shipper), while available capacity consists of the purchased capacity for the load. The load to ship might consist of packages or products without packaging. Purchased capacity may be smaller than a vehicle (less than a truckload), the size of a vehicle's capacity (a full truckload), or the size of several vehicles' capacities. At the vehicle level, the required capacity consists of the load for one vehicle, while available capacity consists of the vehicle for that load. Finally, at the fleet level, required capacity consists of the load in several vehicles, while available capacity consists of a fleet of vehicles for the load. By calculating the ratio of required capacity to available capacity, shippers can obtain a load factor for each level.

In addition to calculating the load factor at each load-factor level, an overall load-factor measure compares the required capacity at the lowest load-factor level with the available capacity at the highest load-factor level. For even more detail, the sum of the smallest units to load (often products) can be compared with the

available capacity in the highest load-factor level; the latter measure also takes into account how well consolidation (i.e. combining items) is performed at the lowest level.

Even if the load-factor model (Figure 19) shows imbalances at different load-factor levels, it is important to consider how load-factor levels interrelate. The packaging at a lower level becomes an item in the load at the next level, and at the next level the required capacity (in volume) is based on the outer dimensions of the packaging (as opposed to the inner volume of packaging, which is the basis for the available capacity). Shippers may exhibit balance between required and available capacity at one level but imbalance at another level. For example, available and required capacity may be balanced at a packaging level, but the shape of the packaging may be bulky or otherwise unusual; it is therefore difficult to consolidate the item with other items, which will then result in an imbalance between required and available capacity at the shipping level.

### 4.3.3 Identifying and comparing actions for increasing load factor

The framework of opportunities for achieving high load factor (Figure 20 and Paper V) provides an overview of the means for achieving high load factor. The framework is based on the required and available capacities described in the previous section. The idea is that when shippers use the load-factor model (Figure 19) they will be able to identify certain areas as having greater potential for improvement in their specific situations: for example, changes to a specific load-factor level or to the required or available capacity at a specific level. The required or available capacity may need to be increased, decreased, or reallocated. The means for achieving high load factor are categorised according to changes that can be made to increase, decrease, or reallocate required and available capacity in the framework of opportunities for achieving high load factor (Figure 20). The various means for changing the required capacity are grouped into changes to number of items, item characteristics, and methods of consolidation, while the means for changing the available capacity are grouped into changes to numbers of units and types of unit. In this way shippers can identify potential opportunities to improve load factor based on whether or not changes can be made to the number of items, item characteristics, consolidation methods, number of units, and type of units, as well as if shippers aspire to increase, decrease, or reallocate capacities.

| | **Required capacity** | | | **Available capacity** | |
|---|---|---|---|---|---|
| | No. of items | Item characteristics | How to consolidate | No. of units | Type of unit |
| **Reduce/ increase capacity** | • Change what orders/ items to consolidate<br>• Change no. to match available capacity | • Change size<br>• Change characteristics to support loading | • Loading and packing method | • Buy, sell or contract<br>• Improve forecasting of required capacity | • Change type<br>• Change design |
| **Reallocate capacity** | • Change order agreements<br>• Change pricing | | | • Postpone/advance maintenance<br>• Change time for utilizing load units | |

*Figure 20: Overview of opportunities for achieving high load factor (Paper V)*

The categorisation scheme in the framework of opportunities helps shippers identify means of achieving the change they need. For example, if they need to reallocate required capacity, they can change order agreements or change pricing. The framework of opportunities also helps shippers compare different means of

improving their load factors in order to identify suitable actions. Using the framework of opportunities, shippers may consider if the means of achieving the change that is required are based on changes that they believe will be possible in their given situation. For example, is it possible for them to change the number of units of available capacity they purchase? Using the framework of opportunities, shippers can compare potential opportunities that they believe will be possible in their particular situations. For example, shippers may consider if certain aspects would be easier to change than others within their specific situations. The framework of opportunities to achieve high load factor is thus a tool that managers can use when they decide which load-factor-increasing actions they should perform. Changes that were made in the cases examined for Paper V provide several examples of the means for increasing load factor (see Figure 21 and Paper V).

**(a) Opportunities at a Packaging level identified in the studied cases**

| | Required capacity | | | Available capacity | |
|---|---|---|---|---|---|
| | No. of items | Item characteristics | How to consolidate | No. of units | Type of unit |
| **Reduce/ increase capacity** | Changes to:<br>• what items were consolidated in each load unit or box | | Changes to:<br>• packing method (modelling) | | Changes to:<br>• add new types (e.g. roll cage)<br>• new design (size)<br>• packaging material |
| **Reallocate capacity** | | | | | |

**(b) Opportunities at a Shipping level identified in the studied cases**

| | Required capacity | | | Available capacity | |
|---|---|---|---|---|---|
| | No. of items | Item characteristics | How to consolidate | No. of units | Type of unit |
| **Reduce/ increase capacity** | | Changes to:<br>• size<br>• stackability | Changes to:<br>• loading method (off-line approach) | Changes to:<br>• quantity (constant no of vehicles)<br>• quantitiy purchased (share of vehicle)<br>• forecast of required capacity | |
| **Reallocate capacity** | Changes to:<br>• order size<br>• delivery frequency<br>• delivery time | | | | |

*Figure 21: Changes made in the studied cases (Paper V).*

The following two paragraphs explain the means for achieving high load factor, as listed in the framework of opportunities (Figure 20; for more detail, see Paper V). One important building block when developing the framework of opportunities for achieving high load factor was the set of determinants of the required and available capacities (described in Paper IV); that is, those aspects that can change these capacities. The various means for achieving high load factor also draw on descriptions from earlier studies in the literature of factors that influence load factor (described in Paper III).

Three aspects can change required capacity: the number of items, the item characteristics, and how items are consolidated. First, the number of items in the load depends on several choices about *what orders or items to consolidate* (i.e. combine in a load unit). In addition, the *number of items can be changed to match available capacity*, thus filling the available capacity in terms of width, length, height, or in layers. Second, related to item characteristics, changes to the *size of*

*the items* reduce or increase required capacity, and *item characteristics can be changed to support loading*, thus making the conditions for positioning items when loading (or packing) more favourable. Third, choices about how the consolidation is performed in terms of *packing and loading method* determine the volume of the actual load: for example, positioning items so that required capacity is minimised. Reallocating the required capacity between time periods may be of relevance when shippers have variations in required capacity between time periods. Moving the number of items between time periods could be achieved by making *changes to order size, delivery frequency*, and *delivery time*. Pricing would be one way to encourage customers to adopt certain order patterns. All three of these aspects (number of items, item characteristics, and consolidation) are interrelated; in other words, changing the number of items and item characteristics can support consolidation.

Two aspects can change available capacity: the number of units available and the type of unit available. One way to change the available capacity is to change the number of units that are available by *buying or selling load units* or by *subcontracting* a larger volume or weight (purchase capacity) from transport providers. Another way to change the number of units of available capacity is to *improve the forecasting* of the required capacity. With improved forecasting of required capacity at the shipping level, the number of units of available capacity do not have to be overestimated. Different types of units vary in their available capacity, and thus *changes to type of unit* (for example, which vehicle or packaging type) will change the available capacity. *Changes to the packaging material* or *design of the packaging* can change the inner volume. Shippers can achieve the reallocation of available capacity between time periods by *postponing maintenance* of vehicles or *changing the time in which load units can be utilised*. Changing the number and type of units is interrelated; for example, changing the type of load unit may change the number of units that are required.

The actions for enabling high load factor identified in the cases examined in Paper VI may be categorised according to the framework of opportunities developed in Paper V. The reallocation of required capacity by changing the number of items to better match available capacity was exemplified in the actions *leave pallets for the next delivery occasion*, *ship pallets at an earlier occasion*, *add extra goods to the load*, and *agreement with recipient on flexibility*. The shipper changed the number of items (required capacity) to match available capacity in the action *order sizes that match a full vehicle/container*. The shipper also changed the number of items to consolidate (the required capacity) and reduced the number of units of available capacity with the action *adjust frequency of deliveries and consolidate deliveries to different plants (inbound)*. Item characteristics of required capacity were the focus of the action *adapt products and packaging to allow efficient packing and loading of pallets*, while the consolidation method (i.e. loading and packing methods for required capacity) was the focus of the action *pack pallets efficiently*. The shipper improved the forecasting of required capacity so that available capacity could be better matched in the action *adapt future loading plans based on measured outcome*. Finally, the action *ensuring capacity at the delivery point* could not be sorted exactly according to the framework of opportunities; this action had to do with the available capacity of the recipient.

### 4.3.4 Approach for identifying suitable actions to increase load factor

The second framework for supporting shippers in identifying actions that would be suitable to their specific situations consists of an approach for identifying suitable opportunities to increase shippers' load factors (see Figure 22 and Paper V). The approach consists of four steps: evaluating the existing load factor, identifying areas for change, identifying which aspects to change, and finally evaluating the effects of changes (see Figure 22). The load-factor model (Figure 19) can be used to help shippers evaluate existing load factors and to evaluate the effects of any changes that are made. The framework of opportunities (Figure 20) can be used to support shippers in identifying opportunities to increase load factor that will be suitable to their particular situations.

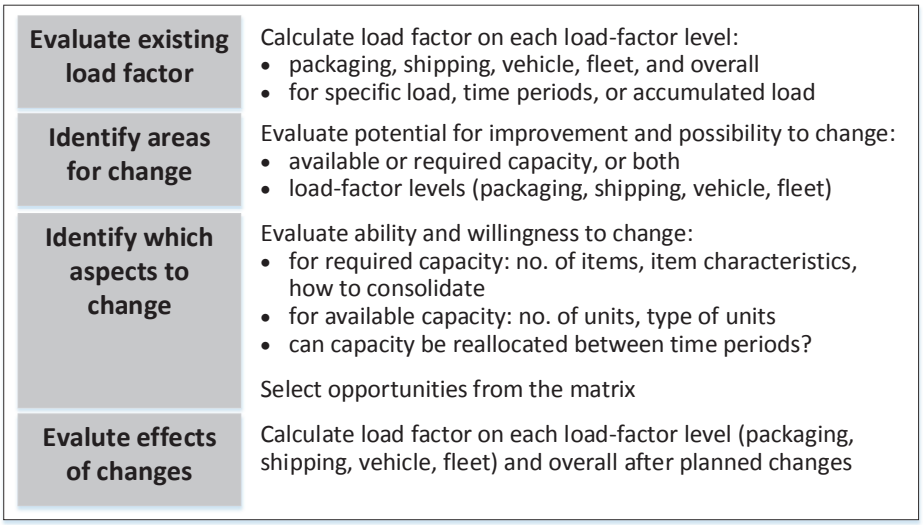


*Figure 22: Approach for identifying suitable opportunities to increase load factor (Paper V)*

The first step is to evaluate existing load factor. Using the load-factor model (Figure 19), the existing load factor is measured in terms of the balance between required and available capacities at the packaging, shipping, vehicle, and fleet levels.

The second step is to identify areas to target for change. Using the results of the calculations of load factor from the first step, the potential for improvement and possibilities to make changes is evaluated for the various load-factor levels (packaging, shipping, vehicle, and fleet), as well as for required and available capacities. For companies that purchase freight transport, the load factor at the fleet level will be outside their responsibility. While a low load-factor figure may indicate the potential for the improvement of load factor at a specific load-factor level, the low figure might be explained by other factors that would indicate that the potential is not as high as was initially thought. These reasons might include handling requirements, the sequence of unpacking, or laws about working conditions, all of which may necessitate a lower load factor. The possibility to enact changes may be restrained by resources or other actors. For example, changing available capacity in terms of truck size would be difficult if the shipper owns trucks of a specific size. The output of the identification of areas to change

is which areas should be targeted to improve the load factor: for example, required capacity at the shipping level.

The third step is to identify which aspects to change in the targeted area. The framework of opportunities (Figure 20) shows that required capacity may be increased, decreased, or reallocated between time periods by changes to number of items, item characteristics, and how to consolidate (i.e. combine) the items; it also shows that available capacity may be increased, decreased, or reallocated by changes to the number and type of units. For the targeted area that was identified in the previous step, the shipper may consider the ability and willingness to change the aspects that were mentioned in the framework of opportunities. First, certain means of improving load factor can be ruled out. Shippers may not be able to change certain aspects, such as vehicle size; shippers may be unwilling to change other aspects. Shippers can consider their ability and willingness to change the various means of improving load factor presented in the framework of opportunities, for example changing order agreement. Those aspects that are not ruled out may be of more or less interest to the shippers. Next, shippers can consider how they would implement the changes. Having ruled out a few means to improve load factor, the output at this stage includes a list of opportunities to improve load factor at the targeted area and an initial impression of the differences in difficulty that would be involved in making the changes. Based on this step, shippers can then identify one or several means of improving their load factors that seem promising.

The fourth step is to evaluate the effects of making those changes that seem promising. This is an important consideration, since making changes at one load-factor level may influence other load-factor levels. Using the load-factor model (Figure 19), the load factor after making the suggested changes is calculated for the selected load-factor level, as well as at the other load-factor levels and the overall load-factor level. The results of these calculations then provide input to the decision about which actions to take to improve load factor.

After performing all four steps, the shippers will have identified actions they can take to improve load factor that they believe would be possible in their particular situations. They will have compared actions to improve load factor in order to arrive at those actions that will be most relevant to them.

## 4.4 Shippers' internal coordination to enable high load factor

### 4.4.1 Overview of findings for answering RQ4

The fourth research question (RQ4) was stated as: *How may shippers' internal coordination enable high load factor?* As illustrated in Figure 13, the research question is addressed by the findings presented in papers III, VI, and VII. In this sub-section, the research question is answered by describing (1) the need for coordination due to dependencies and (2) the coordination mechanisms that describe ways to perform the coordination (see Figure 23).

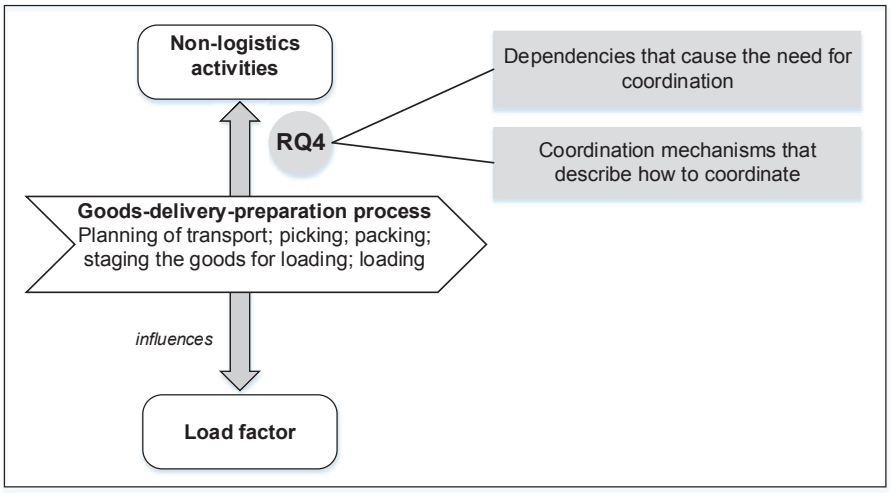


*Figure 23: Findings that answer RQ4*

The internal coordination of shippers' activities is necessary for them to achieve high load factor due to various dependencies between activities. The existence of sequential processes means that activities that come earlier in the process will shape the conditions for activities that come later in the process, thus influencing, facilitating, or restricting the work that is performed within the later activities. When changing the work that is performed in the activities changes to several activities may be necessary. These dependencies are described in more detail in sub-section 4.4.2.

Internal activities may be coordinated in a variety of ways to enable high load factor. Different coordination mechanisms may be used, and which coordination mechanisms to use will depend on whether the coordination is interfunctional or intrafunctional, whether the activities to be coordinated are dyadic or multiple activities, and whether sequential or reciprocal dependencies exist between activities. The use of coordination mechanisms is described in more detail in sub-section 4.4.3.

### 4.4.2 Need for coordination due to dependencies between activities in the goods-delivery-preparation process

When ordering freight transport, it is necessary to access information from other internal activities (for more details see Paper VII); at times, this input will provide the conditions for how load factor may be influenced when planning transport, calculating required space, and selecting a transport provider. In addition, when preparing goods for delivery, internal activities provide the conditions for how load factor may be influenced. Decisions that may directly influence load factor may be found in the following areas: logistics structures, order and delivery, packaging and loading, transport operations, and consolidation (see Paper III). Based on empirical data from the cases examined in Paper VI, the activities in the goods-delivery-preparation process consist of: order processing, production, warehousing, packing, transport planning, order picking, load planning, staging for loading, and loading (see Figure 24). Several sequential and reciprocal dependencies between activities were found within the cases where shippers attempted to achieve high load factors. The existence of these dependencies explains why these activities need to be coordinated in order to enable high load factors.

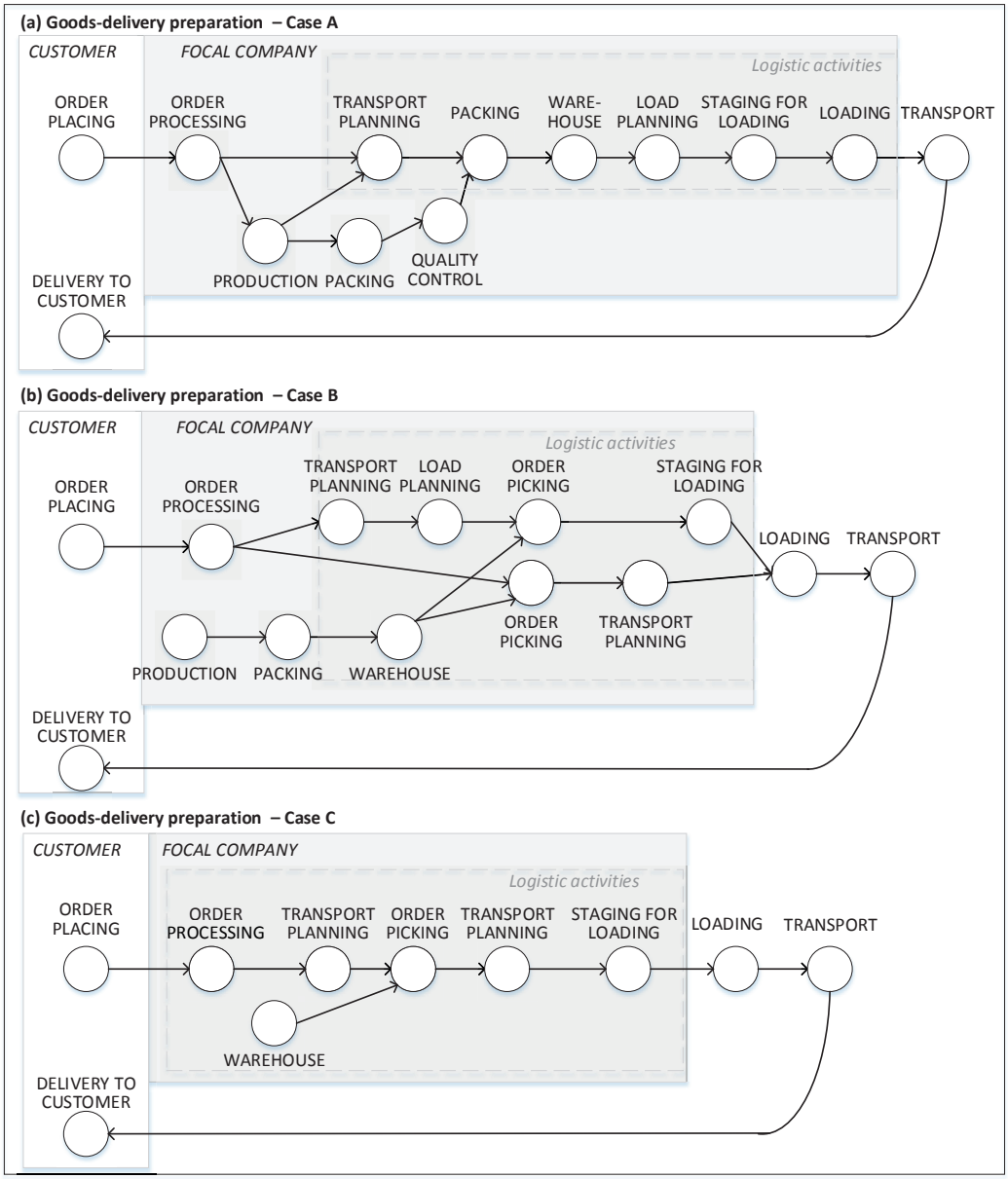


*Figure 24: Activities in the goods-delivery-preparation process in three cases (Paper VI)*

Several sequential dependencies may be found between activities in the goods-delivery-preparation process (see Figure 24). The existence of sequential dependencies between operational activities when delivering goods means that the output of one activity becomes the input of the next activity. Because of sequential dependencies, the following activities need to be coordinated: *order processing*, *transport planning*, *packing*, *order picking*, *load planning*, *staging goods for loading*, and *loading of vehicles*. Figure 24 shows the goods-delivery-preparation processes in the three cases that were studied. The arrows indicate that the output of the activity becomes the input of the activity. In other words, these are sequential dependencies between activities. Shippers must consider sequential dependencies between activities if they wish to enable high load factor.

Reciprocal interdependencies occur between activities when (1) changes are required in several activities and (2) output from 'downstream' activities becomes

input to earlier activities the next time the activities are performed. One example of a situation where changes may be required in several activities is packaging design. During the development of new products the logistics and transport staff are asked for their opinions on packaging design; those opinions are then considered alongside marketing and product-design opinions. The packaging design then creates the conditions for daily packing and loading. An example of when output from a downstream activity becomes input to an earlier activity is when the order-processing staff ask the transport-planning staff for input on suitable order quantities to fill a container. Once the order quantities have been entered by the order-processing staff, the transport-planning and vehicle-loading activities must follow those quantities.

### 4.4.3 Coordination mechanisms for internally coordinating the goods-delivery-preparation process for high load factors

A variety of coordination mechanisms may be adopted when shippers coordinate internally with the aim of achieving high load factor. Of the six coordination mechanisms identified from theory – mutual adjustment, direct supervision, standardisation of work, standardisation of output, standardisation of skills and knowledge, and standardisation of norms (Glouberman and Mintzberg, 2001) – evidence of all six was found in the cases examined in Paper VI.

Figure 25 and Paper VI demonstrate a framework in which the six coordination mechanisms are categorised depending on the need for intra- or interfunctional coordination, type of interdependence to manage (sequential or reciprocal), and whether the coordination is dyadic or between multiple activities. The framework shows the various coordination mechanisms that were used in the case studies. *Intrafunctional coordination* refers to coordination between logistics activities (for example between transport planning and order picking), while *interfunctional coordination* refers to coordination between logistics and non-logistics activities within the company.

The coordination within the different categories in the framework had different foci (Figure 25). Coordination may focus on the execution of activities, which was the case for intrafunctional coordination with sequential interdependencies (categories 1 and 2 in Figure 25). Coordination may focus on improvements to activities, which was the case for intrafunctional coordination with reciprocal interdependencies (categories 3 and 4 in Figure 25). Coordination may also focus on raising awareness of conditions for logistics activities, which was important for interfunctional coordination (categories 5 and 6 in Figure 25). Finally, coordination may focus on ensuring that load factor is considered alongside other priorities; this was especially important for interfunctional coordination between multiple activities with reciprocal interdependencies (category 8 in Figure 25).

INTRAFUNCTIONAL COORDINATION
(LOGISTICS ACTIVITIES)

| | DYADIC | MULTIPLE |
|---|---|---|
| SEQUENTIAL INTERDEPENDENCE | **1** *Direct supervision* *Standardisation of work* *Standardisation of skills & knowledge* | **2** *Standardisation of work* *Standardisation of output* *Standardisation of skills & knowledge* *Standardisation of norms* |
| RECIPROCAL INTERDEPENDENCE | **3** *Mutual adjustment* | **4** *Standardisation of work* |

INTERFUNCTIONAL COORDINATION
(LOGISTICS AND NON-LOGISTICS ACTIVITIES)

| | DYADIC | MULTIPLE |
|---|---|---|
| SEQUENTIAL INTERDEPENDENCE | **5** *Direct supervision* *Standardisation of output* *Standardisation of skills & knowledge* *Standardisation of norms* | **6** *Standardisation of norms* |
| RECIPROCAL INTERDEPENDENCE | **7** *No examples from the cases* | **8** *Mutual adjustment* *Standardisation of work* *Standardisation of skills & knowledge* *Standardisation of norms* |

*Figure 25: Use of coordination mechanisms for intrafunctional/interfunctional coordination depending on type of interdependence and the coordination of dyads or multiple activities*

Several differences exist in the use of coordination mechanisms when comparing intra- versus interfunctional coordination, the coordination of dyadic versus multiple activities, and the coordination of sequential versus reciprocal interdependencies; for more details, see Paper VI. For interfunctional coordination, coordination mechanisms associated with hierarchy (direct supervision, standardisation of work, and standardisation of output) were used more often than for interfunctional coordination. Dyadic coordination uses the coordination mechanism 'direct supervision', which was less common when several activities were involved. For the coordination of multiple activities, the coordination mechanisms 'standardisation of norms' appeared to be used as a means of coordinating many activities. For sequential interdependencies, the coordination meant providing good conditions for the subsequent activities and therefore ensuring that those who were responsible for the activities understood the ramifications for subsequent activities. For reciprocal interdependencies, the coordination meant ensuring that logistics issues such as load factor were considered and then giving higher priority to those issues.

## 4.5 Summary

The results to each research question are summarised in Figure 26 and Figure 27.

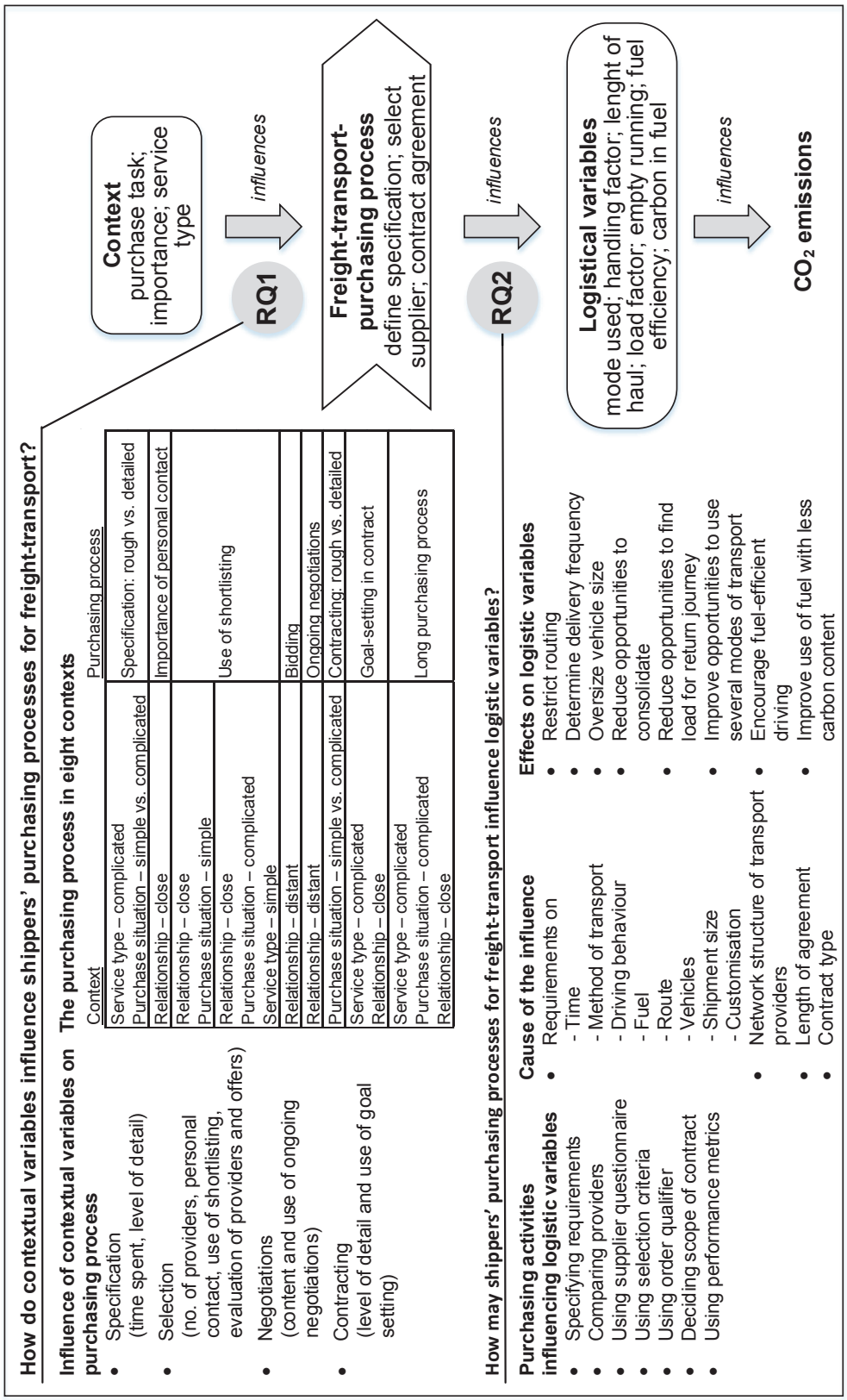


*Figure 26: Overview of results to RQ1 and RQ2*

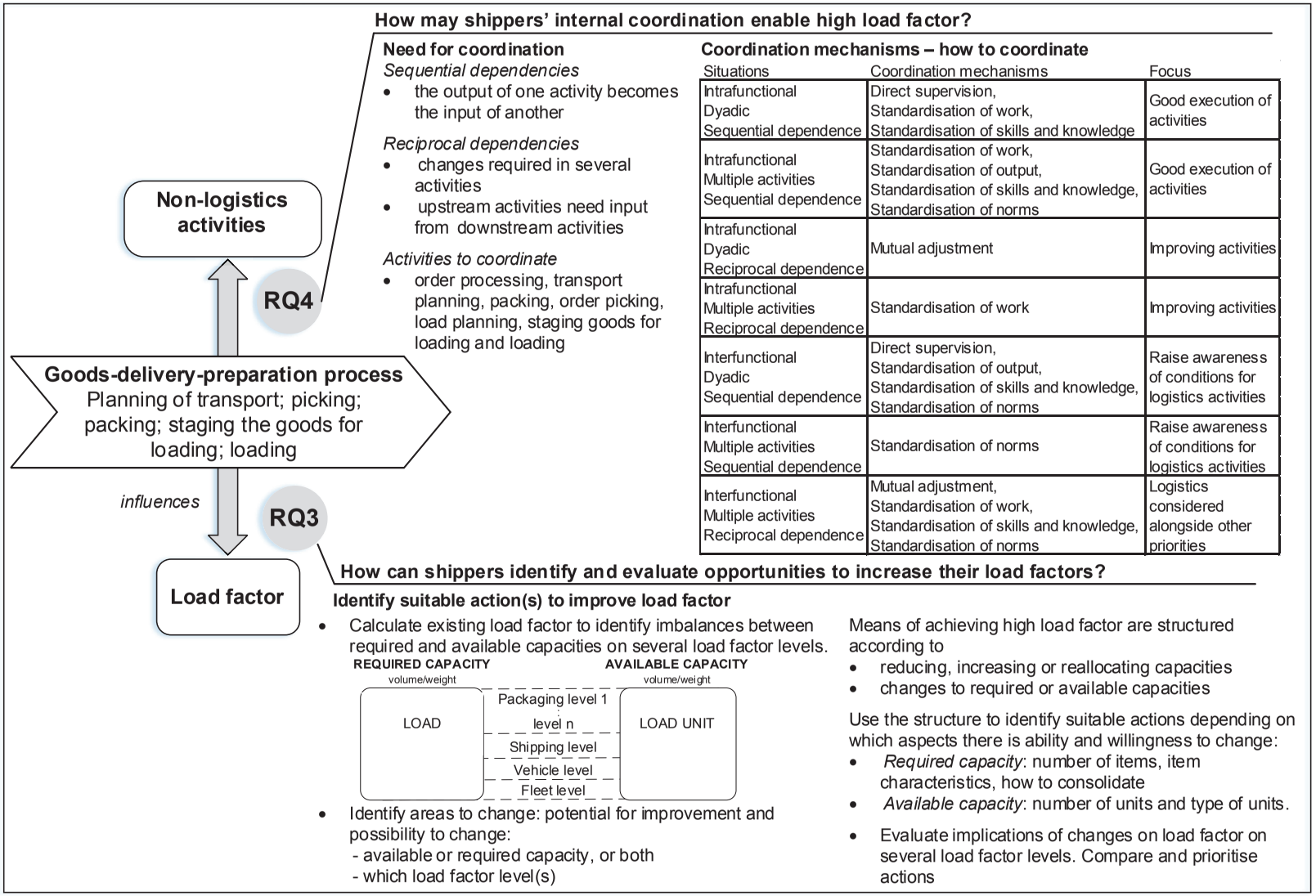


*Figure 27: Overview of results to RQ3 and RQ4*

# 5 Discussion

This chapter is divided into sections and sub-sections that discuss the results and how they contribute to this thesis. Sections 5.1–5.2 discuss how the main findings, as presented in Chapter 4 (Results), relate and contribute to previous research; they also discuss how the results can be used in practice. Section 5.3 relates the purchasing of freight transport and the preparation of deliveries to one another and discusses coordination, based on what has been learnt from the studies. Section 5.4 discusses the transferability of the findings to other contexts, and section 5.5 presents areas for further research.

The purpose of this thesis, as stated in the Introduction (Chapter 1), is *to clarify how shippers can influence $CO_2$ emissions from the freight transport they purchase.*

The results contribute to this thesis by clarifying shippers' roles in reducing $CO_2$ emissions by explaining the implications from shippers' purchasing processes on several logistical variables (one of which is load factor), as well as by providing guidance on the selection of suitable actions for achieving high load factor; the results also suggest several ways in which such actions may be executed in terms of different coordination mechanisms. In this way, the thesis contributes to the field of green logistics. The following two sections, which discuss the results of the four research questions, describe the contributions to the literature on freight-transport purchasing and load factor in more detail.

## 5.1 Influence of shippers' freight-transport-purchasing processes on logistical variables

The results of the first and second research questions (RQs 1 and 2) are concerned with how contextual variables influence the purchasing process and how the purchasing process in turn influences logistical variables (Figure 28). The results show how contextual variables influence the purchasing process and present the purchasing process in eight different contexts. The results also show that by specifying requirements; comparing providers; using supplier questionnaires, selection tools, order qualifiers, and performance metrics in contracts; and deciding the scope of contracts in the purchasing process, shippers may influence all of the logistical variables. Although several causes of the influence on logistical variables were found, specific requirements (on time, for example) were most notably influential.

After an overview of the contributions related to RQs 1 and 2 in sub-section 5.1.1, this section discusses the influence of freight-transport purchasing on logistical variables (RQ2) in sub-section 5.1.2; it then discusses the influence of context on freight-transport purchasing (RQ1) in sub-section 5.1.3. The fourth sub-section (5.1.4) discusses the ways in which context may influence the logistical variables via the influence of context on freight-transport purchasing; this discussion connects RQs 1 and 2. The fifth sub-section (5.1.5) provides further insights into ways in which the results can be used; the results of this thesis are applied to an existing framework from Martinsen (2014).

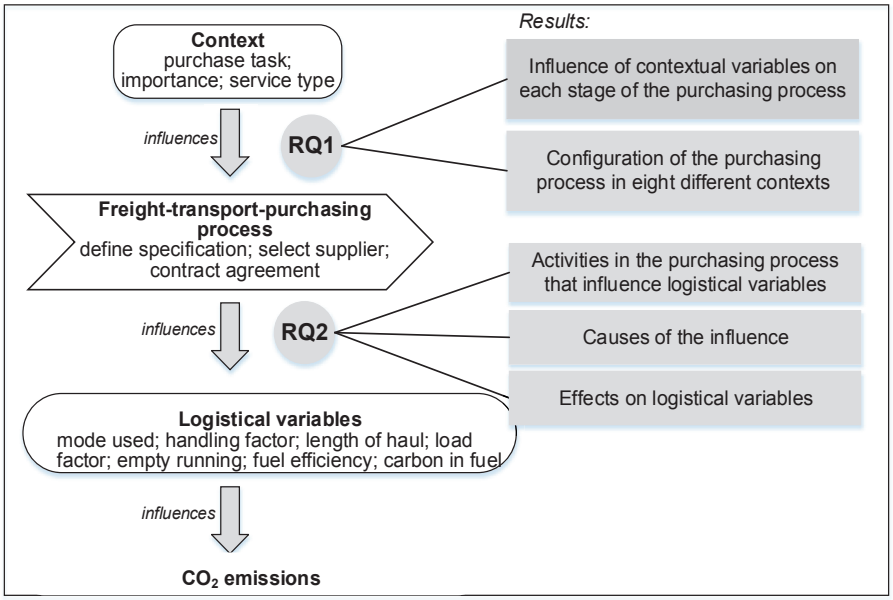


*Figure 28: Overview of findings that answer RQs 1 and 2*

### 5.1.1 Overview of contributions regarding freight-transport-purchasing processes

This thesis connects the purchasing of freight transport to green logistics; it adds to the literature on freight-transport purchasing by demonstrating how such purchasing influences various indicators of $CO_2$ emissions. The results provide increased knowledge by offering detailed descriptions that explain the influence from these purchases; for details, see sub-section 5.1.2. Further, this thesis adds to the literature on the influence of context on freight-transport purchasing by offering detailed descriptions of the influence of a few contextual variables on such purchasing in several contexts; for more details, see sub-section 5.1.3. The thesis offers insights on the influence of context on the logistical variables that indicate $CO_2$ emissions via the freight-transport-purchasing process, particularly level of detail in specifications, the use of performance metrics, and the use of contact that is personal in nature. Finally, the study results suggest that shippers should discuss their influence on the logistical variables with their transport providers; the discussion depending on the environmental ambitions of the shippers and transport providers (sub-section 5.1.5).

### 5.1.2 Influence of freight-transport purchasing on logistical variables

This thesis contributes to the research community by connecting the freight-transport-purchasing process and green logistics in terms of logistical variables related to $CO_2$ emissions. Connecting these two adds to both: the thesis adds a logistical-variable perspective to the purchasing of freight transport and a purchasing perspective to research on logistical variables. Connecting the two fields makes the implications of freight-transport purchasing on $CO_2$ emissions more visible to the purchasing field and uses terminology – the logistical variables – that will be understandable within transportation research and practice.

Adding a logistical-variable perspective to purchasing is a step towards showing the impact of practices in the freight-transport-purchasing process on $CO_2$

emissions, since logistical variables are related to $CO_2$ emissions. Building on research on the purchasing of freight transport in Björklund (2005), Björklund (2011), Lammgård (2007), and Wolf and Seuring (2010), and adding the influence on logistical variables, clarifies the influence on $CO_2$ emissions. The descriptions of the influence on logistical variables describe the ways in which emissions are influenced (for example, if the influence is through the distance-driven, efficient use of vehicles, or if it is through fuel used) and how these factors can be influenced when purchasing freight transport.

For practitioners these descriptions will provide purchasing or logistics managers at shippers with an increased understanding of how their decisions are related to $CO_2$ emissions, indicated by logistical variables. The shippers in the cases examined were unaware of their influence on the logistical variables and thus benefit from gaining an increased understanding in this area. The transport providers, on the other hand, work with logistical variables daily but they did not appear to have reflected on the influence from shippers' purchasing processes in any detail. In the cases examined for this thesis, the transport providers did not communicate shippers' influence on logistical variables to the shippers. Shippers and transport providers can use logistical variables as a way of being explicit about their environmental performance; in other words, these variables can more concretely describe how environmental performance is influenced.

Adding a purchasing perspective to previous research on logistical variables is a step towards showing that the purchasing of freight transport can influence $CO_2$ emissions. Using the framework in Piecyk and McKinnon (2010), this thesis shows that the purchasing of freight transport can also influence all of the logistical variables; it further describes how the purchasing process influences those variables. This means that researchers who hope to demonstrate how logistical variables can be influenced should also include purchasing in their studies. In addition, companies that execute freight transport can clarify how shippers influence that execution by explaining the influence on logistical variables.

This thesis uses logistical variables as indicators of environmental performance; it complements Martinsen and Huge-Brodin (2014) by providing a few similar findings as well as details of a different kind. These details concern the causes of the influence on logistical variables and details on the purchasing activities; the latter offer more details on contracts preconditions. Researchers should consider these specific details in future studies on the relationship between shippers and transport providers.

This thesis finds that time requirements in particular may influence logistical variables and are therefore important for shippers to consider when purchasing freight transport. The finding that specifying non-environmental requirements when purchasing freight transport influences several logistical variables contributes to research in the green purchasing of freight-transport, such as Björklund (2005) and Martinsen and Huge-Brodin (2014). This thesis argues that environmental considerations should not be seen in isolation: for example, it is not enough to include environmental criteria. Instead, for higher environmental performance, the effects of all requirements should be considered.

Many of the companies examined in Study II/Paper II generally spent a short amount of time in the *define specifications* stage. Since that stage can influence logistical variables in several ways, it seems important to ensure that sufficient resources are spent in this stage, for example by understanding the needs that are behind stated requirements. The findings of this thesis recommend that companies that purchase freight transport should properly analyse all requirements (and the consequences of those requirements) on logistical variables, preferably in discussion with potential transport providers. These discussions could also include alternative transport solutions (if the transport providers offer them).

### 5.1.3 The influence of contextual variables on freight-transport purchasing

While answering the first research question, the results showed that contextual differences will result in different configurations of the purchasing process. The findings on the influence of contextual variables on the purchasing process are a step towards explaining why the purchasing process differs in different companies.

This thesis contributes to the results presented on the influence of context on freight-transport purchasing found in Björklund (2005, 2011) and Holter et al. (2008) by providing in-depth descriptions of the influence of a few contextual variables on the purchasing process. Specifically, this thesis describes the influence of purchase task, importance, and service type on the purchasing process. Further, it presents a framework of eight contexts. In comparison to Björklund (2005, 2011), the focus is not limited to environmental considerations or to environmental purchasing, which means that the results on the contextual variables' influence on the purchasing of freight transport is not limited to environmental perspectives on those purchases. Fewer contextual variables have been studied in this thesis than in Björklund (2005, 2011). Studying fewer contextual variables (and studying cases) means that this thesis is able to provide detailed explanations of that influence. This thesis describes more contexts in comparison to Holter et al. (2008), thus making it possible to categorise companies in different ways, such as by their contexts and by their purchasing processes.

Study I/Paper I applies the three variables *buying task*, *product type*, and the *importance of the purchase* from the 'organisational buying behaviour' model (Johnston and Lewin, 1996) to the freight-transport-purchasing context; it defines what the variables mean in this context and shows how they influence the different stages of the purchasing process. The contextual variables can be used to describe contexts for companies that purchase freight transport. The thesis's descriptions of the ways in which the different stages of the purchasing process are influenced by the context increase our understanding of the reasons that purchasing processes differ.

### 5.1.4 Connecting context to logistical variables

While RQs 1 and 2 studied the influence of context on purchasing processes and the influence of purchasing processes on logistical variables, respectively, this section attempts to connect context to logistical variables. This is done by bringing together results on (1) the influence of context on the purchasing process and (2)

the influence of the purchasing process on the logistical variables and then discussing (3) the context where one might find the purchasing process's influence on logistical variables. This sub-section does not discuss all of the results to RQs 1 and 2; rather, it focusses on issues that are relevant to both research questions (see Figure 29). For example, 'detailed specification' is mentioned in the results to answering both RQs 1 and 2. Therefore the influence of context on logistical variables via 'detailed specification' is discussed.

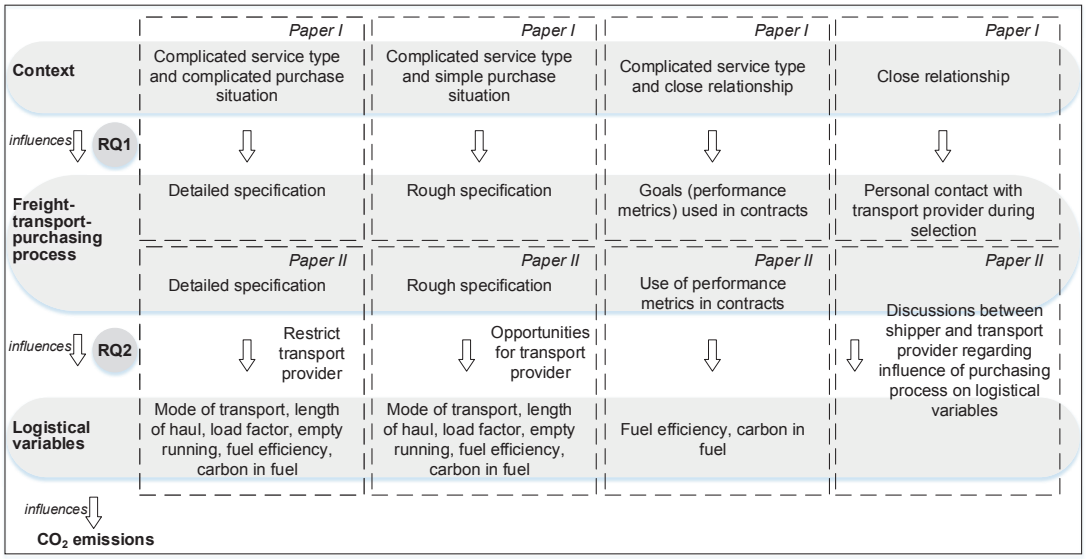


*Figure 29: Influence of context on logistical variables via the freight-transport-purchasing process*

The results on the influence of the freight-transport-purchasing process on the logistical variables highlight the implications of requirements specification, while the results on the influence of context on that process show that this specification is detailed in certain contexts and rough in others. Detailed specification appears to occur in contexts with a complicated service type in combination with a complicated purchase situation. Meanwhile, detailed specification was shown to restrict transport providers and influence the mode of transport, length of haul, load factor, empty running, fuel efficiency, and carbon in fuel. Because 'detailed specification' appears to occur in contexts where both service type and purchase situation are complicated, to avoid restricting transport providers, it may be possible for shippers to reduce the detail in specification via simplification of service type. They could make service type simpler by (for example) dividing the purchase into smaller parts and performing the purchasing process several times, each time with a smaller scope: purchasing freight transport for specific geographic areas, for instance.

In contexts where a rough specification is suggested – namely, contexts with a complicated service type in combination with a simple purchase situation – transport providers are not as restricted in how they design their transport solutions. This means that in contexts with a complicated service type in combination with a simple purchase situation, transport providers should be able to offer (and therefore can be more proactive in offering) transport solutions with less $CO_2$ emissions.

The results on the influence of the purchasing process on logistical variables show that the use of performance metrics on vehicles and fuel in the contracting stage can influence the logistical variables 'fuel efficiency' and 'carbon in fuel', while the results on the influence of context on the purchasing process demonstrate that goals are included in contracts in some contexts while not in other contexts. Performance metrics are goals that can be included in the contract. Contracts that include goals appear to occur in contexts with a complicated service type and a close relationship. It is inferred that the inclusion of performance metrics related to vehicles and fuel in contracts – which in turn influence the logistical variables 'fuel efficiency' and 'carbon in fuel' – appears to occur in contexts with a complicated service type and a close relationship. Particularly salient in the cases examined was a close and collaborative relationship between shipper and transport provider in agreeing on the goals and in following up on those goals. Therefore, shippers that want to influence the logistical variables by including performance metrics in their contracts with transport providers should aim for a close relationship with those providers.

The results on the influence of context on the purchasing process show that more or less personal contact will exist with the transport provider depending on the context; personal contact between shippers and transport providers appear to be included in the freight-transport-purchasing process in those contexts where shippers are interested in having a close relationship with their transport providers during the purchasing process. The results on the influence of the purchasing process on logistical variables suggest that personal contact is important for shippers and transport providers to jointly discuss the implications of their specified requirements on logistical variables. Connecting the two results, this means that shippers who want to examine their influence on logistical variables should include personal contact and aim for a close relationship with their transport provider during the purchasing process. This situation also implies that joint discussions between shippers and transport providers about the implications of specified requirements on logistical variables will occur in contexts with a close relationship between the two actors.

### 5.1.5 Using the knowledge of influence on logistical variables

This sub-section discusses the ways in which the different actors involved can use the knowledge that the purchasing process influences logistical variables: specifically, how shippers and transport providers can use logistical variables as a common terminology in their discussions.

In the cases examined for this thesis, the purchasing functions of a company when it purchases freight transport typically do not consider the environmental consequences of their activities and requirements. Furthermore, the transport providers in these cases did not engage buyers in discussions of the environmental consequences of the transport operations; for example, discussions of how specified requirements on delivery-time windows might influence length of haul did not take place. Based on the study results it is suggested that shippers and transport providers can use logistical variables as a common terminology to discuss ways to reduce $CO_2$ emissions.

Discussing logistical variables in the purchasing process in the relationship between shippers and transport providers can be described using the categorisation of relationships between shippers and logistics-service providers depending on the two sides' environmental ambitions, as presented in Martinsen (2014). The findings on the aspects in the purchasing process that can influence the logistical variables can help both parties discuss the influence of logistical variables when setting targets for reducing $CO_2$ emissions (see Figure 30).

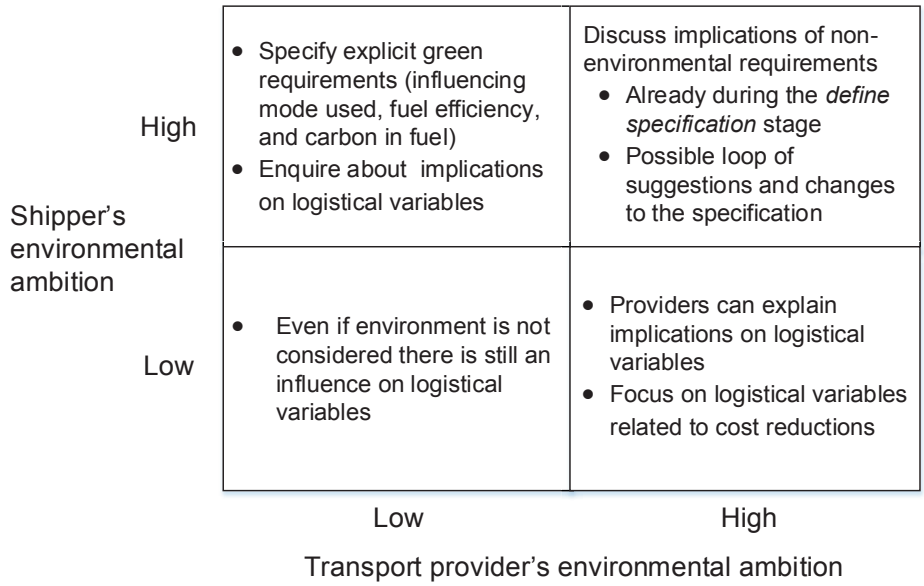


*Figure 30: The use of logistical variables depending on shippers' and transport providers' environmental ambitions; inspired by Martinsen (2014)*

In situations where both shippers and transport providers have a high environmental ambition, the implications of non-environmental requirements could also be added to the discussions between shippers and providers vis-à-vis the environmental performance. Shippers can try to discuss the implications of requirements with transport providers (related to time or the availability of service, for instance) earlier in the purchasing process, thus creating more of a 'loop' in the purchasing process than was observed in the cases examined for this thesis. This loop, in turn, can encourage discussions that will lead to new proposals on what is required from the shipper side and new suggestions for solutions from the transport-providing side.

In situations where shippers have a high environmental ambition while transport providers have a low environmental ambition, shippers may try to control that transport providers pay attention to environmental performance by setting explicitly stated requirements for the providers. Björklund (2005), for example, found that approximately 50 percent of companies that purchased freight transport included environmental requirements in their written contracts. Requirements that are related to logistical variables are more specific and concrete than (for example) the stipulation that the provider must follow the ISO-14000 standard. Such requirements can therefore be used to push transport providers to increase their environmental ambitions. With any luck, discussions on the implications of logistical variables can also counteract the risk that transport providers will be constrained by the stipulated requirements that negatively influence environmental performance. Although shippers might be interested in discussing

the implications of non-environmental requirements, transport providers with low environmental ambition are likely to be less interested in evaluating the environmental effects of such requirements.

In situations where the transport provider has a high environmental ambition while the shipper has a low environmental ambition, Martinsen (2014) found that it was difficult for transport providers to influence shippers regarding environmental activities. Explaining the implications on logistical variables could be a way to push shippers to increase their environmental considerations; specifically, the logistical variables that may be related to cost could be of interest for the two parties to discuss in such situations. Implications such as the possibility of running longer distances, or running half-full vehicles, could be potentially persuasive arguments because the shipper's customers may view receiving nearly empty vehicles negatively.

In situations where environmental ambition is low among both companies involved in the purchasing and provision of freight transport, Martinsen (2014) wrote that the occurrence of environmentally favourable activities are unlikely. Even so, the findings in this thesis show that there is still an influence on environmental performance (in terms of logistical variables) from various activities during the purchasing of freight transport. Under such circumstances, it is unlikely that much discussion will take place about the implications on logistical variables during freight-transport purchasing – either internally or between the buyer and provider. Indeed, in many of the cases examined for this thesis, both the companies that purchased freight transport and the transport providers were passive in their pursuit of environmental goals, i.e. they appeared to have low environmental ambitions. As was argued in the introduction, however, the environmental ambitions are expected to increase.

## 5.2 Improving load factor in shippers' goods-delivery preparation

The results of the third research question (RQ3) provide frameworks for evaluating load factors in terms of the required and available capacities at the packaging, shipping, and vehicle levels, and for evaluating suitable actions that will increase, decrease, or reallocate the required or available capacity as a way of improving load factor (see Figure 31). The results of the fourth research question (RQ4) include description of the dependencies that cause the need for coordination when companies aim to achieve high load factor and the coordination mechanisms they use to coordinate those activities.

After an overview of the contributions related to load factor (in sub-section 5.2.1), this section discusses the evaluation of load factor in goods-delivery preparation (RQ3) in sub-section 5.2.2, followed by a discussion of the coordination of activities (RQ4) in sub-section 5.2.3.

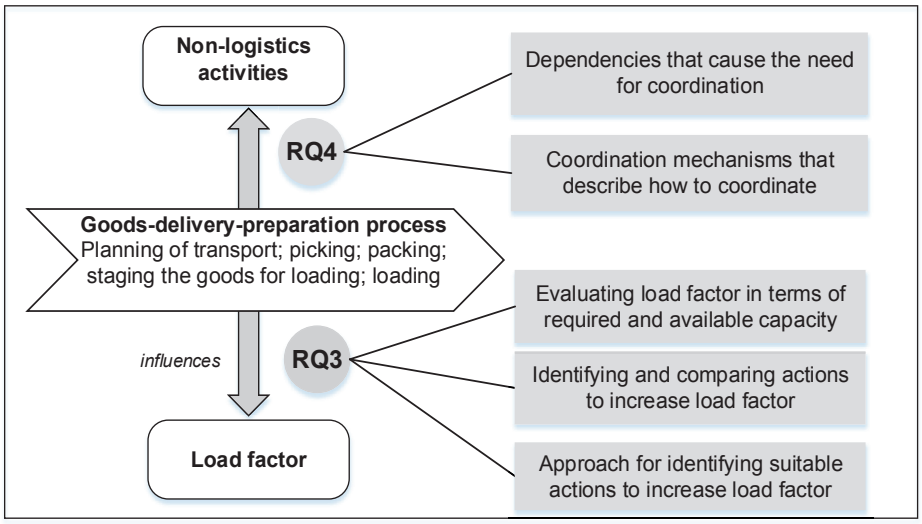


*Figure 31: Findings that answer RQs 3 and 4*

### 5.2.1 Overview of contributions related to load factor

A high load factor is a positive indicator of $CO_2$ emissions and often is also related to low cost. Thus, providing guidance on how shippers can achieve a high load factor has practical relevance. This thesis contributes to research on load factor by providing detailed guidance (in the shape of several frameworks) for enabling high load factors among shippers. One framework, the load-factor model, can be used to calculate shippers' load factors on several levels, for example the packaging and shipping levels. A second framework, the framework of opportunities to achieve high load factor, provides an overview of means for shippers to influence their load factors. The structure of the overview can help shippers in identifying opportunities that will be relevant to their particular situations. A third framework, the use of coordination mechanisms in eight situations, details how shippers can manage the constraint to achieving high load factor that poor internal coordination poses. The framework describes coordination in situations differing in intra- or interfunctional coordination, type of interdependence to manage (sequential or reciprocal), and whether the coordination of two or multiple activities is needed.

This thesis applies five perspectives to making improvements to load factor: capacity management, load-factor levels, order-fulfilment activities, inter-dependencies between activities, and coordination mechanisms; these perspectives then lead to suggestions of ways to achieve high load factor. By using all of these perspectives, the thesis provides several suggestions on ways to achieve high load factor, including the identification of imbalances, opportunities to improve load factor, and the successful implementation of actions in terms of coordination. The different perspectives' individual contributions to the results are explained below.

### 5.2.2 Evaluation of load factor in goods-delivery preparation

This thesis builds on and contributes to earlier research on ways in which shippers can improve load factor. It taps into studies that provide detailed examples – such as Kohn and Brodin (2008), Pan et al. (2014), Pålsson et al. (2013), Treitl et al. (2014), and Ülkü (2012) – and provides a structure in which different

opportunities for shippers to improve load factor can be compared. Shippers can use this structure to evaluate the relevance of opportunities in their specific situations. The thesis agrees with, for example, Aronsson and Brodin (2006) and Piecyk and McKinnon (2010), both of which position load factor as one of many important factors in green logistics. The thesis's focus on load factor means that it can offer concrete suggestions for shippers to achieve high load factors.

The load-factor model adds to the load-factor literature by considering load factor on several levels: for example, the packaging and shipping levels. The load-factor model, described in Paper IV, incorporates vehicle utilisation, as described in Ljungberg and Gebresenbet (2004), McKinnon (2010a), Nadarajah and Bookbinder (2013), and Pahlén and Börjesson (2012), among others; but it also shows that other load-factor levels exist that should be considered for achieving high load factor. The load-factor model, through its focus on load factor – which is narrower compared to the various levels of capacity efficiency described in Samuelsson and Tilanus (1997), including floor occupancy, height utilisation, pallets, boxes, net product, and loading-execution efficiency – offers a simple model for shippers when evaluating their load factor. Applying the perspective of load-factor levels articulates the idea that when using a shipper's perspective, one may evaluate utilisation on several levels (for example inside a box as well as on a pallet). This perspective helped to structure imbalances between available and required capacities in order to understand why the load factor was not high and as a way of defining load factor for shippers.

Using the load-factor model, shippers may specifically identify at which level their capacities are imbalanced and where the low load-factor figures originate. Compared to statistics on load factor at the national level, which may be based on vehicle utilisation, this thesis's inclusion of several load-factor levels is likely to illuminate further inefficiencies. This thesis argues that the lower load-factor levels – for example packaging – also must be efficiently utilised. The load-factor model can visualise inefficiencies; as such, the model presented in this thesis contributes to exposing inefficiencies in load-factor figures: for example, a vehicle with much space inside boxes. In one of the studied cases, for instance, the shipper was able to reduce the amount of unused space in its boxes. Inefficiencies at lower load-factor levels, such as packaging, are the responsibility of the companies that manufacture and package the products. Exposing such inefficiencies highlights shippers' important role in achieving high load factor.

Applying the perspective of capacity management provided inspiration on utilisation of transport resources from the manufacturing, planning, and control area. The thesis shows that the terms 'increasing', 'decreasing', and 'reallocating' of required or available capacity, which are used in manufacturing settings (for example, in Jonsson and Mattsson (2009)), are useful in freight-transport settings and for the management of load factor. This perspective helped to structure various means to increase load factor.

This thesis provides practical value to shippers by breaking down the problem of how best to increase load factor into determining where the problem stems from: for example, determining if any large imbalances exist between required and available capacity, and discerning if anything can be changed to achieve a better balance. The models that this thesis provides to accomplish this are general by

design so that they may be applicable to many different company contexts; shippers must add their own knowledge of their specific situations to select the most suitable actions. For example, some companies may find it easier than others to change packaging sizes.

Structuring load factor into required and available capacity at the packaging, shipping, and vehicle levels can help shippers to identify and visualise at which levels imbalances are to be found. Shippers can use the framework of opportunities to identify actions that are possible to take in their respective situations. The framework provides an overview of which parameters can be changed and which cannot; in this way, shippers can compare possible actions. Such comparisons then support decision making about which actions to implement. The load-factor model can then be used to make detailed calculations of the implications of specific actions that the company considers.

The Introduction chapter (Chapter 1) argued that the properties of the goods provide the conditions for which load factor can be achieved; this argument was then described in more detail in the load-factor model and in the framework of opportunities. The load-factor model in Paper IV, and the framework of opportunities in Paper V, both show that item characteristics (which are part of the properties of goods) determine the required capacity at the vehicle, shipping, and packaging levels, and through these levels the load factor. This means that shippers can try to change items' characteristics in order to increase load factors.

### 5.2.3 Coordination of activities in goods-delivery preparation to enable high load factor

The use of internal coordination presented in this thesis contributes to load-factor research, by taking a starting point in literature that has highlighted a relationship between internal coordination and load factor (McKinnon, 2010b; Piecyk, 2010; McKinnon, 2015b) and clarifying the need for and the nature of coordination. This thesis thus provides details about why internal coordination is needed to enable high load factors in terms of dependencies between activities, which activities need to be coordinated, and how coordination can be performed in terms of coordination mechanisms. Shippers can use this new-found understanding of the need for coordination – and which internal activities need to be coordinated – when performing actions to improve load factor as well as when implementing such actions. This means that shippers can plan and actively coordinate those activities to ensure that good conditions are in place for the actions. In the same way, they can use this thesis's suggestions about suitable coordination mechanisms when performing or implementing actions to improve load factors. Shippers can make use of the coordination mechanisms described in Paper VI and can select suitable coordination mechanisms depending on the situation. This thesis thus describes for shippers which activities they need to coordinate and how they can go about coordinating those activities when planning or performing actions for achieving high load factors.

Further, shippers can investigate if further dependencies exist in their organisations that would require the coordination of activities. The dependencies between the activities that were identified in the cases examined in Paper VI may appear differently in different cases. The activities described in the cases

examined in Study VI/Paper VI are general enough that they may be applied to many contexts, however, the order in which the activities were performed varied between companies, and not all of the activities (for example, production) occurred in every company. The dependencies will differ with different activities or different orders between activities. Even so, shippers can use the method of mapping dependencies to understand the need for coordination in their specific situations. Shippers can also use the descriptions from the cases as a starting point and can consider which of the described dependencies exist for them and if any other dependencies need to be added in their situations.

By providing a matrix that describes the use of different coordination mechanisms in different situations – i.e. depending on intra- or interfunctional coordination, sequential or reciprocal interdependencies, and dyadic or multiple activities – this study offers various explanations of situations where different coordination mechanisms are useful and why these coordination mechanisms work in those situations. This means that shippers can select suitable coordination mechanisms depending on what they want to achieve.

One interesting issue that surfaced when studying the coordination mechanisms used to enable high load factor was the need to make others understand the relevance of high load factor, thereby influencing the decision-making process in other activities. For interfunctional coordination this could be seen in increasing the various parties' understanding and convincing others of the relevance of pursuing high load factor. Due to sequential dependencies, it was important to ensure that those who perform these activities on a day-to-day basis understand the effects and conditions they create for subsequent activities. In the cases examined, shippers used the coordination mechanism 'standardisation of norms' to create an awareness of the relevance of pursuing high load factor. Norms appeared to be particularly useful when several activities needed to be coordinated as well as when the awareness was low. Shippers also used the coordination mechanism 'standardisation of skills' to increase the understanding in other functions by having their logistics staff provide advice to staff in other functions.

Applying the perspective of coordination mechanisms – specifically Glouberman and Mintzberg's (2001) six coordination mechanisms – was useful for describing the types of internal coordination that can enable high load factor. Using the perspective of coordination mechanisms meant that the nature of coordination could be categorised; it was also possible to discuss in which situations certain coordination mechanisms can be used. In the results of this thesis, the use of the coordination mechanisms was presented depending on intra- and interfunctional coordination, as described by Ballou et al. (2000); sequential or reciprocal interdependence (Thompson, 1976); and coordination between two or more activities, inspired by Danese et al. (2004). The results showed that the foci of the coordination efforts differed in the different categories and that different coordination mechanisms were used in the different categories. Clarifying the focus of the coordination, as well as clarifying how coordination mechanisms can be used to coordinate activities, are both useful for shippers that wish to implement actions to achieve high load factors.

Mintzberg's six coordination mechanisms (1989) were applicable to coordination efforts for enabling high load factor. These mechanisms were general enough to

be used to describe the coordination efforts in the cases examined. Because the mechanisms were general, the study outlined more specific ways in which the general mechanisms were applied; for example, direct supervision was used in terms of both instructing and inspecting. To complement the findings of this thesis, and to make the coordination mechanisms more specific, more detailed descriptions of coordination mechanisms – for example, Malone and Crowston (1994) and Van de Ven et al. (1976) – can provide further insights and can help shippers further: specifically, the suggestions in Malone and Crowston (1994) about asking users what they want and the use of participatory design. Van de Ven et al.'s (1976) description of impersonal versus personal coordination and group meetings could be helpful to consider for enabling high load factors by providing more detailed suggestions about how shippers can coordinate. In addition, information sharing, even though it was not neglected by the use of the six coordination mechanisms from Glouberman and Mintzberg (2001), could be presented more explicitly: for example, by using another set of coordination mechanisms.

Applying the perspective of interdependencies between activities in shippers' goods-delivery-preparation process was useful for explaining the need for coordination in order to enable high load factor. Activities in shippers' order-fulfilment processes (Croxton et al., 2001; Croxton, 2003) provided structure for determining in which activities actions to improve load factor are performed. Activities need to be coordinated due to various interdependencies; these may be categorised into sequential and reciprocal interdependencies using Thompson's (1967) categorisation scheme. Using that categorisation helped to identify dependencies between activities; it also meant that the type of dependency was easier to understand. This thesis suggests that different types of dependencies should be managed differently. Applying the same perspective, shippers can identify any dependencies in their particular situations that they need to manage in order to perform actions to achieve high load factors.

For dependencies, the categorisation described in Thompson (1967) was useful for describing sequential and reciprocal dependencies and was also applicable to actions for achieving high load factor. The dependencies presented in this thesis provide examples of sequential and reciprocal dependencies in a logistics context, thus adding to the work of Håkansson and Persson (2004). Study VI/Paper VI, in which general models were used, can be seen as a first step. As a second step, more detailed descriptions of dependencies – such as are found in Malone and Crowston (1994) or Malone et al. (1999) – could provide further insights and help shippers understand the dependencies at a more detailed level. Specifically, sequential dependencies can be broken down into sub-types, as Malone et al. (1999), for example, did in their work. In their study, the authors argued that flow dependencies, which are similar to sequential dependencies, have three sub-types: prerequisites, availability, and usability. Understanding the dependencies at a more detailed level may help to adapt the use of coordination mechanisms.

These insights into coordination mechanisms also add to earlier research on interfunctional coordination between logistics and other functions – for example, Murphy and Poist (1996), Stank et al. (1999), and Caputo and Mininno (1998) – by providing specific examples of coordination efforts that can enable high load factor. The insights into dependencies between activities could be useful for

improving cooperation between functions. Murphy and Poist (1996), for example, found that many companies show room for improvement in their cooperation between the marketing and logistics functions: for instance, in managing issues related to miscommunication and perception, that Lynch and Whicker (2008) identified in their work.

## 5.3 Combining the findings from different research questions

This section discusses how the results to the different research questions can be linked together from the perspective of a company purchasing freight transport; it explains how the purchasing and goods-delivery-preparation processes interact in relation to the findings of this thesis. In this way, the thesis links the two research questions about the purchasing process with the two research questions about goods-delivery preparation.

This section also provides suggestions for shippers based on combining the findings of the four research questions. Coordination, which was not applied to the results of RQs 1–3, is used to develop these new suggestions. Combining the findings also leads to suggestions that will need to be tested in further research.

### 5.3.1 Overview of combined findings

The processes of freight-transport purchasing and goods-delivery preparation are connected through the ordering of transport, which takes place in the 'transport planning' activity of the goods-delivery-preparation process. The ordering of transport is performed in accordance with agreements reached in the freight-transport-purchasing process.

Decisions that are made in the freight-transport-purchasing process and the goods-delivery-preparation process are related to load factor, because the decisions that are made in these two processes determine the required and available capacities; it is imbalance between these capacities that results in low load factor. Required capacity is the output of the goods-delivery-preparation process, i.e. how much goods need to be loaded, while available capacity is the capacity ordered when ordering transport in the 'transport planning' activity of the goods-delivery-preparation process. Available capacity can also be influenced by decisions in the purchasing process, such as purchasing full truckload (FTL) services. The connections between the freight-transport-purchasing process, the goods-delivery-preparation process, and load factor are discussed in more detail in sub-section 5.3.2.

There are several dependencies between the purchasing of transport and transport planning. It is often not the same people who perform the two activities. Internal coordination is necessary because of these dependencies and because different people are involved. Use of the hierarchical coordination mechanisms 'direct supervision' and 'standardisation of work' was found in the cases examined for this thesis, but other coordination mechanisms may also be useful for managing these dependencies. The coordination mechanism 'mutual adjustment' can be employed to improve both activities. The coordination mechanisms 'standardisation of skills and knowledge' and 'standardisation of norms' may both be used to improve the awareness of conditions related to the transport. The

coordination between the purchasing of transport and transport planning is discussed in more detail in sub-section 5.3.3.

Depending on which load-factor level has low load-factor performance – that is, the imbalance between required and available capacities is high – different coordination foci will be suitable: (1) coordination of the goods-delivery-preparation process, (2) coordination of both the goods-delivery-preparation process and the freight-transport-purchasing process, and (3) coordination of the freight-transport-purchasing process and the transport providers. When the load-factor performance is low at the packaging level, for instance, then the first choice above would be most relevant for improving the balance between required and available capacities. When the load-factor performance is low at the shipping level, in contrast, internal coordination of the goods-delivery-preparation process, internal coordination between the freight-transport-purchasing process and the goods-delivery-preparation process, and external coordination of the freight-transport-purchasing process and the transport provider(s) would be of interest for balancing required and available capacities. The relevant coordination depending on the load-factor performance at different load-factor levels is described in more detail in sub-section 5.3.4.

Further, this thesis suggests that different aspects of coordination – namely communication and mutual understanding – will be important depending on whether the situations are stable or ever-changing and if they are complicated or simple. The description of situations as being stable/ever-changing and complicated/simple draws upon the contextual variables that were studied: purchase task, importance, and service type in terms of material-flow characteristics. This thesis also suggests suitable coordination mechanisms in the various situations; more details may be found in sub-section 5.3.5.

### 5.3.2 Links between the freight-transport-purchasing process and the goods-delivery-preparation process

This thesis describes how shippers can influence $CO_2$ emissions from the freight transport they purchase in both their freight-transport-purchasing process and the goods-delivery-preparation process, which are linked through the ordering of freight transport (see Figure 32). The freight-transport-purchasing process, described in papers I and II, consists of six stages: *define specification*, *select supplier*, *contract agreement*, *ordering*, *expediting*, and *evaluation*. Paper VII describes and provides details on the fourth stage of the process (*ordering*) as the freight-transport-ordering process. The contracts that are agreed upon in the third stage of the purchasing process (*contract agreement*) are used when ordering freight transport in the freight-transport-ordering process: for example, when selecting between different agreements, sometimes with several different transport providers. The activities in the freight-transport-ordering process (plan transport, calculate space, select provider, and place order) take place in the activity 'transport planning' in the goods-delivery-preparation process, described in Paper VI. Alternatively, in some instances (for example, in the case of special projects or transports of a unique character), the ordering of freight transport in transport planning begins the purchasing-process stages from *define specification* onwards. Further, the output from the goods-delivery-preparation process forms the basis for new specifications at the start of new purchasing processes (called

'transport data' in Paper 1 and 'currently bought' in Paper II), both in the *define specification* stage.

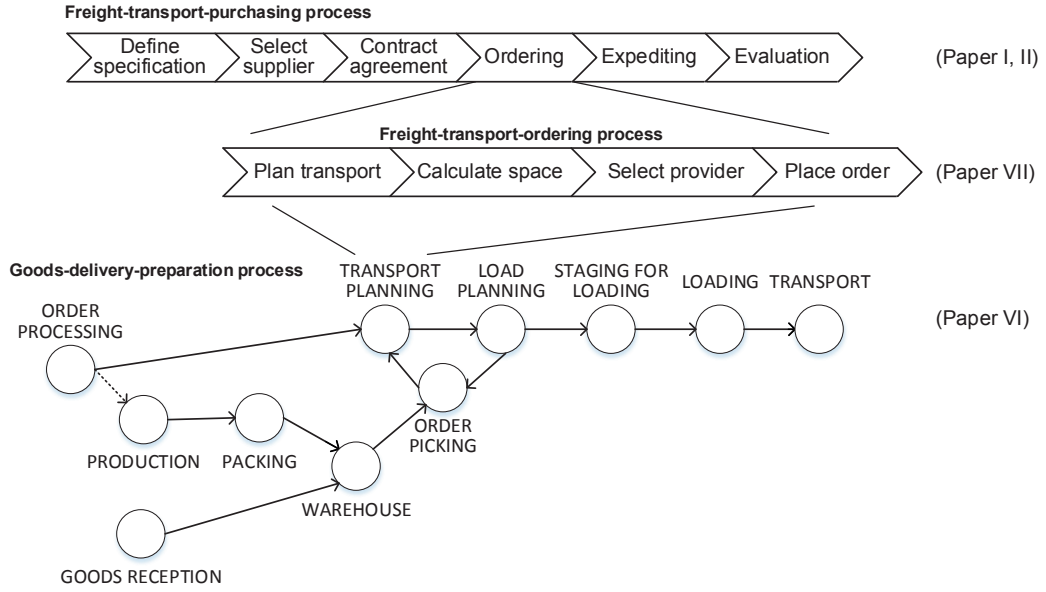


*Figure 32: Relating the processes described in the papers to one another*

For the purposes of defining the specification in the purchasing process, aggregated data is needed on material-flow characteristics, including the locations of recipients, any variations in recipients' locations, and the size of shipments. At a detailed level, the figures originate from the agreements between shippers and their customers, which can take place in the order-processing stage of the goods-delivery-preparation process. The output from that process will determine the size of the shipment, which in turn feeds into the specification definition, both directly (in terms of which size is specified) and indirectly (as a contextual variable that influences the content of negotiations).

The freight-transport-purchasing, freight-transport-ordering, and goods-delivery-preparation processes are related to the frameworks on load factor presented in papers IV and V, because decisions that are made during these processes result in available and required capacity, which should be in balance in order to achieve a high load factor (see Figure 33). The 'available capacity' referred to in papers IV and V corresponds to the capacity ordered in the freight-transport-ordering process, in the 'transport planning' activity (Paper VI), or in more detail when placing the freight-transport order (Paper VII). The 'required capacity' referred to in papers IV and V corresponds to the output from the goods-delivery-preparation process: that is, after loading the vehicle, how much capacity was required. It would be useful for purchasers of freight transport to evaluate the balance between purchased capacity and required capacity; to do so they could make use of the load-factor model presented in Paper IV, where purchased capacity can be translated into available capacity and compared with required capacity.

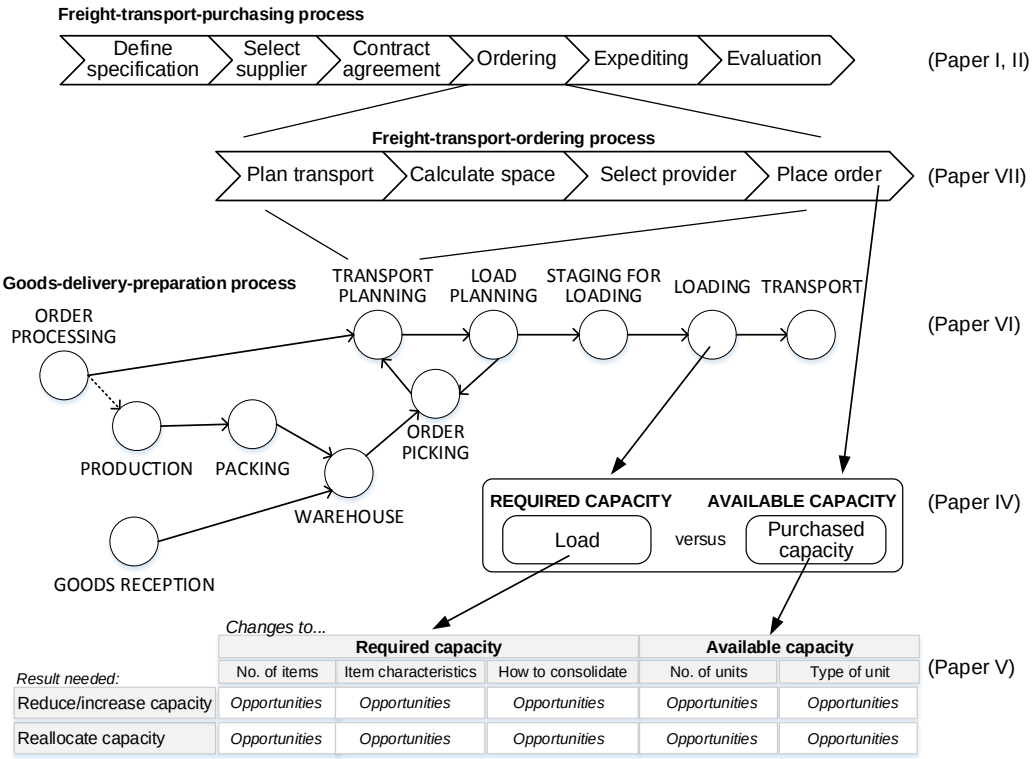


*Figure 33: Relating the processes described in papers I, II, VI, and VII to the load-factor frameworks presented in papers IV and V*

From a purchaser's perspective, the load-factor model could be used to assess how efficiently the purchased capacity has been used. The purchaser might prefer to use the capacity that has been paid for as a measure rather than using volume (to pick one example), since certain characteristics of the products or items may prevent full volumetric usage, such as the inability to stack bulky items. Further, to improve capacity utilisation, the framework of opportunities for increasing load factor presented in Paper V can be used. That framework presents suggestions for ways to change required or available capacity; such changes can be related back to the freight-transport-purchasing process. The contract creates the frames within which the freight-transport order is placed, and may in this way influence available capacity (i.e. purchased capacity). Examples include the type of freight transport that is contracted and at what time the information about required capacity is communicated to the transport provider. For example, in one of the cases examined in Paper V, the agreement with the transport provider was changed vis-à-vis the type of service purchased (less-than-full truckloads [LTL] compared to full truckloads [FTL]), which changed the available capacity.

Relating this to influence on $CO_2$ emissions, load-factor performance is used as an indicator of $CO_2$ emissions, meaning that a high load factor is beneficial for decreased $CO_2$ emissions.

As can be understood from the discussion above, dependencies may be found between the activities in the goods-delivery-preparation process and the activity 'purchasing of freight transport' (see Figure 34). Sequential dependence between two activities appears clear in situations where freight-transport ordering in the 'transport planning' activity depends on the contract agreements from the 'freight-transport purchasing' activity. Reciprocal interdependence may also be found,

since there is a loop where the output of how much is transported (and to where) becomes the input for what is currently bought when a new purchasing process starts: for example, renegotiating contract agreements or selecting new transport providers. In the cases examined in Paper VI, however, the respondents provided no examples of dependencies between the purchasing of freight transport and transport planning when they were aiming to achieve high load factor. It is difficult to ascertain which of the characteristics of those cases prevented this dependence. The next sub-section discusses coordination between transport planning and the purchasing of freight transport.

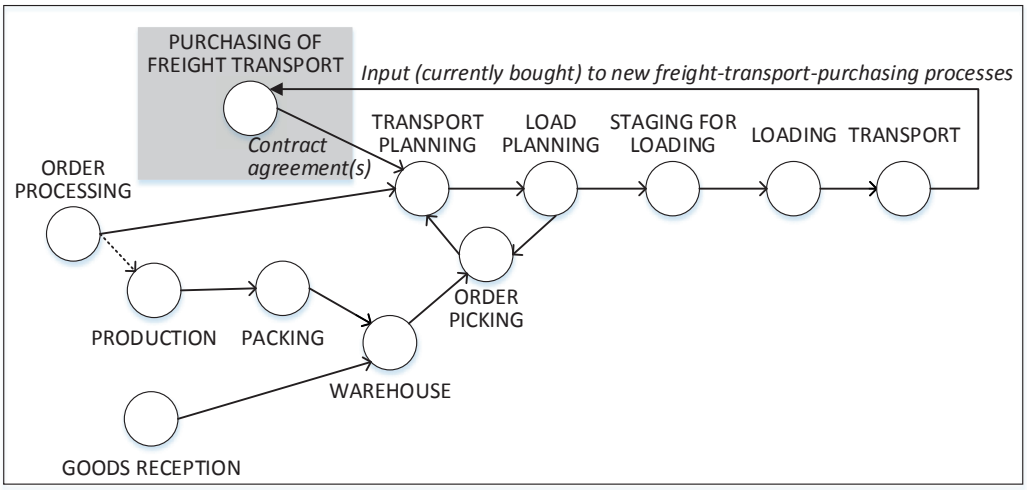


*Figure 34: Interdependencies between activities in the goods-delivery-preparation process and the 'purchasing of transport' activity*

### 5.3.3 Coordination between the 'purchasing of freight transport' and 'transport planning' activities

It is clear from the cases examined that the people who order the transport are rarely the same as those who purchase the freight transport and agree to the contracts. The purchasing of freight transport instead takes place at a tactical level in the organisation, whereas the transport planning occurs in the course of the daily operational work. Managers purchased the freight transport in the small and medium sized enterprises (SMEs) examined in this thesis, while operational staff ordered the freight transport. Often these people were located in different parts of the respective companies. For example, the people who ordered freight transport might work in the vicinity of the dispatch area, while the people who purchased the freight transport worked in office settings.

Further, the responsibility for the purchase of freight transport resides in different organisational functions: the purchasing might performed by purchasing staff or by logistics staff or jointly between purchasing and logistics. These differences in responsibility were found in Study I/Paper I of this thesis, as well as in the work by Gentry and Farris (1992), who found that the responsibility for purchasing inbound freight transport is often shared between the purchasing and distribution departments. If the purchasing of freight transport is performed by the purchasing staff, then interfunctional coordination is required, while if the purchasing of freight transport is performed by the logistics staff, then intrafunctional coordination is required. As was found in Paper VI in terms of the coordination

of the goods-delivery-preparation process, different coordination mechanisms are useful depending on whether intra- or interfunctional coordination is required.

Because different people perform the activities and because dependencies exist between the activities, coordination between activities is required. Although coordination between the purchasing of freight transport and transport planning was not examined within the studies described in this thesis, it is still possible to discuss a few insights into useful coordination mechanisms.

The coordination mechanisms 'direct supervision' and 'standardisation of work' are used in the coordination of the purchasing of freight transport and transport planning. In the cases examined in Paper VII, the coordination of the 'purchasing of freight transport' and 'transport planning' appeared to be performed mainly by the use of coordination mechanisms, which Glouberman and Mintzberg (2001) assigned to those contexts where there is a hierarchy of authority: for example, 'direct supervision' in terms of instructions for the ordering of freight transport or of which providers to select (and under which circumstances) or 'standardisation of work' in terms of process descriptions. This situation corresponds to the hierarchical situation and tactical-versus-operational activities.

While Paper VI showed the usefulness of the coordination mechanisms 'standardisation of norms' and 'standardisation of skills and knowledge', these mechanisms may also prove useful in coordinating between the 'purchasing of freight transport' and 'transport planning'. There appeared to be less use of 'standardisation of norms' in the cases examined, the companies could have used this mechanism to increase awareness of the purchasing of freight transport (in terms of the implications for transport planning) as well as later activities in the goods-delivery-preparation process. In Paper VI, the awareness of conditions in a subsequent activity was improved through the use of 'standardisation of norms'. Based on those findings, this thesis suggests further use of the coordination mechanisms 'standardisation of norms' and 'standardisation of skills and knowledge' in order to improve awareness and understanding within freight-transport purchasing of the implications on various logistical variables (and through those variables on $CO_2$ emissions).

Further, the coordination mechanism 'mutual adjustment' might also be used in coordination between the 'purchasing of freight transport' and 'transport planning' to create a loop that would then improve both activities. Paper V provides an example from one of the cases of greater flexibility in the amount of freight transport that was ordered; this situation could be described as the 'purchasing of freight transport' adjusting to 'transport planning' in terms of the introduction of a differentiated booking process to match order variations, thus adjusting purchased capacity to variations in required capacity across weekdays. In addition, in the same case, the purchasing of freight transport was coordinated with several activities in the goods-delivery-preparation process. Adjusting to improvements that were possible in load planning and staging for the transport, the purchasing of freight transport changed the agreements with the transport provider. In load planning, for example, the improvement consisted of changes to the load units; the change was performed in agreement with the transport provider and thus involved the purchasing of freight transport. In staging for transport, the improvement consisted of introducing preloading staff, who staged the goods;

because the staff were employed by the transport provider, the change was performed via the purchasing of freight transport. In these examples of improvements, the purchasing of freight transport adjusted to the improvement possibilities in the operational activities, i.e. transport planning, load planning, and the staging of transport.

In addition, it may also be possible to take inspiration from the use of coordination mechanisms presented in Paper VI when coordinating between the purchasing process and other activities and actors vis-à-vis the requirements that form the specification in the first stage of the purchasing process, *define specification*. As was highlighted in Paper II, requirements such as delivery-time windows influence logistical variables and set the conditions for the freight-transport execution of transport providers. The requirements are often not established by the people who are responsible for the purchasing process, however, but instead come either from other parts of the organisation or originate with customers (or suppliers for inbound freight transport). It may be possible to use the six coordination mechanisms described by Glouberman and Mintzberg (2001). A first step would be to map the dependencies in order to understand what needs to be coordinated, similarly to the method used in Paper VI.

### 5.3.4 Focus of coordination depending on load-factor performance

In this sub-section, the structure that is provided by the load-factor model (in Paper IV) is used to describe the relevant focus of coordination depending on load-factor performance at different load-factor levels.

What type of coordination will be most relevant will differ depending on the load-factor performance at the packaging, shipping, or vehicle/fleet levels (see Table 26). When load factor is high at all load-factor levels, then shippers should target other possibilities than load factor for decreasing their $CO_2$ emissions. When load factor is low at one or more load-factor levels, coordination can be used to improve the balance between required and available capacities. When load-factor performance is low at the packaging level, internal coordination of goods-delivery preparation is suggested as being the most relevant to change required and available capacities. When load-factor performance is low at the shipping level, (1) internal coordination of goods-delivery preparation is suggested to change required capacity, (2) internal coordination between goods-delivery preparation and freight-transport purchasing is suggested to balance required and available capacities, and (3) external coordination between freight-transport purchasing and the transport provider(s) is suggested to change available capacity. When load-factor performance is low on the vehicle or fleet level, external coordination between the shipper and the transport provider is suggested in order to investigate whether the load factor can be increased via consolidation with other goods from other shippers.

*Table 26: Relevant coordination depending on load-factor performance at different load-factor levels*

| **Load-factor performance** | | | **Relevant coordination** |
|---|---|---|---|
| Packaging level | Shipping level | Vehicle/ fleet level | |
| High | Low | Low | **Internal coordination:**<br>– of goods-delivery preparation: to balance required and purchased capacities<br>– of goods-delivery preparation and freight-transport purchasing: to balance required and purchased capacities<br>**External coordination:**<br>– of freight-transport purchasing and transport provider: to change purchased capacity<br>– of freight-transport purchasing and transport provider, to change conditions for required or available capacities at the vehicle or fleet level |
| High | High | Low | **External coordination:**<br>– of freight-transport purchasing and transport provider: to change conditions for required or available capacities at the vehicle or fleet level |
| Low | Low | Low | **Internal coordination:**<br>– of goods-delivery preparation: to balance required and available capacities at the packaging and shipping levels<br>– of goods-delivery preparation and freight-transport purchasing: to balance required and purchased capacities<br>**External coordination:**<br>– of freight-transport purchasing and transport provider: to change purchased capacity<br>– of freight-transport purchasing and transport provider: to change conditions for required or available capacities at the vehicle or fleet levels |
| Low | High | Low | **Internal coordination:**<br>– of goods-delivery preparation: to balance required and available capacities inside the packaging<br>**External coordination:**<br>– of freight-transport purchasing and transport provider: to change conditions for required or available capacities at the vehicle or fleet levels |
| High | Low | High | **Internal coordination:**<br>– of goods-delivery preparation: to change required capacity<br>– of goods-delivery preparation and freight-transport purchasing: to balance required and purchased capacities<br>**External coordination**:<br>– of freight-transport purchasing and transport provider: to change purchased capacity |
| High | High | High | Target areas other than load factor for improvement |
| Low | Low | High | **Internal coordination:**<br>– of goods-delivery preparation: to balance required and available capacities at the packaging and shipping levels<br>– of goods-delivery preparation and freight-transport purchasing: to balance required and purchased capacities<br>**External coordination:**<br>– of freight-transport purchasing and transport provider: to change purchased capacity |
| Low | High | High | **Internal coordination :**<br>– of goods-delivery preparation: to balance required and available capacities inside the packaging |

The most relevant coordination for enabling high load factor is especially clear in three situations where load-factor performance is low at one level (packaging, shipping, or vehicle/fleet) while it is high at the other levels. Low load factor at the packaging level means that there is empty space inside the packaging itself,

while low load factor at the shipping level means that the purchased capacity is not well utilised: for example, only one layer of pallets is loaded in the truck, thus leaving empty space above the pallets, or more floor space has been purchased than was required. Low load factor at the vehicle level means that the vehicle is not well utilised: for example, there is empty space inside the vehicle. Low load factor at the fleet level means that the fleet of vehicles is not well utilised: for example, the load could have been carried by fewer vehicles.

An example of low load factor at the packaging level while load factor at the other load-factor levels is high would be when a vehicle is filled with boxes but the boxes themselves are almost empty. An example of low load factor at the shipping level while load factor at the packaging and fleet levels is high would be a situation where the boxes are full and the transport providers utilise all of their vehicles, but the shipper's purchased capacity has unused space. An example of low load factor at the vehicle level while load factor at the other load-factor levels is high would be a situation where the purchased space is full of full boxes, but the remainder of the vehicle is empty, meaning that the transport provider has not succeeded in filling the remaining space with goods from other shippers.

When load factor at the packaging level is low, then the balance between required and available capacity at the packaging level should be improved, and internal coordination of the goods-delivery preparation appears necessary in order to change the required as well as available capacity as a means of increasing the load factor. Therefore, when load factor is low at the packaging level but high at both the shipping and vehicle/fleet levels, internal coordination of the goods-delivery preparation is suggested in order to increase the load factor.

When the load factor at the shipping level is low, then the balance between required and available capacity at the shipping level should be improved. Then, internal coordination of goods-delivery preparation is suggested to change the required capacity, and internal coordination of freight-transport purchasing and goods-delivery preparation is suggested to ensure that purchased capacity is in balance with required capacity. Further, external coordination between the freight-transport purchasing and the transport provider is suggested to change available capacity at the shipping level. Therefore, when load factor is low at the shipping level but high at the packaging level, internal coordination of goods-delivery preparation, internal coordination between goods-delivery preparation and freight-transport purchasing, and external coordination between freight-transport purchasing and the transport provider(s), is suggested to balance required capacity with purchased capacity.

When the load factor at the vehicle or fleet level is low, external coordination between the shipper purchasing transport and the transport provider is suggested to investigate if the load factor can be increased at the vehicle or fleet levels. Therefore, when load factor is high at both the packaging and shipping levels but low at the vehicle or fleet levels, external coordination between shipper and the transport provider in the freight-transport-purchasing process is suggested to increase the load factor. This means that the actors involved should investigate whether transport providers can consolidate the goods from the particular shipper with goods flows from other shippers, or if there are any specified requirements

that cause the low load factor at the vehicle or fleet level: for example, requirements about specific delivery time windows or pick-up times.

In contexts where load-factor performance is low on more than one load-factor level, coordination for each of these levels individually appears to be important. For example, when load factor is low at both the packaging and shipping levels, there is the potential for coordination to increase the load factor at both of these levels. In order to increase load factor at the packaging level, internal coordination of goods-delivery preparation is suggested to ensure that required and available capacities inside the packaging are well balanced. To increase load factor at the shipping level, internal coordination of goods-delivery preparation, internal coordination between goods-delivery preparation and freight-transport purchasing, and external coordination between freight-transport purchasing and the transport provider(s), is suggested to balance required capacity with purchased capacity. Internal coordination of goods-delivery preparation is suggested to change the required capacity: for example by double-stacking the items. Internal coordination of purchasing and goods-delivery preparation is important to ensure that purchased capacity is in balance with required capacity: for example that the purchased capacity is not overestimated compared to the required capacity. External coordination between freight-transport purchasing and the transport provider is suggested to make any changes to purchased capacity that may be needed to balance the required capacity.

When load factor is low at all load-factor levels, then shippers can coordinate both internally and externally to increase their load factor at the packaging, shipping, vehicle, and fleet levels. The load-factor model (Figure 19) and the framework of opportunities (Figure 20) can be used to support shippers in deciding which load-factor level to target first.

The actions that shippers can take to influence logistical variables during both the purchasing and preparation of freight transport are summarised in Table 27. In addition to including actions that shippers may take to enable high load factor, this table includes actions they can take that will influence the other logistical variables; the table also serves as a summary of this thesis's implications for practice.

*Table 27: Overview of actions shippers can take to influence logistical variables during the purchasing and preparation of freight transport*

| Logistical variable | What can shippers do? |
|---|---|
| **Mode used** | In the freight-transport-purchasing process:<br>**Defining specification**: consider the need for the following requirements: *time*, *frequency*, *delivery precision*, *specific time for delivery*, *flexibility in departure*, and *method of transport.* Discuss implications on the mode that is used with the transport provider.<br>The same consideration of issues and discussions are relevant if investigating possible change of mode. |
| **Handling factor** | In the freight-transport-purchasing process:<br>**Selecting providers**: compare their network structures. |
| **Length of haul** | In the freight-transport-purchasing process:<br>**Defining specification**: consider the need for the following requirements: *route*, *time windows*, *nominated delivery day*, *method of transport.* Discuss implications on distance with the transport provider.<br>**Selecting providers**: compare their network structures. |
| **Load factor** | In the freight-transport-purchasing process:<br>**Defining specification**: consider the need for the following requirements: *time windows*, *delivery before certain time*, *frequent deliveries*, *size of shipment*, *load units*, *dedicated transport*, and *variation in volume.* Discuss implications on load factor with the transport provider.<br>Coordination with goods-delivery-preparation activities in terms of sizing the purchased available capacity to match required capacity.<br>**Selecting providers**: compare concentration of clients in areas that are being delivered to and collected from. Discuss load factor in vehicles and fleet.<br>**Contracting**: consider implications of agreement length and contract type on load factor. Include performance metrics for load factor; consider how it can be measured so that it can be monitored and followed up during the contract period. Discuss sizing of available capacity to match required capacity (e.g. variations in the latter).<br>In the goods-delivery-preparation process:<br>**Evaluate existing load factor** by calculating overall load factor as well as on different levels.<br>**Identify areas for change** by evaluating the potential for improvement and possibility to change available or required capacity as well as different load-factor levels.<br>**Identify which aspects to change** by evaluating ability and willingness to change the determinants of required or available capacity and any possibilities to reallocate capacity between time periods. Possibilities include to reallocate required capacity in terms of number of items; to reduce/increase required capacity in terms of number of items, item characteristics, and consolidation method; to reallocate units in available capacity; and to reduce/increase available capacity by changing number of units or type of units.<br>**Evaluate** implications of changes (calculate) and decide which actions to take.<br>**Map interdependencies between activities** to perform selected actions. Based on these interdependencies, **use the appropriate coordination mechanisms**. For intrafunctional coordination between logistics activities with sequential interdependence, use 'standardisation of work' and 'standardisation of skills and knowledge'. If the coordination is dyadic, 'direct supervision' is also of interest. If the coordination is between multiple activities, 'standardisation of output' and 'standardisation of norms' are of interest. For intrafunctional coordination between logistics activities with reciprocal interdependence, use 'mutual adjustment' in situations with dyadic coordination and 'standardisation of work' for coordination between multiple activities. For interfunctional coordination, 'standardisation of norms' is useful. In situations with sequential interdependence and dyadic coordination, 'direct supervision', 'standardisation of output', and 'standardisation of skills and knowledge' can also be used. In situations with reciprocal interdependence and coordination between multiple activities, 'mutual adjustment', 'standardisation of work', and 'standardisation of skills and knowledge' are of interest. |
| **Empty running** | In the freight-transport-purchasing process:<br>**Defining specification**: consider the need for the following requirements: *time windows*, *late collections*, *specialised vehicles or equipment*, and *transport method.* Discuss implications on empty running with the transport provider. |
| **Fuel efficiency** | In the freight-transport-purchasing process:<br>**Defining specification**: include training on eco-driving. Also consider the need for time restrictions and discuss implications on fuel efficiency with the transport provider.<br>**Selecting providers**: enquire about and compare transport providers' eco-driving capabilities. Discuss possibilities for improving fuel efficiency with providers.<br>**Contracting**: include performance metrics on vehicles and eco-driving. Consider ways to measure eco-driving so that it can be monitored and followed up on during the contract period. |
| **Carbon in fuel** | In the freight-transport-purchasing process:<br>**Defining specification**: consider the use of alternative fuels. Discuss possibilities with the transport provider.<br>**Selecting providers**: enquire about and compare transport providers' use of alternative fuels.<br>**Contracting**: include performance metrics on the use of alternative fuels. Consider ways to measure their usage so that it can be monitored and followed up on during the contract period. |

### 5.3.5 Internal coordination depending on context

This sub-section discusses whether or not the different contextual variables that were studied in Paper I result in situations in which different aspects of coordination are important (i.e. communication or mutual understanding), as well as if different coordination mechanisms are suitable. The discussion draws on the contextual variables described in Paper I, the coordination mechanisms described in Paper VI, and a framework introduced by Mentzer and Kahn (1996).

The classification in Figure 35 below is inspired by Mentzer and Kahn's (1996) model of integration between logistics and other departments, where high communication but low mutual understanding are required for stable products and markets; high communication and high mutual understanding are required for complex, critical, and customised situations; high mutual understanding and low communication are required for ever-changing and special situations; and finally, low mutual understanding and low communication are required for department-specific activities.

With this in mind, the contextual variables from Paper I have been categorised according to higher or lower levels of stability (i.e. repetitiveness) and whether the variables are complicated or simple.

Similarly to Mentzer and Kahn's work (1996), high communication and low mutual understanding is required in stable situations. Stable situations refer to repetitive locations of recipients/senders, repetitive shipment sizes, and functional products (i.e. few changes). A modified rebuy-purchasing situation has also been assigned to this quarter in this thesis, since one aspect of the purchase (either the supplier or the product) remains stable.

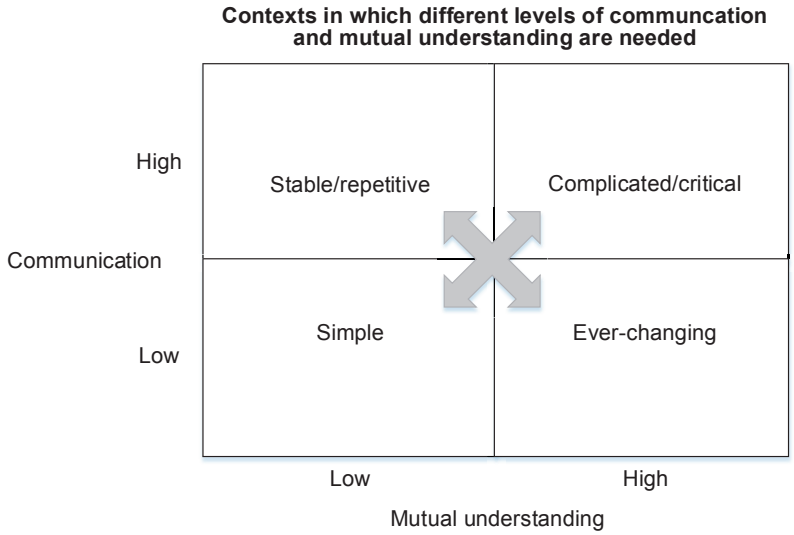


*Figure 35: Linking contexts to coordination (inspired by Kahn and Mentzer, 1996)*

As in Mentzer and Kahn's work (1996), high mutual understanding and low communication are required for changing and special situations. 'Changing situations' refer to changing locations of recipients/senders, changing shipment sizes, and innovative products: an example of all of these would be a new product with a customised shipment size sent to a new location. With a high degree of uncertainty (in this case, a context of changing locations, changing shipment sizes,

and innovative products), there may not be time to communicate every single thing that differs; instead, mutual understanding is needed to ensure that people make decisions in the same direction.

High mutual understanding and communication are both needed for complicated or critical situations. 'Complicated situations' refer to new task-purchasing situations, purchasing multiple services, and a high degree of freight-transport customisation. If it is for more than one product, and if not repetitive, a high degree of freight-transport customisation could instead require a high degree of mutual understanding but low communication. 'Complicated' may also refer to global locations of recipients/senders, many recipients, and an aim for full-load services (i.e. this is complicated in the sense that work is required to fill the purchased capacity). 'Critical' in this context refers to high freight-transport costs, a high 'unique driver', and the requirement for a partnership-relationship approach with the transport provider.

Low mutual understanding and communication – which, according to Mentzer and Kahn (1996), is needed in department-specific situations – in this case is assigned to simple tasks where relatively little interaction is needed. 'Simple tasks' refer to local locations, few recipients/senders, partial-load services (where one sends what one has and leaves consolidation to the transport provider), and no freight-transport customisation (i.e. purchasing existing services with no modifications). Simple tasks also refer to straight rebuy situations, where both the transport flow and the supplier stay the same; purchasing only freight transport; aiming for an 'arm's-length' supplier relationship; having low freight-transport costs; and where freight transport is not a unique driver. Companies that have viewed transport as a commodity and have used an arm's-length approach to their transport providers have likely kept the activity within the transport function; communication with other functions or mutual understanding with others has thus not been necessary.

As a second step, suitable coordination mechanisms for each category may be suggested. These suggestions are based on achieving a mutual understanding, for which standardisation of norms is important; and on a good fit with uncertainty and stability. For example, 'standardisation of work' and 'standardisation of output' would be appropriate coordination mechanisms in situations that are repetitive, while 'mutual adjustment' would be suitable in situations that are either very simple or very complicated. 'Standardisation of skills and knowledge' is also a coordination mechanism that can be used in situations with higher uncertainty that are also more complicated.

## 5.4 Discussion of transferability of findings to other contexts

This section discusses how the results of this thesis can be of interest to shippers in general.

There are no obvious reasons that several of the models should not be applicable more generally than to only the cases examined for this thesis. The load-factor model, the framework of opportunities, and the model linking the freight-transport-purchasing process to logistical variables all drew on work from the

literature in their development, meaning that they are not limited to the contexts in which the empirical data was collected.

The load-factor model (Figure 19) and the framework of opportunities to achieve high load factor (Figure 20) are applicable both to outbound and inbound transport, but because they were developed using empirical data from outbound transport, they place more emphasis on aspects that are relevant for outbound transport. The fact that outbound transport was studied means that the models cover the preparation of goods for outbound transport and include customer agreements. For inbound transport, the load-factor model can be applied to the supplier of goods. The load-factor model is general enough that the user can decide at which load-factor level it should be applied. For example, packaging levels may be performed at a supplier company. The study of coordination (Study VI/Paper VI) applied the framework of opportunities to inbound transport.

The focus on road transport in Study V led to a model that is designed for road transport, although the idea of balancing required and available capacities is general enough that it could be applied to other modes of transport as well. There are several differences in the way in which load factor is measured in other modes, however, and thus the application of the model to other modes would be a suitable topic for further study.

Even though the companies examined in this thesis are Swedish, both international and national transport flows have been studied. The findings on international transport flows may be transferable to export flows from companies based in other countries. Since the descriptions of the processes for goods-delivery preparation and freight-transport purchasing drew on existing research that is not limited to the Swedish context, there are likely similarities in other countries even though the empirical data that was collected is from the Swedish context.

The cases examined for this thesis are not limited to a particular type of company. Both manufacturing companies and wholesalers/distributors were studied. Instead, the descriptions of material-flow characteristics presented in Paper I/Study I is useful for describing the transport flows of a company and to help one understand what is special in that company's situation.

Because internal coordination within a company is an important antecedent for successful interorganisational coordination (for example of a supply chain), the results on internal coordination are thus relevant to companies that are interested in external coordination.

For company size, Paper II/Study II examined SMEs, where few people worked with purchasing freight transport. As such, they had limited resources to work with greening their freight-transport purchases; the guidance provided in this thesis can therefore be valuable to them. The level of detail of activities in the purchasing process was low in Paper II/Study II and may be higher in larger companies. Company size is also relevant to coordination: in a small company the same person may be responsible for several activities. If that person performs several activities, then coordination between them will be different compared to coordinating different people who perform the activities. If the same person manages several activities, then hierarchical coordination mechanisms will be

more relevant to his or her purposes. For the application of the framework of coordination mechanisms in eight situations, the activities that are managed will have implications for intra- versus interfunctional coordination. Coordination may also involve fewer people in a small company compared to what might be the case in a larger company, which can be relevant for deciding which coordination mechanisms to use.

The cases examined in this thesis covered many different types of transport services – and the models are in general applicable, regardless of the type of transport service – but the type of transport service will result in different requirements and foci. For example, urgent express services do not allow the same time for dialogue with the transport provider to take place for each specific shipment compared to a dedicated transport.

The results illuminate several points for shippers to consider. Although the activities, causes, and effects of influences of the freight-transport-purchasing process on the logistical variables will not be exactly the same in another company (due to its specific context), they may recognise one or more of the influences. Similarly, the order in which activities are performed in the goods-delivery-preparation process may differ between companies, but shippers may recognise one or more of the dependencies that cause the need for coordination to enable high load factor. Shippers may gain inspiration from the suggested actions for achieving high load factor described in Study V/Paper V and Study VI/Paper VI. Study I/Paper I illuminated the fact that differences exist in the purchasing process due to service type, purchase situation, and relationship, and shippers should consider what these factors mean in their specific situations. The study may have different implications in other contexts that it did not examine, but it can still be valuable for examining differences (and the implications of those differences). The results from Study II/Paper II brought attention to time requirements' effects on logistical variables; shippers should examine whether or not the influences that have been identified in this thesis exist in their particular contexts. Even when the time requirements are different, those requirements' influence on logistical variables may still be examined. Study VI/Paper VI showed differences in coordination depending on intra- or interfunctional coordination, number of activities to coordinate, and type of dependence. Shippers could consider what situation they are in (and the implications for their focus of coordination) as well as the coordination mechanisms to use.

## 5.5 Suggestions for further research

As shown in Table 27, this thesis has studied the influences on load factor from the goods-delivery-preparation process. The same level of detail could be applied to the other logistical variables examined within the thesis. In Study V, changes performed within the 'distribution round' case had implications on the distance driven and would thereby influence the logistical variable 'average length of haul'. Further studies could extend the research presented in this thesis by exploring (1) the influence of the goods-delivery-preparation process on the other logistical variables, (2) in which ways the logistical variables are influenced, (3) what actions can be taken in the goods-delivery-preparation process to influence the logistical variables, and (4) what types of coordination is needed.

This research described the influence of several specific contextual variables on the freight-transport-purchasing process, and suggested contextual variables' influence on the logistical variables via the purchasing process. Further research could test these suggestions and study more precisely the influence of contextual variables on logistical variables via the purchasing process.

Following from the findings on the influence of the purchasing process on logistical variables, a future step could be to measure $CO_2$ emissions before and after changes in the purchasing process. Data on before-and-after $CO_2$ emissions would provide further details on the influence of the purchasing process on logistical variables. The transport provider and the transport operator would need to be included in such studies in order to measure the $CO_2$ emissions of particular shipments.

As this research has not differentiated between types of transport provider, further research could study the consequences of purchasing from a third-party logistics provider compared to purchasing from transport operators who own their own vehicles. The interviews conducted for this thesis indicated that larger logistics-service providers were used when shippers were specific in their environmental requirements; they also indicated that the relationship between the shipper and the transport provider differed depending on the size of the transport provider: for example in the dialogue on alternative solutions. Based on this idea, researchers may find differences in the way in which dialogue about logistical variables is performed depending on the type of transport provider.

In the one case examined for this thesis where services other than freight transport were purchased at the same time, the respondents stressed the importance of a good working relationship and a long-term perspective; they also described that the process involved other criteria related to the warehousing service. Further research could examine situations in which other services in addition to transport are purchased from the provider; any differences in the purchasing could then be compared to when only freight transport is purchased.

It became clear from the interviews with the shippers that the requirements specified in the freight-transport-purchasing process sometimes originated with the shippers' customers; this means that shippers may need to work together with the customers of the goods in order to change the requirements. The studies on load factor provided examples of companies that did work with their customers to achieve better flexibility. Whether that would also be possible for logistical variables other than load factor and for the freight-transport-purchasing process was not discussed in this thesis, but this aspect could be studied further.

While this thesis has focussed on the purchasing process that leads up to contract agreements with transport providers (since these agreements create the conditions for the freight transport), it became apparent during the course of conducting this research that shippers are interested in improving their follow up of environmental performance. Following up on environmental performance, for example following up on specified environmental requirements, occurs after the contract has been signed in the ongoing relationship between the shippers and the contracted transport providers. The studies on the influence on the logistical

variables could be extended to practices in the ongoing relationship between shippers and transport providers within the purchasing-process-stage *evaluation*.

Two of the models that were developed were suggested based on empirical findings, but they should be tested in further contexts. The description of the purchasing process and different coordination mechanisms in eight contexts and eight situations (respectively) were developed based on the case studies; it would be of interest to gather empirical evidence for their application in other companies and contexts. The frameworks suggested in this thesis could be tested by using surveys to collect data in a variety of contexts, for example.

In addition, the frameworks could be further developed to cover other contexts. For the results on load factor, for example, the case studies had a higher representation of road transport than other modes of transport. The application of the load-factor model (Figure 19) and the framework of opportunities (Figure 20) to other modes of transport (such as air and rail) could be studied further to identify any differences and to adapt the models to those modes of transport. Because much of the focus related to load factor in this thesis was on consolidation – for example when packing, loading, and transporting – further research could study contexts where consolidation is not as important in order to identify which aspects are particularly important in such contexts and to test the applicability of the framework of opportunities to improve load factor (Figure 20) or to suggest necessary adaptations of the framework.

The application of the frameworks could also be developed in further research. For example, the use of the load-factor model and the framework of opportunities by shippers could be examined by identifying potential hindrances to applying the frameworks and by suggesting how companies could adopt the frameworks. Identifying in which situations different actions to achieve high load factor would be most suitable would be helpful for shippers to select suitable actions to perform. Researchers could study whether or not materials-flow characteristics could be used to describe such situations. Identifying barriers for implementation of different actions would help shippers in their implementation efforts.

The internal coordination process was studied in this thesis from the perspective of the logistics/transport function; this does not explain how other functions view work for achieving high load factor. Further research could extend the findings of this thesis by studying the understanding of load-factor performance in other functions in companies that achieve high load factor; the organisation of the activities that need to be coordinated could also be studied.

The study findings highlighted the importance of using the coordination mechanisms ‘standardisation of norms’ and ‘standardisation of skills and knowledge’ to achieve interfunctional coordination aimed at enabling high load factor. The use of these coordination mechanisms could be compared to their use in interfunctional coordination aimed at other goals. The similarities and differences between the uses of the coordination mechanisms for different goals could also be studied: for example, the applicability of the use of offering advice to other activities, which was used for improving load factor in the cases examined for this thesis.

The results in this thesis focus on what shippers can do internally to increase their load factor, but it would also be of interest to extend the scope to coordination with other actors, since various actions can be taken to improve load factor that will involve other actors (for example the transport provider). Paper III identified previous papers in the literature focussed on other actors' perspectives. This thesis has mentioned external coordination between shippers and transport providers, but such coordination could be further examined, as could interorganisational coordination between shippers and their customers and suppliers. The studies on load factor provided several examples of interactions with customers and suppliers to implement actions to improve load factors, but these were outside the scope of this thesis. The framework (Figure 25) presented in this thesis on the use of coordination mechanisms in different situations could be extended to include interorganisational coordination by studying the use of coordination mechanisms between shippers, customers, suppliers, and transport providers. The use of mutual adjustment in terms of negotiation appears to be of particular relevance for an interorganisational setting. Sallnäs (2016) found use of all six coordination mechanisms between shippers and transport providers and also illustrated that coordination mechanisms linked to hierarchical situations (e.g. direct supervision) were used for interorganisational coordination. This may also be the case between shippers and their customers and suppliers.

One apparent difference between the purchasing of freight transport and goods-delivery preparation is the degree of awareness and understanding of the implications for the various logistical variables. In the purchasing of freight transport, for instance, this thesis found the awareness of the implications for logistical variables to be quite low. Shippers were not accustomed to discussing logistical variables nor to considering what implications their actions might have had on such variables. When studying the goods-delivery-preparation process and load factor, on the other hand, a high degree of understanding of the importance of improving load factor was found; the organisations in the case studies took several actions to achieve their respective load factors. The shippers in the cases examined for this thesis thus showed a high awareness of the implications from the process on the logistical variable 'load factor'. The reasons and implications for the differences in levels of awareness and understanding could be studied in future research.

# 6 Conclusions

This chapter presents the conclusions of this thesis.

In order to enable shippers to make the most appropriate decisions related to reducing their $CO_2$ emissions from the freight transport they purchase, it was necessary to clarify their possibilities for doing so, which led to the purpose of this thesis: to clarify how shippers can influence $CO_2$ emissions from the freight transport they purchase.

- *The frameworks that have been provided in this thesis identify key points about how shippers can influence $CO_2$ emissions from the freight transport they purchase.*

  Six frameworks have been presented in this thesis: the purchasing process in eight type of contexts (Figure 16), the influence of purchasing process on logistical variables (Table 22), the use of coordination mechanisms (Figure 25), the load-factor model (Figure 19), opportunities to achieve high load factor (Figure 20), and relevant coordination types depending on load-factor performance at different load-factor levels (Table 26). These six frameworks illuminate specific points and provide various categories for sorting data. One example of illuminating specific points is that the load-factor model defines load factors at several levels in a shipper's system. Knowing which level to target for improvements is important for determining which actions to take in order to achieve high load factor. An example of providing categories may be found in the framework of opportunities, which provides an overview of the means to achieve high load factor. By categorising the opportunities, the user of the framework can compare opportunities and can identify any relevant actions that shippers can take to achieve high load factors.

- *This thesis provides various suggestions that shippers can use to achieve higher load factor, both in terms of balancing required and available capacities and for coordinating between activities to realise higher load factors.*

  This thesis has described load factor from a shipper's perspective; it makes clear that shippers work at several load-factor levels and can perform a variety of actions to achieve high load factor. Shippers must consider several important issues in order to achieve high load factor: managing the imbalance between required and available capacity, looking into how these capacities can be changed, and knowing that achieving high load factor demands coordination between activities. Using the suggestions found in this thesis, shippers can improve their load factors by identifying those actions that will be most relevant for them – and applying internal coordination to ensure that those actions are well implemented.

- *This thesis increases the knowledge about the influence of shippers' freight-transport-purchasing processes on $CO_2$ emissions.*

  This thesis has described how shippers influence logistical variables related to $CO_2$ emissions in their freight-transport-purchasing processes. By considering the influence of their specifications, selection criteria, and decisions that they make on various logistical variables, shippers can adapt their purchasing

processes to reduce $CO_2$ emissions. This thesis's results suggest that shippers should undertake discussions with their transport providers to better understand the effects of that influence. The use of dialogue (rather than simply stating requirements to transport providers) is suggested to reduce $CO_2$ emissions.

- *Shippers should create good conditions for the execution of freight transport both internally and externally (with transport providers).*

  This thesis has identified various dependencies between activities, which means that other activities set conditions that create the boundaries for what can be achieved. Such conditions might consist of, for example, not constraining options for how goods can be combined when loaded. Options for transport providers can also be loosened: for example by not specifying unnecessary requirements on time.

  In order to manage internal conditions and to realise aims to achieve high load factors, coordination between activities is crucial. Logistics managers who actively use coordination mechanisms are also more likely to secure support for their ideas within the company. Specifically, the use of 'standardisation of norms' is useful to increase general understanding among others and to increase the prospect that others will align themselves with the necessary actions to achieve high load factor. In addition, 'standardisation of skills and knowledge' was found to be useful in the cases as a way to increase the skills among other activities; in this way, those activities could then perform their tasks in alignment with achieving a higher load factor.

  Improving conditions for transport providers consist of making sure that utilisation is high within packages, on load units, and within the purchased capacity, as well as in providing item characteristics that would enable high vehicle and fleet utilisation. While this thesis has focussed on internal coordination, it also suggests that external coordination merits further research.

- *The study results contribute to research on the purchasing of freight transport and on load factor.*

  This thesis positions shippers' purchasing of freight transport within green logistics research. It contributes to the literature by describing the influence of the freight-transport-purchasing process on various logistical variables, which are used as indicators for $CO_2$ emissions. It also adds new findings that focus on the ways in which shippers can influence their load factors. It provides concrete suggestions for how shippers can improve their load factors and a structure for comparing and evaluating actions to improve load factor. It also describes why internal coordination is necessary to enable high load factor, what activities need to be coordinated, and how to perform coordination.

- *The results build on earlier research and combine different perspectives.*

  The connection of the two fields of purchasing and green logistics clarifies the causes and implications for logistical variables and shows the implications on $CO_2$-emissions to the purchaser of freight transport. Combining capacity management and load-factor levels clarifies various problems in terms of imbalances of required and available capacities as well as the means for improving the load factor. Combining order-fulfilment activities,

interdependencies between activities, and coordination mechanisms clarifies the different ways to realise high load factors.

- *Rich case-study data has led to the creation of various models and frameworks.*

  The deep understanding of each situation that was gained in the five case studies examined in this thesis was important for developing the models and frameworks that it presented. It was from the rich data provided by the case-studies that the models were refined. The close discussions with the respondents helped to ensure that the results would have practical relevance; in addition, the literature review helped to increase this understanding.

- *The results from this thesis are one step towards reducing transported goods' negative effects on the environment.*

  Given its concrete suggestions for ways in which shippers can enable high load factor and its discussions of how they can use the knowledge that they influence $CO_2$ emissions when purchasing freight transport, this thesis contributes numerous suggestions for increasing load factor, utilising freight-transport systems more efficiently, and reducing negative effects on the environment.

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# Appendices

| | |
|---|---|
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| Appendix II: | Literature searches in the studies |
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# Appendix I: Papers I–VII

The appended papers have been removed for copyright reasons.

# Appendix II

Literature searches in the studies

*Appendix II: Literature searches in the studies*

| Study | Search string combinations | Search tools |
|---|---|---|
| **I** | 'purchasing', 'purchasing process' OR 'freight transport purchasing' AND 'business services', 'process characteristics' OR 'contextual factors'; 'contingency theory' AND 'purchasing', 'purchasing process' OR 'logistics' | Google Scholar, ABI/Inform, Science Direct |
| **II** | 'purchas* transport', 'procur* transport', 'buy* transport', transport buy´', 'purchasing process' AND transport, 'procurement process' AND transport, 'logistic*' OR 'freight transport' OR 'transport' AND 'purchasing process', Mode AND Procur* AND transport, Mode AND Purchas* AND transport, Modal AND Procur* AND transport, Modal AND Purchas* AND transport, Handling AND Procur* AND transport, Handling AND Purchas* AND transport, , Handling factor AND Procur* AND transport, Handling factor AND Purchas* AND transport, Length of haul AND Procur* AND transport, Length of haul AND Purchas* AND transport, Distance AND Procur* AND transport, Distance AND Purchas* AND transport, , Haul AND Procur* AND transport, Haul AND Purchas* AND transport, Length AND Procur* AND transport, Length AND Purchas* AND transport, Fuel efficiency AND Procur* AND transport, Fuel efficiency AND Purchas* AND transport, , Fuel consumption AND Procur* AND transport, Fuel consumption AND Purchas* AND transport, Carbon intensity of fuel AND Procur* AND transport, Carbon intensity of fuel AND Purchas* AND transport, Fuel AND carbon AND Procur* AND transport, Fuel AND carbon AND Purchas* AND transport, , Empty running AND Procur* AND transport, Empty running AND Purchas* AND transport, Load factor AND Procur* AND transport, Load factor AND Purchas* AND transport, Fill rate AND Procur* AND transport, Fill rate AND Purchas* AND transport, , Lading AND Procur* AND transport, Lading AND Purchas* AND transport, Loading AND Procur* AND transport, Loading AND Purchas* AND transport, Fill AND Procur* AND transport, Fill AND Purchas* AND transport, Utilization AND Procur* AND transport, Utilization AND Purchas* AND transport | Scopus, ABI Inform, Web of Science, Google Scholar |
| **III** | 'logistic*', 'purchasing process', 'freight transport', 'freight, transport management', 'buy' AND 'shipper'; 'traffic manager' AND 'freight transport' | ABI/Inform, Scopus, ProQuest |
| **IV** | 'load factor' AND 'freight transport', 'load factor' AND 'freight transportation', 'load factor' AND 'goods transport', 'load factor' AND 'goods transportation', 'loading factor' AND 'freight transport', 'loading factor' AND 'freight transportation', 'loading factor' AND 'goods transport', 'loading factor' AND 'goods transportation', 'lading factor' AND 'freight transport', 'lading factor' AND 'freight transportation', 'lading factor' AND 'goods transport', 'lading factor' AND 'goods transportation', 'fill rate' AND 'freight transport', 'fill rate' AND 'freight transportation', 'fill rate' AND 'goods transport', 'fill rate' AND 'goods transportation', 'filling rate' AND 'freight transport', 'filling rate' AND 'freight transportation', 'filling rate' AND 'goods transport', 'filling rate' AND 'goods transportation', 'vehicle fill' AND 'freight transport', 'vehicle fill' AND 'freight transportation', 'vehicle fill' AND 'goods transport', 'vehicle fill' AND 'goods transportation', 'vehicle loading' AND 'freight transport', 'vehicle loading' AND 'freight transportation', 'vehicle loading' AND 'goods transport', 'vehicle loading' AND 'goods transportation', 'vehicle utilization' AND 'freight transport', 'vehicle utilization' AND 'freight transportation', 'vehicle utilization' AND 'goods transport', 'vehicle utilization' AND 'goods transportation', 'truck utilization' AND 'freight transport', 'truck utilization' AND 'freight transportation', 'truck utilization' AND 'goods transport', 'truck utilization' AND 'goods transportation', 'vessel utilization' AND 'freight transport', 'vessel utilization' AND 'freight transportation', 'vessel utilization' AND 'goods transport', 'vessel utilization' AND 'goods transportation', 'ship utilization' AND 'freight transport', 'ship utilization' AND 'freight transportation', 'ship utilization' AND 'goods transport', 'ship utilization' AND 'goods transportation', 'train utilization' AND 'freight transport', 'train utilization' AND 'freight transportation', 'train utilization' AND 'goods transport', 'train utilization' AND 'goods transportation', 'cargo utilization' AND 'freight transport', 'cargo utilization' AND 'freight transportation', 'cargo utilization' AND 'goods transport', 'cargo utilization' AND 'goods transportation', 'utilization of vehicle capacity' AND 'freight transport', 'utilization of vehicle capacity' AND 'freight transportation', 'utilization of vehicle capacity' AND 'goods transport', 'utilization of vehicle capacity' AND 'goods transportation', 'empty running' AND 'freight transport', 'empty running' AND 'freight transportation', 'empty running' AND 'goods transport', 'empty running' AND 'goods transportation' | Summon |
| **V** | Draws on literature review in Study IV. | |
| **VI** | 'interfunctional coordination' AND logistic* AND transport*, 'interfunctional co-ordination' AND logistic* AND transport*, Abstract (interfunctional co-ordination) AND Abstract (logistic*) OR Abstract (transport*), Abstract (interfunctional coordination) AND Abstract (logistic*) OR Abstract (transport*), Abstract ('interfunctional co-ordination') AND Abstract (logistic*) OR Abstract (transport*), Abstract ('interfunctional coordination') AND Abstract (logistic*) OR Abstract (transport*)<br>Also draws on literature search in Study IV. | Summon |

# Appendix III

Interview guide Study I, which provided input to Paper I
(translated from Swedish)

**Interview with (Name):**
**Role/position:**
**Company:**

**Company size:**
Number of employees: _____
Turnover (2009): _____ SEK

Estimate total logistic costs as a percentage of the company's turnover: _____ %

Estimate freight-transport costs as a percentage of the company's turnover: _____%

How much freight does your company send per annum?

How much freight does your company receive per annum?

**Where in the supply chain is the company?**

**What is the main line of business?**

**To what extent does your company use:**
Own production _____ %
Make-to-order _____ %
Make-to-stock _____ %

Distribution from warehouse in other country to Sweden?

**Describe your goods flows:**

*Volumes transported? Volume of freight per year.*
*Large or small quantities*
*Recurring goods flows*
*Variation in volume*
*Repetitive goods flows?*
*Few pickup and delivery locations?*
*Customised requirements on handling of goods*
*Coordination of goods flows*

**Describe the type of products your company sells/manufactures:**

*High or low value*
*Long or short product life cycle*
*Complicated product*
*Product size*
*Weight*
*Volume*
*Sensitivity (to damage)*
*Cumbersome*
*Dangerous goods*
*New innovative product*
*Rapid product changes*
*Modular*
*What is the most important product characteristic (quality, price ...)*
*Product range*
*Technical complexity*
*Risk of theft*
*Large, wide, needs customised solutions?*
*Packaging*
*Design*

**Describe the market for your products:**

*Stable?*
*Difficulties in forecasting demand*
*Competitors*
*Market share*
*Seasonal fluctuations*
*Cyclic fluctuations*
*Many/few customers*
*Large/small customers*
*Power relationship with customers*

**Describe your supplier relationships:**

*Access to raw material and components?*
*Long relationships?*
*Many or few suppliers?*
*Large or small suppliers?*
*Close or distant locations of suppliers? Where?*
*Power relationship with suppliers?*

**Where are the company's customers located?**

*Mainly export?*
*Local?*
*Regional?*
*National?*
*EU?*
*Rest of Europe*
*Rest of world (where?)*

**Do your customers make demands that influence the freight transport?**

*Speed*
*Timing of delivery*
*Packaging*
*Environment*

**Describe your distribution structure:**

*Location of warehouses*
*Direct delivery to customers*

**What customer service do you offer?**

*What level do customers demand?*

**How many production units exist, and where are they located?**

**How many warehouse units exist, and where are they located?**

**How high up on the agenda is the environment at this company?**

*How can this be seen?*

**Does the company have an environmental policy?**

*Does the environmental policy cover your freight transports? In what way?*

**Describe how logistics is organised:**

*How many people work with logistics issues?*
*Is there a logistics department?*
*Who handles transport issues? How many? Describe how it is organised.*

**What transports is your company responsible for?**
Inbound (extent of all inbound)
Outbound (extent of all outbound)
Transport between company units

**Do you purchase or run your own goods transport?**
*To what extent*

**Describe your transport providers:**
*Large? National/International? Small? Local? 3PLs* [third-party logistics], *transport operators?*
*Which ones* [names]
*Do you have long-term contracts?*
*Who negotiates these? How often?*
*Why did you select that/those transport provider(s)?*

**What services do you buy from the transport provider?**
*Transport*
*Warehousing*
*Information services*
*Product handling*
*Value-added services (assembly, configuration, installation, packaging, labelling, return, repairs, etc.)*
*Warehouse management*
*Consultants, logistics development*
*Administrative services*
*Other*

**Who makes the decisions on transport-provider selection?**

**What/which modes of transport are used?**
*Most common?*
*Extent of use*

**Do your customers set any environmental requirements that influence your transport solutions?**

**What influences your transport demand?**

**How often are your goods damaged during transport?**

**How does the volume to be transported vary?**

**What determines the selection of transport mode? Do you have an opinion about which mode of transport to use?**

**How far are your goods transported?**

**How many transport providers do you use?**
*Written agreements?*
*Frame agreements?*
*Less formal agreements?*
*Do you use transport providers that you do not have contracts with? In what situations?*
*How many transport providers do you have contracts with?*
*How many transport providers do you use that you do not have contracts with?*

**Describe the purchasing process for freight-transport services.**

**Why is it done in this way?**

**What options are there when purchasing transport and selecting transport providers?**

**What types of requirements do you pose on transport providers and on the transport itself?**

*Does your company set specific environmental requirements on your freight transports?*
*Who defines these requirements?*
*How much is specified towards the transport provider?*
*What is specified?*
*Why does your company require this? What is behind the requirement?*
*How detailed are specifications? What is specified in detail?*
*Requirement versus wish list?*

**Do you use any time restrictions for freight transport?**

**How often do you renegotiate your contracts? A completely new purchasing process? Describe how it is it done.**

**Does the selection of transport provider or transport solution influence company routines?**

**How do you handle express deliveries?**

**How do you handle unexpected transports?**

**Do you consolidate goods for transport?**

**How interested is the top management in freight-transport purchasing? In the environment?**

**Are there any environmental laws you have to follow?**

**How do you measure/follow up environmental performance from freight transport?**

*Is environmental performance from transport reported?*

**What is most important when selecting transport solutions?**

**Is there anything you have told me that you plan to change in the near future?**

**How is freight transport developing at your company (trends, plans)?**

**Is there anything you would like to add?**

# Appendix IV

Interview guide – Shipper, Study II, which provided input to Paper II
(translated from Swedish)

**Date:** _____
**Company:** _____

**Interview with (Name):** _____
**Role:** _____

**Interview with (Name):** _____
**Role:** _____

**Purchasing process for:** _____
**Time period:** _____
**Transport provider:** _____

**Contact information for transport provider (name, phone, e-mail):**
_____

**Type of process:**
- ☐ **New task**
- ☐ **Modified rebuy**
- ☐ **Straight rebuy**

**Critical change for some reason? (e.g. urgent or high importance to company)**

**Background information**

| | |
|---|---|
| Type of business | _____ |
| No. of employees | _____ |
| Turnover (MEUR) | _____ |
| Volume / transport provider | _____ |
| Number of requirements in contract | _____ |
| Number of requirements in RfQ | _____ |
| Variation in destinations | _____ |

**Please describe the purchasing process for freight transport.**

**What steps or activities do you perform?**

## From need to specify requirements

**Do you map what you need in any way? How do you do this?**

**WHEN**
When did you realise you needed the freight-transport service?
Within which time frame did you do something about that need?
How much time did you spend mapping what you needed?

**WHAT**
What did you need? Please describe.
Why did you need this?

**HOW**
How did you define what you needed?
Why did you do it that way?

Was it measurable?
What data did you collect?
Why did you collect that data?
Did you perform a risk analysis?

**WHO**
Who was involved?
Why were they involved?
Who did what?
Who specified the need? Who identified the need? Who approved that something should be done? Who mapped the need? Who was consulted?
Are the people who work with ordering transport involved? Are the people who load the transport involved? Are the recipients (customers) involved? Are the senders (suppliers) involved? What is their involvement?
Why are those people involved, and why did they do what they did?
Did you use external help (e.g. consultant)? Did you use internal help from others in the same organisation (e.g. advice)? Did you search on the Internet, in books, etc.?

**How is the need translated into a specification of requirements?**

**How do you develop the specification of requirements?**

**WHEN**
When did you start working on the specification of requirements?
How much time did you spend developing the specification of requirements?

**WHAT**
What did you do?
What is important to do?
What is most important?
Are there any trade-offs? If so, what are they?
What requirements are mandatory?
What requirements are desirable (i.e. on the wish list)?
How much is specified?
What is specified?
Are there any special needs? What are they?
What does the specification of requirements look like?

**HOW**
How do you express requirements (input/output/outcome/throughput)?
Why is it expressed in this way? Were there other alternatives?
How did you plan to handle deviations? Did you plan routines to prevent them?
Did your specification of requirements make it easy to compare different transport providers?

**WHO?**
Who was involved?
Why those people?
Who did what?

## Potential transport providers

**How did you decide which transport providers to contact (send requests for information/quotation to)?**

**How did you identify potential transport providers?**

**WHEN**
When did you start listing/looking for potential transport providers?
How long did it take before sending requests for information/quotation?

**WHO**
Who was involved?
Why those people?
Who did what?

**WHAT**
What did you do?

**HOW**
Did you use previous experiences, phone calls, online searches, recommendations from others, suggestions from colleagues, quotations received earlier …?
Why in that way?
Do you prefer to include new or only existing transport providers?
How does your previous experience matter?

**Did you send a request for information (RfI) or request for quotation (RfQ)? What did these contain?**

*Request for information*
Did it include transport data? What kind of data?
What other information did it contain? Requirements? Needs? About the company?
When did you send it?
How did you send it?
To how many people?
What did you want to know?
Why did you send it?
Did you narrow down the transport providers to a shortlist? How did you narrow them?

*Request for quotation*
Did it include transport data? What kind of data?
What other information did it contain? Requirements? Needs? About the company?
When did you send it?
How did you send it?
To how many people?
What did you want to know?
Why did you send it?
What did it look like?
What did it contain?
Did you use a questionnaire?
Was there a list for the transport provider to complete?
Did you ask for a presentation by the transport provider?
What did you look for at the presentation?
Did you visit the transport provider?
At the visit, what did you look for?
Why did you ask for a presentation (or a visit)?
Did you use previous experiences of their performance?
Did your specification of requirements make it easy to compare different transport providers?

## Selection

**How is the quotation analysed (comparisons between transport providers, evaluated against specification of requirements)?**

**How are transport providers evaluated?**

**WHO**
Who is involved? Why? Who did what?

**WHEN**
When did you start the evaluation of the offers?
How long did it take?
How did you compare transport providers/offers?
How much time did you spend on this?
How do you conduct comparisons? What do you use to compare (comparison against specification of requirements, against other transport providers)?
Is the evaluation model general or specific, and in what way?
Do you do different types of evaluations (company, process, service)?
What requirements are critical?
What requirements are mandatory?
What requirements are incentives?
What requirements are 'good to have'?

What method do you use? (General impression, score, weighting? Total cost of ownership, environment, etc.? Quantitative/qualitative?)
What criteria did you use?
Had you decided on trade-offs (e.g. cost vs time, quality vs customer service)?
Who works with evaluation of offers?
Who makes the decisions?
Why those/that person?
How is the evaluation linked to the company's need for freight transport?
Are environmental issues included?
How many companies do you move forward with?

**How were transport providers selected?**

**How many times did you go back, allow revised proposals, move forward with fewer, etc.?**
Please describe the procedure.
In what way were transport providers asked to revise their offers?
Who was involved?
What was the result?

## Negotiation

**How were the negotiations performed?**

**WHEN**
When did it start?
How much time did you spend (time span)?

Did you negotiate with several transport providers in parallel and/or after one had been selected? Did you go back and change transport providers after negotiation had started, or was it a question of getting the best terms?
What aspects do you negotiate? Time, price, delivery service, etc.?
Do you negotiate regarding environmental aspects? If so, what?
What terms do you negotiate?
How many transport providers do you negotiate with?
What is the time frame for requirements (fulfilled before contract is signed / during contract period / long-term goal)?
Who participates in the negotiation?
Were there several stages of negotiations?
How did the negotiation fit with the rest of the purchasing process?
What was your goal with the negotiation (win-win, joint decisions, win-lose, discuss differences between parties)?
What type of negotiation was it?
Was one party stronger than the other? Why? In what way could this be seen?
Was there no negotiation at all?
How did you prepare for the negotiation? Did you use any particular tactics? What? (meet halfway, consider all options, allow time, 'good cop/bad cop')?
Did you discuss payment terms?
Did you discuss incentives and penalties?
Did you discuss resources, responsibilities, measures? What did you agree?

**WHO**
Who was involved? Why those people? Who did what?

**How did you select the final transport provider?**
In this specific case, what closed the deal (what was crucial for the decision)?
How was the selection made: first mode of transport, then unit, and then transport provider? Or all aspects treated at the same time or another way?
In this specific case, what was crucial for the decision? (For example, criteria for selecting transport providers and then within that group, or other criteria? In that case, what criteria? Was the environment included, and if so, when?)
Who makes the decision?
What happens with transport providers that do not fulfil the stated requirements?

- No effect. (What requirements does this concern?)
- No longer in the selection process; another transport provider is selected
- They can revise their offer
- They are told to revise their offer in order to stay in the process
- The transport provider can promise to fulfil demand a) before contract is signed, b) before first purchase, c) during the contract, d) via continuous improvement
- The transport provider is offered training or financial support to meet the requirement.

**WHO**
Who was involved? Why those people? Who did what?

## Contract agreement

**What does the contract look like?**
Who was involved when agreeing to the contract? Did someone prepare the contract? Did someone approve the contract?
What was agreed upon in the written contract?

What was agreed upon verbally?
How comprehensive is the formal contract?
Are environmental issues included in the contract?
Are environmental issues included in the verbal agreement?
What is the time span of the contract? How long is it valid? How much time elapsed between when the contract was signed and its validation? What happens when the contract ends?
Who prepares the contract (transport provider or shipper)?
How are extra fees handled?
Do you consider total cost of ownership?
How much is specified in the contract? Is it detailed? Or is it rough? Is only a result asked for, or does the agreement specify how the result should be achieved?
Is the frame agreement complemented with less formal agreements about, for instance, volume or responsibilities? What do the less formal agreements include?

**WHO**
Who was involved?
Why those people?
Who did what?

**Communication with the transport provider**

**What information/communication between shipper and transport providers took place** (criteria, requirements, future requirements; why these)?
**When** (before/during evaluation)?

# Appendix V

Interview guide – Transport provider, Study II, which provided input to Paper II (translated from Swedish)

**Date:** _____
**Company:** _____

**Interview with (Name):** _____
**Role:** _____

**Customer (company):** _____
**Time period:** _____

**Type of agreement:**

- ☐ **Renewal**
- ☐ **New customer**
- ☐ **Large**
- ☐ **Frame agreement**
- ☐ **Specific agreement**

**Type of shipment:**

- ☐ Express
- ☐ Parcel
- ☐ Smaller goods via terminals
- ☐ Direct transport with pick-up from several customers
- ☐ Full load
- ☐ Dedicated transport (between units)

**Background information:**

Number of requirements in contract _____
Number of requirements in RfQ _____
Variation in destinations _____

**Was there anything in the way your customer acted or in the company's demands that could have influenced the following?**

- Mode of transport
- Handling
- Length of haul
- Load factor
- Empty running
- Fuel efficiency (e.g. queues, eco-driving, type of vehicle, etc.)
- $CO_2$ in fuel (what fuel?)

**Please describe the purchasing process from your point of view.**

What steps/activities were performed in the specific case?
When were you in contact?
What were you in contact about?
What information did you receive?
Who was involved from your company? Who did what?
What was your opinion of the customer's interest in the environmental performance of the freight transport?

**More detailed questions [if time allows]**
When was the contact initiated?
Who was involved?
What was done at that time?

**What information/communication between shipper and transport providers took place** (criteria, requirements, future requirements; why this)**?**
**When** (before/during evaluation)**?**

**What did the request for quotation include?**
Did you receive a request for quotation?
When did you receive it?
What did it include?
Was transport data included? What kind of data?
What other information about needs, requirements, and the shipper's company?
Could you understand the needs underlying the requirements?
Were mandatory requirements clearly stated?
Were 'good to have' requirements clearly stated?
Were there any special requirements?
How was the service expressed (outcome or throughput)?
Was there a questionnaire?
Were you given the opportunity to present your offer verbally?
Were there any site visits?

**How did you experience evaluation or offers and comparisons between transport providers?**
How long from when you submitted your quotation to when you heard from the shipper?
Did they ask follow-up questions? What about?
Were you given the opportunity to revise your offer? (Many times?)
Did you receive feedback about the outcome of the evaluation?
Who were you in contact with at the shipper?
Who at the shipper made the decision (as you understood it)?

**Were there any negotiations? How? What were they about?**
Did you negotiate environmental issues? What?
Did you negotiate other issues (e.g. time, price, delivery service)
Were there requirements that were not mandatory or that did not influence the final decision?
Were there requirements to be fulfilled during the contract period or for continuous improvement?

**What does the contract look like?**
Who was involved in the contract agreement?
What was agreed in writing?
What was agreed verbally?
Were environmental issues in the written contract?
Were environmental issues agreed verbally?
What is the time span of the contract? When does it end? How much time elapsed between when the contract was signed and its validation?
How do shippers ensure that requirements are fulfilled?
What are the procedures in case of deviations?
How much is specified in the contract? Is it detailed? Or is it rough? Is only a result asked for, or does the agreement specify how to achieve the result?
Is the frame agreement complemented with less formal agreements regarding (for instance) volume, responsibilities, etc.? What do the less formal agreements include?

# Appendix VI

Interview guide Study III, which provided input to Paper VII
(translated from Swedish)

**Date: _____**
**Company: _____**

**Interview with (Name): _____**
**Position/role: _____**

**Transport provider (Company name and name of contact person):**
**_____**
**Time period of contracting that transport provider:**
**_____**

**Describe the contract:**

- ☐ Contracted for a long time
- ☐ Relatively new transport provider for us

- ☐ Frame agreement exists
- ☐ Verbal agreement exists

**Describe the shipment:**

- ☐ Express
- ☐ Parcel
- ☐ Smaller goods via terminals
- ☐ Direct transport with pick-up from several customers
- ☐ Full load
- ☐ Dedicated transport (between units)

How often do you order transport?
How often do you order transport from this transport provider?

Is the service purchased from this transport provider customised or standard?

Describe the workflow for ordering transport.

How is the need for transport initiated?
When is transport order initiated (on forecast, when goods are ready to ship, etc.)?
Why at this time?
What information do you need?
How do you get that information?
Where do you get that information (system, person)?
What happens next? Do you need to calculate how much space to order?
When do you calculate how much space is needed?
Why at this time?
What information do you need to calculate?
How do you get that information?
Where do you get that information (system, person)?
How do you select a transport provider?
When do you select a transport provider?
Why at this time?
How much is already predetermined? (From others in the company, for example in contract agreements?)
What information do you need?

How do you get that information?
Where do you get that information (system, person)?
How is the actual ordering performed?
What does the order look like? What is included in an order?
What is specified? Requirements on delivery time, pick up time, address?
How difficult is it to specify what you need?
What information do you need?
How do you get that information?
Where do you get that information from (system, person)?
When is the ordering performed?
Why at that time?
Is the timing important? … to you? … to the transport provider?

What is already predetermined, and what is done in the transport-ordering process?
What possibilities are there to influence the transport?
To what degree is the transport specified before it is ordered? In what way?
How is the contact with the transport provider made? Describe the interactions.
What contacts do you have with the transport provider?
What are the most important issues discussed between you and the transport provider?
What else do you discuss? Price? Delivery information?
How often are you in contact (phone, e-mail, visits)?

What contact do you have with other internal functions (production, purchasing, logistics, marketing, sales) when ordering transport?
In what way are they involved in the ordering of transport?
How are you in contact?
How often?
What do you discuss?

Who in your company is in contact with the transport provider?
On what issues?
In what way?
How often?

Are you in contact with anyone else at the transport provider? If yes, please describe.
Do you discuss changes with the transport provider?
Who initiates these discussions? Who is involved? What is behind the changes?

What information does the transport provider ask for?
What information does the transport provider provide?
Is information provided to anyone else in your company?

In your opinion, is there much contact between you?
Is there any contact between orders? Describe.

Is expertise at the transport provider important to you?
Is expertise important in your company when ordering transport?
How much do you use information systems? Internally? Between you and the transport provider?
Has any investment been made (e.g. systems) for the transport service?
Is there anything special about your relationship with this particular transport provider?

Has the transport provider had to adapt to how you generally work with freight transport?

Would you say that people like you who order transport can influence the execution of the transport? Load factor / empty running / fuel efficiency / fuel / handling / length of haul / mode of transport

Could you tell me some background information about the transport provider?
What services do they offer?
What is your opinion about the transport provider?
How long have you used this particular transport provider?
What is your opinion about your relationship?
What works well, and not as well?
How do you view the competence of the transport provider? Do they offer high-quality service?
Are communications with the transport provider effective?
Does the transport provider deliver as promised?
Does the transport provider understand what you mean and what you need?
Do you have to spend much time in managing the transport provider?
Have there been any incidents?

In what way is the transport service different from what you buy from other transport providers?
Is the transport service different from what you have previously bought from that transport provider?
Does the customer have any contact with the transport provider?
Does the customer provide any input to your contact with the transport provider?

How is the transport followed-up?
What happens if a delivery fails? If it is not delivered on time? What can happen?
Is it difficult to evaluate performance?
How is the transport provider evaluated?
Who is involved?

How difficult would it be to change transport providers? How costly?
Are there many alternatives?

Does the transport provider offer innovative ideas?

In your opinion, how important is the service to your company? To your customers?
Is transport a high cost to your company?
In your opinion, is the transport provider important to the company?

# Appendix VII

Interview guide Study V, which provided input to Paper IV and Paper V
(translated from Swedish)

## First interview

**Transport planning:**

- How is transport planned (in general)?
- How do you predict (plan) how many goods will be on each pallet and in each vehicle?
    - Is there a problem with planning how much volume or surface space is needed for a combination of products?
- Who places orders?
    - What is your role?
        - Can you see the customers' systems/stock levels?
        - Are orders placed against forecasts?
    - When do customers place orders themselves?
        - Extra order when out of stock or during sales campaigns?
        - Are orders placed against forecasts?
- What is the quality of transport/logistics?
- What requirements from customers influence transport solutions?
    - How are transport solutions influenced?
- What requirements on time influence your transport solutions? In what way?
    - Time of order placement
    - Time between order placement and delivery
    - Planning time
    - Adjustment time
    - Time for packing/loading
    - Delivery window
    - Frequency of deliveries

When matching orders and pallets/vehicles:

- How do you match order size against available capacity, pallet sizes, etc.?
- Are order sizes multiples of layers on pallets?
- Do you break packages into smaller components?
- Are order sizes adjusted after packing pallets/loading vehicles? If not, could they be adjusted?

Delivery frequency:

- How can delivery frequency influence load factor? In which cases?
- How often do you discuss standard schedules with the stores? How are such discussions done?

Delivery windows:

- Do you discuss delivery windows with the stores? Describe.
- How do you plan transport based on delivery windows?
- How do you consolidate with existing delivery windows?
- How is the load factor influenced by delivery windows? In which cases?

Suppliers:

- How do you combine deliveries to stores and the pick-up of goods from suppliers?
- Who orders from suppliers?
- How are those orders made?

Return flows:

- Is the amount of goods adjusted when picking up at suppliers (since it is difficult to know the available space due to unpredictable returns from stores)?

Load factor:

- In what way(s) have you worked to increase load factor?
- What transport flows could potentially improve load factor?
- What bottlenecks prevent the organisation from achieving an efficient system?
- What aspects influence load factor or time?
    - Store size
    - Geographical location, urban vs rural location, clusters of suppliers
    - Dedicated transport vs co-loading several stores
    - Type of goods (frozen, fruit and vegetables, etc.)

## Second interview

**Questions about the process:**

- When in the process is transport planned?
- What is planned, and when?
- What happens during the initial planning?
- Do you agree with our description of the process stages [image shown that was drawn based on earlier interview]
- How do you work to agree on delivery patterns with the stores?
- When are decisions made about external transport providers? When are they booked?
- What happens from order to delivery? Do you agree with our description of the process stages [image shown]?
- When do customers place their orders?
- How are goods allocated to vehicles? How are routes planned?
- How is the load planned in the vehicles?

**Changes to time aspects:**

- What are the consequences of changing different time aspects?
    - In what way is vehicle-capacity utilisation influenced?
    - Are more or fewer vehicles needed? In what way? Why?
    - Is vehicle-level load factor influenced? In what way? Why?
    - Is pallet-level load factor influenced? In what way? Why?
    - Is fuel consumption influenced? In what way? Why?
    - Is distance driven influenced? In what way? Why?

**Background information on the specific transport flow (case):**

What vehicles are available?

What equipment is available in these vehicles?

Is it possible to stack pallets?

Are there any regulations on vehicle length?

Are there any accessibility constraints (e.g. height constraints upon delivery)?

Are there any traffic constraints (e.g. queuing)?

What pallets are used?

Are there any restrictions on combining products?

What are the stores' opening hours (working hours)?

What are the truck drivers' working hours?

What are the working hours for the warehouse?

How many customers are there?

Where are the customers located?

How often do you delivery in that area?

When do you delivery which goods?

What are customers' requirements about flexibility?

In what ways are the goods sensitive to damages?

What are the temperature requirements?

When do customers place their orders?

Describe order variation.

How do you judge required surface space?

How do you match shipment size with vehicles?

Describe the balance (or imbalance) in the transport flow

Is it possible to add other goods to adjust order size and fill the vehicle (e.g. add a pallet of toilet paper that stores sell much of, or keep something for the next day's delivery)? If yes, when? If no, why not?.

## Third interview

Describe how transport planning is performed, using an example.

- Based on the general plan, is there a pattern? If so, what does it look like?
- How do you then adjust on a particular day?
- How do you match required capacity with available capacity in vehicles?
- How are routes adjusted?
- When and how are external transport providers booked?

How is vehicle loading planned?

- How many pallets fit in one shipment?
- Do you plan how to load the pallets in the vehicles ahead of time?
- When do you plan loading?
- Who plans loading of pallets in vehicles?

In what order are transport-planning and order-planning activities performed?

- When is the staging area of goods for loading decided – before order picking?
- When are routes decided?
- When is pallet height decided? How does that fit with knowing if the vehicle has equipment to support pallet stacking?

Who loads the vehicles?

Is there anything you do that can affect:

- Vehicle load factor?
- Number of vehicles required?
- Pallet load factor?
- Fuel consumption?
- Distance driven?

What can you do? What are the consequences of your actions?

Can a shorter or longer time improve load factor?

- Time for loading
- Time for allocating goods to vehicles
- Time for route planning
- Time for packing goods on pallets
- Time for load planning
- Time for reducing empty space in the staging area
- Time for loading in vehicles
- Time for booking external transport providers:
    - Time for transport
    - Time for consolidating goods from the warehouse and goods from inbound vehicles

What are the consequences (on fleet utilisation, number of vehicles required, vehicle-level load factor, pallet-level load factor, fuel consumption, distance driven)?

# Appendix VIII

Interview guide Study VI, which provided input to Paper VI
(translated from Swedish)

**Work with load factor**

- What do you do to achieve a high load factor in your transports?
- Describe in detail the actions that you take.
- What routines exist related to load factor?
- What are your targets related to load factor?
- Why is it important to work with load factor?

**Interaction with other activities**

- Which activities or departments interact (with regard to work related to load factor)?
- What interactions with other activities or departments are necessary to enable a high load factor?
- In what way do these interactions make it possible to achieve a high load factor?
- What information is shared (influencing load factor)?
- What decisions influence the load factor?
- Are there any constraints in your work to achieve a high load factor in regard to interaction with other activities or departments?
- In what way do these constrain the work to achieve a high load factor?
- What routines exist related to interaction with other activities/departments?
- Is there anything that could be changed in the interaction with other activities/departments?
- Are other activities or departments aware of your work with load factor?
- Are goals in other activities or departments conflicting with load factor?
- Do you cooperate with other parts of the company (e.g. other units) in any way that influences load factor?
- What about the management level, how aware are the management of load factor, and how do they view goals regarding load factor?

**Background**

- Are your examples valid for specific types of transport or special in any other way?
- Are they valid for all types of transport in your company?
- Please describe the process for delivering on customer orders in your company.
- Please describe the process for receiving goods from your suppliers in your company.
- Please describe the organisation of logistics and transport in your company.
- Please describe/characterise your transport flows (e.g. locations, modes of transport used, type of transport services).