CHALMERS
UNIVERSITY OF TECHNOLOGY

Exploring the Relationships Between Service Quality Requirements and Load Factor

Master's thesis in Supply Chain Management

HAMPUS ADERHJELM
JOSEFIN HALVARSSON

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SUPPLY AND OPERATIONS MANAGEMENT

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2024

www.chalmers.se

Exploring the Relationships Between Service Quality Requirements and Load Factor

HAMPUS ADERHJELM
JOSEFIN HALVARSSON

Department of Technology Management and Economics
Division of Supply and Operations Management
CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden 2024

Exploring the Relationships Between Service Quality Requirements and Load Factor
HAMPUS ADERHJELM
JOSEFIN HALVARSSON

Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

Gothenburg, Sweden 2024

Exploring the Relationships Between Service Quality Requirements and Load Factor

HAMPUS ADERHJELM
JOSEFIN HALVARSSON

Department of Technology Management and Economics
Chalmers University of Technology

ABSTRACT

Road transport is crucial for supply chains, but it also significantly contributes to greenhouse gas emissions. Improving transport efficiency would reduce both transport costs and environmental impacts. However, the trend is moving towards increasing service quality requirements, which creates difficulties in achieving high transport efficiency. One aspect of transport efficiency is load factor, which has a relationship with service quality requirements that has received limited attention in previous literature. This thesis aims to explore the relationship between service quality requirements and load factor.

A model for illustrating the relationships between load factor and lead time has been created from existing literature. Interviews were done with five different companies, resulting in two additional models illustrating the relationships between load factor and frequency as well as load factor and time windows. The results show that the relationships between service quality requirements and load factor described in the literature generally correlate with the empirical findings of this study. However, the results also displayed contradictory relationships and that it is important to consider contextual factors when changing service quality requirements.

These models and findings provide companies with insights to better manage service quality requirements, optimize load factor, and improve transport efficiency. The study suggests that companies can use the models for planning and in negotiations with customers to highlight the operational impact of service quality requirements and explore possible alterations to improve load factor performance.

Keywords: load factor, service quality requirements, transport efficiency

ACKNOWLEDGEMENTS

This thesis was conducted as a part of the master's programme Supply Chain Management at Chalmers University during the spring of 2024. The project was carried out in collaboration with RISE as a part of the research project TRYFFEL, which focuses on transport efficiency and load factor. We want to express our gratitude to Vendela Santén for giving us this opportunity and everyone involved in the project who has contributed valuable insights to our study, as well as to the staff of RISE for your kindness and hospitality.

In addition, we would like to thank all respondents for their participation in this study. Their willingness to answer our questions and the interest they have shown in both us and the study have been valuable for the completion of this thesis. We would also like to extend our thanks to Felicia Ohlson and Desirée Staaf for your excellent feedback, which has helped us improve the clarity and quality of our work.

Finally, we would like to sincerely thank our supervisor Sara Rogerson at RISE and our supervisor and examiner Dan Andersson at Chalmers. Sara, your expertise within the area and involvement in our work have been essential for completing this thesis. Dan, your guidance and expertise have provided us with valuable insights. Without you two, this thesis would not have reached its full potential. Thank you for your support and encouragement throughout this journey.

Table of Contents

1. Introduction

This chapter serves to motivate and outline the aim of the study. The introduction is presented as follows: Section 1.1 provides the study's context and significance of the topic. Following, section 1.2 presents the aim of the study and research questions. Lastly, section 1.3 contains the limitations of the study.

1.1 Background

The world today relies on transportation as it serves a vital role in supply chains, where effective movement of goods is critical for seamless operations and overall supply chain success. For example, in 2022, over 13.6 billion tonnes of goods were transported in the European Union by road, covering a distance of 1920 billion tonne-kilometers (Eurostat, 2023). The extensive use of road transport has environmental consequences. Transport emissions account for roughly 25% of total greenhouse gas emissions in the EU and have risen in recent years (European Commission, 2023).

This emphasizes the importance of improving transportation efficiency in order to minimize environmental impact, reduce costs and improve overall logistics performance. Improving transportation efficiency is a long-standing interest in the logistics industry. A diverse range of stakeholders, including researchers, companies, and policymakers, are investigating strategies and technologies to enable efficient transportation (European Commission, 2023; Näringsdepartementet, 2018; Rogerson & Santén, 2017).

At the political level, the EU and several national bodies have launched projects and set goals to improve the transport sector. The overall political goal is to provide a socioeconomically efficient and long-term sustainable transport supply for citizens and businesses. The commitments to increased transport efficiency is motivated by two primary reasons: lower costs and reduction of transport emissions. The European Commission, for example, has launched a package to make transport more efficient and sustainable, with the goal of reducing emissions by 90% by 2050 (European Commission, 2023). Another example is the Swedish government, which has a mission to develop proposals for horizontal collaborations and open data to increase transportation efficiency (Näringsdepartementet, 2018).

At the research level, there has been considerable examination into factors influencing transportation efficiency, with an increased interest in the concept of the load factor. According to Pahlén and Börjesson (2012), the load factor does not on its own contribute to improved transportation efficiency, however, it does play an important role in increasing resource utilization and promoting sustainability. A number of studies have looked into the relationship between load factor optimization and transportation efficiency. Researchers such as Rogerson and Santén (2017) created a framework of opportunities to assist shippers in managing imbalances between required and available capacity, with the goal of increasing the load factor. Other research has focused on internal coordination of activities (Rogerson & Sallnäs, 2017) and distribution network configuration (Lumsden et al., 1999) to increase load factors. Furthermore, as described by Aronsson and Huge Brodin (2006), shippers' material flow management and planning set both limits and opportunities for transport operations, influencing the load factor. Another important factor affecting transportation efficiency is requirements on service quality. The trend is moving towards higher expectations for service quality from customers (Oskarsson et al., 2021). Consequently, meeting these demands has led to neglecting the importance of load factors (Piecyk, 2010).

The relationships between these factors, i.e., service quality requirements and the load factor, has received limited attention in research literature and is sometimes contradictory. Schöneberg et al. (2010) proposed a model that demonstrates how delivery frequency decisions influence the load factor. Adhering to a fixed delivery frequency compared to no fixed frequency was found to increase the load factor under the assumption that demand is predictable over time. In contrast, Browne and Gomez's (2011) findings indicate that being limited by a predetermined delivery frequency has a minimal to negligible effect on the load factor compared to planning without any restrictions.

In addition to delivery frequency, consideration has been directed towards how delivery time window constraints influence the load factor. Arvidsson et al. (2013) investigated the relationship between delivery time restrictions and load factor in city distribution and concluded that the ability to increase the load factor is frequently limited by delivery time windows. Piecyk and McKinnon (2010) maintain that order size variability and lead time are two significant influences on load factor performance. Wu and Dunn (1995) also described the latter relationship, examining the trade-offs between cost savings from full vehicle loads and the costs associated with freight delays in order to achieve goods consolidation.

Although existing literature discusses the relationships between service quality requirements and load factor, these studies seldom consider the point raised by one researcher. Wehner (2023) states that it is especially important not to generalize and simplify the relationship between service quality and transport efficiency factors, as they interact. Understanding the complex interactions between these factors is crucial because it can lead to more effective transportation management strategies and better outcomes for transport efficiency. Furthermore, existing literature only considers how service quality requirements influence the load factor to a limited extent. Similarly, as mentioned by Arnäs et al. (2013), little to no exploration has been performed in terms of altering service quality requirements for increased load factor performance.

Understanding the effect customer service quality requirements can have on the load factor could hold significant value for companies. Lower volumes and higher speed, as well as higher precision, is being required by customers to a greater extent (Oskarsson et al., 2021). Increasing requirements for service quality are limiting the potential of shippers to improve load factor performance (Arvidsson, 2013; Bø & Hammervoll, 2010; Santén, 2017). Both Oskarsson et al. (2021) and Walker (1990) emphasize that relaxing the service quality demands should be possible in certain situations to achieve higher transport efficiency. From a shipper's perspective, opportunities can emerge to improve the load factor, by identifying the potential to adjust service quality requirements of customers.

1.2 Aim and research questions

The aim of this thesis is to *explore possible relationships between service quality requirements and load factor.* The objective is to provide an understanding of relationships that could hold value for researchers, supply chain stakeholders, and policymakers in the ultimate goal of improving transport efficiency. By examining the impact of service quality requirements on load factor performance, this thesis aims to contribute valuable insights which can act as a basis for decision-making processes and enhance overall transportation operations. Following, three research questions have been formulated to contribute to the aim of the thesis, which are presented below:

1. What service quality requirements do exist that have an impact on the load factor?

The first research question examines the relationships between service quality requirements and the load factor. This question seeks to identify the key requirements for service quality that have a significant impact on the load factor. While some aspects of these relationships have been discussed in previous research, this question is an important starting point for delving deeper into the relationship of service quality requirements and load factor.

2. How do service quality requirements affect the load factor?

Building on the findings of the first research question, the second research question examines the relationships between service quality requirements and load factor. It hopes to gain insights in how service quality requirements affect the load factor.

3. What alterations can be made to the service quality requirements to improve the load factor while still meeting customer needs?

To examine deeper into the relationships between load factor and service quality requirements, the third research question examines potential variations in service quality requirements. The goal is to investigate the extent to which service quality requirements may be altered, with the objective to increase load factor performance. In previous literature, this topic has received little to no attention, and is thus of great interest to further explore.

1.3 Limitations

The first limitation is that the study will focus on the service quality requirements that actors within the supply chain impose on each other, i.e. inter-organizational requirements. An examination of service quality requirements which are intra-organizational, regulatory or governmental will not be completely excluded, but is not the primary focus.

The second limitation of the study is that the focus is on business to business (B2B) relationships and how businesses interact with each other rather than business to customer (B2C) relationships and the interaction with individual consumers. Our existing connections are primarily in the B2B sector. Leveraging these connections allows for easier access to data collection opportunities within the B2B landscape, making it a natural focus for this study.

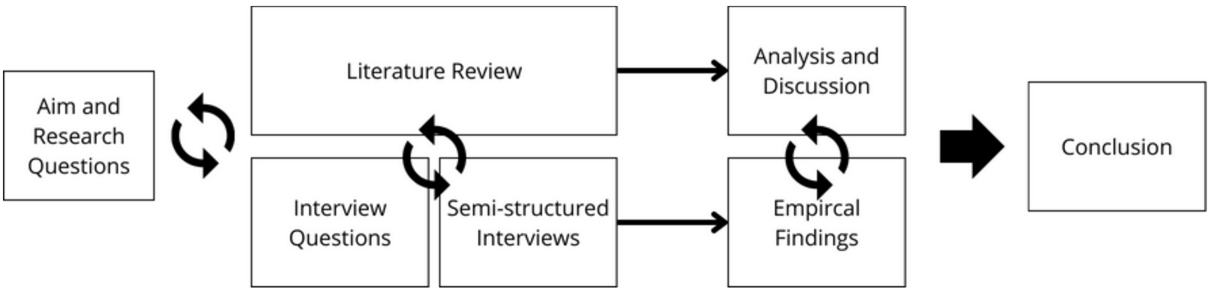
2. Methodology

The relationships between service quality requirements and load factor have been explored through a literature review and case studies. The literature review examines existing research on service quality and load factor interactions, while the case studies provide practical insights. This chapter outlines the design of the study, including the research and methodological approaches.

Figure 1 illustrates the progression of the work over time, as well as how the various activities overlapped. Formulating the aim and research questions was an iterative process that was refined as new interesting fields and concepts were discovered from literature and through interviews. Similarly, the process of working with and analyzing the empirical findings has been characterized by iteration and refinement before reaching a conclusion. As data was gathered and analyzed, new patterns emerged, resulting in the analytical approach being revisited and adjusted iteratively.

Figure 1

An overview of the progression of work throughout the study



2.1 Literature review

The literature review was conducted in parallel with additional data collection methods to gather relevant theory for the theoretical framework as well as to develop relevant interview questions and to answer the research questions. The review contributed to increased knowledge and understanding of load factor and service quality and their relationships, as well as to finding possible gaps in the literature where this thesis may contribute.

The search for literature was conducted through reading scientific papers, reports and books. The main sources used were Chalmers Library and Google Scholar, as well as borrowing books from Chalmers Library. The database search query to find relevant literature included keywords such as fill *rate, load factor, interdependencies, service quality requirements, service quality factors, transport efficiency, transport quality, customer requirements, resource utilization* and *customer logistics*. These keywords were used both individually and in combination to ensure comprehensive coverage of the relevant topics. Moreover, relevant literature was recommended by our supervisor at Chalmers, Dan Andersson, as well as by our supervisors at RISE, Sara Rogerson and Vendela Santén.

Snowballing was applied to find additional articles. As explained by Wohlin (2014), snowballing is a structured method of looking at the reference lists and/or citations of already relevant papers to find additional literature. This method is suitable to use as a complement to database searches.

2.2 The case study research approach

A multiple case study was conducted in order to find answers to the research questions. The primary focus of this study was to investigate the relationship between service quality requirements and load factor. Multiple case studies were specifically chosen to incorporate diverse industries as these have different flows and customers. As described by Bell et al. (2022), a multiple case study is suitable for comparing findings between cases to discover differences and similarities. By examining different industries, the study could capture a broad spectrum of service quality requirements and their impacts on load factor, thus enhancing the generalizability of the findings. A case study approach can be used to provide this understanding or provide a new perspective on an already researched topic (Eisenhardt, 1989; Ellram, 1996). Case studies are also appropriate when trying to answer a question starting with "how" (Blomkvist et al., 2018; Ellram, 1996); the multiple case study approach was therefore determined to be an appropriate method to explore the aim of the study.

To understand the relationship between transport efficiency and service quality requirements, particularly focusing on how the load factor is influenced by factors related to service quality, an in-depth exploration was seen as necessary. To dig deeper into the phenomena studied, both within-case and across-case analyses were conducted. Within-case analysis was conducted to examine each case individually, allowing for a detailed understanding of the contexts of each case. This helped in identifying key elements intrinsic to each case. As described by Ayres et al. (2003), within-case analysis highlights key elements for the examiner, whereas across-case analysis aims at comparing the elements across studies to identify similarities and differences. Across-case analysis, on the other hand, was used to compare and contrast the findings from the individual cases. This approach aimed at identifying commonalities and differences across the cases, which could help in identifying themes.

Sample and case selection are frequently influenced by specific arrangements or case accessibility. The case selection in this study was limited by the conditions of finding companies willing to participate. Flyvbjerg (2006) describes a narrow selection of cases as appropriate for studying the causes of a problem in depth. Therefore, this study was focused on five companies to allow enough time for in-depth analysis and qualitative interviews to answer the research questions and achieve the study's goal, see Table 1.

Table 1

Overview of case studies

Company	**Company Type**	**Flow**	**Distribution Process**
PartsBuyer	Manufacturer	Inbound	*Deliveries from suppliers to production units*
BeverageManufacturer	Manufacturer	Outbound	*Deliveries to large customers and wholesalers as well as through third party logistics for smaller customers*
FoodDistributor	Wholesale	Outbound	*Deliveries from warehouse to customer or via terminals to restaurants in or around nearby cities*
RetailFood	Wholesale	Outbound	*Deliveries from warehouse to stores, sometimes consolidation via terminals with external goods*
TechWholesaler	Wholesale	Outbound	*Deliveries from central warehouse to stores and business customers*

2.3 Qualitative data collection

In order to answer the research questions the collection method had a qualitative approach. Semi-structured interviews were used to qualitatively collect data in each case, which, according to several researchers, enable discussions and provide space for follow up questions (Bell et al., 2022; Blomkvist et al., 2018). Semi-structured interviews are deemed more appropriate than structured interviews to achieve a deeper understanding of the perceived problems related to service quality requirements and load factor. Furthermore, as in this study, when there is more than one researcher, semi-structured interviewing is preferred to ensure a degree of comparability (Bell et al., 2022).

The structure of the semi-structured interviews is to combine both open-ended questions and more specific questions. The questions in the interview guide reflect the research questions, but on a lower level of analysis and were divided into several sub questions. A list of questions was prepared before the interviews around the topics of interest, including both a guide regarding the outbound and inbound distribution flow. The interviews were conducted in Swedish; for the translated versions of the interview guides, see Appendices A and B. Depending on the focus of the interview, different interview guides were used. Appendix B, containing interview questions related to the inbound flow, was used for *PartsBuyer*. Whereas for the other four companies, Appendix A containing outbound interview questions was utilized.

Respondents were selected based on their ability to contribute to a theoretical understanding of the subject. The majority of interviews were conducted via video meetings due to the geographical distance of the respondents, as well as considerations of time availability. All interviews were audio recorded and transcribed with the respondents approval to be able to correct the limitations of the authors memories, and allow for a more thorough examination of what was discussed during the interviews. Additionally, respondents had the opportunity to review and confirm the written material to ensure accuracy and completeness.

Table 2 shows the six respondents which were interviewed from the five studied companies. Two rounds of interviews were performed for *PartsBuyer* and the Transport Manager at *RetailFood* due to the large number of follow-up questions, while for the rest of the interviews follow-up questions were sent via email. Conducting additional interviews and following up via email on data previously gathered were useful for verifying that the responses had been understood correctly, and to ask additional questions about topics that had arisen during the analysis.

Table 2

Respondents in the cases

Case company	Respondents	Dates	Type of interaction	Duration (approx.)
BeverageManufacturer	Senior Delivery Planner	28/2-24	Teams interview	40 min
PartsBuyer	Project Manager and Network Developer	4/3-24 19/3-24	Teams interview	90 min + 60 min
FoodDistributor	Transport Planner	13/3-24	Teams interview	70 min
TechWholesaler	Transport Manager	3/4-24	Teams interview	60 min
RetailFood	Manager of Transport Planning	27/3-24 3/4-24	Teams interview	60 min + 45 min
	Manager of Delivery Optimization	9/4-24	In person	30 min

2.4 Qualitative data analysis

After collecting data from case study interviews, the data was structured and grouped for analysis. Blomkvist et al. (2018) define thematic analysis as the process of pre-defining a number of themes in order to sort data and contribute to pattern recognition while also explaining the phenomenon of interest. Therefore, to find answers to the research questions in a structured way, a thematic analysis was conducted.

The analysis of the interview data began after the first interview, and was thereafter performed parallel to the rest of the data collection. Yin (2013) describes five phases of qualitative data analysis: compile, disassemble, reassemble, interpret, and conclude data. Compiling data consists of organizing and sorting the material collected through the interviews, which later was disassembled according to the thematic approach described in the introduction of section 2.4. The data from the interviews was sorted according to the themes of the interview guide as well as according to the three research questions. First, the sorting and coding of data was performed separately for each interview, allowing for a deeper investigation of key elements as described by Ayres et al. (2003). Moreover, the data was reassembled through new groupings of the themes and codes from the previous analysis step by creating tables connecting the codes. Subsequently, the identified themes within each case were compared across cases to find commonalities and differences.

There are three types of coding of data from case studies, as described by Ellram (1996): open, axial and selective coding. Open coding is used to compare and categorize data, axial coding to make connections between the categories created from open coding and selective coding is then used to identify key categories which contribute most significantly to the phenomena being studied. The reassembly of data allowed for comparison amongst the respondents' answers in each category, as well as analysis of the categories of interests separately and comparing the categories with each other. The data was organized according to the three research questions, with subcategories for each research question consisting of service quality requirements. These subcategories were further subdivided into more specific groups based on the purpose of each research question, allowing for a thorough examination of respondents' answers.

Lastly, as mentioned by Yin (2013), the data was interpreted and conclusions drawn by assigning explanations to the categorized data. This was also performed on the basis of finding relationships between service quality requirements and load factor as well as by seeking ways to aggregate the findings to general statements. To achieve this, the empirical data was compared to findings from the literature review to find similarities and differences.

2.5 Method discussion

The criteria below were selected to evaluate the research undertaken in this thesis in terms of four aspects of trustworthiness: credibility, transferability, dependability and confirmability (Bell et al., 2022). These criteria are designed for qualitative research and were chosen over validity and reliability, which are commonly used in quantitative research (Bell et al., 2022).

Credibility means that the research follows best practices and that any participant in the study had the opportunity to confirm the findings (Bell et al., 2022). Respondent validation, or triangulation is an important part of qualitative studies, as these confirm there is good correspondence between the findings and the perspectives of the research participants. Ellram (1996) and Yin (2013) describe triangulation as the use of different methods to study the same phenomenon. In this study, interviews with multiple respondents were performed and literature on the topic studied which was thereafter compared to ensure credibility. Furthermore, the interviews were recorded and transcribed, which according to Yin (2013), reduces the need for triangulation. The transcribed responses were later checked by and discussed amongst both authors to avoid misconceptions. Moreover, additional interviews were conducted, and responses on data previously collected were followed up to reduce the possibility of misinterpretations, which according to Yin (2013), increases the credibility of a study.

Transferability refers to the extent to which findings can be applied to other contexts (Bell et al., 2022). A qualitative research typically consists of an intensive study of a small group (Bell et al., 2022), which is consistent with this study in that it focuses on depth rather than width. Thus, while generalizing qualitative studies to other contexts can be difficult, it can still be useful in generating new knowledge applicable to similar companies or settings (Alvesson & Sköldberg, 2004).

The aim of the research questions in this study was to provide theoretical insights that could benefit others and possibly be applied in other settings. Furthermore, the thesis described the context of the studied companies, allowing readers to draw comparisons with their own. For example, while trucks are the primary focus of this study, the findings are intended to be broadly applicable to other modes of transportation as well.

Dependability could be related to 'reliability' and concerns that complete records should be kept of all phases of the research process (Bell et al., 2022). High reliability is mentioned by Ellram (1996) as achieving replication of results when repeating the study under the same conditions. All the interviews followed an interview guide to retrieve information from the respondents. Furthermore, it is important for qualitative researchers to document the process of the study so that it is possible for others to understand and replicate the methodology taken to reach the findings (Bell et al., 2022). Therefore, the full interview guide is provided in the thesis along with the strategy taken to analyze the data, and the types of companies and respondents represented in the interviews.

Confirmability is concerned with the objectivity of the research, which means that the researcher did not intentionally allow personal or theoretical biases to influence the research (Bell et al., 2022). To confirm the research interpretations, the research design, analysis, and results were discussed with the supervisors and colleagues. Further, the empirical findings were presented to researchers within the area of the thesis at repeated occasions where they could share their opinions.

3. Literature review

In this chapter, the literature review is presented. The literature review is structured as follows: In section 3.1, service quality is defined, and performance indicators to measure service quality in transport and logistics are presented. In section 3.2, a brief overview of the load factor and different ways to measure it is provided. Section 3.3 presents the current literature on the relationships between service quality requirements and load factor. Following, in section 3.4, the ability to influence service quality requirements and capacity to increase load factor performance are presented. Lastly, a model connecting load factor performance, capacity, and service quality requirements is presented in section 3.5.

3.1 Service quality

The objective of a service-based business is to facilitate value for the customer, where the service provider and the customer often engage in an interaction (Bergman et al., 2022; Grönroos, 1990). Therefore, understanding service quality becomes imperative, as it forms the cornerstone of service-based businesses' ability to deliver value during the interaction between the service provider and the customer. The customer plays an active role in determining the value created from the service (Bergman et al., 2022), and quality problems in service organizations stem from the misalignment between customers' expectations and the perceived quality of service (Ghobadian et al., 1994). Therefore, service quality hinges on customer perceptions of how effectively the service provider meets their expectations, as determined by the customers themselves.

The concept of service quality in logistics had, when Byrne & Markham (1991) wrote their article, not garnered nearly as much understanding as the term productivity. Today, defining service quality can be challenging due to its multitude of definitions and varying perspectives. Value in logistics is created by meeting customers' delivery requirements in an efficient way, therefore, good logistics means consistently delivering products within the requested delivery frame without costing too much (Bowersox et al., 2007).

There seems to be a consensus among researchers that service quality can be related to measurements. Accurate and flexible performance metrics are essential for management to effectively oversee their supply chains (Caplice & Sheffi, 1995). Juran (2003) defined service quality as a performance measure which results in customer satisfaction. Aligning with Juran's perspective, Markowska (2020) describes quality of service in freight transport as transport that is *"planned and organized appropriately, offering products in an appropriate place, time, quantity, of an appropriate quality, with correct costs"* (p. 106) while satisfying the customer and maintaining a good relationship. Performance measurements are used for identifying if the desirable service quality is met against the customer requirements. Hence, for the purpose of this thesis, the term "service quality" will refer to the performance measures within the context of logistics and freight transport.

There exists a multitude of performance indicators for evaluating service quality in logistics. The primary ones include delivery time, reliability, flexibility, completeness, frequency, accuracy, ease of order placement, stock product availability, and document convenience (Markowska, 2020; Oskarsson et al., 2021).

3.2 Load factor

Load factor is a performance measurement related to transport efficiency and is measured by the ratio of actual, utilized load to maximum load of goods that can be carried in a vehicle (Jonsson & Mattsson, 2023; McKinnon & Ge, 2004). There exists two main issues related to load factor; no standardized way of measuring exists and the availability of data is often limited.

The challenges in collecting load factor data is related to finding correct and consistent data (McKinnon, 2009; McKinnon, 2010; Pahlén & Börjesson, 2012). This issue is related to freight transport seldom being a core process of the shipper as well as limitations in time, thus, information regarding the load factor is not documented (Pahlén & Börjesson, 2012). The lack of data in company databases, as described by McKinnon (2009), may result in subjective estimations of volume and/or height utilization, which contributes to difficulties in obtaining accurate data.

Since there exists no standardized measurement, load factor performance may vary depending on which definition is used (Jonsson & Mattsson, 2023). McKinnon (2007b) discusses five different ways of measuring load factor; volume-based, weight-based, deck-area coverage, tonne-km and level of empty running. Previous studies have primarily measured load factor with respect to weight, which may not be the most suitable in contexts where the maximum load is restricted by volume and/or available deck space (Jonsson & Mattsson, 2023; McKinnon, 2009; McKinnon, 2010). However, volumetric data is in practice generally difficult to collect (McKinnon, 2010). Additionally, the different utilizations of measurements makes it difficult to compare results between studies.

Moreover, only using one of these measurements to evaluate the load factor may not provide a comprehensive understanding of the overall utilization. For instance, solely considering deck area disregards height utilization and only considering weight neglects volume utilization (Santén & Rogerson, 2018). The different capacity restrictions (in terms of weight, volume, deck-area etc) entails that a truck can never be 100 percent filled in all aspects (Pahlén & Börjesson, 2012). For instance, a truck may be full in terms of weight but under-utilized in regards to volume because of goods being high density.

Combining and considering more than one of the measurements described above provides a more thorough picture for the load factor, however, this may also not be sufficient. For instance, as displayed in the load factor model by Santén and Rogerson (2018), there exists different levels to the load factor: packaging level, shipping level, vehicle level and fleet level. Considering the balance between the required and available capacity, i.e. the capacity of orders to be transported and the actual capacity acquired, on all levels is important to gain a more extensive understanding of load factor performance. For instance, as is the case in most studies, measuring load factor solely on vehicle level in terms of volume leads to conclusions about high load factor performance although the load consists of mostly empty boxes.

3.3 Relationship between service quality and load factor

Customer service requirements are factors that influence load factor performance. Traditionally, the transport industry has focused on high load factor instead of customer requirements but is now moving towards increasing customer focus (Oskarsson et al., 2021). For instance, Oskarsson et al. (2021) describe that the trend for customer service requirements is moving towards increasing demand for shorter lead times, smaller volumes and high delivery precision. The shift in focus, from cost-driven to service-driven logistics (Christopher, 2005; Piecyk, 2010), emerging from more demanding customer requirements, has consequently impacted the load factor. According to Piecyk (2010), transport providers have been sacrificing an optimal load factor to fulfill customer service requirements.

The interdependencies between service quality and load factor have received attention by some researchers and practitioners. Santén (2012) discusses different logistics actions related to lead time, order frequency and order size as factors which may increase the load factor. Similarly, Rogerson (2017) mentions specifications regarding time windows, delivery precision, shipment size, frequency, volume variations, load units, dedicated transport and using multiple delivery rounds as factors influencing the load factor. Service provider's management of load factor is constrained by customer-determined requirements (Nielsen et al., 2003), such as transport speed, delivery frequency, and specified delivery times.

Since time is a crucial component affecting load factor performance (Arvidsson et al., 2013; Bø & Hammervoll, 2010), the criterion previously mentioned related to time were selected to be investigated further, which are lead time, delivery precision and frequency. Shipment size has also been listed as one of the more influencing operational factors on load factor and variations in shipment size have large impacts on load factor performance (Piecyk & McKinnon, 2010). Variations in shipment size are inherently tied to variations in order size. Therefore, this factor was also chosen for further evaluation. The selected service quality measurements and their respective definition are presented in Table 3. In the following sections each of these service quality requirements and their relationships with load factor will be presented.

Table 3

Definitions of the selected service quality requirements

Service quality measurements	Definitions
Lead time	*Refers to the time from when a customer order has been received until completion of delivery (Christopher, 2005; Jonsson & Mattsson, 2023).*
Delivery frequency	*Refers to how often deliveries are sent or received (Lumsden, 2011)*
Delivery precision (time windows)	*Refers to what extent an order is delivered at the agreed time with the customer (Christohper, 2005; Jonsson & Mattsson, 2023). Delivery too early or too late both indicate low delivery precision. Delivery precision can be measured in different ways, for example if the delivery is made at a specific time or within a wanted time window (Jonsson & Mattsson, 2023).*
Order size	*Refers to the quantity or volume of products requested by a buyer from a seller during a transaction (Jonsson & Mattsson, 2023)*

3.3.1 Load factor and lead time

According to Bø and Hammervoll (2010) and Arvidsson et al. (2013) time is a key component that influences the load factor. More specifically, previous researchers, such as Piecyk and McKinnon (2010), have emphasized that lead time stands out as one of the primary operational factors in road freight transport significantly impacting the load factor.

The trend towards shorter lead times and quick responses to customers limits possibilities for full load to accumulate (McKinnon, 2018). Therefore, lead time can set boundaries for achieving an increased load factor in freight transport, as supported by various authors and researchers. For instance, Wehner (2018) mentions that the demand for short lead times contributed to unutilized capacity for shippers. Jonsson and Mattsson (2023) points out that longer lead times allow for greater consolidation opportunities, leading to an enhanced load factor. Whereas the demand for short lead time often contributes to limited time available for consolidation of goods, hence, a lower load factor is expected (Pahlén, 2014). Rogerson and Santén (2017) also discusses the importance of lead time duration as a condition in enabling changes to the load factor. The length of the lead time can limit or increase opportunities for detailed planning of the packaging and loading processes. In the analysis of how to increase load factor, Santén (2017) mentions that short lead times can impact packaging and loading efficiency. The conclusion drawn was that greater flexibility in lead times, such as allowing customers to submit orders ahead of time or postponing the delivery day can improve load factor. The modification of lead time is further discussed by Rogerson (2017) who states that increasing the lead time of one day increases the possibilities for consolidation and thus load factor performance. Moreover, in a study conducted by Strand and Fremstad (2020), interviews with transport industry stakeholders revealed a common belief that longer lead times could improve day-to-day planning efficiency, and therefore optimize load factor performance.

3.3.2 Load factor and frequency

As previously stated, lead time is one of the time components that may influence the load factor. Specifying requirements related to the frequency of deliveries is another aspect of time which can affect load factor performance (Bø & Hammervoll, 2010; Rogerson, 2017). Santén (2016) mentions that frequency requirements create conditions for transport planning and scheduling, which in turn affects required and available capacity and thus the load factor.

One way of increasing the load factor is to decrease the delivery frequency, i.e. decreasing the number of deliveries to fill the trucks to a greater extent (Aronsson & Huge Brodin, 2006; Jonsson & Mattson, 2023). However, the increased time between deliveries and increased delivery sizes caused by a decrease in frequency may not be acceptable by the customer or feasible due to goods characteristics (Strand & Fremstad, 2020).

Another way of increasing the load factor but not necessarily changing the frequency of deliveries is by using a system of delivery profiles (Bömer & Meyer, 2022; Schöneberg et al., 2010) or nominated days (Jonsson & Mattsson, 2023; McKinnon, 2007a) for each transport buyer. These methods include using a fixed delivery frequency by making customers comply with a timetable for order and delivery (McKinnon, 2007a). Thus, the transport and load planning become less complex which has positive effects for the load factor. The study by Browne and Gomez (2011) shows that being limited by a fixed frequency when planning the transport in urban distribution results in a load factor nearly as high as when planning without any restrictions at all. Additionally, low delivery frequency and low demand variability is favorable to achieve a balance in the distribution volumes over the days of a week when adhering to a fixed frequency (Bömer & Meyer, 2022).

3.3.3 Load factor and time windows

Specifying requirements for delivery precision is another time-based component that influences the load factor. In a case study by Rogerson (2017), delivery precision requirements compelled the transport provider to conduct several delivery rounds each day. Delivery precision requirements reduce possibilities to accumulate goods for consolidation, which can have a negative effect on the load factor (Rogerson, 2017). Forslund and Jonsson (2010) mention that the most common method for evaluating delivery precision is by specifying a day as a time unit for delivery. However, the trend, as well as the concern among transport providers, is that transport buyers are demanding even stricter times for delivery through the use of time windows (Santén & Arvidsson, 2011). This concept entails specifying both a start and end time within which a delivery must be completed (Browne & Gomez, 2011).

The planning and scheduling of transports is often shaped by the time window requirements set by transport buyers (Nielsen et al., 2003). In the study of business-to-business distribution by Santén and Arvidsson (2011), transport providers stress greater time windows as a facilitator for increased load factor. The study of Browne and Gomez (2011) displays that being limited by a delivery window has a significantly higher negative impact on the load factor compared to being limited by solely a fixed delivery frequency.

Specifications of a time window for delivery may restrict possibilities for consolidation and thus load factor improvements (Oskarsson et al., 2021; Rogerson, 2017). Baykasoglu and Kaplanoglu (2011) also mention that time windows may decrease the possibilities of achieving efficient consolidation as well as routing of vehicles. Consolidation of deliveries in one trip results in adhering to several time window restrictions during a route, as mentioned by Quak and De Koster (2007). The more orders that are consolidated, the greater number of time windows needs to be considered, meaning difficulties in achieving an efficient transport system. World Economic Forum/Accenture (2009) listed increasing time windows as one of the potential actions to improve the load factor. Thus, removing or extending time windows may facilitate better planning and consolidation of goods, which could have a positive effect for load factor performance.

Arvidsson (2013) mentions that the use of time windows, imposed by authorities in city distribution, can be used as a method to increase the load factor. This entails only allowing deliveries in the city center during certain times of the day. However, the study from Arvidsson et al. (2013) shows that regulated time windows in city distribution may also restrict the possibilities to achieve a high load factor. Moreover, local municipalities often decide time windows in their cities without consideration to neighboring municipalities. This results in conflicting time windows of different cities which entails that deliveries to these cities are not feasible to consolidate (Quak & De Koster, 2007). Zang et al. (2023) examine the delivery routing problem in urban settings where time windows conflict. The authors present three common solutions to handle conflicting time windows, the first one being to deploy more vehicles than optimal which is described to have a negative impact on transport efficiency and costs. Furthermore, price incentives can be used to encourage customers to opt for less popular time slots by raising the delivery prices in popular time windows. Lastly, the authors suggest postponement or rescheduling of deliveries to optimize delivery routes, however, this approach could potentially lower customer satisfaction.

3.3.4 Load factor and order size

There are relatively few studies on the relationship between load factor and order size. However, some authors have highlighted that order size can impact the load factor. Piecyk and McKinnon (2010) lists order size as one of the most influencing operational factors on load factor. Santén (2016) highlights the process of order and delivery which involves agreements with customers and considers factors like order size, which then impact other activities and play a role in determining the load factor. Moreover, small shipment sizes may increase shippers' reliance on transport providers to achieve a high load factor (Rogerson & Sallnäs, 2017).

Furthermore, studies have indicated that variations in demand, reflected in changes in order size, have a significant influence on the overall load factor. These fluctuations can have a negative impact on the load factor (Bø & Hammervoll, 2010; Piecyk & McKinnon, 2010) as it is more difficult to plan for. The more the demand varies, the more difficult it is to make accurate forecasts to be able to match required and available capacity (Rogerson & Santén, 2017). Potter and Lalwani (2008) conclude in their study of freight transport that an increasing level of demand amplification correlates with a reduced transport performance, such as load factor and costs. However, the authors' findings also present some exceptions, where spare capacity can be filled by the increased variability in the volumes moved. In other instances, the additional capacity may not be utilized, which has a negative effect on costs and load factor.

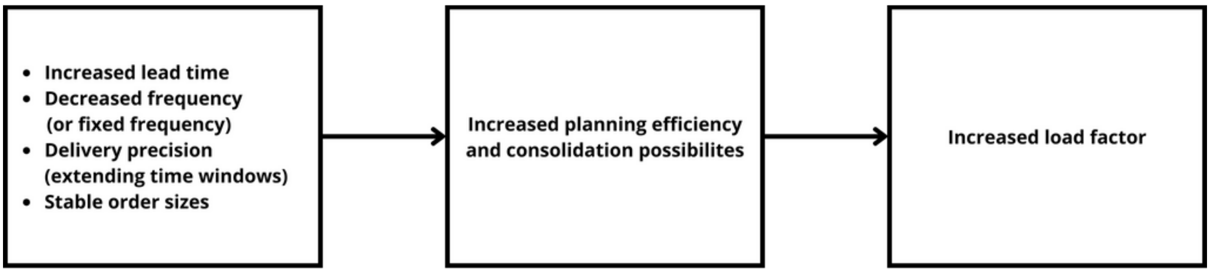
Ni and Wang (2021) analyzed load factors for less-than-truckload deliveries. The results of the study shows an increase in load factor performance for under-loaded tours when the number of shipment orders increased since there exists more flexibility for the transport provider in how to combine shipments for an optimal load factor. However, for tours that were overloaded (the required capacity exceeds the available capacity) the increase in the number of shipment orders implied a slight decrease in the load factor. The authors suggested that as the number of shipments increase, the transport providers introduce additional or larger vehicles.

3.3.5 A summarizing chapter

A summary of section 3.3 is presented in Figure 1 below and visualizes the relationship between service quality requirements and load factor as discussed in current literature. The summary is based on the literature presented in section 3.3.1 to 3.3.4.

Figure 1

The impact of service quality requirements on load factor



3.4 Managing service quality requirements and load factor

Identifying the potential to adjust customer service requirements contributes to discovering opportunities where the load factor may improve. Moreover, the load factor is affected by required and available capacity, which requires further examination of the changes that can be made capacity-wise without deteriorating load factor performance.

3.4.1 The trade-off between service quality requirements and load factor

Service quality requirements in isolation is not the sole thing affecting the load factor, the requirements also impact each other. For instance, a reduction in frequency often entails an increase in lead time and increase in shipment size, but may be necessary to increase the load factor (Aronsson & Huge Brodin, 2006; Jonsson & Mattsson, 2023). Adhering to a fixed day delivery schedule facilitates both delivery precision and consolidation which affects load factor performance positively, however, the lead time may increase (Jonsson & Mattsson, 2023).

This trade-off between load factor and service quality performance is further discussed by Bömer and Meyer (2022) where the authors mention a short lead time as one of the most important measures for maintaining a high customer service level. However, methods such as consolidation to reduce costs by increasing load factor performance instead entails a longer lead time. Furthermore, decreasing the frequency of deliveries is positive for economies of scale and load factor (Lumsden, 2011). The results of Bömer and Meyer's (2022) study showed that using a consolidation period, i.e. increasing the lead time, between two to five days, resulted in cost savings up to approximately 25% for a freight distributor. The cost savings increased incrementally for each day that elapsed, however, for each extra day of consolation after day five, additional cost savings declined. Thus, introducing measures to increase load factor and lower costs is seldom in accordance with a high service level, resulting in transport providers having to make the trade-off between service level and load factor.

Contrary to previous descriptions of the interaction between service quality requirements and its effect on load factor performance, the results of a case study performed by Rogerson and Santén (2017) displayed that it is possible to achieve an increased load factor while maintaining, and in some cases improving, service quality factors. One of the case companies, a wholesaler of food, updated their order agreements to entail that two out of four of their customers obtained an increase in delivery frequency and reduction in delivery sizes. Moreover, the lead time remained the same as prior to the changes in ten instances of delivery during a week, improved by one to two hours in four instances, and was postponed for two hours in two instances. The average load factor increased by three percentage units. Thus, it is possible to achieve a high load factor performance without significantly impacting service quality performance, however, the interaction between factors needs to be considered.

3.4.2 The ability to affect service quality requirements to increase load factor

Mason and Lalwani (2006) highlights the conflict between transport buyers' and transport providers' goals and ideal operational settings. Transport buyers strive for flexibility and the ability to meet changing requirements. Conversely, transport providers desire stable and predictable demand as well as wide delivery windows in order to achieve a high load factor. Deviating demands and behaviors from transport buyers which deviate from the desired state of order and delivery for transport providers contributes to inefficient freight transport (Pahlén & Carlson, 2013).

Oskarsson et al. (2021) mention the concept of adjusting customer requirements within the context of logistics operations. The authors raise a crucial question regarding the necessity for customers to receive shipments with maximum speed and flexibility, or if these requirements are shaped by what customers perceive as essential, leaving shippers with limited space for alternative strategies. Oskarsson et al. (2021) highlight that customers often demand the highest achievable service level, even when such levels of service may not always be necessary. Similarly, Santén and Arvidsson (2011) noted that transport buyers are not always fully aware of their needs, suggesting a potential gap between perceived needs and actual requirements. A key issue contributing to inefficiencies in transportation is the mismatch between the services offered to transport users and their actual needs (Pahlén & Carlson, 2013). Consequently, many transport users pay for short lead times, high frequency and late pick-up times, overlooking their actual need for cost efficient and reliable transport services.

Customer service requirements are viewed as relatively rigid, and are rarely explored to what extent they may vary to increase fill rates (Arnäs et al., 2013). From the perspective of the shipper, trying to fulfill these service quality requirements can limit the potential to improve the load factor (Arvidsson, 2013; Bø & Hammervoll, 2010; Santén, 2017). The question of imposed versus actual requirements prompts shippers to understand the balance between meeting customer requirements and optimizing load factor. Oskarsson et al. (2021) conclude that there should exist situations where it is possible to negotiate changes with the customer, such as extending lead times or reducing delivery frequency. This was already emphasized by Byrne & Markham (1991) which noted that logistics service requirements are often not absolutes. They mentioned that most customers can tolerate a range of service performance, defining it as the range of acceptability within which a service requirement can be adjusted.

These adjustments could then not only improve load factor but in the end increase the possibilities to improve customer service levels. For example, customers do not always perceive an increase in lead time negatively. A study by Aronsson and Huge Brodin (2006) showed that increased lead time contributed to improved delivery precision as it made the distribution planning easier for the shipper. The notion of making adjustments, or relaxing constraints was already emphasized by Walker (1990), who indicated that such actions could achieve higher efficiency. Furthermore, Walker (1990) suggested that if customers were made aware of the effects they cause by setting high service requirements, they could be more willing to relax these constraints. In a study of goods transport in Sweden, goods owners were relatively aware of the effects of their requirements, and mentioned more relaxed and flexible delivery windows as important to facilitate higher utilization rates and load factor for their transport providers (Karlsson et al., 2021). Other respondents in the study highlighted the need to change demanding customer requirements and to frequently discuss and implement modifications to service quality requirements with transport providers to enable higher transport efficiency and load factor. There exists a balance between transport providers' and transport buyers' responsibilities to realize higher transport efficiency and lower environmental impact (Rogerson & Sallnäs, 2017).

Through various incentives, companies can attempt to influence customers to relax their constraints. Lumsden et al. (2019) suggests encouraging customers to make preliminary bookings for their orders, or persuading customers to accept a flexible delivery time. Facilitating planning, or increasing the flexibility for the shipper can improve possibilities to increase the load factor. For example, Hallin and Karlenäs (2008) proposes that shippers could differentiate the price for different lead times, i.e. introducing a system where a discount is provided when a long lead time is selected, and vice versa, charging a higher price if customers request a short lead time.

3.4.3 The ability to affect load factor through capacity changes

The load factor is affected by the required and available capacity, i.e. the capacity needed to transport the goods leaving the shipper and the purchased capacity, which often is a part of a vehicle, a full vehicle or several vehicles (Rogerson & Santén, 2017). Increasing, decreasing or reallocating required and/or available capacity may result in increased load factor performance. For example, in the case study by Rogerson and Santén (2017), which is also described in section 3.4.1, reallocation of required capacity between weekdays was possible through changes in customer order agreements. This removed the need to purchase more than one truck each day, resulting in an increase in load factor performance. The authors further discuss changing the combination of orders, introducing loading adjustments and encouraging certain order patterns through pricing or marketing as measures for changing the required capacity. In regard to changing the available capacity, a measure such as utilizing available vehicles during an increased number of hours during a day through, for instance, introducing night time deliveries are presented. Lastly, better matching of available capacity to required capacity through improved forecasting of required capacity and/or buying and selling of available capacity when necessary are ways to improve the load factor.

A comparison to the relationship between how changes in required and available capacity affects the load factor can be made to the changes that occur in total costs as capacity is changing. Lumsden (2011) presents a stepwise model in which the total costs of a truck is dependent on the fixed costs in the transport system together with the variable costs, which increases marginally as the capacity increases. When the maximum capacity of a truck is reached, a new investment has to be made, and the pattern of fixed and variable costs for the second truck is repeated until the capacity limit is reached. Changing capacity in these systems, where a new transportation entity needs to be added to meet increasing demands, can be associated with a large marginal cost. Potter and Lalwani (2008) further mention fluctuating demand as a reason for deploying additional capacity, which is costly and has negative effects for fleet utilization.

Changing the required capacity through modifications to service quality requirements to better match available capacity have in previous literature been described as measures with high potential to improve the load factor. This may be realized through, for instance, larger or more stable order sizes, longer lead times, decreased frequency or extended time windows (Aronsson & Huge Brodin, 2006; Browne & Gomez, 2011; Jonsson & Mattsson, 2023; Piecyk & McKinnon, 2010; Rogerson & Santén, 2017). However, drawing parallels to the work of Lumsden (2011), the alteration in service quality requirements will presumably, as goods are accumulated, reach a point where there is a need to increase the available capacity with an additional transport entity. If sufficient goods needed to fill the additional unit are not possible to gather, it will have extensive, negative effects for both costs and load factor performance.

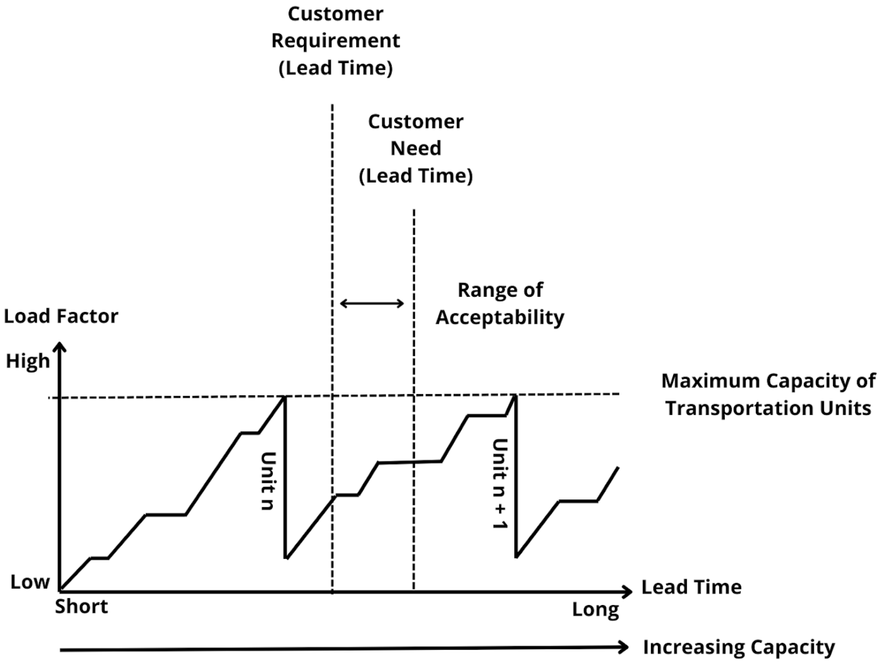
3.5 A model for exploring relationships between customer service requirements and load factor

To address the aim of the report described in section 1.2 a model (see Figure 2) was developed based on the literature described in chapter 3. The model presents the relationship between lead time and load factor performance. Furthermore, the model addresses the challenges of understanding the impact of changes in lead time requirements on the load factor and how this is related to customer requirements and needs as well as capacity limits. The model highlights three important aspects, namely:

- illustrating the interplay between service quality requirements, specifically lead time and load factor
- considering capacity limits when altering lead time
- exploring possible differences between customer needs and customer requirements, and thus providing a range of acceptability in regards to lead time alterations

Figure 2

A model for lead time and load factor performance



The logic of the model is built around the reasoning in section 3.3.1 and section 3.4 which indicated that modifications to service quality requirements can support a gradual, or stepwise, increase in load factor performance. The y-axis in the model represents the load factor while the x-axis represents lead time. If assuming that a constant flow of orders is provided to the transportation unit, the relationship between the load factor and lead time increases linearly. However, if the flow of orders is not constant, and there exists a waiting time between the loading of orders, the relationship will evolve as a stepwise increase. The width of the step represents the time between orders whereas the height represents the contribution of the order to the load factor, i.e. the order size. The width and height of the steps are not fixed in reality, and their size may fluctuate depending on the order sizes and the flow of orders being loaded.

The model also considers the capacity limitations in transport entities. As the lead time increases, the load factor is expected to gradually increase, however, only up to the maximum capacity limit of transport unit *n*. Subsequently, as the next transport unit is introduced, the load factor experiences a similar pattern of growth over time until the capacity limit of unit *n+1* is reached. Thus, as mentioned in section 3.4.3, capacity limits of the transportation units also have to be considered when lead time is increasing to be able to match required and available capacity optimally. The capacity limit of the transportation units may vary between units and unit sizes, however, the model is still applicable to explore the relationship between load factor and lead time.

Furthermore, the model considers that alterations to service quality requirements have to be carried out with respect to customer needs and requirements. As presented in section 3.4.2, transport buyers may demand a certain level of service quality, however, their actual needs may differ. The customer requirement is the specification outlined within the order agreement with the transport provider i.e. the imposed need. Whereas the customer need encompasses the service level that ensures that customers can continue their operations without interruptions. The customer requirement and customer need limits indicate starting and end points for the range of customer acceptability to alterations in lead time. Within this interval modifications to customer service requirements may be possible without significantly affecting the level of customer satisfaction. Surpassing the customer need limit results in a decreasing customer satisfaction due to perceived reduction in service level. As seen in Figure 2, the customer need is located to the right of the customer requirement, meaning in reality that the customer could accept a longer lead time. However, in some cases, the limits for the customer service requirement and the customer service need might be located in the same position, i.e. no further modifications can be made for the lead time without affecting customer satisfaction. Moreover, in some instances the customer requirement may be further to the right than the customer need, i.e. the customer actually needs a shorter lead time than required but may not be able to demand this for several reasons.

4. Case company descriptions

This section provides concise yet comprehensive descriptions of all five case companies involved in the study. Each description outlines the specific segment of their supply chain that was the primary focus of investigation, accompanied by an exploration of the contextual variables that were found to be most relevant.

4.1 BeverageManufacturer

BeverageManufacturer is a brewery producing and distributing beverages in Sweden. The outbound flow was studied, i.e. the distribution of beverages from *BeverageManufacturer* to their customers.

Distribution process: *BeverageManufacturer* has two main distribution flows from their production site: direct deliveries from their production site to larger customers and wholesalers, whereas other goods are routed through a third-party partner for further distribution to various, smaller customers.

Transport planning: All transportation activities are externally contracted, without any in-house fleet owned or operated by the company. The company is responsible for the transport planning of distribution to larger customers from the production location and to the respective cross-docks from where the third party takes charge of the planning and further distribution.

Central findings: Conflicting time windows and short lead times are complicating *BeverageManufacturer*'s transportation planning, potentially resulting in low load factors. The short lead times cause speculation of required capacity when booking transportation, and having to adhere to several time windows along a route limits consolidation possibilities. The respondent emphasized that longer lead times and more flexible time windows would create better conditions for achieving higher load factors.

4.2 PartsBuyer

PartsBuyer is a manufacturer of products for industrial applications. The inbound flow of material from the company's suppliers to their production sites was examined.

Supplying process: From the suppliers to the production sites, *PartsBuyer* employs four different ways to transport the material. Goods may be delivered directly from the supplier to the production sites. Alternatively, if the volume from a single supplier is insufficient to fill a truck, several suppliers can be visited in a milk run before delivery to production. For even lower volumes, the goods are transported via an X-dock or a Y-dock for consolidation before being delivered to the production sites. The Y-dock serves as a smaller, regional consolidation point, where goods are collected before being sent to an X-dock for further consolidation and transportation to production sites.

Transport planning: The company manages the planning of all transportation from their suppliers to the production sites. *PartsBuyer* does not operate their own transport fleet, all transportation is externally sourced. In cases when *PartsBuyer* does not purchase the full capacity of a truck, the transporter has the possibility to bring external goods. Even if *PartsBuyer* does not have their own transport fleet, the company is actively involved in designing their transportation network and the process of transporting goods from the supplier to production sites. For instance, *PartsBuyer* is responsible for determining what goods to consolidate from the cross docks as well as the modification of material call-offs to suppliers to efficiently fill the trucks.

Central findings: *PartsBuyer* has two service quality requirements that stood out from the rest of the cases. The company has strict time windows for delivering incoming goods, therefore their transporters must adhere to a specific schedule for unloading of deliveries. Transport providers are enforced with non-flexible lead times, indicating a strict approach to delivery timelines and emphasizing the importance of on-time deliveries in supply chain operations.

4.3 FoodDistributor

FoodDistributor is a wholesaler, serving customers in both the public and private sector. The company offers a range of fresh produce, groceries as well as beverages, equipment, non-food items and chemicals. The flow discussed during the interview was from *FoodDistributor*'s warehouse to their customers, and also to their different terminals in Sweden.

Distribution process: The company has several warehouses in Sweden, but this interview mainly focused on the warehouse in southern Sweden which serves the regional area surrounding its location. However, for some customers who for instance require specific certification for handling their products, the warehouse delivers to these customers regardless of their location.

The main distribution from this warehouse can be separated into two flows. The transportation of goods can be carried out to a terminal in the closeby, larger cities and then onward to end customers located within or outside these cities (outside the area of delivery for the studied warehouse). The second flow encompasses the direct transport to end customers within the regional area surrounding the warehouse.

Transport planning: The company has a combination of their own fleet of vehicles complemented with externally hired transport. The transport planning is done by *FoodDistributor*, both for their own fleet and the purchased transport.

Central findings: *FoodDistributor* operates with very short lead times, where some of their customers can place orders just hours before delivery. The company also adheres to strict requirements imposed by their customers in terms of time windows. These often conflict with each other, leading to difficulties in transport planning. The respondent emphasized the inflexibility in changing customer requirements as a large contributor to difficulties in achieving a higher load factor.

4.4 TechWholesaler

TechWholesaler is a technical distributor in the Nordic region specializing in installation products, tools, and machinery. The flow discussed during the interview was outbound from the company's central warehouse in the middle of Sweden to their customers.

Distribution process: *TechWholesaler*'s products are distributed to business customers, and to company-owned stores. The outbound transportation starts from the central warehouse, going directly to the final customer if the volumes are large enough to fill a truck. Alternatively, the transports may route through one of the transport provider's distribution terminals located across Sweden before reaching the final customer.

Transport planning: *TechWholesaler* has an entirely outsourced transport fleet, working mainly with seven transport providers. They opt to collaborate with transport providers engaged in a collective transport network, allowing for the transportation of external goods alongside *TechWholesaler*'s products. From the central warehouse to the terminals across Sweden, the company is responsible for the transport planning, whereas for the flow from the terminals to the end customers, the transport providers are to a larger extent responsible for filling the trucks.

Central findings: *TechWholesaler* passes on their customers' requirements to their transportation providers, both in terms of time windows and lead time. The company also imposes time window requirements at their facilities, resulting in difficulties for the transport providers to plan transport efficiently. These requirements were discovered to be the most limiting factors in achieving a higher load factor by creating difficult conditions for their transport providers to locate external goods. The respondent emphasized that time constraints, such as short lead times and time windows, limit the opportunities for synergies and consolidation.

4.5 RetailFood

RetailFood is distributing refrigerated food, frozen food and groceries to Swedish supermarkets, but also to e-commerce customers. The flow discussed during the interview was from their warehouse to their customers which range from larger grocery stores to smaller convenience stores.

Distribution process: The company has several warehouses located across Sweden. The flow can either be directly to customers from their warehouse, or going through a distribution terminal to be consolidated with external goods.

RetailFood manages the flow of goods throughout the week to minimize large volume fluctuations between days by changing the delivery agreements, i.e. changing the day for delivery for certain customers. Additionally, the company allows customers to order different food segments during the customer's different delivery days of a week to balance the flow of goods. This approach is designed to align the order volumes with warehouse picking capacity constraints, while also facilitating more efficient stocking of shelves in stores.

Transport planning: *RetailFood* performs the transport planning for their own fleet as well as for the externally sourced transport. All orders from customers are coming through their ordering system which are handled in different ways. In some cases, the system dynamically manages the orders to maximize transport efficiency by consolidation based on a number of factors such as time window requirements and locations of stores. In other cases, *RetailFood* employs fixed route setups for transport planning, primarily because stores located in rural areas are typically only feasible to consolidate with each other.

Central findings: At *RetailFood*, narrow and conflicting time windows were explained to be a limiting factor for load factor. Alterations of delivery agreements with *RetailFood*'s customers were further discussed during the interviews. The company frequently alters both the delivery frequency and time windows for their stores, with the aim to optimize routes and to achieve a higher load factor. However, product characteristics such as perishable items with short expiration dates were explained to be one source contributing to difficulties in changing the service quality requirements.

5. Empirical findings

In the following chapter, the empirical data from the interviews with the case companies will be presented. Section 5.1 covers the customer requirements mentioned during the interviews, which were described to have a relation with the load factor. Furthermore, the reasons why alterations to customer requirements are possible and not possible, according to the respondents, will be presented in section 5.2.

5.1 Customer requirements affecting the load factor

The following section will present empirical findings on what and how customer requirements affect the load factor. Several customer service requirements were identified in the studied cases that influence the load factor, including lead time, delivery frequency, and time windows. Requirements of order size were not that prominent from the case studies and was often mentioned together with the other service quality requirements. Hence, order size is included in three following sections.

5.1.1 Lead time

A common view amongst the interviewed cases was that lead time is an influencing customer requirement on the load factor. Four interviewees from *BeverageManufacturer*, *FoodDistributor*, *RetailFood* (Transport Planning Manager) and *TechWholesaler* all indicated that the length of the lead time has an impact on the planning process, which in turn can affect the load factor. In all case companies there exist examples of very short lead times, which leaves little room for planning the transport. As a result, transport bookings are often made before all customer orders have been received.

The Transport Planning Manager at *RetailFood* specifically emphasized that the shorter the lead time, the shorter the time for planning, and the harder it is to work towards achieving a high load factor. The Delivery Optimization Manager at *RetailFood* explained that most lead times are designed in a way to allow time for order processing, picking and transport planning. The Transport Planning Manager mentioned that the most common scenario is that orders are placed on day one and delivery is scheduled for day three, with an order cutoff time late in the evening of day one.

However, in certain product categories, such as perishables like meat, fruit, and vegetables, the customers of *RetailFood* demand even shorter lead times. For these items, the order cutoff can be as short as 12 hours before delivery to customers. Consequently, the company must speculate on the required capacity during transport planning and consider possible volume variations. As the Transport Planning Manager at *RetailFood* stated, *"we also plan based on forecasts or, on historical data, in some cases because we have such short order lead times, and therefore we do the planning before all orders are finalized".*

This speculation occasionally leads to discrepancies between required and available capacity, particularly in connection with campaigns. The Transport Planning Manager noted that such mismatches are often discovered during the actual loading of goods onto trucks. To address this challenge, *RetailFood* either seeks available capacity in alternative trucks or deploys additional vehicles as needed.

Similarly to *RetailFood*, *BeverageManufacturer* also exemplified that the short lead times compels them to not match the required and available capacity optimally. One example mentioned by the respondent from *BeverageManufacturer* is for customers with a lead time of 48 hours. These customers can order up until 17:00 two days before delivery, with the trucks being loaded the day after orders have been received. This entails that the transport booking is performed continuously throughout the same day as orders are received, ensuring that the transport planners have time to arrange all transport needed before the end of their workday, at 17:00. When additional orders are received after some of the transport booking has been performed, *BeverageManufacturer* has to contact the transport provider and ask if they can bring these order(s) on the already booked truck. If the transport provider has already filled the truck with external goods, a new transport has to be booked, which may affect the load factor negatively.

For *FoodDistributor*, certain customers are allowed to complete their orders close to when the orders are set to leave the warehouse. Therefore, not all volumes are in the system when planning the transport, resulting in the transport planners speculating in what capacity to book to meet the demand. If the required capacity exceeds what is available on the day of transport, additional trucks must be deployed. For example, some customers are allowed to order up until 21:00 for delivery the next day. The company looks at the orders that have been received and plans the transport before they leave work at 17:00. If the required capacity exceeds the available the following morning, the respondent explained that they have to *"move around resources and deploy an additional truck for the areas that need it. Then the load factor may not be so high (on the additional truck); however, for the other trucks, the load factor is high"*. Another example mentioned by the respondent is when customers have an order cutoff time on the weekend. For instance, some customers can order up until Sunday for delivery on Monday. Therefore, the planning of transports has to be performed on Friday, which makes the transport planners speculate on the size of the volumes to be transported on Monday. If the required capacity does not match the available capacity on the day of transportation, the load factor may be low. The respondent further commented that for customers with longer lead times, the volumes to be transported are usually more constant, which makes the planning easier.

The respondent from *TechWholesaler* highlighted short lead times as their primary challenge, limiting a higher load factor. The respondent elaborated that, in certain instances, the order cutoff time is as late as 18:00, with loading scheduled between 20:00 and 00:00, leaving minimal time for transport planning. Furthermore, the planning in terms of warehouse personnel and the required capacity for transport is based on forecasts. Therefore, the respondent commented that longer lead times would provide more accurate planning as it could be performed on actual volumes. As *TechWholesaler* does not have their own transport fleet, the respondent also suggested that a longer lead time would provide improved conditions for the transport providers to plan for loading external goods.

The respondent elaborated further that shorter lead times can impact the load factor, providing an example. When working with their transport providers, *TechWholesaler* has a predetermined capacity booked each day, for example, a certain deck-area coverage of a truck. The respondent mentioned that when volumes decrease, *TechWholesaler* does not decrease the predetermined capacity on a daily basis. If a permanent change is to be made to the predetermined capacity, the transport providers are given 1-2 weeks' notice to be able to find volumes elsewhere. However, if there is an increase in volume one day, it is possible to book extra capacity in addition to the predetermined capacity. Together with the transport providers, *TechWholesaler* can make such adjustments on short notice. Until 12:00, on the same day as pickup, the booking can be adjusted at the same cost rate as the predetermined capacity. Whereas adjustments after 12:00 are more costly as *TechWholesaler* has to pay for half of, or an entire truck, even if the goods do not occupy such a large space. When asked about how this affects the load factor and the capacity, the respondent said it differs from case to case, depending on the transport provider's commitments to external goods. In the case of adding extra capacity before 12:00 to the predetermined capacity, the transport provider usually manages this within their existing planned transports. The respondent commented that in cases where they make these adjustments really late, after 12:00, the transport provider has to arrive at *TechWholesaler*'s warehouse within an hour, meaning that they might not have the time to combine their goods with external goods.

In the case of *PartsBuyer*, discussions primarily revolved around lead time and load factor concerning full truckload (FTL) or less than truckload (LTL) shipments. Specific transportation lead times are decided by *PartsBuyer* together with their transporters. According to the respondent, adhering to this specific lead time for the transportation of FTL shipments poses no issues for the transport provider since no external goods have to be acquired. However, the respondent acknowledged that specified lead times with no flexibility are challenging for their transport providers. Transport providers typically receive LTL bookings only one or two days prior to collection from *PartsBuyers* suppliers or cross docks. During this short timeframe, transporters must find additional goods to fill the truck, aligning with *PartsBuyer's* required collection and delivery dates. Consequently, for LTL transports, transport providers often request extended lead times to accommodate this logistical challenge. However, such requests are not accepted by *PartsBuyer*, potentially resulting in lower load factors.

PartsBuyer's rigid requirements on lead time have a significant impact on the load factor at a network level, demonstrated by a scenario involving transport of an order from one supplier by different modes of transport, namely road and rail. For rail transport, the company allocates additional time for loading, unloading, and buffer time to accommodate potential delays. However, due to system constraints, road transport providers are also obliged to adhere to this lead time, which often exceeds the actual lead time that it takes to take the goods from point A to point B. For example, while road transportation may only require two days from collection to delivery, the road solution must adhere to a three-day lead time requirement because of the train solution, resulting in one day of waiting time for the truck driver. Furthermore, if there are no disturbances during rail transportation, waiting time is incurred before unloading. The respondent acknowledged the challenges this poses for transport providers, noting that it prevents resources such as drivers, trucks, and trailers from undertaking other tasks during this idle time. He stated that *"a resource in the form of a driver, a resource in the form of a truck and maybe a trailer becomes blocked, and cannot perform any other work during this time"*. Additionally, this practice diminishes the overall capacity of the transportation network that *PartsBuyer* operates within. To address this issue, one of *PartsBuyer*'s production units has implemented a solution where transporters can drop off full trailers at a storage center and pick up empty ones to continue their operations, thereby optimizing the use of transport system resources.

5.1.2 Frequency

Four cases mentioned that the frequency of deliveries can influence the load factor. For *BeverageManufacturer*, a higher delivery frequency could lead to customers placing smaller orders, which may be too small to fill up a truck each day. The respondent from *TechWholesaler* highlighted that some customers follow a more fixed order frequency schedule, whereas others order more sporadically. This combination contributes to rather stable order volumes throughout the days of the week, facilitating transport booking and planning.

FoodDistributor commented that fixed delivery days can affect the load factor as it limits the possibility of moving volumes for consolidation. Moreover, the respondent provided two examples illustrating the relationship between adhering to a fixed frequency with varying order sizes. Firstly, having a balance of different customers in a rural area, serving both public schools and private restaurants, helps balancing volume fluctuations. For instance, during school holidays when the schools are closed, private customers tend to place larger orders, and vice versa. The second example highlighted an area with large seasonal variations due to tourism where private customers order large volumes during the peak tourist season and close to nothing the remaining year. With fewer public customers in these areas, there is a challenge in achieving a high load factor. The public customers still expect and require deliveries during the same number of days as during the high season.

PartsBuyer stated that they decide the frequency of pickups depending on volumes. The respondent commented that if the order volumes decrease, then a strategy for increasing the load factor is to decrease the frequency of pickups. However, the respondent stated that it may sound good in theory to decrease the number of collection days per week but could be problematic in reality since the volumes cannot be divided evenly throughout the week. For example, the respondent illustrated that collection five days per week corresponds to a shipment volume of 20% of the production needed per day. However, for a frequency of collection of two days per week, for example, Tuesday and Thursday, the shipment size is not divisible by two since production needs have to be addressed for the days when there are no collections. On Tuesdays, not only would the current day's production needs have to be addressed, but also those of Wednesdays, while on Thursdays, the shipment volume to cover Thursday's, Friday's, and Monday's production needs would have to be addressed. This results in 40% of the production needs being picked up on Tuesdays and 60% on Thursdays, illustrating the unevenness of volumes throughout the week when reducing the frequency. The respondent mentioned that their priority is to have a frequency of five days per week since it is easier and more cost-efficient to move volumes for pickup between days compared to when having a lower frequency. Consequently, if a delay in supplier production occurs one day, the backordered parts can be shipped the following day. However, for suppliers with less frequent delivery schedules, additional express transport has to be deployed, which can incur high costs.

5.1.3 Time windows

A common view among all respondents was that time windows have a large impact on their operations, mostly related to transport planning, which in turn affects the load factor. For *RetailFood*, adhering to time windows was mentioned by the Transport Planning Manager as the largest challenge, limiting a higher load factor. The respondent from *BeverageManufacturer* stated that having to book arrival times for multiple customers means adherence to several time windows, which adds complexity to transportation planning.

The respondent at *FoodDistributor*, mentioned time windows as one of the largest challenges limiting the possibilities of achieving a higher load factor. Currently, most customers of *FoodDistributor* have a time window lasting between one and four hours. The respondent indicated that the wider the time window, the easier it is to plan the transport. However, if the customer is closed for delivery during some of the hours within the window, for instance, during lunch hours, the planning becomes more complex. Moreover, *FoodDistributor* have to adhere to both time window requirements set by their customers as well as time windows imposed by the municipality for customers in the city center. The respondents at *RetailFood*, including both the Transport Planning Manager and the Delivery Optimization Manager, also underscored the challenges posed by adhering to time restrictions imposed by municipalities in city centers. These restrictions add another layer of complexity to route planning. Such constraints are beyond the company's control, requiring them to adapt their operations accordingly to ensure timely deliveries while navigating these limitations.

One of the largest issues mentioned by the respondents was conflicting time windows. The respondent from *FoodDistributor* illustrated that conflicting time windows, especially in the case of requirements from both customers and the municipality, can be an issue for the load factor. For example, when there are both customers in the city centers and outside with similar time windows, the customers in the city centers often have to be prioritized due to the time window restrictions set by the municipality. This makes it hard to plan the routes and may contribute to dissatisfaction for customers outside the city center, whose desired delivery times are not prioritized over urban deliveries. According to the respondent, the option is to deploy an additional truck, however, this is stated to be negative for the load factor performance.

For *BeverageManufacturer*, the respondent noted another challenge regarding time windows and the potential to achieve high load factors. The respondent emphasized that drivers operate within finite time frames to complete their designated routes. Attempting to load a vehicle with numerous stops proves impractical as it exceeds the feasible working time frame, even if the vehicle has sufficient space. He stated that *"you cannot fill the truck with 40 stops; you will never make it within 8 hours"*. The respondent from *BeverageManufacturer* observed that the more stops you can fit onto a truck and strict time window adherence result in a longer time for drivers to load and deliver goods effectively. Consequently, the increasing number of orders on a vehicle leads to an increase in driving time, further complicated by the need for drivers to adhere to time windows. This occasionally makes it infeasible to fully utilize the capacity of the trucks.

FoodDistributor mentioned that many of their customers require deliveries during a similar time in the mornings, often between 08:00 and 11:00, which is not optimal for the utilization rates of the trucks. Consequently, the company has been urged to persuade customers to opt for afternoon delivery slots. However, afternoon deliveries may not be feasible for all geographical regions. For instance, in areas where time windows are widely dispersed throughout the day, i.e., some customers require deliveries in the morning and some in the afternoon, consolidating these orders becomes challenging.

RetailFood's customers have varying time window requirements: certain customers require delivery within a specific hour, while others accept delivery throughout the entire workday, spanning approximately eight hours. Notably, smaller stores often feature six-hour delivery windows. This allows for adaptability in delivery scheduling, enabling the synchronization of deliveries to stores with narrower time windows, as highlighted by *RetailFood*'s Delivery Optimization Manager. Regardless, increasing the load factor remains a challenge due to time window requirements, especially when the order volumes are low, according to the Transport Planning Manager. *RetailFood* tries to consolidate as many orders as possible while maintaining the ability to meet time window requirements, resulting in fewer trucks being deployed when the volumes are low. However, the Transport Planning Manager suggested that further reduction in truck usage is possible, stating, *"Of course, if the time window had been a bit more dynamic, then we could increase the load factor by compressing the trucks more when the volumes are low"*.

The discussion among several respondents revolved around the significant impact of time windows on the efficiency of geographical deliveries and optimal routing strategies. As mentioned before, *FoodDistributor* tries to compile orders going to the same area on the same truck. However, it is not always possible due to the time windows conflicting or being widely spread during the day. For *PartsBuyer*, when one truck is going to the same production unit but needs to deliver to different goods receptions within specific time windows, the respondent raised the challenge of fitting and sequencing the goods according to the different time windows, which can result in a lower load factor.

PartsBuyer further raises an issue with time windows not being planned optimally relative to each other. The respondent provides an example of one truck being loaded with three different orders going to the same production unit but to three different goods receptions where each order has a unique time window. He stated, *"two of them might operate smoothly, however, there may suddenly be a number of waiting hours between the second and third stop"*. The same issue, as mentioned in section 5.1.1, regarding the potential strain this puts on the transportation network in terms of capacity reduction, was raised by the interviewee in relation to the time window schedule and the waiting time it may incur.

The respondent from *BeverageManufacturer* mentions that having two delivery points geographically close with the same required delivery time and a time window of +/- 15 minutes restricts the possibility of consolidating these orders, making the company deploy two separate trucks. Lastly, the Transport Manager from *RetailFood* highlighted the impact time window requirements have on the routing of the trucks. The respondent described how for example conflicting time windows in a city reduces the ability to consolidate orders. Conflicting orders to be delivered to the same geographical area have to travel on separate trucks, leading to intersecting driving paths. This results in excessive distance driven to fulfill time window requirements, compared to the scenario of customers having time windows aligned with each other based on geographical placement to minimize the driving distance.

Another challenge with the strict time window requirements mentioned by three of the respondents is that they can affect the whole transport system, making it time sensitive and potentially negatively impacting the load factor. *FoodDistributor* raised this issue from the perspective of a transport provider. When asked about potential difficulties in filling up the trucks due to time window requirements, the respondent said that it is not often an issue, however, time window requirements make the system more time sensitive. Any delay at one customer's location can impact the driver's ability to maintain punctuality for the remainder of the delivery route. Similarly, The Delivery Optimization Manager at *RetailFood* mentioned delays at their warehouses or due to traffic as factors negatively impacting the ability to fulfill time window requirements. He further commented that they were exploring the implementation of wider time windows for stores scheduled at the end of delivery routes to decrease this time sensitivity.

The respondent at *PartsBuyer* were critical of their own strict requirements on time windows (15 minutes from the booked arrival time), as it could block the transporter's ability to load external goods. Moreover, when the receiving warehouse at *PartsBuyer* is not able to keep up with the time windows, the ability to collect goods for backhaul is affected negatively. According to the respondent, failure by the goods reception to adhere to the specified time windows for incoming goods could result in the transport provider needing to revise their plans. This may entail deploying an additional truck, potentially leaving the original truck scheduled for the backhaul only partially loaded.

Whilst the respondent at *PartsBuyer* were rather critical of the narrow time window requirements the company imposes on the transport providers, he highlighted the positive effects wider time window entails. *PartsBuyer* requires many of their suppliers to be open for collection of orders between 08:00 and 17:00. The reason, according to the respondent, is to aid their transport providers in building efficient transportation practices, such as enabling transporters to organize milk rounds both with *PartsBuyer*'s and external volumes. The respondent stated that, theoretically, the milk round concept can enable a high load factor. However, he raised an issue regarding milk rounds: if the first suppliers in a round are delayed, it can result in the remaining suppliers closing before the round is completed, meaning that the truck is only partially filled.

Just as *PartsBuyer*'s transport providers must adhere to time window requirements at both the production sites of *PartsBuyer* and supplier sites, *TechWholesaler* imposes similar time window requirements on their transport providers. *TechWholesaler* passes on the time window requirements of the customers to the transporters and requires certain times for the transporters to collect the goods at their warehouse. The respondent highlighted that this practice reduces the transporters' ability to find external goods which align with the schedule of *TechWholesaler* and *TechWholesaler*'s customers.

5.2 Managing service quality requirements and load factor

The following section covers the empirical findings regarding alterations to service quality requirements to improve the load factor. The section includes the respondents' explanations and reasoning for whether or not it is possible to adjust service quality requirements.

5.2.1 Lead time

Two of the respondents provided examples of when it was possible to perform alterations to the lead time to achieve a higher load factor. The respondent at *BeverageManufacturer* elaborated that they, for larger customers, have flexibility in adjusting the delivery date either one day forwards or backwards to fill up the trucks. He exemplifies, *"if there are too many orders one day, you could try to persuade the customer to move (some volumes) to the next day (in order to) avoid making a trip with small, excess volumes"*. However, he acknowledged that they rarely perform these types of volume adjustments and that they could improve in this area. Nevertheless, in some instances, if the weekly volumes of a customer are known in advance and correspond to, for instance, five full loaded trucks, the company tries to deliver one truckload of goods each day, instead of 2,5 truckloads during two days of the week. The customer typically agrees to this change, even if it is not in accordance with the contracted terms.

At *PartsBuyer*, moving shipment volumes between days to increase the load factor is possible for less than half of their suppliers. To achieve full truck loads, the collection and delivery date of some pallets can be adjusted either forwards or backwards in time. This adjustment before the transporters receives transport bookings. This option is available for those suppliers capable of handling and accepting daily, sudden changes to their production plans. The replanning of what goods to deliver when is performed daily at *PartsBuyer*. However, the ability to manipulate the collection and delivery dates are only possible to a certain extent. Consistently receiving goods earlier than scheduled at *PartsBuyer*'s production units results in stock buildup, whereas receiving deliveries later than initially planned constitutes a risk as the production then relies on the safety stock. As a consequence, the modification was limited to delivery one day earlier or later than originally scheduled.

Generally, *RetailFood* does not change the lead time to their customers, as mentioned by the Delivery Optimization Manager. However, a recent change in the warehouse setup, order throughput time has increased, resulting in a lead time change to reflect the time needed for order processing, picking and transport planning. Thus, it was possible to alter the lead time, however, the customers were not satisfied.

When questioned about the reason behind customers demanding certain lead times, the respondent from *BeverageManufacturer* implied that it is the norm, and exemplified *"if you are a Stockholm customer, it is 48 hours that apply"*. The respondent from *TechWholesaler* mentioned that short lead times have historically been used as a competitive advantage. Thus, consistently having spoiled customers with this level of service, the customers have grown accustomed to short lead times and it is viewed as the new normal. The respondent from *FoodDistributor* suggested that the demand for a particular lead time stems from habits, which the customers are reluctant to change. The respondent explained that short lead times makes it challenging to plan transports, and there exists no flexibility in rearranging the delivery date of goods. As per the order agreements, if a delivery is not performed on the agreed-upon date, the customer has the right to order from another actor and *FoodDistributor* has to bear the cost.

Altering the lead times for customers of *FoodDistributor* is described by the respondent to generally not be feasible, changes cannot be performed on a daily basis. The respondent further elaborated on the reason why lead times cannot be altered, noting that customers might have additional personnel scheduled for the days of delivery. Extending or shortening the lead time temporarily is hence not possible due to staffing arrangements.

A similar view in regards to the limited flexibility in altering lead times was shared by the Transport Planning Manager at *RetailFood*. However, the reason behind customers demanding a certain lead time was mainly connected to product characteristics. For instance, fresh produce often has short expiration dates, prompting stores to request deliveries as fast as possible to minimize waste. Additionally, shorter lead times enables stores to more closely make orders reflect actual sales. Longer lead times introduces the likelihood of more unforeseen events occurring between order placing and actual sales. The stores have to take this into account when placing orders, risking over- or understocking which can result in waste or dissatisfied customers, respectively.

For certain customers to whom *FoodDistributor* offers short lead times, where order completion is possible the same day as delivery, the objective is to persuade these customers to change another of their requirements. An example provided during the interview was in relation to preferred time windows. *FoodDistributor* has a large number of customers demanding morning deliveries, contributing to challenges in fitting all orders in the trucks and fulfilling the demanded, and sometimes conflicting time windows. Hence, the company offers shorter lead times as a means to convince some customers to accept afternoon deliveries instead.

From the perspective of *PartsBuyer*, where the company imposes requirements on a transport provider, the respondent stated that no flexibility exists in changing transport lead times and that dynamic lead times are not a possibility. For both FTL and LTL transports, *PartsBuyer* requires a certain transport lead time. The transporters often need more time for the LTL transports to collect external goods which fits the *PartsBuyer* schedule, however, extra time is not provided to the transporters. When asked to further explain why the transport lead times can not be dynamic the respondent stated a couple of reasons. One reason was due to the scale of the company's operations and the multitude of transporters involved, engaging in individualized discussions regarding lead times was deemed impractical. The respondent stated, *"we are too large to have this dialogue with our transporters"*.

The constraint of being a large scale company was also brought up by *TechWholesaler* in a similar discussion of making adjustments to lead times. The respondent at *TechWholesaler* mentioned that when there are larger orders from customers there is much more planning and direct dialogue with the customers. Recognizing if there is potentially a better solution than the standard setup for the transporter, the company tries to check in with the customer if it is possible to make changes to the lead time, for instance. The respondent of *TechWholesaler* stated *"the goal is to find a solution that is best for all actors" and highlighted that "it is usually possible to find a good compromise"*. When asked about why *TechWholesaler* cannot make these changes for all deliveries the respondent said, similar to *PartsBuyer*, that it would be too resource heavy to contact every customer and ask if the lead time could be extended. He quantified this by stating, *"there are around 10 000 deliveries each day, so that is 10 000 customer calls each day"*.

Returning to *PartsBuyer* and the reason for lead times not being dynamic. Another reason for it not being possible to perform lead time alterations was that the transporter has to adhere to strict time-windows at their production unit. If the truck arrives earlier than planned it is almost never possible to unload the goods. The respondent said this is due to *PartsBuyers* goods receiving units having their time-window slots for delivering entirely filled and planned in advance. There are trucks arriving continuously combined with unexpected delays, and there is a limited amount of unloading and freight handling personnel in the goods receptions. Therefore, it is almost never possible to unload in advance. Moreover, the respondent highlighted limitations within the material planning system used by the company, which fails to accommodate varying lead times. This system constraint further restricts the feasibility of dynamic lead time adjustments.

These required lead times are communicated to potential transport providers during tendering processes. However, it was noted that not all transporters fully comprehend these requirements. An illustrative example was provided by the respondent, who described a situation where a transport provider discovered upon receiving a booking that the given transport lead time exceeded the actual driving duration between points A and B. The transport provider therefore takes the decision to pick up the goods at a later date than initially scheduled. The respondent said that this is problematic for several reasons. The first reason is that it causes a lot of manual work because *PartsBuyers* material management system issues warnings that the pick up has not been completed, and the system starts recalculating to cover for production. The material planner has to look at what has happened and follow up with the transport provider to correct the problem. Another reason mentioned by the respondent is that it can cause problems for their suppliers when their transporter does not pick up the goods as planned. The respondent mentioned that the supplier can have limited space, and not picking up the goods in time can cause manual work for them too.

5.2.2 Frequency

Four of the interviewed case companies mentioned possibilities in altering frequency of deliveries. The respondent from *BeverageManufacturer* stated that it is often easier to reschedule the delivery to another day if the customer receives delivery everyday of the week. The respondent explained that it is thus generally more feasible and acceptable for the customer to have the order moved one day forwards or backwards. However, for customers with a lower delivery frequency, altering the delivery day is highly dependent on the customer's availability for unloading on days where delivery has not previously been scheduled by *BeverageManufacturer*.

The respondent from *FoodDistributor* stated that adhering to fixed delivery frequency can affect the load factor. The respondent exemplified this stating that if there is excess volume one day compared to the available capacity, it is not possible to move the volume to another day. The reason for this is similar to making changes to lead time as explained in section 5.2.1, the customer often has additional resources for specific days. Changing the days of delivery would require the customers to change their work schedules which is described as a lengthy process potentially taking months to complete.

The respondent from *TechWholesaler* mentioned that environmentally conscious customers take the initiative to improve delivery agreements by asking how they best may order to align with the work of *TechWholesaler* and the transport provider. This often entails the customer receiving fewer deliveries of full truckloads, whereas, at other times, it may result in longer lead times.

Similar to some customers at *TechWholesaler*, the customers at *RetailFood* sometimes approach the company requesting a change in the number of days delivery occurs. At other times, the initiative stems from *RetailFood*. The decision to alter delivery frequency can be driven by changes in volume, such as decreases or increases in product turnover at the stores, as highlighted by the Transport Planning Manager. Additionally, if multiple stores that were previously consolidated experience a significant growth in volumes, one store may need to change its delivery day due to capacity restrictions of the truck, as suggested by the Delivery Optimization Manager. Furthermore, the Delivery Optimization Manager mentioned a scenario where there are three stores with deliveries spread evenly over the week, such as in a smaller city. If one of the three stores closes, this could prompt a change in delivery day to align the remaining two stores for consolidation.

Both the Transport Planning Manager and Delivery Optimization Manager at *RetailFood* highlighted another aspect to why changes in delivery frequency are not feasible. Due to height and/or length restrictions at the customer sites, *RetailFood* has to employ specialized trucks and conduct deliveries more frequently compared to customers without such restrictions but with similar order volumes.

5.2.3 Time windows

While altering lead time and frequency were feasible in some instances, respondents expressed a greater challenge in adjusting time windows, both in terms of extending the duration and moving the entire window. However, the respondent from *FoodDistributor* mentioned that some customers may agree to deliveries outside the predefined time window, nevertheless, the change must be performed together with the sales division and the customer. Similar to what is described in regards to lead time and frequency alterations in section 5.2.1 and 5.2.2, implementing this change can be a lengthy process.

FoodDistributor has tried, and succeeded, to shift some of their customers' time windows to the afternoon through the incentive mentioned in section 5.2.1 and others through negotiation. This move served to fulfill time window requirements and to better utilize their fleet of trucks throughout the day. A few customers of *FoodDistributor* have begun to recognize the benefits of this adjustment. By rescheduling their time windows to the afternoon, the customers can reduce the personnel scheduled in the mornings, and as these businesses tend to be slower in the afternoons, it is suitable to receive deliveries then. The respondent noted a shift in terms of when during the day the time windows are required. Previously, most customers required morning deliveries, however, deliveries during the afternoon are increasingly becoming a customer demand.

During periods when order volumes are low, *FoodDistributor* strives to consolidate deliveries to multiple geographical areas whenever possible. However, conflicting time windows can pose planning challenges in terms of what orders are feasible to consolidate. Thus, *FoodDistributor* occasionally contacts customers, asking if delivery at a later time is possible, to ensure adherence to all order time windows. The respondent mentioned that customers usually agree to this adjustment once, possibly twice. However, this practice is not something *FoodDistributor* can continue with, a permanent change has to be performed if they want to continue with the "new" time window.

Another solution for extending time windows was explained by *FoodDistributor* which involves unassisted deliveries, i.e. customers authorizing delivery drivers to access the premises and complete deliveries in the absence of customer staff. The respondent stated that this approach provides greater flexibility in transport planning and diminishes the need for customers adapting the staffing schedules to accommodate specific delivery times.

However, the majority of respondents all agreed that alterations to time windows is difficult and not always possible for several reasons. For instance, *BeverageManufacturer* highlighted that certain customers require delivery within specific time frames due to staffing arrangements tailored for unloading goods during those periods. Additionally, for some customers having many suppliers, 30 to 60 minutes between each time window slot is required to be able to process the goods, resulting in difficulties in altering the time window. The respondent at *FoodDistributor* commented that the reason for customers demanding a certain lead time and time window is, according to the respondent, that it usually is a habit the customer does not want to change. Meanwhile, *PartsBuyer*, faces constraints in adjusting delivery time windows at their goods receptions due to the extensive amount of arriving transports, limiting flexibility in alterations to their transport requirements.

Similar to *BeverageManufacturer*, the Transport Planning Manager at *RetailFood* mentioned that there are time window requirements due to planning of the personnel, i.e. having the right number of staff in place when orders are delivered. The Delivery Optimization Manager at *RetailFood* further elaborated on the width of the time windows, stating that stores initially provided with a 6-hour time window may request a narrower 4-hour window due to insufficient staffing. The store may lack the necessary personnel available to efficiently handle goods during the entire 6-hour window. Additionally, the requirement of some stores having 2-hour delivery windows is to avoid scheduling personnel for extended periods during goods receiving. Another reason for certain time window requirements mentioned by the Transport Planning Manager was that certain customers request morning deliveries for their products to ensure that the stores are stocked to meet customer demands. The respondent drew parallels to the convenience of buying breakfast items or coffee at a convenience store during morning rush hour. Customers strive to offer the best possible assortment, hence they prefer an early morning delivery to meet this demand.

The respondent from *TechWholesaler* commented that there are requirements on certain time windows due to scheduling of machines and other on-site equipment during specific times. Therefore, the respondent at *TechWholesaler* stated that it is crucial that they deliver at the specified time for the machines and equipment not to be idle. Furthermore, for their stores deliveries usually have to take place in the morning, since their customers usually start their day by picking up their online orders from the stores and shops from the stores.

Altering the time windows were discussed with the Transport Planning Manager and Delivery Optimization Manager at *RetailFood*. The respondents said that as new stores open and others close, challenges may arise in terms of meeting time windows, necessitating adjustments of when during the day delivery is to be performed. Additionally, the Delivery Optimization Manager highlighted that as certain stores grow, the order volumes increase, resulting in the existing delivery route not having the ability to accommodate the volume increases. Consequently, the delivery to the stores have to be assigned to different routes, potentially leading to changes in delivery time windows. The respondents noted that the initiation of changing time windows can originate from both *RetailFood* and their customers. One example provided by the Delivery Optimization Manager was that stores sometimes identify cost-saving opportunities by scheduling staff for unloading during certain times of the day, resulting in requests for changes to the delivery time window. The Transport Planning Manager at *RetailFood* mentioned that the number of times alterations are performed to time windows or frequency depends on the customer size. Smaller stores are often a faster changing environment in terms of new stores emerging and closing, therefore changes to time windows and frequency happen more often than for larger stores.

The Transport Planning Manager at *RetailFood* emphasized that making changes to service quality requirements are not straightforward. For instance, he noted that if one customer requests a change in time windows, it necessitates adjustments to the schedules of other geographically proximate customers as well. These changes could take several months as consensus must be reached among all affected customers. When asked how a situation is handled if an agreement is reached with everyone except one or a few customers, he stated that it depends on the type of arrangement. The respondent illustrated that if all customers change from day to evening deliveries, while one customer still requires deliveries in the morning, there could be a separate truck going to this customer. He also explained that there are cases with a transition period during a delivery agreement change if all customers are not able to change at the same time. For example, some customers can start with new time windows in 3 months while others are able to start in 5 months. This can result in starting with the new time windows for the customers agreeing to an early start after 3 months and thus running an inconsistent setup until month 5 with varying levels of load factor. However, the respondent emphasized that achieving the goal of the change outweighs the complexities encountered during the transition period.

Aside from adhering to staffing arrangements, *BeverageManufacturer* stated that trying to change either of two conflicting time windows to create a better fit for consolidation can be difficult due to the existing schedule of the customer. The respondent at *BeverageManufacturer* illustrated this problem by describing two stores relatively close to each other with the same time window contributing to consolidation on the same truck not being feasible and two trucks having to be used. The respondent stated that they can ask the customers if it is possible to receive new time windows to enable consolidation of the orders. However, often the customer has a set schedule with deliveries from other suppliers booked in the remaining time windows, resulting in *BeverageManufacturer* having to ask these suppliers for a change which the respondent indicated is complicated.

Similarly, *FoodDistributor* reported that in some cases orders cannot be loaded on the same truck due to conflicting time windows. He commented that the inability to adjust schedules due to conflicting time windows and customer requirements complicates logistics. The respondent stated *"in theory, we could fit the entire volume (of orders) on a truck, although (in practice) it is not possible because the time window schedules dictate it so rigidly"* and *"moving time windows can make the customers dissatisfied"*.

The respondent from *FoodDistributor* raised another example in relation to altering customer service requirements, indicating the difficulties in performing changes to time windows back and forth for the same customer. He stated that *"once a certain time point for delivery is in place, it is difficult to change it"*. Furthermore, the respondent illustrated that during summers when the number of customers are declining, the remaining customers still need deliveries. Then if the time windows are changed to facilitate higher load factors, the customers get used to this change and it is difficult to return to the initial time window if needed.

Another example brought up by *FoodDistributor* was that in the beginning of performing deliveries to a new customer there is often a favorable time window in the contracts, for example 07:30 to 13:30. However, once deliveries commence at a specific time, such as 10:00, this initiates a new expected and contractually binding delivery time, accompanied by a time window of approximately +/- one hour. Any deviation from this revised time window necessitates notification to the customer.

5.2.4 Changes to several service quality requirements: an example of delivery agreements at RetailFood

Changes to the delivery agreements at *RetailFood* have been touched upon in previous sections, however, the respondents also mentioned that changes to both time window requirements and delivery frequency can be performed simultaneously. The interaction between these two factors will be further elaborated in this chapter.

The Transport Manager at *RetailFood* mentioned that the delivery agreements and the alterations of those are not created randomly. *RetailFood* tries to create agreements which contribute to a higher load factor. Any changes to the delivery agreements must be communicated to the customer four to eight weeks before the change is to occur and has to be accepted by the customer. During the negotiation process, *RetailFood* does not suggest delivery agreements which they know the customers will not accept, for instance if they know that a customer is not available for deliveries during a specific time of the day. Both the Transport Manager and the Delivery Optimization Manager estimate that 80% of *RetailFood*'s proposals successfully turn into agreements, while the remaining 20% necessitate further discussion, often due to customers needing to adjust their schedules.

The Delivery Optimization Manager commented that for larger stores, accommodating these changes might be as straightforward as adjusting a single employee's schedule. However, for smaller stores, especially those with only two employees and a requirement for two people to manage unloading, implementing these changes demands a larger change. Consequently, the revision of proposals after discussions can lead to compromises which may result in a non-optimal solution and result in a lower load factor than initially aspired. On the other hand, when asking the Transport Planning Manager at *RetailFood* whether incentives could influence customers to change their time window or lead time requirements, he indicated that it could, for certain stores. Using price differentiation to extend the time windows might be feasible for smaller stores where *"the financial manager, store manager and shelf stockers are the same person"*, allowing for flexibility in adjusting their work schedule based on delivery times. However, in larger stores, there is a greater reliance on knowing when the goods will arrive to schedule staff accordingly, as personnel costs are a large expense. Moreover, larger stores, as mentioned in section 5.2.1, work greatly with reducing food waste, making short lead times viewed as a necessity.

If *RetailFood* determines that a change to both time window and frequency is necessary, they aim to perform the change at one occasion to avoid frequent changes of the store's operations to fit the delivery agreement. At times when changes to the delivery agreements are initiated to one of the service quality requirements, it often impacts both factors. For instance, if order volumes increase and exceed the capacity of a truck, the delivery has to be separated into two occasions, meaning that the frequency of deliveries increases and an additional time window is needed. Furthermore, as new stores emerge and others close, the current transport arrangements may no longer be optimal in terms of load factor and routing. Therefore, revision of current agreements with the remaining stores on the route is needed, potentially leading to changes in both delivery frequency and time windows.

5.2.5 Lead time alterations to avoid speculative planning

A recurrent theme in the interviews was a sense amongst interviewees that longer lead times makes it easier for planning the transports, and thus increasing the possibilities to achieve a higher load factor. As the respondent from *TechWholesaler* stated, *"everything about time constraints, short lead times and time window requirements, decreases the possibilities for consolidation and synergies".* To further elaborate on this subject, it was asked how much longer lead time would be beneficial to facilitate planning and to avoid speculation on required capacity. Specifically, insights were gained into whether the respondents considered additional lead time in terms of hours, days, or weeks as a facilitator for planning according to actual orders.

The respondent at *BeverageManufacturer* mentioned, as described in section 5.1.1, that for customers with a lead time of 48 hours and an order stop time at 17:00, it requires the transport planners to speculate in what capacity to book. The orders are to be loaded the following day, resulting in transport booking being performed gradually throughout the day as orders are received to ensure all bookings are complete before the workday ends. As additional orders are received, transport providers may be contacted to add these orders to existing bookings, which is not always possible. The respondent explained that an additional day of lead time, meaning a total lead time of 72 hours, would assist greatly in the transport planning and achieving a higher load factor, assuming that goods could be stored at the cross-docks. With a 72 hour lead time, speculation of capacity is not needed, enabling *BeverageManufacturer* to deliver full trucks to the cross docks instead of partially filled ones.

For *FoodDistributor*, as presented in section 5.1.1, the lead times for customers vary significantly. Public customers typically have an order cut-off time two days before delivery, making the transport planning easier because volumes are known beforehand. Conversely, private customer lead times are notably shorter, making the transport planning more speculative. The majority of private customers place orders the day before delivery, with some extending the order cut-off time until 17:00-18:00 in the evening to be delivered at 08:00 the following morning. Moreover, certain customers can place orders as late as 12:00 for afternoon delivery, while others may order until 21:00, for next-day delivery. The company reviews received orders and undertakes transport planning before their workday ends at 17:00, leading to capacity speculation due to the narrow planning timeframe. When asked about the extent to which longer lead times could help in achieving higher load factors, the respondent emphasized that an order stop time before 12:00, the day prior to delivery, would provide significant advantages. This was illustrated by suggesting a scenario where orders for delivery on a Friday would need to be placed by 12:00 on Thursday.

6. Analysis and discussion

The following chapter analyses and discusses the empirical findings and literature review. The chapter intends to follow up and discuss the relationship between service quality requirements and load factor and to answer the three research questions of the study. The case companies have demonstrated challenges in achieving a high load factor in both similar and different ways. This is discussed in relation to the models presented in section 6.1, which describe the relationship between the load factor and each service quality requirement. In section 6.2, factors limiting the ability to alter service quality requirements are presented. Following, section 6.3 evaluates and compares the models introduced in section 6.1. Lastly, section 6.4 takes a wider perspective on load factor, by describing the influence of service quality requirements on transport efficiency.

6.1 Models for analyzing the relationship between service quality requirements and load factor

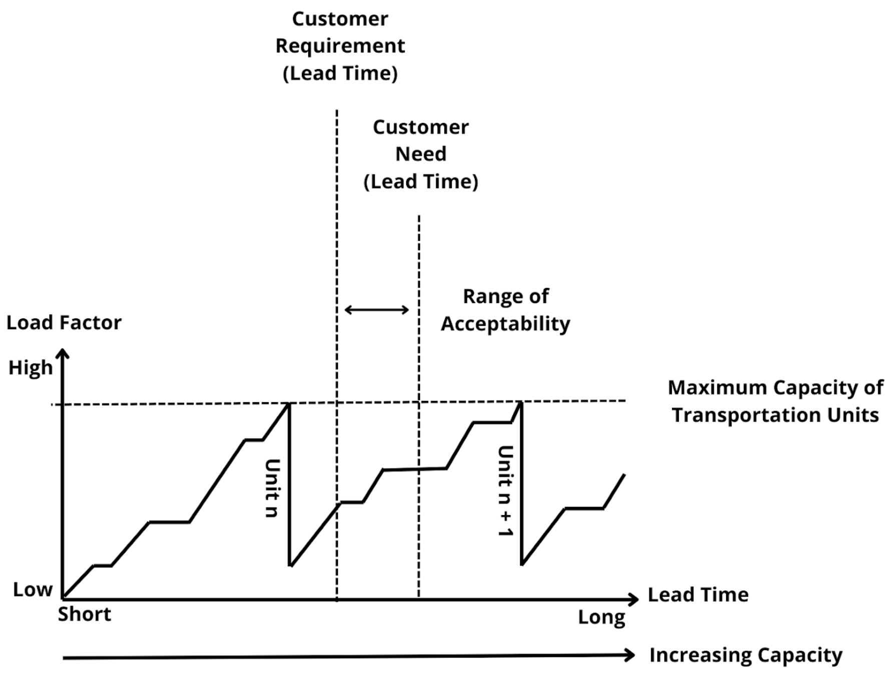
In section 3.5, a model was developed to describe the relationship between load factor, lead time, capacity of transportation units, customer needs, and customer requirements based on existing literature. Two similar models describing the relationship between load factor and frequency, as well as time windows, were created to capture a larger extent of findings from the cases. Below, the different components of the models are analyzed and discussed in relation to the empirical findings. This enables evaluation of the models applicability in practice, and a deeper understanding of the relationship between load factor and service quality requirements. This section contributes to research question 2: *How do service quality requirements affect the load factor?* and research question 3: *What alterations can be made to the service quality requirements to improve the load factor while still meeting customer needs?*

6.1.1 Lead time

The model presented in Figure 2 is the same model presented in section 3.5 which was developed based on existing literature regarding the relationship between lead time and load factor. The subsequent sections will discuss the empirical findings related to the model's various parts: the x- and y-axis, gradual or stepwise increase, capacity limitations and range of acceptability.

Figure 2

A model for lead time and load factor performance



The x- and y-axis

The first component of the theoretical model is the relationship between load factor and lead time, as illustrated by the increase in load factor performance (y-axis) as the lead time (x-axis) increases. The relationship between load factor and lead time illustrated in the model is consistent with the empirical findings, namely, the longer the lead time, the greater the load factor. Across all studied companies, relatively short lead times were identified as the cause of more difficult transport planning, limiting the ability to achieve higher load factors. For example, both *TechWholesaler* and *BeverageManufacturer* emphasized that having a longer lead time than they currently have would make planning for consolidation of orders easier, allowing them to achieve higher load factors. This is consistent with the findings of other researchers, such as Pahlén (2014), who found that short lead times frequently contribute to limited time available for goods consolidation. Also, Rogerson and Santén (2017) emphasized the importance of lead time duration as a load factor condition, as lead time length can limit or increase opportunities for detailed planning of the loading processes.

Linear or stepwise increase

The second component of the model assumes that when the transportation unit receives a constant flow of orders, the relationship between the load factor and lead time increases linearly, while for fluctuating order patterns, the increase is stepwise. According to the model, the width of each step represents the time interval between orders, whereas the height represents the contribution to the load factor. The time between orders as well as the size of order is assumed to not be correlated to the length of the lead time, and may vary unrelated to lead time variations.

The assumption that the height of a step represents the size of an order and the width being connected to the time between orders was not clearly established in the empirical findings. However, indications of the increase in load factor being stepwise and the width being measured in the unit hours was discovered. For instance, *BeverageManufacturer* and *PartsBuyer* demonstrated the reallocation of volumes 24 hours forwards or backwards from the initial delivery day as a method to increase the load factor. Additionally, respondents mentioned that they employ order stop times, which represents the latest point in time as of when customers may place orders. The respondent at *BeverageManufacturer* further mentioned that booking of transport is performed both before and after order stop times. In most cases, the reception of orders and booking of transport was therefore gradual. This means that assumption of the width illustrating the time between orders may represent the time between transport booking of orders, receiving orders or loading orders.

Consequently, the behavior of the line can be applied to different settings, including loading of transportation units, transport planning and booking. When performing alterations to lead time, understanding the time required to impact load factor performance and the alteration's contribution becomes significant. If the time between orders exceeds the lead time limit for an acceptable alteration by the customer, the alteration will entail the load factor level being on the same step as if no alteration was performed. Thus, additional studies establishing the line's behavior will be required to develop a complete picture.

Capacity limitations

The third component of the model illustrates the relationship between lead time and capacity. Short lead times were mentioned by the respondents to lead to speculation of available capacity. Previous literature, such as Santén (2017), has mentioned that shorter lead times can negatively impact efficient transport planning, resulting in lower load factor performance. However, speculation of booking capacity has not been highlighted in prior literature. Thus, these findings extend the perspective of how short lead times creates difficulties in planning of transports. Companies such as *BeverageManufacturer* and *FoodDistributor* book transport based on incomplete order information, which may result in discrepancies between available and required capacity, and thus a lower load factor. If the required capacity exceeded the available capacity upon reviewing actual orders, *FoodDistributor* deploy an additional truck, often resulting in a lower load factor for this truck. Lumsden (2011) explained that each additional transport entity is associated with large marginal costs. Hence, not utilizing available capacity optimally is expected to result in both a lower load factor and higher costs. A similar reduction in load factor performance is expected if the available capacity exceeds the required capacity when order information is complete.

The respondent at *BeverageManufacturer* highlighted that an additional day of lead time, meaning a total lead time of 72 hours, would contribute significantly to less complex transport planning. According to the respondent, extending the lead time would aid in avoiding speculation of capacity and enable deliveries of full truck loads. A similar reasoning about longer lead times to assist transport planning was provided by the respondent at *FoodDistributor*, who suggested an order stop time at 12:00 the day before delivery. These statements correspond to the theoretical findings indicating that longer lead time contributes to higher load factor, by facilitating greater opportunities for consolidation (McKinnon, 2018) and planning (Santén, 2017). One limitation of the model is its failure to consider a clear threshold for when available capacity transitions from speculation to transport planning based on actual volumes. However, as indicated from the case companies, a shorter lead time often results in speculation and a lower load factor, which is consistent with the relationship between load factor and lead time described in the model.

Another consequence of short lead times and capacity speculation was the reduced ability of transport providers to efficiently plan for loading of external goods. *TechWholesaler* worked with predetermined capacity which could be adjusted without any additional cost up until 12:00

the same day as loading is to be performed. Booking capacity after 12:00 incurred additional costs, but was sometimes necessary due to sudden changes in order volumes. In the latter case, transport providers were required to arrive at the premises of *TechWholesaler* within an hour of receiving the booking, leaving little room to find external volumes aligning with the needs of *TechWholesaler* and their customers.

Another important finding was that, rather than comparing short or long lead times as factors influencing the load factor, the respondent at *PartsBuyer* mentioned the rigidity of lead times as a challenge. In some cases, *PartsBuyer* required transport lead times that were longer than the actual driving time, making it difficult for transporters to find external goods to fill the available capacity. This example demonstrates that, rather than the issue of short lead times, the issue was the inability to adjust them, which may limit a high load factor. This is an aspect that the model does not consider when looking at the relationship between load factor and lead time. Furthermore, transport providers receive transport bookings from *PartsBuyer* one or two days before goods collection. Within this short timeframe, the transporters must try to find external goods aligning with the collection and delivery dates requested by *PartsBuyer*. Short lead times, combined with inflexibility in adjusting lead times to better support goods consolidation, have been expressed to limit the possibility of achieving a high load factor.

Range of acceptability

The final component of the model is the range of acceptability. It identifies a range of acceptable lead time alterations, without significantly affecting customer satisfaction. The empirical findings of this study did not necessarily identify a common range among the case companies within which changes could occur. According to Oskarsson et al. (2021), there should exist situations where it is possible to change service requirements, such as lead times. Similarly, the empirical findings of this study show that, while some case companies provide examples of how to change service quality requirements to achieve a higher load factor, others provide examples of when such changes were not possible.

BeverageManufacturer and *PartsBuyer* showed instances where lead time flexibility was feasible and allowed for optimization of load factors by shifting volumes between days. At *PartsBuyer*, it was possible to move shipment volumes one day forward or backwards from the original delivery date to better match required and available capacity. Similarly, *BeverageManufacturer* has the possibility to move excess volumes one day forward to avoid deliveries with partially filled trucks, according to the respondent. This aligns with the model's suggestion that lead time adjustments can increase load factor performance, however, capacity limits of transport units have to be considered. These examples also illustrate an assumption that can be made from the model, suggesting that parts of order volumes can be moved to align required and available capacity. Partial deliveries, where customers receive volumes meeting their immediate needs at one point in time with the remaining volumes at a later time, were identified to be feasible by *PartsBuyer* and *BeverageManufacturer*. Not only having a range of acceptability in terms of lead time but also related to order volumes allows for greater flexibility in how to achieve a higher load factor.

The model appears to have a continuous range of acceptability, implying there exists a great number of possibilities to alter the lead times to different lengths within this range. However, empirical findings indicated instances where such changes were not feasible. For instance, consider the above-mentioned cases of *PartsBuyer* and *BeverageManufacturer*, which indicated that lead times could only be changed by one day from the initial delivery date. Any changes to the lead time of less than one day are assumed to be not feasible, which could be explained by the companies having strict time schedules at their respective delivery sites to follow. Therefore, alterations were limited to the scheduled times for delivery of already planned transports.

Assuming that, for instance, deliveries are scheduled at 12:00 during one day and the same time the following day, as well as there exists possibilities to shift volumes between days, the range of acceptability is 24 hours. However, within this range, only one possible alteration exists. In such cases, the range of acceptability is not constant, but discrete. The discreteness may cause difficulties in identifying and performing alterations feasible for both the shipper and customer, potentially limiting increases in load factor. While the model suggests flexibility in lead time adjustments within the range of acceptability, the empirical findings displayed the complexities related to such changes. Understanding both theoretical principles and practical limitations in transport logistics is crucial to achieve effective lead time alterations contributing to increased load factor.

As assumed in the model, crossing beyond the customer need limit can decrease satisfaction due to perceived reductions in service quality. There were instances in the empirical findings where the customer need and requirement were located in the same place, i.e. no alterations could be performed. The inflexibility in performing adjustments to the lead time was explained by *FoodDistributor*, *RetailFood* and *PartsBuyer* to be due to system constraints and operational constraints such as staffing, product characteristics or warehouse capacity.

The respondents from *BeverageManufacturer*, *TechWholesaler* and *FoodDistributor* all brought up an interesting point about the historical expectation of short lead times, which has created a rigid requirement that customers are reluctant to deviate from. This presents a challenge to the model's suggestion that there exists a range of acceptability in lead time alterations. The observations of historical expectations of short lead times, which has become a competitive measure, can be seen as an example of the mismatch highlighted by Pahlén & Carlson (2013) between the services offered to transport users and their actual needs. This mismatch can lead to inefficiencies, as companies strive to meet or exceed customer expectations despite possible operational constraints. Therefore, it may be the case that companies increase the distance between customer requirements and customer needs by offering shorter lead times, putting themselves in a position where it is difficult to return to the actual need, because these customers may perceive these short lead times as necessary. Santén and Arvidsson (2011) identified a potential gap between actual and perceived needs, indicating that customers may not be fully aware of their needs. Comparing this gap to the historical offerings of short lead times, customers may have been influenced to believe that short lead times are necessary. The perceived need of the customer is then imposed as a requirement, and alterations to the requirement is not viewed as possible by the customer. This is consistent with what Oskarsson et al. (2021) presented, questioning if the requirements customers impose are truly necessary, or if requirements customers impose are based on what customers perceive as essential.

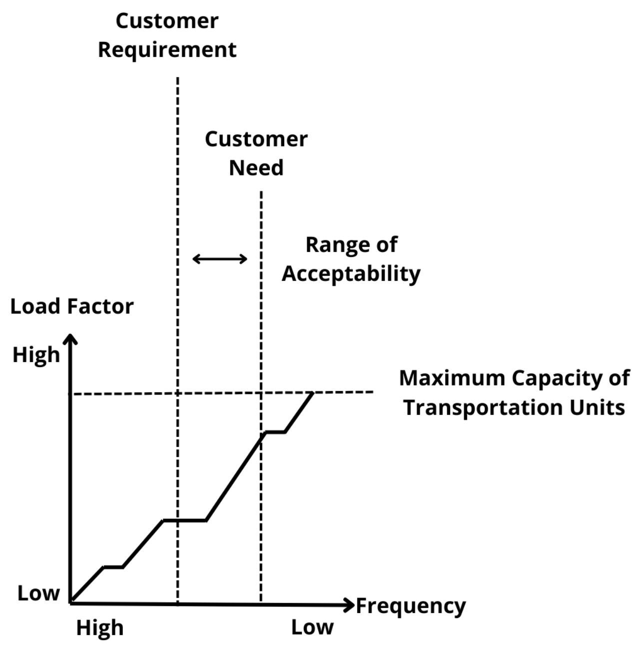
The expectation of short lead times and the inability to alter those, has led companies to use incentives to shape the requirements to be beneficial for the shipper. Persuading customers to place orders earlier and thus extending the lead time was suggested by Lumsden et al. (2019) as a way to facilitate planning and increase load factor performance. In three of the case company interviews, incentives were discussed both in relation to price differentiation and achieving a better condition for one service quality factor by accepting a trade-off with another service quality factor. *FoodDistributor* has shortened their lead times for some customers to incentivise them to agree to time windows during less busy hours. Both *RetailFood* and *TechWholesaler* mentioned price differentiation for different lead times as a possible way of persuading some customers to agree to longer lead times. This suggests that companies could benefit from offering incentives to make alterations to lead times, allowing for comprehensive planning based on actual order volumes and potentially increasing load factors. This aligns with the model's recommendation to investigate the acceptable range of lead time changes in order to achieve higher load factors while maintaining a high level of customer satisfaction.

6.1.2 Frequency

A similar model to the one of load factor and lead time was derived to explain the relationship between load factor and frequency based on literature and the empirical findings, see figure 3. The model has similar components to the first one with lead time, including an x- and y-axis to describe the relationship between frequency and load factor, the increase in load factor being linear or stepwise, capacity limitations, and the range of acceptability.

Figure 3

A model for frequency and load factor performance



The x- and y-axis

As suggested by research, one way of increasing the load factor is to decrease the delivery frequency (Aronsson & Huge Brodin, 2006). Therefore, as assumed in the model, the first component of the model is that there exists a relationship between increasing load factor (y-axis) and decreasing frequency (x-axis). In this study, frequency was found to have an impact on load factor. For *BeverageManufacturer*, the respondent stated that a higher delivery frequency may result in customers placing smaller orders each time, which may not be enough to fill a truck, leading to difficulties in achieving a high load factor. The respondent from *TechWholesaler* also stated that changing delivery agreements at the request of their customers frequently results in fewer deliveries of full truck loads. This supports Aronsson and Huge Brodin's (2006) findings that a higher frequency correlates with a lower load factor and a lower frequency correlates with a higher load factor.

Linear or stepwise increase

The second component of the model concerns the line's behavior, specifically whether the increase in load factor follows a linear or stepwise pattern. Although not decisively proven by the empirical findings, there are indications supporting a stepwise increase in load factor, as discussed in section 6.1.1. As exemplified by *BeverageManufacturer*, a higher frequency often entails smaller order sizes, resulting in a lower contribution to the load factor (reflected in a smaller step height) compared to orders with a lower frequency. Furthermore, customers of *TechWholesaler* requesting full truckloads resulted in a reduction in frequency. In the context of the model, this implies a relatively large step width, and upon receiving the order, a larger step height. Contrary to previous assumptions about the absence of a relationship between the lead time duration and step size described in section 6.1.1, indications of such association were discovered for the frequency model. As described above, smaller order sizes are often a result of a higher frequency, meaning that the step height and width is small. Conversely, lower frequencies typically entail longer time between orders and larger order sizes. Understanding this relationship is of high importance when performing alterations to frequency, as it allows for evaluation of the contribution such alteration may have for load factor performance. Moreover, understanding potential constraints of alterations in relation to step width is crucial. For example, if the frequency is relatively low, indicating longer time between orders, it is important to consider the potential limits to what extent the frequency can be changed. This consideration helps determine whether the change will improve the load factor or keep it on a plateau.

Capacity limitations

The third component of the model takes capacity in relation to frequency into account. Some of the study's empirical findings did not reveal results consistent with the model in terms of a lower frequency having a positive effect for load factor performance. One respondent's observations calls into question the assumption that reduced frequency equals higher load factor. *PartsBuyer* illustrated deviations from the expected relationship between frequency reduction and load factor increase, emphasizing the interplay between volume variation and production logistics.

The respondent from *PartsBuyer* emphasized that while decreasing the frequency to increase load factor may seem appealing in theory, it could pose practical challenges due to uneven volume distribution throughout the week. Production requires a consistent flow of materials to sustain operations, meaning that a lower frequency may disrupt this balance, resulting in discrepancies between available and required capacity. *PartsBuyer*'s example illustrates that while lower frequency may seem like a straightforward strategy to increase the load factor, it can be complicated by the practical reality of production needs.

Another example that contradicts the notion that higher frequency leads to a lower load factor is that frequency has a significant impact on lead time adjustments, such as moving volumes one day earlier or later, to better balance required and available capacity. The respondent at *PartsBuyer* emphasized that their priority is to have a frequency of five days per week. This makes it is easier and more cost-efficient to move volumes for pickup between days to better match required and available capacity, thus a higher load factor can be achieved. As a result, the model's assumption based on previous literature that a lower frequency leads to a higher load factor does not hold true in all scenarios.

Range of acceptability

The final component in the model is the range of acceptability which defines frequency adjustments that can be made without significantly affecting customer satisfaction. The empirical findings showed instances where alterations to delivery frequency were acceptable by the customers and could enhance load factor performance. For instance, the respondent from *BeverageManufacturer* highlighted, similarly to what *PartsBuyer* described above, a case where a higher frequency contributed to greater flexibility in altering delivery lead times. Conversely, adhering to a lower delivery frequency, rearrangements of deliveries is highly dependent on customer availability on days that *BeverageManufacturer* was not previously scheduled for delivery. This example illustrates that a high frequency can contribute to a higher load factor compared to a low frequency, by enabling lead time adjustments which better align required and available capacity. This finding has not been described in previous literature and contradicts the model's suggestion that a lower frequency has a positive effect on the load factor.

Another shortcoming of the model is its failure to consider the options of adhering to a fixed delivery schedule versus adopting a flexible frequency and its impact on load factor. In the empirical findings as well as in the theoretical framework, discussions have addressed the impact of nominated days on load factor. Thus, comparison of the literature review and empirical findings will be presented in the paragraphs below regarding this aspect.

As discussed by Bömer and Meyer (2022), a high demand variability combined with fixed delivery days can pose challenges in planning and consolidating shipments to achieve a high load factor. Similarly, the respondent at *FoodDistributor* highlighted the difficulties in supplying an area with customers adhering to a fixed delivery frequency and large seasonal variations. Customers were reluctant to change their delivery days during periods of low order volumes to facilitate consolidation, thus negatively impacting the load factor.

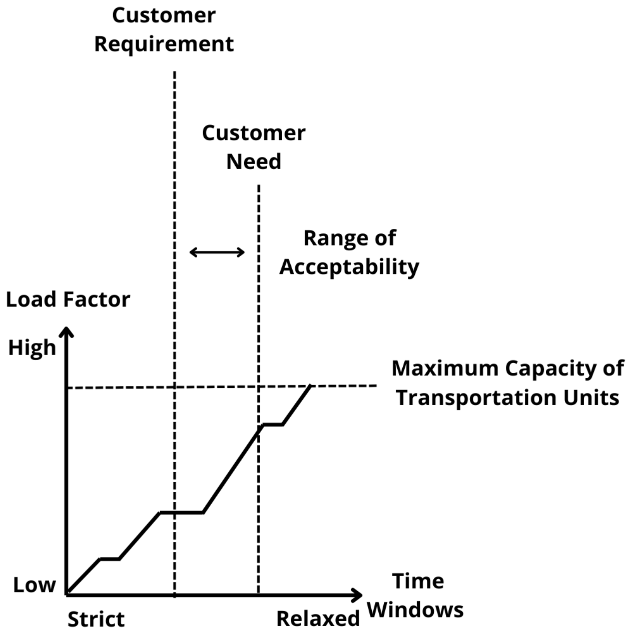
Furthermore, the flexibility in changing delivery days differs between *RetailFood* and *FoodDistributor*. *RetailFood* had the possibility to adjust delivery days based on operational and customer needs. For instance, if a store on one route closes, *RetailFood* can consolidate deliveries from different routes to be delivered on the same day. Conversely, *FoodDistributor* lacks the capabilities in modifying the fixed delivery days. The inability of redistributing volumes between days may have a negative impact on the load factor.

6.1.3 Time windows

A model for the relationship between time windows and load factor was developed based on empirical findings and literature, similar to those for frequency and lead time, see figure 4. The model has similar components to the ones: an x- and y-axis to describe the relationship between frequency and load factor, the increase in load factor being linear or stepwise, capacity limitations, and the acceptable range.

Figure 4

A model for time windows and load factor performance



The x- and y-axis

The result of the study's empirical findings indicates that the x- and y-axis relationship between load factor and time windows is as follows: when time windows are strict, defined by narrow time windows or strict adherence to specific times, it results in a lower operational flexibility for the transporter and tends to correlate with lower load factors. For instance, *PartsBuyer* enforces 15-minute time slots for transportation, while *FoodDistributor* customers often require morning deliveries, even when afternoon deliveries could be more advantageous for *FoodDistributor*'s operations. Whereas, when time window requirements are more relaxed, with wider intervals and positioned at a time that is beneficial for the transporter's efficiency, the load factor tends to increase. For example, *PartsBuyer* forces suppliers to provide full-day pickup windows for their transporters, facilitating better transport planning. *RetailFood* underscores the potential for dynamic time windows, suggesting that greater flexibility could enable consolidation of more orders and thus higher load factors. These examples illustrate the difference between strict and relaxed requirements on windows and their impact on load factor.

The empirical data analysis revealed an important finding: time windows appear to be a significant service quality requirement, limiting the ability to achieve a higher load factor. This finding is consistent with those of many other researchers, including Oskarsson et al. (2021) and Rogerson (2017), who discovered that time window specifications may limit consolidation options and thus load factor performance. The constraints imposed by time windows and their limitations on achieving a higher load factor were discussed with the respondents.

Another interesting finding from the cases was that when consolidating several orders to different customers on the same transportation unit, adhering to multiple time windows was displayed to be a limitation to achieving a higher load factor. While this is not directly connected to the time windows being more strict or relaxed, connections between the quantity and nature of time windows can be made. The multitude of time window requirements, together with the inability to modify them, creates a strict time schedule. Quak and De Koster (2007) mentioned this challenge, noting that consolidating deliveries into a single trip necessitates adhering to multiple time window restrictions along the route. The more orders consolidated, the more time windows to consider, complicating the logistics of running an efficient transportation system.

The respondent from *BeverageManufacturer* exemplified this challenge by linking time window requirements to driver's working hours. Despite having free space in the vehicle, attempting to load it with more orders becomes impractical because adhering to an excessive amount of time windows makes it impossible for the driver to complete all of the stops. Similarly, *RetailFood* strives to consolidate as many orders as possible while fulfilling time window requirements, emphasizing that if the time windows were more dynamic, the load factor could increase even further. The respondents from *FoodDistributor* and *PartsBuyer* additionally acknowledged the route's time sensitivity due to strict time windows. Any delay in one location can affect the driver's ability to complete the delivery route on time. The relationship between time windows and a route's time sensitivity has not been identified in the literature reviewed in this thesis. These examples indicate that the dynamics of adhering to multiple time windows along a delivery route can influence the load factor. Specifically, the need to accommodate various strict time window requirements limits vehicles' potential load factor since incorporating too many stops within a route becomes impractical, and are sometimes not possible. Relaxing time window requirements could significantly benefit companies dealing with a multitude of different orders in terms of load factor performance. However, it is important to note that other factors, such as driving time, still impose constraints to how much the load factor can increase.

Linear or stepwise increase

The second component of the model assumes that an increase in load factor is either linear or stepwise. Similarly to the assumption in section 6.1.1 regarding the line's behavior, the height and width of the step, i.e. order sizes and time between order are assumed to not be correlated to the time windows being strict or relaxed. Moreover, the empirical findings displayed no clear indications in regards to the pattern of the line and time window requirements, similar to what was discussed in section 6.1.1 and 6.1.2. However, *BeverageManufacturer*'s and *RetailFood*'s observations described above challenge the model's assumption regarding the contribution of order sizes to the load factor and the time between orders. Even if the time between orders is short, i.e. having a near-constant flow of orders to transportation units, a high load factor is not guaranteed. The respondents noted that order sizes, combined with each order's time window requirement, poses challenges for increasing the load factor. While orders may align with transportation unit capacities and be available for booking or loading, ensuring fulfillment of all time window requirements is not feasible. Thus, achieving a high load factor necessitates not only considering the time between orders and the size of orders, additional constraints also have to be considered.

Capacity limitations

The third component considers the relationship between capacity and time windows. Another restriction identified in the empirical findings is conflicting time windows, which makes it challenging to optimally consolidate orders. Whether time window requirements are conflicting or not is not clearly displayed in the model. However, strict time window requirements are displayed in the model, which together with the infeasibility to alter the requirements often creates conflicting time windows. For instance, the majority of *FoodDistributor*'s customers require morning deliveries during one to four hour windows and are not open to changing their requirements, resulting in difficulties in consolidation as the windows often conflict.

The respondent from *FoodDistributor* further described difficulties in consolidating deliveries across multiple geographical areas due to conflicting time windows. Similar time windows in different cities had to be delivered by separate trucks as the driver can not visit two geographically spread areas at the same time. This dilemma was described by Quak and De Koster (2007) in relation to municipality issued time windows not being optimally planned against each other. However, *FoodDistributor* demonstrated that this can be applicable for time window requirements imposed by B2B customers as well. Additionally, conflicting and narrow time windows can hinder consolidation efforts even when customers are geographically close, requiring the deployment of more trucks than optimal, as described by *BeverageManufacturer*. This leads to lower transportation efficiency and higher costs (Zang et al., 2023). These examples, together with the inability to adjust requirements, contribute to discrepancies between required and available capacity, resulting in a low load factor.

Other examples from the empirical findings related to time windows that contributed to a misalignment between required and available capacity included imposing several time windows for the same delivery. Both *TechWholesaler* and *PartsBuyer* inflict time windows at both collection and delivery sites for their transport providers. This practice limits transporters ability to secure external goods that align with the requirements of *TechWholesaler* and *PartsBuyer*, potentially contributing to required capacity not being aligned with available capacity. While this specific aspect of time window requirements being imposed for both pick-up and delivery has not been described in previous literature, several authors mention the relationship between adherence to multiple time windows and a lower load factor (Baykasoglu & Kaplanoglu, 2011; Quak & De Koster, 2007).

Similarly, the challenge of adhering to several time windows set by customers and municipalities emerged as an issue in the empirical findings in terms of optimal consolidation and routing. Municipality-issued time windows can restrict the possibilities to achieve a high load factor (Arvidsson et al., 2013). *RetailFood* highlighted the increased complexity in transport planning created by municipality-issued time windows, resulting in the adaptation of their operations to meet all time window requirements. The respondent from *FoodDistributor* noted the dilemma they faced when encountering conflicting time windows from customers with municipality-issued time windows and time window requirements from customers outside those municipalities.

Range of acceptability

The final component of the range of acceptability in the model defines time window adjustments that can be made without significantly affecting customer satisfaction. The study's empirical findings demonstrate that some case companies offer instances where changing service quality requirements were achievable, whereas others highlight situations where such adjustments were not feasible. All case companies provided examples of customer needs and customer requirements being aligned, making alterations not feasible. The inflexibility was explained to be due to capacity constraints at the customer site, adhering to the customer's scheduling of staff and equipment availability, and timely delivery of goods to satisfy the customer's customer.

FoodDistributor provided an example involving time window adjustments and the benefits observed post-implementation. Initially, most customers required morning deliveries, leading the company to encourage some customers to accept afternoon deliveries for better fleet utilization and to facilitate planning. The customers later realized that this change was beneficial for their operations. Consequently, time window adjustments contributed to alignment between customer requirements and customer needs. This finding is consistent with existing literature, such as Santén and Arvidsson (2011), which highlights that customers sometimes lack full awareness of their needs, leading to a discrepancy between perceived and actual needs. This gap likely contributed to the late realization of benefits for *FoodDistributor*'s customers regarding the adjusted time windows.

6.2 Influencing factors limiting load factor performance

The case companies examined in the study operate primarily as intermediaries within the supply chain, each managing logistics to connect production with end-users across diverse industries. Regardless of the differences in their products and services, from beverages to technical supplies and food distribution, all of these companies face the same challenge: balancing customer-specific requirements with achieving high load factor. This (im)balance creates operational planning challenges, especially for those tasked with meeting these requirements. Currently, the findings indicate that the operational landscape leans toward accommodating customer requirements, which complicates achieving higher load factors. This was clearly demonstrated at *RetailFood*, for instance, where shorter lead times allowed stores to more closely align orders to actual sales, however, it complicated transportation planning.

The empirical findings revealed instances when service quality requirements could not be altered due to several influencing factors. These findings extend the scope of research question 2 and 3, and include other factors influencing the relationship between service quality requirements and load factor. The inability to modify the lead time, frequency or time window requirements may result in discrepancies between required and available capacity, as displayed in the models in Figure 2, 3, and 4, limiting load factor performance. Table 4 outlines the factors limiting alterations to service quality requirements as identified from the case companies, with further descriptions provided in the following sections. It is important to note that while other factors likely impact the ability to modify service quality requirements, only those identified in the empirical findings are presented and analyzed below.

Table 4

Factors influencing the ability to alter service quality requirements

	Time Windows	Lead Time	Frequency
Historical Offerings and Norms	x	x	
Customer Scheduling	x	x	
Multitude of Deliveries	x	x	
Physical Unloading Constraints			x
Product Characteristics		x	x
Warehouse Capacity		x	
Company Structure	x	x	x

Historical offerings and norms

One of the more interesting findings when discussing the service quality requirements was that in some cases, often in relation to lead time, the requirements were the norm, as mentioned by *FoodDistributor* and *BeverageManufacturer*. Short lead times are therefore expected by customers and are imposed as a requirement. A possible explanation for this might be that, as the respondent at *TechWholesaler* mentioned, offering more service requirements in favor of the customer has been used to gain a competitive advantage. While Oskarsson et al. (2021) suggest that customers frequently demand the highest possible service level, it is worth noting that in certain contexts the customers are offered high service levels. Hence, these findings may raise the question of where the requirements came from; strict service requirements may be established as industry norms from strategic measures previously used to gain a competitive advantage.

Customer scheduling

Another key factor identified in the empirical findings that limits the ability to adjust service quality requirements in order to increase load factor was the scheduling of staff at delivery sites. Adjusting the lead time with short notice was explained to be unfeasible by the respondent from *FoodDistributor* due to customers employing additional staffing for days of delivery. Similarly, time window adjustments could not be performed at *RetailFood* and *BeverageManufacturer* as a result of customers' personnel schedules. Furthermore, one of the respondents at *RetailFood* suggested that the size of the store also influences the ability to adjust employee schedules. In larger stores, revising a single employee's schedule is often sufficient, whereas in smaller stores, the scheduling of personnel has to be more comprehensively revised.

Another constraint in terms of scheduling limiting service requirement alterations was identified at *TechWholesaler*, *PartsBuyer* and *BeverageManufacturer*. The customers or production sites, for *BeverageManufacturer* and *PartsBuyer* respectively, already had other deliveries scheduled around the initial time or day for delivery, making time window and lead time alterations unfeasible. Similarly, at the customer's sites of *TechWholesaler*, specific machinery and equipment were scheduled for on-site use during specific hours, necessitating deliveries from *TechWholesaler* during certain time windows.

Multitude of deliveries

The number of deliveries emerged as another factor in the empirical findings, limiting the possibility to alter service quality requirements. Both *TechWholesaler* and *PartsBuyer* highlighted the multitude of deliveries performed each day as a hindrance to modifying lead times. *TechWholesaler*, for instance, noted that they perform 10 000 deliveries each day, and attempting to change lead times for each customer to facilitate a higher load factor would require an immense number of resources. However, performing lead time alterations on a smaller scale could create better conditions for achieving a higher load factor. This highlights the trade-off companies face between resources needed to achieve a high load factor compared to the resources needed to fulfill current customer requirements. If companies allocate resources to adjust lead times to achieve a higher degree of consolidation and, consequently, a better load factor, they can reduce the resources needed for actual transportation. For instance, altering lead times for some customers with the aim of achieving a higher degree of consolidation, less trucks will be needed to transport the orders. Conversely, if no resources are directed towards optimizing the load factor, more resources will be required for transportation, i.e. if lead time adjustments are not performed, more transportation resources will most likely be needed. Thus, the decision to change lead times depends on the resources required to implement the changes. It must be carefully assessed against the resources required for fulfilling present requirements as well as possible benefits in terms of greater load factor and cost savings.

Furthermore, the multitude of deliveries *PartsBuyer* receives together with the many goods receptions at its production units, contributes to the rapid filling of each time window slot. Each truck often transports different orders destined for multiple goods receptions. Consequently, adjusting an order's time window slot or lead time requires consideration of other orders on the same truck to create an effective unloading process. The rigid time window schedule negatively affects the ability to reschedule within or between days, especially as the number of orders per truck increases.

Physical unloading constraints

Restrictions at the customer sites were also identified as a contextual factor influencing the possibility to modify service quality requirements. At certain customer sites, *RetailFood* faced limitations due to height and length restrictions at goods receptions. These restrictions required the use of specialized, smaller trucks. Consequently, the frequency of deliveries could not be adjusted to align with order volumes. Thus, the company had to maintain a higher delivery frequency for those stores than would be optimal, given the constraints imposed by the smaller truck sizes.

Product characteristics

Furthermore, product characteristics at *RetailFood*, in terms of perishable items with short expiration dates, restricted the ability to alter lead times. This observation aligns with the findings of Strand and Fremstad (2020), whose study indicated that the possibility to change delivery frequency can be constrained by customers preferences and goods characteristics. Even though not explicitly mentioned by *FoodDistributor*, the characteristics of their products are similar to those of *RetailFood*, and could be a factor restricting service quality alterations. *FoodDistributor* experienced difficulties in altering delivery days and times for restaurants as these customers required delivery as close in time as possible to when the cooking was to be performed, thus, the perishability of items could be an influencing factor. This suggests that product characteristics are closely connected to creating time restrictions. Consequently, *RetailFood* and *FoodDistributor* had to speculate in capacity when booking transport which may result in occasional discrepancies between required and available capacity.

Warehouse capacity

The empirical findings also demonstrated examples where service quality requirement alterations were feasible to a certain extent. *PartsBuyer* was able to alter the collection and delivery dates for shipments from some suppliers with a one-day flexibility, either forwards or backwards compared to the initial date. The warehouse capacity, including stock buildup management and safety stock considerations, were factors identified to restrict the possibility of altering lead times beyond these limits. This indicates that there exists an upper and lower limit to how much the lead time can be altered before negatively impacting company operations. The limits for making adjustments could be set by comparing the costs incurred with the savings realized from a change. For instance, if a certain lead time contributes to a safety stock with higher costs compared to the savings from increased truck loads, companies may choose not to perform alterations. Once the benefits of a change exceed the costs, the limit to the alteration is most likely established.

Company structure

When comparing the cases, there were some noticeable differences in the ability to change the service quality requirements, particularly between *RetailFood* and the rest of the case companies. In some cases, changes to service quality requirements had a greater negative impact on some companies than on *RetailFood*. For example, *FoodDistributor* stated that if the customer's expectations are not met, the customer may choose to go with a competitor, whereas *RetailFood* made no mention of similar effects.

A possible explanation for this could be the company's structure, as *RetailFood*'s customers are internal, whereas *FoodDistributor*'s customers are not owned by the parent company. For *RetailFood*, owning its customers under a single 'company umbrella' potentially allows for smoother transitions when adapting or changing requirements, as these customers are directly managed within the organizational structure. There is no risk of losing customers to competitors, however, it may affect customer satisfaction negatively. In contrast, *FoodDistributor* does not have the same influence on its customers, and might find it more challenging to implement changes without affecting customer satisfaction. This suggests that *FoodDistributor* could potentially face more difficulties in trying to change the service quality requirements in order to achieve a higher load factor.

However, there were some differences between *RetailFood* and *TechWholesaler*, despite the fact that both companies have internal customers. During the interview with *RetailFood*, it was noted that requirements are changed for their customers more frequently than *TechWholesaler*. A possible explanation for this might be in the end-customer characteristics. *TechWholesaler*'s store customers, primarily in the construction sector, rely heavily on timely deliveries to maintain operational efficiency, where any short-term changes to service requirements may have more immediate negative consequences for these customers. Changes in requirements at retail-oriented businesses, such as *RetailFood*, may not be as immediately disruptive because there are no activities to the same extent as *TechWholesaler* else dependent on delivery, but there may be dissatisfied end-customers due to stock-outs.

6.3 The models' applicability to different case companies and different time frames

From the empirical findings as well as section 6.1 and 6.2, another aspect of research question 3 emerged, namely, the possibility to alter service quality requirements with regards to different time frames and cases. In the following sections, the models introduced in section 6.1 are evaluated both in terms of similarities and differences with the empirical findings as well as their applicability to different time perspectives. Discrepancies between the models and empirical findings became apparent in section 6.1, with further analysis and discussion provided below. The empirical findings further displayed instances of short- and long-term alterations to service quality requirements, hence, the applicability of the models on these perspectives are analyzed and discussed below.

This section is structured as follows: section 6.3.1 discusses and compares relationships described in the models with deviations emerged from the cases. Section 6.3.2 discusses the use of models to apply short- and long-term perspectives on service quality requirements. Examples from empirical data demonstrate short- and long-term adjustments, along with their potential for improved load factor performance.

6.3.1 Discrepancies between the models and empirical findings

From the empirical findings, in the majority of cases, more demanding requirements such as short lead times, strict time windows and high frequency tend to limit the possibility to achieve a high load factor. This observation is consistent with both existing literature (Aronsson & Huge Brodin, 2006; Pahlén, 2014; Rogerson, 2017) as well as the relationship between service quality requirements and load factor displayed in the models. However, there are instances provided by the case companies where deviations from these expectations occur. *PartsBuyer* mentioned having a longer lead time compared to the actual driving time resulted in opposite effects for the load factor than what is presented in the models. Requirements for a specific pick-up and delivery day not aligning with actual driving time resulted in inefficiencies at both the vehicle and fleet level. Transport providers faced challenges in sourcing external goods matching the requirements from *PartsBuyer*, which could result in a lower load factor in each truck. The waiting time incurred by the inflexibility in altering pick-up and delivery days negatively affected the utilization of truck capacity on a fleet level. Moreover, a higher frequency enabled lead time alterations for both *BeverageManufacturer* and *PartsBuyer*, contributing to increased load factor performance, which is not consistent with the relationship presented in the models. For *BeverageManufacturer*, the flexibility in lead times was influenced by customer schedules, while for *PartsBuyer*, the ability to alter lead times was impacted by pick-ups being planned the nearby days as well as the rigid time schedules at production sites. Thus, the inability to alter lead times was primarily constrained at *BeverageManufacturer* and *PartsBuyer* by external factors at their customers' and suppliers' sites, respectively.

Comparing *BeverageManufacturer* with *RetailFood*, it becomes apparent that company structure significantly influences the feasibility of altering lead times. *RetailFood*, having their customers within the same corporate umbrella entails relatively few deliveries each day, as it is mainly *RetailFood* that supply their stores. Although lead time changes are not commonly performed by *RetailFood*, the potential for such alterations exists. Conversely, *BeverageManufacturer*'s customers often receive a multitude of deliveries from different suppliers each day, resulting in inflexible time schedules difficult to change. Similarly, the scale of *PartsBuyer*'s operations results in rigid time schedules, as described in section 6.2, reducing the ability to alter lead times and is consequently negative for load factor performance.

These examples display discrepancies between the expected effects of lead time adjustments and frequency changes on load factor performance and the actual outcome of such changes. It highlights that the relationship between load factor and service quality requirements can vary depending on various situational factors such as operational constraints and logistical considerations. This underscores the importance of considering the specific context of each case when applying theoretical models. The examples from *PartsBuyer* and *BeverageManufacturer* challenge the models to hold true for all scenarios and highlight the need for understanding the dynamics between service quality requirements across different scenarios in relation to load factor performance.

Moreover, both possibilities and difficulties in performing alterations were found in each case for the different service quality requirements, as displayed in sections 5.2.1, 5.2.2 and 5.2.3. As discussed in section 6.1 and 6.2, customers are not always fully aware of their actual needs, leading to difficulties in performing alterations. Industry norms as well as past service level offerings may have led customers to believe that they need shorter lead times, higher frequencies or narrower time windows than they actually do. This discrepancy contributes to difficulties in identifying the range of acceptability, particularly the customer need, limiting the flexibility in altering service quality requirements. The models indicate that there exists a clear customer need, and that companies should be able to identify the range of acceptability, however, practical examples have highlighted that this is not always the case. The lack of awareness of customers' actual needs was evident in the case of *FoodDistributor* where the company offered shorter lead times in exchange for a time window change from morning to afternoon, with customers only realizing the benefits of the changes after they were implemented. Thus, it is crucial for companies to identify and aid customers in realizing their actual needs to bridge the gap between customer needs and customer requirements in order to improve load factor performance. Companies could take a more proactive approach by actively seeking feedback and creating opportunities for customers to provide their opinions in order to better understand where requirements stem from. Companies can use this information to offer mutually beneficial solutions that considers each actor's preferences and operational constraints.

6.3.2 Applying short- and long-term perspectives on the models

The empirical findings and literature review highlight that short-term modifications to service quality requirements can contribute to rapid improvements in load factor performance, especially in current systems containing inefficiencies. *PartsBuyer* performs lead time alterations on a daily basis, resulting in a better match between required and available capacity and thus load factor performance. Given that most load factor challenges occur on a daily basis, short-term adjustments of the requirements are often necessary. However, the company specific context determines whether changes can be implemented quickly or not, as well as the implications of short- versus long-term changes on the load factor.

Adjusting service quality requirements has been demonstrated to also be feasible when considering long-term perspectives. Long-term changes are assumed to both be of a more permanent nature as well as taking longer time to achieve. Altering lead times and time windows for customers of *FoodDistributor* necessitates changes to customers' schedules, which can be a process taking months to complete. Similarly, changes to delivery agreements, i.e. changes to time windows and delivery frequency, with *RetailFood*'s customers must be communicated and accepted one to two months before implementation. Changes to one customer delivery agreement are not performed in isolation, it requires adjustments to nearby customers agreements as well to create an optimal delivery route. Gaining acceptance from all affected customers can be a lengthy process. Additionally, *TechWholesaler* provides one to two weeks' notice to their transport providers when reducing the predetermined capacity. The changes being long-term is often a consequence of customers needing to adapt significant parts of their operations, however, the changes can impact the load factor performance greatly once performed.

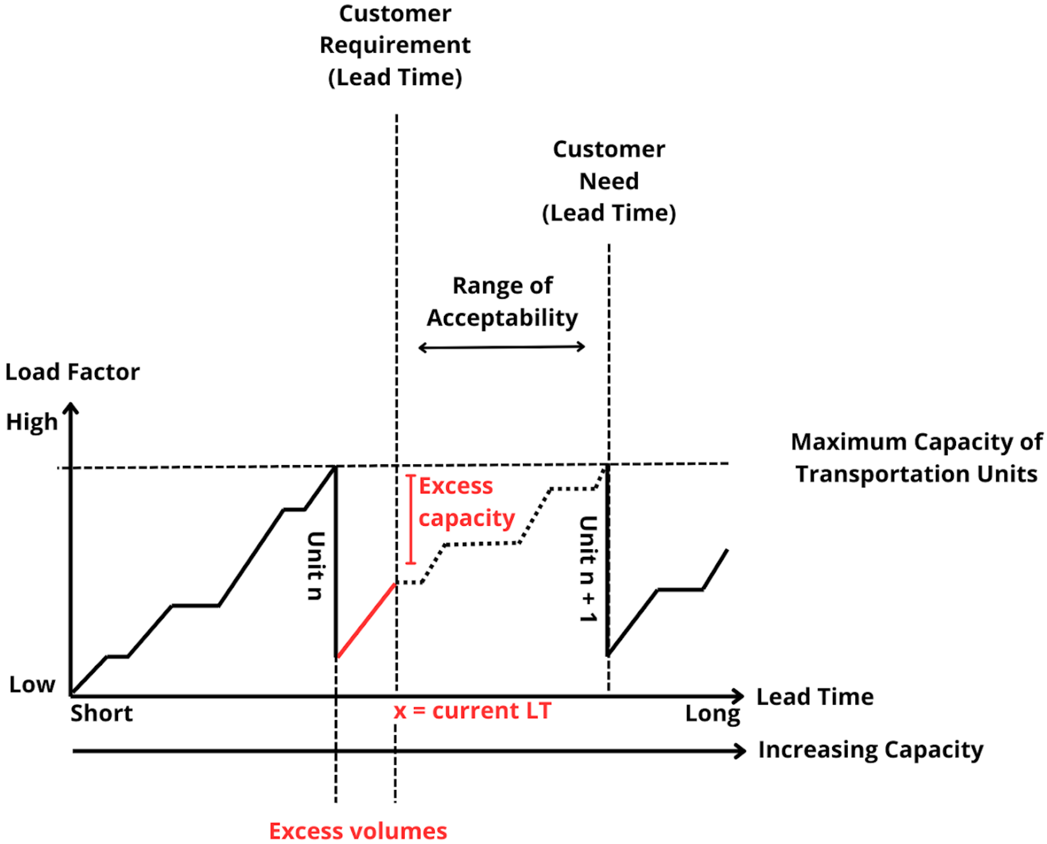
The examples showed that service quality requirement alterations can be both short- and long-term. Therefore, further exploration of the perspectives applicability to the models presented in sections 6.1.1, 6.1.2 and section 6.1.3 was seen as necessary. Below, short- and long-term perspectives are discussed for each model.

Lead time model

From a short-term perspective, there are examples in the empirical data that demonstrate how the model (Figure 2) can adopt this approach. *BeverageManufacturer*, *FoodDistributor*, and *RetailFood* all demonstrated that when there was a mismatch between available and required capacity, such as when required capacity exceeded available capacity. The solution was to deploy another truck to meet the current lead time requirement, often with a low load factor, as illustrated in Figure 5. In Figure 5, variable x represents the current lead time requirement and implies that one full and one partially loaded truck have to be used to meet this requirement. To avoid the deployment of a partially loaded truck resulting in a low load factor, *BeverageManufacturer* in some cases asked customers if excess volumes could be moved one day ahead of schedule. The volumes could be combined with orders on a truck the following day, thereby improving load factor performance. For *FoodDistributor* and *RetailFood*, this option was not available as the respondents stated customers personnel schedules to be a factor limiting short-term alterations, resulting in the deployment of more trucks than optimal, and hence a lower load factor is expected.

Figure 5

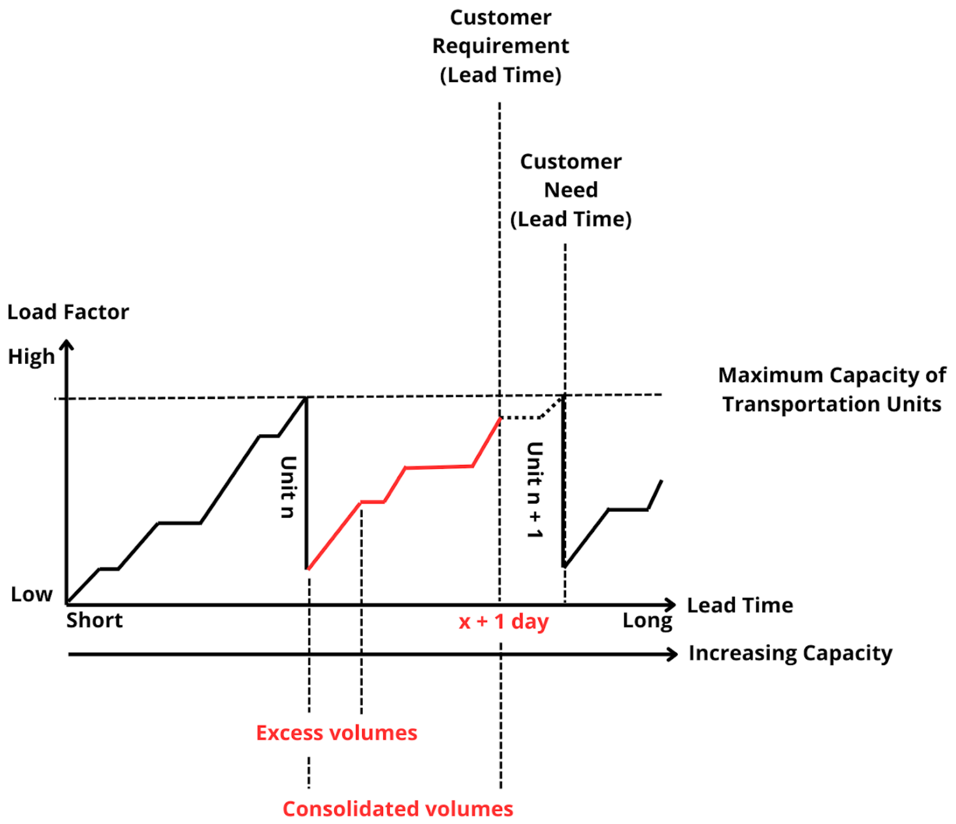
Scenario with a full truck load n and partially filled truckload n + 1



In this example, requesting a lead time extension from the customer revealed a gap between the initial customer requirement and the underlying customer need. *BeverageManufacturer* investigated the acceptable range and discovered that some customers are willing to temporarily accept a day longer lead time than initially required, as illustrated in Figure 6, moving the customer requirement closer to customers' needs. This gap presents an opportunity for companies to transition towards an extended lead time, thereby optimizing the load factor at that particular moment.

Figure 6

Scenario where the lead time for excess volumes was extended with 1 day



Furthermore, this may help us understand that *BeverageManufacturer*'s practice of adjusting delivery dates for larger customers on a case-by-case basis represents a short-term strategy to optimize load factors in response to capacity constraints. By moving excess volumes to another day to consolidate orders and maximize truck capacity, *BeverageManufacturer* can achieve immediate improvements in overall load factor performance without necessitating significant structural changes to its logistics operations.

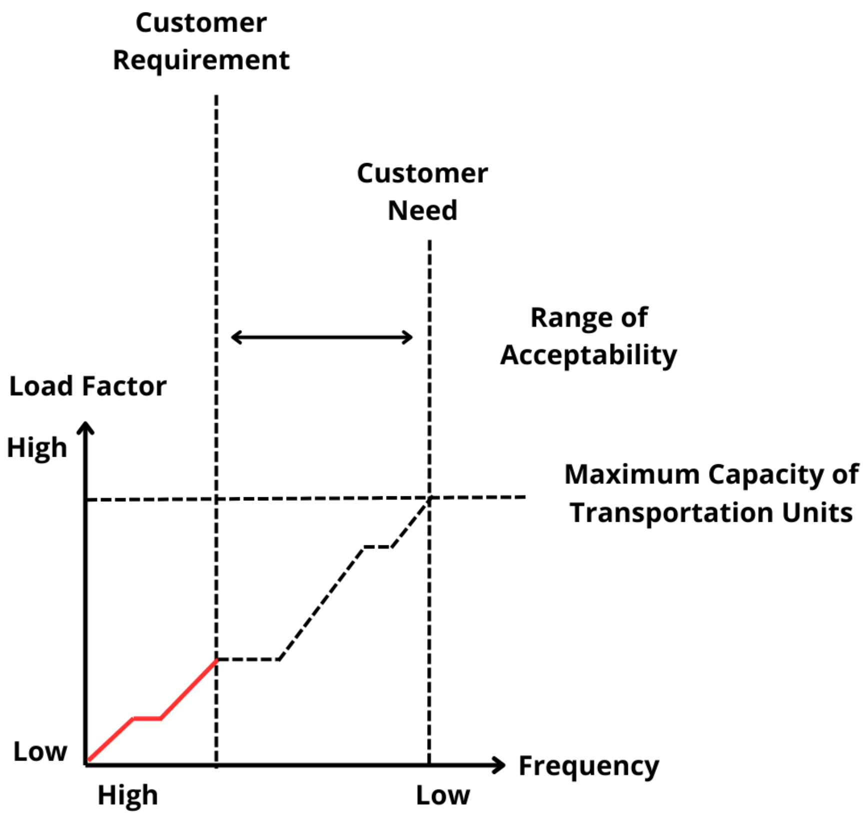
The lead time model can be used to take a long-term view of the relationship between lead time and load factor while also identifying potential differences in customer needs and requirements. As previously stated, short lead times frequently lead to speculation of required capacity, resulting in over- or under-booking of available capacity and poor load factor performance; consider the situation displayed in Figure 5 with excess volumes. According to the respondent at *FoodDistributor*, changing lead times is a lengthy process, however, the benefits realized from such changes could have positive impacts on their operations. Extending the lead times would avoid speculation as transport could be planned based on complete order information. This could reduce the risk of over- or underbooking and ensure that available capacity matches actual demand, thereby improving load factor performance. By extending lead times beyond the requirement, companies can engage in more detailed planning and shipment consolidation, resulting in situations similar to those depicted in Figure 6 with higher load factor performance.

Frequency model

The empirical data included examples of the model describing the relationship between frequency and load factor that demonstrated its applicability in both the short- and long-term perspective. The respondent from *FoodDistributor* demonstrated a scenario in which it was impossible to change the frequency in the short term, and the respondent mentioned that a more long-term, permanent approach was required if the company wanted to change the delivery frequency. The respondent highlighted an example of an area with significant seasonal variations due to tourism, with private customers ordering large volumes during the peak tourist season but ordering almost nothing the rest of the year. Despite the fact that there are fewer customers in these areas during off-season, they still expect and require deliveries on the same number of days as during the peak season, making it difficult to maintain a high load factor due to the high frequency. This scenario can be depicted in Figure 7 describing the overall load factor performance.

Figure 7

Scenario where customers still require a high frequency

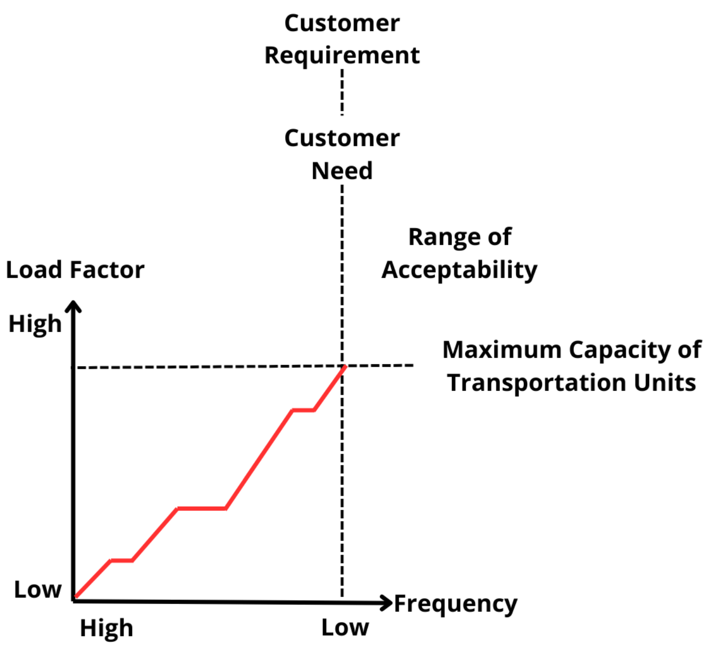


In this scenario, a lower frequency would improve load factor performance by allowing for better consolidation of volumes. However, *FoodDistributor* stated that changing the customer requirement within the acceptable range in the short term during the off-season was impossible due to the customers' rigid requirements. In this scenario, no range of acceptability exists from the perspective of the customer; however, customers may have been content with a lower delivery frequency for a short period of time without significantly affecting their operations. As mentioned before, customers are not always aware of how much change they can accept.

From a long-term perspective, changes to the frequency can improve the load factor performance. Over time, changes in volume can drive the decision to change delivery frequency, such as reducing or increasing the number of days of delivery, in order to better align available and required capacity. There were instances where customers at *TechWholesaler* and *RetailFood* realized that their customer requirements did not match their actual needs, thus a range of acceptability to make changes existed. Changes to the delivery agreements could not be performed short-term, as customers had to change their staffing schedules at *RetailFood*. Contacting customers and asking if they could agree to short-term changes required significant resource allocation at *TechWholesaler*. Instead, some customers of *TechWholesaler* take the initiative to improve delivery agreements by asking how they best may place their order to align with *TechWholesaler* and their transport provider's operations. This often resulted in a lower frequency of full truckload deliveries for the customer, shifting from the scenario depicted in Figure 7 to the scenario depicted in figure 8, which aligned the customer requirement with the customer's need to improve the load factor over time. The proactive engagement of customers indicates that some customers are well aware of their needs, resulting in the shipper having to spend fewer resources on contacting customers and seeking acceptance for possible alterations to delivery frequency. This proactive approach allows customers to actively participate in finding mutually beneficial solutions, improving load factor performance. However, for customers not as engaged as those of *TechWholesaler*, there exists challenges in performing alterations and a different approach may be necessary. Walker (1990) emphasized that if customers were made aware of the effects their service quality requirements have on shippers and transport providers, they may be more willing to relax their requirements. Communicating such effects caused by customers therefore becomes crucial for companies. As mentioned by Rogerson and Sallnäs (2017), both transport providers and transport buyers have a responsibility in achieving higher transport efficiency.

Figure 8

Scenario where the frequency was lowered

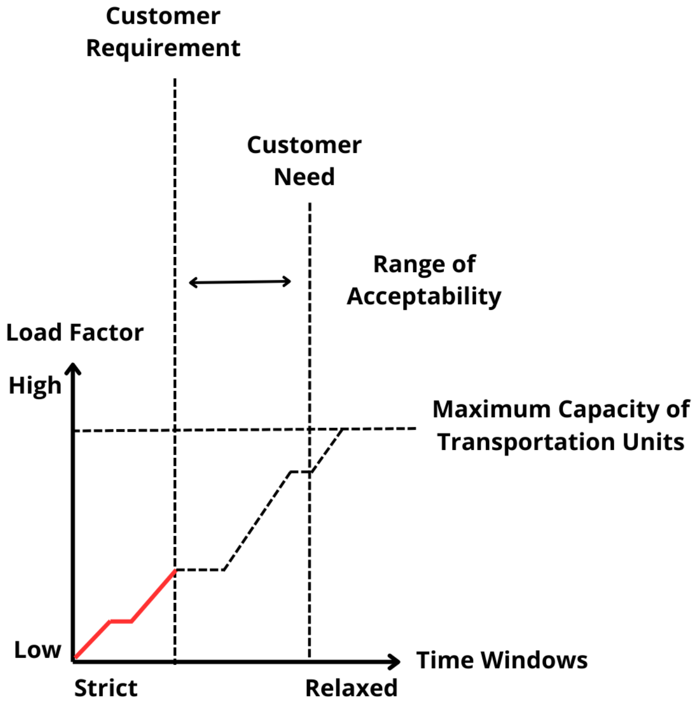


Time windows model

The empirical data included examples of the time windows model that demonstrated the model's applicability in both the short and long perspective. *FoodDistributor*, *RetailFood*, and *BeverageManufacturer* all mention how strict time window requirements can have a direct impact on operational decisions. Strict time windows may limit the number of orders loaded onto a truck to be able to adhere to all time windows, which potentially leads to lower load factor performance and may result in a scenario similar to Figure 9.

Figure 9

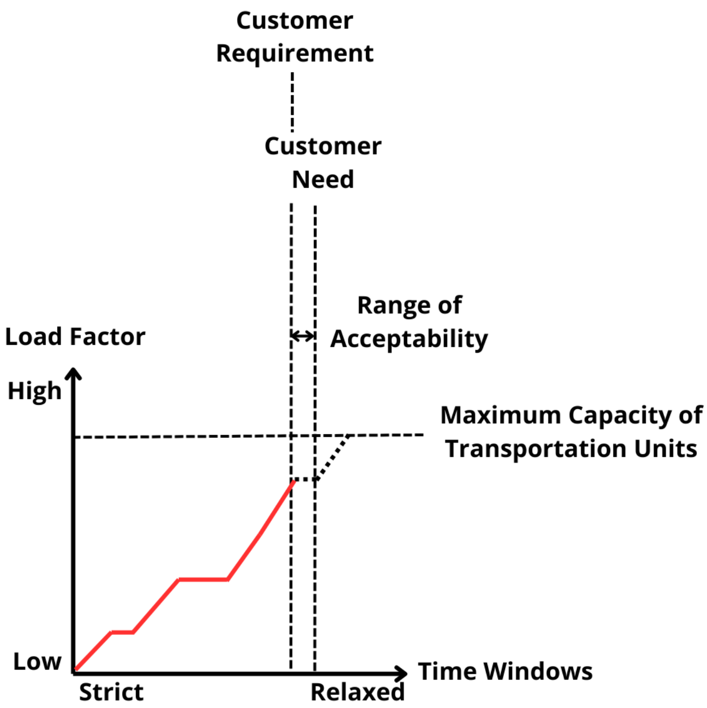
Scenario with strict time window requirements



The overall load factor performance in the scenario illustrated in Figure 9 is lower since, when there are conflicting time windows there are cases when more trucks than optimal have to be deployed. As mentioned in section 6.1.3, conflicting time windows are often a result of narrow time windows and the difficulties in changing the requirements. *FoodDistributor* uses a short-term strategy to deal with conflicting time windows by occasionally contacting customers and asking if delivery at a later time is possible, thereby temporarily relaxing customers' time windows. This ensures adherence to all order time windows as well as being able to consolidate more onto one truck and achieve a higher load factor, as shown in Figure 10. However, this strategy was not feasible at repeated times for each customer, as they were unwilling to switch back and forth between different time windows; instead, a permanent change was required to continue with the "new" time window. While short-term strategies may offer temporary improvement of load factor performance, a permanent change in time window requirements is often necessary to address operational inefficiencies effectively long-term.

Figure 10

Scenario where strict time window requirement are relaxed



The model also addresses long-term perspectives by examining strategic adjustments to time window requirements. For instance, *FoodDistributor*'s initiative to encourage some customers to accept afternoon delivery in exchange for shorter lead times reflects a long-term strategic approach for changing customer requirements in order to improve load factor performance. This contributes to increased utilization of trucks on a fleet level, as trucks can be utilized during the whole day. Similar to the situation depicted in Figure 9, the majority of customer's strict requirement for morning deliveries resulted in conflicting time windows and thus lower load factor performance. Furthermore, the possibility to exchange shorter lead times for relaxing time window requirements indicates that there exists a range of acceptability time window requirements. In this case, many customers realized that afternoon hours were more convenient for them, bringing the customer requirement closer to actual needs, as depicted in Figure 10. This implies that customers may perceive that there exists an alignment between their requirements and needs, however, if offered suitable incentives or alternatives, companies can increase load factor performance as well as customer satisfaction.

6.4 Service quality requirements and transport efficiency

As discussed in sections 6.1.1, 6.1.2 and 6.1.3, service quality requirements and the ability to change the requirements have a significant impact on load factor performance. However, as mentioned in the thesis background in section 1.1, it is important to not solely consider load factor as a measure of transport efficiency. Through the empirical findings, other effects related to the impact of service quality requirements on transport efficiency have been raised, and will be analyzed and discussed below. *RetailFood* highlighted time window requirements as a limiting factor for route efficiency, by compelling drivers to drive excess mileage to fulfill the requirements. This is consistent with the findings by Baykasoglu and Kaplanoglu (2011), who highlighted that meeting time window requirements often poses challenges in achieving efficient routing. The strict requirements of *RetailFood*'s customers prevented optimal consolidation of orders based on the geographical placement of stores. This resulted in intersecting truck driving paths, and drivers often having to navigate back and forth along a route to fulfill time window requirements.

Furthermore, *PartsBuyer* and *RetailFood* mentioned the time sensitivity arising from strict service quality requirements and the potential impact on utilization rate of the transport system. *RetailFood* identified that strict time window requirements creates a time sensitive system, and mentioned an ongoing discussion with customers about widening time windows at the end of routes to decrease time sensitivity. Delivering within the specified time windows of customers positioned early in routes is usually not an issue. However, if delays occur at the warehouse sites or due to traffic, fulfilling the remaining time window requirements becomes an issue. Assuming that a driver has several routes to complete each day, delays might necessitate the deployment of additional trucks to meet time window requirements for remaining routes. Similarly, the respondent at *PartsBuyer* noted that both rigid lead time and time window requirements contribute to a time sensitive system. The company imposes narrow time windows of 15 minutes for their transport providers, thus, making use of every available minute becomes crucial to minimize the number of delays. *PartsBuyer*'s goods receptions occasionally struggle to keep up with incoming deliveries, resulting in occasional delays, necessitating the transport provider to deploy another truck for backhaul transport originally intended for the delayed truck. Consequently, the original truck may drive back partially filled or empty, leading to a decrease in load factor on a fleet level. Moreover, system constraints at *PartsBuyer* limits the possibility of altering collection and delivery dates from suppliers to align with actual driving times for trucks, as they currently have to adhere to a longer lead time than optimal. This results in idle time for both drivers and trucks, reducing truck utilization rates and efficiency of the transportation network.

Considering the impact of service quality requirements on the transportation network, significant differences exist between the case companies depending on their type of transport fleet. For companies like *TechWholesaler*, *PartsBuyer* and *BeverageManufacturer*, which heavily rely on externally sourced transport, findings reveal that these companies impose both their own and their customers' requirements on their transport providers. This often results in the transport providers having to adhere to time windows requirements at both the pickup and delivery sites, reducing the ability of transport providers to find external goods aligning with the needs of both the shipper and customer. Moreover, the short lead times imposed by customers contributes to that the shippers book transport within relatively short timeframes. Consequently, the time between receiving bookings and performing transport is therefore often very short for transport providers, which also significantly impacts the transport providers ability to source external goods, and therefore impacting the load factor.

FoodDistributor and *RetailFood* have some externally sourced transport, however, they mainly manage their own transportation fleets, acting both as shippers and transport providers. Consequently, their customers impose service quality requirements directly on such companies. The findings highlight that, by managing transportation internally, they can optimize their fleet to solely focus on the specific needs of their customers, as consolidating external goods is not commonly performed at these companies. Therefore, the challenge of having to align several requirements from different shippers may not be as present in the case of having an internal fleet. Having to consider the operations of an additional party creates significant challenges in achieving an efficient transportation system fulfilling the needs of all parties involved. However, other challenges in terms of fleet utilization could arise in companies solely relying on an internal fleet. Assuming that the internal fleet is intended to only perform transport for one company, a decrease related to the utilization rate of the fleet could occur, for instance, when order volumes are lower than normal.

In summary, while load factor has demonstrated to be influenced by service quality requirements, it is crucial to broaden the perspective beyond this metric when assessing transport efficiency. As mentioned by Pahlén and Börjesson (2012), the load factor alone does not contribute to improved transport efficiency, emphasizing the need to broaden the perspective to include other influencing factors. The empirical findings highlight various other factors intertwined with service quality that impact overall efficiency. Service quality requirements have demonstrated their impact on not only increasing load factor performance, but also on the ability to achieve efficient routing and high utilization rates of transport fleets. Highly demanding service quality requirements creates time sensitive transport systems where minor delays might seem insignificant at first sight, however, these can create large challenges when they occur. Moreover, demanding service quality requirements and the inability to alter those, presents challenges for shippers and transport providers in achieving optimal routes in terms of driving distance and resource utilization. Hence, understanding the interaction between service quality requirements and different measures of transport efficiency is key for achieving effective transportation networks and reducing environmental impact.

7. Conclusion

The aim of this thesis was to examine and explore possible relationships between service quality requirements and load factor. Three research questions were formulated on this topic, which are answered in this chapter. The first research question is: *What service quality requirements do exist that have an impact on the load factor?* This study has found that requirements for three service quality factors significantly influence the load factor: lead time, delivery frequency, and time windows.

The second research question is: *How do service quality requirements affect the load factor?* Generally, more demanding service quality requirements, such as short lead times, narrow time windows and high frequency, limit the ability to achieve a high load factor. These requirements result in conflicting time windows and speculation of transport capacity, creating challenges in achieving efficient transport planning and consolidation. Consequently, aligning required and available capacity becomes challenging, potentially limiting load factor improvements. However, the empirical findings displayed instances that contradicted relationships between load factor and service quality requirements described in previous literature. For instance, a higher frequency did not always have negative effects on load factor performance; in some instances, it enabled lead time alterations, contributing to load factor improvements. These findings are in line with what was described in section 1.1, that service quality and transport efficiency factors interact, meaning that it is important not to simplify and generalize the relationship between such factors.

The last research question addresses the gap highlighted in previous literature regarding possible alterations to service quality requirements to improve load factor performance. Research question 3 is: *What alterations can be made to the service quality requirements to improve the load factor while still meeting customer needs?* This study has highlighted examples where alterations to service quality requirements could not be performed due to contextual factors such as customer schedules, warehouse capacity, multitude of deliveries and company structure. Nevertheless, this thesis has also identified instances where changes to service quality requirements could be performed, examining the circumstances that enabled alterations as well as discussing to what extent alterations are feasible. The study also displayed that it was generally more challenging to perform short-term alterations to service quality requirements, but these rapid and flexible changes can have a large impact on load factor performance. In other cases, a more long-term and permanent approach is needed to be able to, for instance, align the schedules of several customers to create optimal conditions for load factor improvements. The company specific context was shown to significantly determine the feasibility and load factor impact of short- or long-term alterations to service quality requirements.

This study introduces three models describing the relationship between service quality requirements and load factor. Additionally, the models consider capacity limitations of transport units and a possible range of acceptability, i.e. the range between a customer need and customer requirement. Thus, the study expands on previous literature by illustrating as well as broadening the perspective of these relationships. Previous studies have emphasized extending lead times and time window durations as well as reducing delivery frequency to achieve a higher load factor. However, this study displays that the flexibility in altering service quality requirements has a significant impact on load factor performance. Furthermore, the interaction between service quality requirements and how this affects the ability to achieve a high load factor has rarely been explored in prior studies. This study displayed that a higher frequency facilitates lead time adjustments, thereby better aligning required and available capacity, resulting in a higher load factor. Lastly, the empirical findings have identified factors (*historical offerings and norms, customer scheduling, multitude of deliveries, physical unloading constraints, product characteristics, warehouse capacity and company structure*) limiting the ability to alter service quality requirements, contributing to a deeper understanding of the interactions between such factors, service quality requirements and load factor.

The results from this study can be used by companies operating in environments shaped by service quality requirements to understand the relationship between such requirements and load factor. Companies aiming to achieve a high load factor may be inspired to explore the range of acceptability, and may use the models to explore the limitations to possible alterations, and the impact for load factor. Moreover, the results and models can be used by companies in their improvement work, for instance, in negotiations regarding service quality requirements with customers. By highlighting the impact requirements have for a company's operations, customers may be more prone to change.

The major limitation of this study is that the models are only able to describe the general relationship between service quality requirements and load factor. There exists empirical evidence indicating that these models and their relationships may not hold true across all contexts. Therefore, it is important to consider the company-specific contexts as well as other factors when applying the models. While this study has considered such factors to some extent, additional research delving deeper into this area would be beneficial.

Additionally, further research could explore the range of acceptability, i.e. the range between customer needs and customer requirements, displayed in the models from additional perspectives. As stated in this study, an initiative to change service quality requirements could come from both customers imposing requirements and the company receiving requirements. Understanding how different actors navigate the acceptable range is critical for making better decisions. One initial approach could be to conduct a study exploring different strategies for identifying customer needs, as the case companies studied in this thesis often lacked awareness of the actual needs, resulting in difficulties in identifying the range of acceptability. From the perspective of the companies, a further study could also attempt to identify how strategies for gaining customer acceptance of service quality change, taking factors like communication methods, incentives, and negotiation into consideration. The data in this thesis were not directly from end-customers, so the study was somewhat limited in terms of direct insights from their perspective. This study found differences in getting customers to accept short-term versus long-term change. Furthermore, it is worth noting that the specific context appeared to influence whether changes could be implemented quickly or not. Further research could build on these findings to determine whether customers find it easier or more difficult to accept short- or long-term changes.

Finally, as the load factor is solely one measure contributing to improved transport efficiency, further research could explore how service quality requirements impact other measures of transport efficiency. Understanding how service quality requirements affect the different measures of transport efficiency would provide a more complete picture. As this study lacks a quantitative perspective, further studies in this area could help quantify the impact of service quality requirements on transport efficiency. For instance, quantifying how different service quality requirement alterations affect load factor performance. The case companies have emphasized that a longer lead time could improve planning and consolidation possibilities. By specifying the lead time extension required and the resulting increase in load factor, companies can communicate more effectively and precisely in negotiations with customers.

References

Alvesson, M., & Sköldberg, K. (2004). *Tolkning och reflektion: vetenskapsfilosofi och kvalitativ metod* [Interpretation and reflection: philosophy of science and qualitative method]. Studentlitteratur.

Arnäs, P. O., Holmström, J., & Kalantari, J. (2013). In-transit services and hybrid shipment control: The use of smart goods in transportation networks. *Transportation Research Part C: Emerging Technologies*, *36*, 231-244. https://doi.org/10.1016/j.trc.2013.09.005

Aronsson, H., & Huge Brodin, M. (2006). The environmental impact of changing logistics structures. *The international journal of logistics management*, *17*(3), 394-415. https://doi.org/10.1108/09574090610717545

Arvidsson, N. (2013). The milk run revisited: A load factor paradox with economic and environmental implications for urban freight transport. *Transportation Research Part A: Policy and Practice*, *51*, 56-62. https://doi.org/10.1016/j.tra.2013.04.001

Arvidsson, N., Woxenius, J., & Lammgård, C. (2013). Review of road hauliers' measures for increasing transport efficiency and sustainability in urban freight distribution. *Transport Reviews*, *33*(1), 107-127. https://doi.org/10.1080/01441647.2013.763866

Ayres, L., Kavanaugh, K., & Knafl, K. A. (2003). Within-case and across-case approaches to qualitative data analysis. *Qualitative health research*, *13*(6), 871-883.

Baykasoglu, A., & Kaplanoglu, V. (2011). A multi-agent approach to load consolidation in transportation. *Advances in Engineering Software, 42*(7), 477-490. https://doi.org/10.1016/j.advengsoft.2011.03.017

Bell, E., Bryman, A., & Harley, B. (2022). *Business research methods*. Oxford University Press.

Bergman, B., Bäckström, I., Garvare, R., & Klefsjö, B. (2022). *Quality from customer needs to customer satisfaction.* Studentlitteratur AB.

Blomkvist, P., Hallin, A., & Lindell, E. (2018). *Metod för företagsekonomer: Uppsats enligt 4-stegsmodellen* [Method for Business Economists: Essay according to the 4-step model]. Studentlitteratur AB.

Bowersox, D. J., Closs, D. J. & Cooper, M. B. (2007). *Supply chain logistics management.* Mcgraw-hill.

Browne, M., & Gomez, M. (2011). The impact on urban distribution operations of upstream supply chain constraints. *International Journal of Physical Distribution & Logistics Management*, *41*(9), 896-912. https://doi.org/10.1108/09600031111175843

Byrne, P. M., Markham, W. J. (1991). *Improving Quality and Productivity in the Logistics Process - Achieving Customer Satisfaction Breakthroughs.* A.T. Kearny, Inc.

Bø, E., & Hammervoll, T. (2010). Cost-based pricing of transportation services in a wholesaler–carrier relationship: an MS Excel spreadsheet decision tool. *International Journal of Logistics: Research and Applications, 13*(3), 197-210. https://doi.org/10.1080/13675560903271203

Bömer, T., & Meyer, A. (2022). Freight Costs Versus Service Level: Optimizing the Distribution of a Materials Trader. *International Conference on Computational Logistics,* 397-411. https://doi.org/10.1007/978-3-031-16579-5_27

Caplice, C., & Sheffi, Y. (1995). A review and evaluation of logistics performance measurement systems. *The International Journal of Logistics Management, 6(1)*, 61-74. https://doi.org/10.1108/09574099510805279

Christopher, M. (2005). *Logistics and Supply Chain Management - Creating Value Adding Networks*. (3rd ed.). London FT Prentice Hall.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, *14*(4), 532-550. https://doi.org/10.2307/258557

Ellram, L. M. (1996). The use of the case study method in logistics research. *Journal of business logistics, 17(2)*, 93.

European Commission. (2023, 11 July). *Providing efficient, safe and environmentally friendly transport.* Transport and the Green Deal - European Commission

Eurostat. (2023). *Road freight transport statistics.* Road freight transport statistics

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative inquiry*, *12*(2), 219-245. https://doi.org/10.1177/1077800405284363

Forslund, H., & Jonsson, P. (2010). Integrating the performance management process of on-time delivery with suppliers. *International Journal of Logistics: Research and Applications*, *13*(3), 225-241. https://doi.org/10.1080/13675561003712799

Ghobadian, A., Speller, S., & Jones, M. (1994). Service quality: concepts and models. *International journal of quality & reliability management, 11*(9), 43-66. https://doi.org/10.1108/02656719410074297

Grönroos, C. (1990). *Service management and marketing* (4th ed.). Lexington, MA: Lexington books.

Hallin, P., & Karlenäs, A. (2008). *Miljöfördelaktiga förändringar i distribution - En studie av miljöfördelaktiga förändringar i Tibnor ABs distributionssystem* [Environmentally beneficial changes in distribution - A study of environmentally beneficial changes in Tibnor AB's distribution system]. Unpublished manuscript.

Jonsson, P., & Mattsson, S.-A. (2023). *Logistik - Läran om effektiva materialflöden* (4th. ed.) [Logistics - The science of efficient material flows]. Lund: Studentlitteratur AB.

Juran, J. M. (2003). *Juran on leadership for quality.* Simon and Schuster.

Karlsson, J., Kjellsdotter Ivert, L., & Brunner, S. (2021). *Triple F Etableringsprojekt Omvärldsanalys Logistik* [Triple F Establishment Project Environmental Analysis Logistics]. https://urn.kb.se/resolve?urn=urn:nbn:se:vti:diva-16061

Lumsden, K. (2011). *Economy of Transportation Systems.* Unpublished Manuscript.

Lumsden, K., Dallari, F., & Ruggeri, R. (1999). Improving the efficiency of the hub and spoke system for the SKF European distribution network. *International Journal of Physical Distribution & Logistics Management*, *29*(1), 50-66. https://doi.org/10.1108/09600039910253878

Lumsden, K., Stefansson, G., & Woxenius, J. (2019). *Logistikens grunder* (4th. ed.) [Fundamentals of Logistics]. Studentlitteratur.

Markowska, K. (2020). Shaping Quality of Service in Freight Transport. *Modelling of the Interaction of the Different Vehicles and Various Transport Modes,* 105-130. https://doi.org/10.1007/978-3-030-11512-8_2

Mason, R., & Lalwani, C. (2006). Transport integration tools for supply chain management. *International Journal of Logistics: Research and Applications*, *9*(1), 57-74. https://doi.org/10.1080/13675560500534599

McKinnon, A. C. (2007a). CO2 Emissions from Freight Transport in the UK. *Report prepared for the Climate Change Working Group of the Commission for Integrated Transport*, *57*, 35-42.

McKinnon, A. C. (2007b). Road transport. *Global Logistics: New Directions in Supply Chain Management*, 273.

McKinnon, A. C. (2009). Benchmarking road freight transport: Review of a government-sponsored programme. *Benchmarking: An International Journal*, *16*(5), 640-656. https://doi.org/10.1108/14635770910987850

McKinnon, A. C. (2010). European freight transport statistics: limitations, misinterpretations and aspirations. In *5th ACEAa Scientific advisory group meeting. ACEA. Bruxelles.*

McKinnon, A. C. (2018). *Decarbonizing logistics: Distributing goods in a low carbon world.* Kogan Page Publishers.

McKinnon, A. C., & Ge, Y. (2004). Use of a synchronised vehicle audit to determine opportunities for improving transport efficiency in a supply chain. *International Journal of Logistics Research and Applications*, *7*(3), 219-238. https://doi.org/10.1080/13675560412331298473

Nielsen, L. D., Jespersen, P. H., Petersen, T., & Hansen, L. G. (2003). Freight transport growth—a theoretical and methodological framework. *European Journal of Operational Research*, *144*(2), 295-305. https://doi.org/10.1016/S0377-2217(02)00395-8

Ni, L., & Wang, X. (2021). Load factors of less-than-truckload delivery tours: An analysis with operation data. *Transportation Research Part E: Logistics and Transportation Review*, *150.* https://doi.org/10.1016/j.tre.2021.102296

Näringsdepartementet, (2018). *Uppdrag att utarbeta förslag om horisontella samarbeten och öppna data för ökad fyllnadsgrad* [Mission to Develop Proposals for Horizontal Collaborations and Open Data to Increase Fill Rates]. Uppdrag att utarbeta förslag om horisontella samarbeten och öppna data för ökad fyllnadsgrad

Oskarsson, B., Aronsson, H., & Ekdahl, B. (2021). *Modern logistik: för ökad lönsamhet* (5th ed.) [Modern Logistics: for Increased Profitability]. Liber.

Pahlén, P. O. (2014). *Energieffektiva transporter: förbättrad kundservice med samtidig reducerad energianvändning baserad på informations och kommunikationsteknologi (IKT)* [Energy-efficient Transport: Improved Customer Service with Simultaneous Reduced Energy Consumption based on Information and Communication Technology (ICT)]. Chalmers Tekniska Högskola.

Pahlén, P. O., & Börjesson, F. (2012). Measuring resource efficiency in long haul road freight transport. In *Proceedings of the 24th Annual Nordic Logistics Research Network (NOFOMA) Conference, Naantali, Finland* (pp. 689-702).

Pahlén, P. O., & Carlson, R. (2013). Transport user involvement-analyzing the impact of sustainability on freight transport. *In Logistics Research Network (LRN) Conference.*

Piecyk, M. I. (2010). *Analysis of long-term freight transport, logistics and related CO2 trends on a business-as-usual basis* (Doctoral dissertation, Heriot-Watt University). http://hdl.handle.net/10399/2326

Piecyk, M. I., & McKinnon, A. C. (2010). Forecasting the carbon footprint of road freight transport in 2020. *International journal of production economics*, *128*(1), 31-42. https://doi.org/10.1016/j.ijpe.2009.08.027

Potter, A., & Lalwani, C. (2008). Investigating the impact of demand amplification on freight transport. *Transportation Research Part E: Logistics and Transportation Review, 44*(5), 835-846. https://doi.org/10.1016/j.tre.2007.06.001

Quak, H. J, & De Koster, R. (2007). Retailer's sensitivity to time-window policies. *Managing Supply Chains-Challenges and Opportunities*, 227-245.

Rogerson, S. (2017). Influence of freight transport purchasing processes on logistical variables related to CO2 emissions: a case study in Sweden. *International Journal of Logistics Research and Applications, 20*(6), 604-623. https://doi.org/10.1080/13675567.2017.1308472

Rogerson, S., & Sallnäs, U. (2017). Internal coordination to enable high load factor. *The International Journal of Logistics Management*, *28*(4), 1142-1167. https://doi.org/10.1108/IJLM-02-2016-0031

Rogerson, S., & Santén, V. (2017). Shippers' opportunities to increase load factor: managing imbalances between required and available capacity. *International Journal of Logistics Research and Applications*, *20*(6), 581-603. https://doi.org/10.1080/13675567.2017.1306612

Santén, V. (2012). *Building a framework for increased load factor - mapping actions and effects from a transport buyer's perspective.* Unpublished manuscript.

Santén, V. (2016). *Towards environmentally sustainable freight transport - Shippers' logistics actions to improve load factor performance.* [Doctoral Thesis, Chalmers University of Technology]. https://publications.lib.chalmers.se/records/fulltext/243257/243257.pdf

Santén, V. (2017). Towards more efficient logistics: increasing load factor in a shipper's road transport. *The International Journal of Logistics Management, 28*(2), 228–250. https://doi.org/10.1108/IJLM-04-2015-0071

Santén, V., & Arvidsson, N. (2011). Road freight transport efficiency and less environmental impact-the perspectives of transport buyers and operators. Unpublished manuscript.

Santén, V., & Rogerson, S. (2018). Shippers' transport efficiency: An approach for measuring load factor. *Logistics Research*, *11*(3), 1-15. https://doi.org/10.23773/2018_3

Schöneberg, T., Koberstein, A., & Suhl, L. (2010). An optimization model for automated selection of economic and ecologic delivery profiles in area forwarding based inbound logistics networks. *Flexible services and manufacturing journal*, *22*, 214-235. https://doi.org/10.1007/s10696-011-9084-5

Strand, A., & Fremstad, R. (2020). How does customer requirements affect transport efficiency?. https://hdl.handle.net/20.500.12380/301189

Walker, M. (1990). The transport costs of customer service. *Logistics and Distribution Planning. Strategies for Management, Revised Edition, Kogan-Page, London*, 51-68.

Wehner, J. (2018). Energy efficiency in logistics: An interactive approach to capacity utilisation. *Sustainability*, *10*(6), 1727. https://doi.org/10.3390/su10061727

Wehner, J. (2023). *Transporteffektivitet och fyllnadsgrad: Analys och åtgärdsförslag för ökat resursutnyttjande* [Transport efficiency and fill rate: Analysis and action proposals for increased resource utilization]. Statens väg- och transportforskningsinstitut, Samhälle, miljö och transporter, SAMT, Trafikanalys och logistik, TAL. https://urn.kb.se/resolve?urn=urn:nbn:se:vti:diva-19643

Wohlin, C. (2014). Guidelines for snowballing in systematic literature studies and a replication in software engineering. In *Proceedings of the 18th international conference on evaluation and assessment in software engineering* (pp. 1-10). https://doi.org/10.1145/2601248.2601268

World Economic Forum/Accenture. (2009). *Supply chain decarbonization: Role of transport and logistics in reducing supply chain carbon emissions.* Geneva: World Economic Forum.

Wu, H.-J., & Dunn, S. C. (1995). *Environmentally responsible logistics systems*. International Journal of Physical Distribution & Logistics Management, *25*(2), 20-38. https://doi.org/10.1108/09600039510083925

Yin, R. K. (2013). Kvalitativ forskning från start till mål [Qualitative Research from Start to Finish] (J. Retzlaff, Trans.). Studentlitteratur.

Zang, X., Jiang, L., Liang, C., & Fang, X. (2023). Coordinated home and locker deliveries: An exact approach for the urban delivery problem with conflicting time windows. *Transportation Research Part E: Logistics and Transportation Review, 177.* https://doi.org/10.1016/j.tre.2023.103228

Appendix A - Interview Guide Outbound Flow

Theme: Introductory Questions

- Can you please introduce yourself and your role within the organization?
- How long have you worked for the organization?
- Have you worked in your current role the entire time?
- Describe the process from customers placing orders to the distribution of goods from your warehouses to the customers.
    - How is the transport planned?
    - Are orders consolidated?
    - What is considered when choosing what goods or customers to consolidate?
    - How is the routing planned?
    - What aspects are considered when planning the routes?
- Does your organization have its own fleet of vehicles, or is it purchased from external parties, or a combination of both?
    - Do you plan the internal and external fleets differently?

Theme: Load Factor

- Does your company measure the load factor?
    - How high or low is the mean load factor?
- How is the load factor measured at the company?
- Are there any targets, or requirements related to the load factor in your company?
- What measures are taken and have been taken to achieve a high load factor?
- What is the largest bottleneck(s) to achieving an efficient transport system, related to achieving a high load factor?

Theme: Service Quality Requirements

- In short, what customer requirements exist and how do they affect the business?
    - How are the requirements managed?
- What requirements, related to transport and delivery, do the customers put on your organization, or are the specifications of service quality something your organization offers and the customer accepts?
    - How do these service quality requirements affect the transport solution?
    - How are the order agreements decided upon with the customers? How often does a change in the order agreements occur?
- Are the service quality requirements measured and followed up on in any way?

Theme: Service Quality Requirements Impacting Load Factor (Relationship):

- What service quality requirements have you noticed influence the load factor?
    - How do these service quality requirements affect the load factor? Are there any concrete examples?
- How does your organization prioritize meeting load factor targets and maintaining service quality standards?
    - Have you noticed that service quality requirements limit the possibilities of achieving a high load factor? Which ones? In what way?

Theme: Comparing load factor and each service quality requirement

Frequency

- Does your company currently adhere to a fixed (order and) delivery schedule? How can it influence the load factor?
- What different frequencies does the customer have?
  - Have you noticed any differences in how different delivery frequency requirements influence the load factor? How?
- What possibilities exist to change the frequency? (increase/decrease)
  - Have you discussed a possible change to the frequency or delivery schedule with the customers?
- Do you know why the customers need the agreed frequency?

Lead time

- How long is the lead time for your customers (from when you receive the order until you deliver it)?
- What is the longest and shortest lead time? What is the most common?
- Have you noticed any differences in how different lead time requirements influence the load factor? How?
- What possibilities exist to change the customer lead time?
  - Have you discussed a possible change to the lead time with the customers?
- Do you know why the customers need the agreed lead time?

Delivery Precision & Time Windows

- Does your company have time windows to adhere to?
- How is the spread of time windows during the day? Do all customers want delivery at a similar time, or is it more evenly spread over the day?
- How is the transport planned to meet the time window requirements?
- How does consolidation work with existing time window requirements?
- Have you noticed any differences in how different time window requirements influence load factor? How?
- What possibilities exist to change the delivery windows?
  - Have you discussed a possible change with the customers?
- Do you know why the customers have the agreed time windows?

Order size

- Do the customers have any minimum and/or maximum order quantities to follow?
  - Have you noticed any differences in how different order size requirements influence the load factor? How?
  - Do you know why the customers have the min/max order sizes (if they adhere to this), or why they do not?
- Are the order variations large?
  - Have you noticed any differences in how different order size variations influence the load factor? How?
- What possibilities exist to change the order size agreements?
  - Have you discussed a possible change with the customers?

Theme: Alterations

- Do your company have any margins (+/-) in relation to the service quality requirements that are acceptable for the customers?
- What effect could changes in service quality requirements have on the load factor? Have you noticed any past changes to the requirements that had an effect on the load factor?

    - Are there any concrete examples?
- To be able to change the service quality requirements, do any incentives have to be put in place? Which ones? Why? Is this something that has been tried in the organization in the past?
- For your organization, how should the service quality requirements be formulated to achieve the best possible conditions for a high load factor?
- Is there any feedback provided by your company to the customer regarding how their requirements affect the load factor?
- How do you work with matching the required and available capacity (for example, the capacity of the orders and the capacity of a truck)?
    - Has it ever happened that the required capacity exceeds the available capacity? How did you solve this? How did it affect the load factor?
- What would be the largest challenges relating to matching the required and available capacity if the customer requirements changed? (e.g. longer lead time) Why?
- How much more time (hours, days, etc) do you think would have helped to achieve a higher load factor?

Appendix B - Interview Guide Inbound Flow

Theme: Introductory Questions

- Can you please introduce yourself and your role within the organization?
- How long have you worked in the organization (have you worked in your current role the entire time)?
- Describe briefly the process from order placement until you receive the goods.

Theme: Service Quality Requirements

- How are the order agreements decided upon with the transport providers/suppliers?
    - What requirements, related to transport, does your organization put on the transport providers/suppliers? Or are the specifications of service quality something that is offered and that you, as a customer, accept?
    - How often are the order agreements renegotiated?
- Have you looked at how service quality requirements affect the transport solution? If yes, what did the analysis show?
- Are these service quality requirements measured and followed-up in any way?
    - If yes, do you only measure the performance of the requirements, or is the impact also measured?

Theme: Comparing load factor and each service quality requirement

Frequency

- Do you currently adhere to a fixed (order and) delivery schedule?
- What different frequencies do you place orders according to?
- Have you noticed any differences in how different delivery frequency requirements influence the load factor? How?

Lead time

- How long are the lead times from when you place the order until you receive the order?
- What is the longest and shortest lead time? What is the most common?

- Have you noticed any differences in how different lead time requirements influence the load factor? How?

Delivery Precision & Time Windows

- Are there time windows for when you receive the order?
- How is the spread of time windows during the day? Do you have the same time window for all deliveries, or is it spread throughout the day?
- Have you noticed any differences in how different time window requirements (length of the time windows) influence the load factor? How?

Order size

- Are there any minimum and/or maximum order quantities to follow?
- Are your order variations large?
- Have you noticed any differences in how different order size requirements influence the load factor? How?

Theme: Alterations

- Is there any feedback provided to you from the transport provider/supplier regarding how your company's requirements affect the load factor?
- Do you currently have any margins (+/-) in relation to the service quality requirements that are acceptable for your company? (e.g. if the transport is x hours/days late or early, is it still fine?)
- Would it be possible to make change(s) to the service quality requirements?
    - Do any incentives have to be put in place for your company to agree upon such change(s)? Which ones?
- For your organization, how should the service quality requirements be formulated to achieve the best possible conditions for your operations?

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SUPPLY AND OPERATIONS MANAGEMENT
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY