The importance of supplier information quality in purchasing of transport services

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Betydelsen av leverantörers informationskvalitet vid inköp av transporttjänster

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Abstract

An important prerequisite for successful supply chain integration is the ability to convert data into information combined with structured storing and sharing processes. The purpose of this master thesis is to investigate potential relation between supplier data quality and performance of purchasing of transport services. The output of the thesis generates evidence about the imperative to emphasize on the supplier data quality throughout the supplier selection process.

A supplier data quality assessment framework consisting of 4 dimensions - ease of manipulation, accessibility, accuracy and completeness, is developed as the core product of this research project. The weights of these dimensions were assigned specifically for the case company - Cramo, to determine the quality score for a selected sample of carriers. A coefficient $k_1$ representing the ratio of transport expenditure over sales was introduced to facilitate the identification of relation between supplier data quality and transport expenditure. Business units served by transport companies with higher quality data displayed a lower $k_1$, consequently, paying less for the transport services in comparison to their revenue than business units served by carriers with lower data quality score.

The framework developed is adaptable - dimensions and metrics can be added or excluded according to situational factors and case peculiarities. The application of the supplier data quality assessment framework allows for a more objective and streamlined supplier selection. It stresses on the overall costs experienced during the period of cooperation. The finding regarding the importance of supplier data quality in purchasing of transport services can be nonetheless generalized for other cases when companies strive for achieving better informed strategic decisions.

Keywords: supply chain integration, purchasing performance, transport services, information infrastructure, supplier data quality, assessment framework, total cost of ownership
Sammanfattning

En viktig förutsättning för framgångsrik integration av leverantörskedjor ligger i förmågan att omvandla data till information, kombinerat med en strukturerad lagrings- och delningsprocess. Syftet med denna masteruppsats är att undersöka potentiell relation mellan leverantörers datakvalitet och hur effektivt inköpet av transporttjänsterna är. Utfallet av uppsatsen understryker vikten av att beakta leverantörers datakvalitet i alla delar av en upphandling.


Den utvecklade bedömningsmallen är anpassningsbar – dimensioner och mått kan enkelt adderas eller elimineras utifrån rådande omständigheter i varje fall. Bedömningsmallen ger möjlighet till en mer objektiv och harmoniserad leverantörskommission. Mallen understryker även vikten av att beakta den totala kostnaden under avtalstiden. Kunskapen från denna uppsats kring Vikten av datakvalitet gällande just transportinköp kan även generaliseras till andra fall där företag strävar mot bättre informerade strategiska beslut.

Nyckelord: leverantörskedja integration, inköpseffektivitet, transporttjänster, informationsinfrastruktur, leverantörsdatakvalitet, bedömningsmall, totalkostnaden för ägande
Acknowledgements

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We would also like to thank the rest of the Cramo office staff and employees of other business units who were involved in the data gathering process and other stages of this research project. Their committed participation and input ensured that the research was successfully conducted, what made the outcome satisfactory and meaningful to the company.

We would like to acknowledge the significant contribution of our KTH supervisor Andreas Feldmann. He was keen to advise us when we ran into a dead end or needed guidance regarding the research or academic writing. During our meetings, he provided us with valuable input that helped us delimit our thesis to a topic interesting to both - academia and Cramo.

Lastly, we would like to acknowledge the contribution of our seminar group and seminar leader Luca Urciuoli at KTH, as they came to be the second readers of this thesis. We appreciated their valuable feedback and different perspectives they provided on the challenges we faced.

Jonas Bulovas and Pygmalion-Alexandros Gordos
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1. Introduction

This chapter introduces the background of the study. The investigation of this paper starts with looking into the function of supply chain management and funnels down to purchasing, purchasing of services and purchasing of transport services in the described order. The reasoning for the selection of this focus area is provided subsequently. That is followed by the problematization and purpose of this master thesis. Further on, the research questions operationalizing the purpose are introduced.

1.1 Background

Supply chain management represents one of the most important functions in modern businesses that involves optimizing operations to maximize agility and efficiency. Responsiveness is becoming an important feature since customers value how quickly something is delivered to them. Increasing availability and responsiveness are followed by higher costs and thus, must be balanced by simultaneously achieving efficiency. The most effective supply chains deliver products quickly and at highly competitive prices without sacrificing the quality. (Mack, 2018) A trend linked to supply chain efficiency is the integration of supply chain parties. By having supply chain stakeholders work together in a collaborative and smart way businesses can reap the benefits of more efficient operations (Robinson, 2018).

Supply chain integration is defined as the degree to which a focal company has integrated the flow of information, materials, and finances with its supply chain partners. Information flow integration is the extent to which operational, tactical and strategic information is shared between a focal firm and the supply chain partners. (Rai, 2006) Distorted information exchange between supply chain stakeholders can lead to substantial inefficiencies (Lee et al., 2015).

Purchasing is an integral function of supply chain management, both being tightly interconnected. Supply chain management provides purchasers with benefits utilized for improved supplier coordination. Subsequently, it results in higher commitment and long-term supplier relations what in turn helps to reduce costs for the purchasing organization. (Giunipero & Brand, 1996) Purchasing of services is a specific branch, distinct from that of products. This is because services include a much greater deal of human discretion, therefore are more difficult to standardize. Literature stresses that services are a result of continuous interaction between the buying and the selling entity (Axelsson & Wynstra, 2002). Moreover, it is a more complex task to determine criteria for service quality evaluation as it requires subjective ratings resulting in difficulty to quantify the results (Fitzsimmons et al., 1998).

Transport is one of the services that have significant importance for the equipment rental companies. One of the reasons is their dependability on transportation as a crucial component of customer experience. This is because quick delivery alleviates the issue related to urgency experienced by the customers. Moreover, there is a 100% of returns in equipment rental industry what adds an extra level of complexity in the companies’ supply chain. It means that every item rented is later delivered back to the point of distribution. Hence, such companies in particular, must develop solid purchasing
processes in order to assure required resources, routines and competences needed to purchase logistics and transport services effectively. (Andersson & Norrman, 2002)

Possession of high-quality and up-to-date data at all times is one of the most critical business assets (Tieto, 2013). Many companies nowadays possess a vast amount of data. However, it is often gathered without having a specific purpose. A widespread assumption is that the data is available in the internal systems and can be used when it is necessary. However, this is often not the case. (Adam & Humphreys, 2008) A vital prerequisite for successful supply chain integration is the ability to convert data into information combined with structured storing and sharing processes. The cost of turning data into information increases exponentially with relation to age of the aforementioned data. That leads to a significant decrement in potential of further utilization in supporting business decisions or monitoring performance. Thus, it is necessary to consider the required investments in terms of different corporate resources including supplier education. (Madnick et al., 2009) In turn this could assure high quality of receivable historical data, so that specific segments of it can be leveraged to drive the generation of new sustainable business models and improve daily operations.

This paper analyses the role of information in managerial decision making, with a strong focus on the purchasing function, in specific, purchasing of transport services. In many occasions, the information that is scarce or hardly accessible has the highest value for the company and relevant knowledge or lack of it can even determine firms existence (Adam & Humphreys, 2008). In order to conduct this research a major player in the equipment rental industry - Cramo AB, was selected as the case company. The company owns multiple depots of different types that are collectively referred to as business units in the paper.

1.2 Problematization

Every field of business has its specific opportunities and challenges to overcome in order to operate sustainably evaluating it from different perspectives. The focal company is in the forefront of construction equipment rental business in geographic areas of northern, eastern and central Europe. The size of the enterprise, the spread of client serving depots and the diversity of product portfolio renders company’s transportation network extremely complex. One of the main reasons for the latter challenge is the lack of national transport providers who were able to serve the company of interest with regard to every different type of product, location or required additional service. Cramo is not an exception facing the aforementioned challenge and it must deal with the previously enlisted phenomena. After considering the situation described, the initial problem formulation presented by the contracting company was the following:

“The number of depots and the extent of carrier portfolio causes transport network complexity leading to suboptimal equipment movement and increased transport expenditure.”

The problem formulation provided showcases the peculiarities of the business field the company of interest operates in, including the obstacles that it seeks to overcome. After further investigation of the business environment situation, interviewing relevant stakeholders and an initial review of various
data sources, the initial statement was transformed into a non-trivial and researchable problem. The final formulation was concluded as follows:

“Given the increased customer demand for supply chain and price transparency, businesses face the challenge of achieving supply chain integration to sustain control over expenditures and assure optimal pricing.”

1.3 Purpose

The purpose of the project was exploratory, since the transport handling related activities had to be observed in order to understand the business, its internal processes and the challenges related to obtaining high quality supplier data. In addition to that, potential data quality dimensions suitable for the case study were investigated. The identification of information gaps in the collected data led to the formulation of the following purpose:

The purpose of this master thesis is to investigate the potential relation between information quality and performance of purchasing of transport services.

Aside from the benefit for the company resulting from the investigation of its transport network, this research contributes to the identification of potential relation denoted in the purpose. Given that the relation is confirmed, the output would help communicating the importance of operational data quality and alleviate the problems experienced by similar companies. The expected contribution of the thesis pertains to both - the economical and the environmental sustainability, what in turn can facilitate the contribution to sustainable development of companies utilizing the findings.

1.4 Research questions

The most dominant way of constructing research questions in the empirical material was gap-spotting. This method includes the identification of various ‘gaps’ in existing literature (Sandberg & Alvesson, 2010). In order to fulfill the purpose of this work, these research questions are addressed:

Main RQ: How does information quality influence and impact the purchasing of transport services?

RQ1: What are the challenges for achieving accurate shipping pricing?
RQ2: How can supply chain integration contribute to reduced total cost of shipping?
RQ3: How can the supplier evaluation process be systematically performed?
2. Theoretical Background

In this chapter, the theoretical background of the thesis is presented. Theoretical concepts are discussed and explained. This helps the reader follow the theoretical framing of the study. The chapter starts by discussing the concept of supply chain transparency and its importance for supply chain efficiency. It funnels down to the trend of supply chain integration and how information is shared between supply chain entities. Further on, purchasing strategies are discussed with a focus on the purchasing of services. Then, the concept of total cost of ownership is explained with regard to purchasing. Lastly, theoretical frameworks for assessing supplier performance are introduced that function as the base for the development of the supplier data quality assessment framework.

2.1 Supply chain transparency

By definition, supply chain transparency refers to the visibility of information across the extended supply chain utilized to improve efficiency and compliance (Alan, 2015). The lack of visibility to and integration with company’s suppliers can become a major source of inefficiency and unnecessary expenditure in the supply chain. Achieving high visibility over suppliers allows for control and agility in an outsourced supply chain environment. (Supply Chain Digest, 2016)

The concept of transparency goes beyond visibility in the extended supply chain. It is rather a controlled process of the focal company taking action on the information gained through sufficient visibility in order to manage risks in a more effective way (Linich, 2014). In the past, physical and communication distances separated supply chain activities between its constituent entities. However, nowadays, the availability of technology has rendered the upstream risks much closer to the attention of downstream stakeholders, including consumers, business partners, media, regulatory agencies and nongovernmental organizations (Supply Chain Digest, 2016). In the aforementioned situation, transparency becomes the necessary process to manage associated risks by accessing, learning from and making decisions based on supply chain information (Linich, 2014). Features of a transparent supply chain according to Alan (2015) include:

- Bundling visibility and control of the value chain into a synchronized portal view
- Consolidating events across the end-to-end value chain - customer, distribution, manufacturing, multi-tiered supply
- Managing by exception, what means issuing alerts and recommending action when key performance indicators (KPIs) are trending towards tolerance boundaries
- Initiating recovery action automatically or through decision feedback loops
- Using advanced analytics to achieve optimized costs, inventory and network alignment

According to a study conducted by a supply chain focused information agency, companies have social and environmental systems for internal operations, however, less than a third of them have similar structures for monitoring the practices of their immediate and extended network of suppliers. As organizations are increasingly addressing the importance of environmental and social sustainability, being transparent with a broader range of supply chain constituents increases the level of credibility and trust with customers and other stakeholders. However, many companies lack detailed visibility
into their own operations, let alone that of suppliers and subcontractors. While control is directly related to visibility, the latter is of critical importance in a world dominated by Lean philosophy, volatile demand and increasing focus on mitigation of risks. Supply chain transparency can be quantified according to three main criteria of information: timeliness, accuracy and robustness. Timeliness pertains to how quickly relevant information is made available to the focal company after it is created. Accuracy relates to the quality of this information coming from suppliers, number of errors and how much can it be trusted in the decision-making process without additional analysis. Lastly, robustness measures the quantity of available information, judging if suppliers are able to provide information the company wants to see. (Supply Chain Digest, 2016)

All in all, the transparency is dependent on partnerships with suppliers, industry associates and other contractors. Seeking to deliver high level of transparency, the practices of collaborative supply chain must be utilized throughout the end-to-end supply chain. Sustainable and transparent supply chains decrease risk of error, therefore significantly contributing to reduced possible public scrutiny, loss of customer trust and waste in the supply system. (Dittman P., 2016)

2.2 Supply chain integration & information sharing

The strategy to reduce the number of carriers and establish long-term relationships with a few of them is not a novel idea. According to Keller (1987), transport suppliers must show the willingness to do whatever is necessary to efficiently meet the transportation needs of the buyer (Carr & Green, 1998). Supply chain integration can be defined as the degree to which a company has integrated the flow of information, materials and finances with its supply chain partners (Lotfi et al., 2013).

One of the services that buyers of transport services value is the management of information concerning the status of products from point of origin to point of destination (Carr & Green, 1998). Information flow integration is the extent to which operational, tactical and strategic information is shared between a company and its supply chain partners (Rai et al., 2006). It usually refers to the sharing of demand-related information, inventory, production and delivery schedules, and performance metrics as indicators of information flow integration. Seidmann & Sundarajan (1997) support that operational information sharing can help leveraging the economies of scale and expertise across organizations. Strategic information sharing refers to the phenomenon when the information that generates insignificant value by itself, creates strategic value when shared (Lotfi et al., 2013). Information sharing enables retailers, manufacturers, and suppliers for improved forecasting, production and delivery synchronization, inventory-related decision coordination (Swink et al., 2007). However, theorists suggest that internal integration is a prerequisite for both customer and supplier integration (Flynn et al., 2010).

Supplier integration may not contribute to operational performance directly, but instead interacts with customer integration in improving operational performance, reflecting the importance of manufacturers’ integration with both downstream and upstream supply chain partners. Developing a good understanding of the manufacturers’ operations, suppliers become capable of achieving a high level of customer service which in turn helps the manufacturers improve their customer service. (Flynn et al., 2010) In the case of equipment rental companies, that translates into higher level of
responsiveness towards the end customer if the third-party carrier understands the significance of delivery timeliness and accuracy. Meanwhile, distorted information exchange between supply chain stakeholders can lead to substantial inefficiencies (Lee et al., 2015). Having entered the era of digitalization, the volume of data stemming from diverse data sources, processes and systems is staggering (EY, 2016). The phenomenon of upstream amplification of error in the demand signal is called the bullwhip effect (Lee et al., 1997) and causes problems such as excessive or inadequate inventory, suboptimal cash flows, customer service, production and capacity planning (Rai et al., 2006). The integration of information flow allows for utilization of data and better-informed decision-making process what in turn minimizes the bullwhip effect.

2.3 Strategic Purchasing

Purchasing strategy is the “process of planning, implementing, evaluating and controlling the strategic and operative purchasing decisions”. These decisions influence all activities of the purchasing function as a whole towards the opportunities that are congruent with the capabilities of the company and therefore contribute to the achievement of long-term corporate goals (Martinez et al., 2014).

During the past several decades the function of purchasing has gradually changed from a passive administrative performance role into a strategic function assuming a direct responsibility for the cost of purchased goods as well as the supplier management (Alinaghian & Aghadasi, 2006). As referenced by Hesping and Schiele (2015), Essig (2011) states that “it makes sense not to talk about ‘the’ purchasing strategy; instead strategic sourcing decisions [...] are always decided specifically for each category and their supply market conditions”. This means that purchasing should be strategically developed for homogenous supply markets or groups of purchased products or services, also called ‘categories’ or ‘product groups’. Further on, this is followed by supplier specific strategies. A supplier strategy describes the approach towards an individual supplier in a specific sourcing category. (Hesping & Schiele, 2015) Thus, supplier strategy and category strategy are not identical, and the type of the purchase consequently determines the requirements for supplier capabilities and relationship features. Moreover, supplier relationships and selection criteria tend to vary across sourcing categories, hence, different strategies can be applied in the same sourcing category (Hesping & Schiele, 2015).

The function of strategic purchasing facilitates communication what is an integral part in achieving effective supplier integration into the supply chain. This in turn contributes to the development and improvement of inter-organizational standard processes. In the cases where the focal company communicates openly and frequently with its suppliers, both parties can expand their knowledge and improve the understanding of competitive challenges by utilizing greater disclosure of information between each other. Evidently, strategic purchasing is critical in order to facilitate interactions with a limited number of supply partners. This combined with increasing investments in relationship-specific areas fundamentally leads to greater trust, dependability and cooperation among supply chain members. (Chen, 2004) Conclusively, more cooperative relationships between the buyer and supplier are supported in previous research of purchasing. Hence, it is evident that firms that utilize strategic purchasing have higher level of cooperation with their supplying partners and tend to emphasize “win-win” negotiations and development of the alliance (Carr & Smeltzer, 1999).
2.4 Total cost of ownership

Purchasing decisions have an effect on a big part of a company’s total costs. This effect pertains not only to direct acquisition costs but also indirect costs in areas such as inventory management, quality assurance and administration among others (Hurkens et al., 2006). Total Cost of Ownership (TCO) refers to a more recent method to cost a particular portion of the supply chain. It is a structured approach used to distinguish the total costs associated with the acquisition and following utilization of a specific product or service from a supplier. (LaLonde et al., 1996) In addition to the aforementioned aspects, vendor performance is an important constituent component of the total cost as it affects the cost of ordering, expediting, receiving and inspecting the deliverables. TCO aims to summarize the total price of acquisition by including cost of purchasing, holding, poor quality and delivery failure (LaLonde et al., 1996). It is mainly applied at the operational and tactical levels. For example, TCO models are developed for the purpose of managing, measuring, and improving suppliers. In addition to that, TCO can be used to consider cost at the strategic level. A TCO model could be the base for redesigning and making the entire supply chain more cost efficient. (Hurkens et al., 2006)

Furthermore, assigning costs to specific activities influenced by the purchaser decision presents a measure in supplier selection decision process. Subsequently, buyers can assess alternative suppliers based on the costs related to the number of returns, undershipments, inaccuracy or late shipments. In the aftermath, companies including these criteria in the considered factors can more effectively determine which suppliers can provide highest overall value. (LaLonde et al., 1996)

Another criterion that should be considered when applying the model of total cost of ownership is the profile of the supplier with regard to sustainability. It must be acknowledged that partners may not be at the level of sustainability the purchasing company requires. Although, the decision to accept a supplier with shortcomings in this area can be made, an attainable plan for the supplier to advance to the sufficient level of visibility, traceability and overall sustainability is necessary to meet the supply chain expectations in the near future. (Alan, 2015)

Advocating for the usefulness of applying TCO, it allows for using the information in negotiations with selected upstream channel members based on total acquisition costs and other criteria of performance. It also offers the possibility to evaluate how the inter-firm relationships influence costs experienced by the purchasing organization. TCO connects the supplier performance to specific activities performed in the purchasing firm that result from the latter - finally, these activities are translated into costs. (LaLonde et al., 1996)

2.5 Supplier assessment frameworks

Supplier selection and evaluation is one of the most critical activities in the purchasing and procurement processes. The supplier selection process is very important as choosing the right suppliers, aligned with the company’s strategy, brings drastic savings (Imeri et al., 2015). The supplier evaluation process is used to mitigate purchasing risk and maximize the overall value to the purchaser (Monczka et al., 1998). This process can be split into 4 main steps: defining objective, formulation of
the selection criteria, qualifying the suitable candidates and final selection (Thanaraksakul & Phruksaphanrat, 2009).

Dickson (1966) conducted a comprehensive study on the criteria utilized in supplier selection process. He validated 23 supplier evaluation criteria in total, mentioning that each participant in his study suggested five to ten metrics. The results of his work showcased considerable variation in the factors that are considered meaningful for the evaluation of potential suppliers. He also suggested that the purchasing criteria must differ depending on what is purchased. According to his findings, the ability of suppliers to meet the required quality was the most important criterion. Weber (1991) and Cheraghi (2004) continued researching the area of supplier evaluation contributing with criteria such as reliability, flexibility and consistency. Thanaraksakul and Phruksaphanrat (2009) conducted an extensive research trying to rank the supplier selection criteria with the results summed up in the following Table 1.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Number of papers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>74</td>
<td>97,37</td>
</tr>
<tr>
<td>Delivery</td>
<td>72</td>
<td>94,74</td>
</tr>
<tr>
<td>Cost</td>
<td>72</td>
<td>94,74</td>
</tr>
<tr>
<td>Flexibility and reciprocal arrangement</td>
<td>52</td>
<td>68,42</td>
</tr>
<tr>
<td>Production facility and capacity</td>
<td>52</td>
<td>68,42</td>
</tr>
<tr>
<td>Technical capacity and support</td>
<td>49</td>
<td>64,47</td>
</tr>
<tr>
<td>Information technology and communication systems</td>
<td>41</td>
<td>53,95</td>
</tr>
<tr>
<td>Financial status</td>
<td>40</td>
<td>52,63</td>
</tr>
<tr>
<td>Innovation and R&amp;D</td>
<td>38</td>
<td>50,00</td>
</tr>
<tr>
<td>Procedural compliance</td>
<td>15</td>
<td>19,74</td>
</tr>
</tbody>
</table>
Table 1: Data quality criteria summarized by Thanaraksakul and Phruksaphanrat (2009)

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Number of Papers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude and strategic fit</td>
<td>14</td>
<td>18.42</td>
</tr>
<tr>
<td>Environmental and social responsibility</td>
<td>6</td>
<td>7.89</td>
</tr>
<tr>
<td>Cultural congruence</td>
<td>4</td>
<td>5.26</td>
</tr>
</tbody>
</table>

The number of papers pertain to the amount of academic research papers that the criterion appeared in. The '%' displays how often the criterion appeared in the research papers in scope. This research showed that the three main criteria were quality, cost and delivery with significant difference from the rest of the criteria. In recent years, firms acknowledged the need for alignment of supply chain practices with the level of their information quality in order to achieve enhanced overall business performance. However, even though the strategic value of supplier information quality and communication systems has started gaining attention, basic criteria such as cost, quality and delivery performance are still widely used (Thiruchelvam & Tookey, 2011).

When it comes to purchasing of transport services, the selection process of the right carrier involves rating the carrier’s performance. The relationship between a shipper and a carrier is based on the carrier’s performance on metrics such as on-time delivery, reliability, efficiency and consistency. A good relationship between a shipper and a carrier in most cases results in increased productivity and improved customer satisfaction (Carr & Green, 1998).

2.5.1 Data Quality Assessment

Data quality is a multidimensional concept (Ballou & Pazer, 1985). It is used in every real-life or business activity and has a heavy impact on the quality of processes. Data can stem from a variety of sources and be represented in a variety of formats. Moreover, data can be substantially versatile, representing real objects, in a format that allows for storing and retrieval when necessary, elaborated by software procedures, and communicated through a network. The process of representing the real world by means of data can be applied to several phenomena, such as measurements, events, characteristics of people, the environment and sounds. (Batini & Scannapieco, 2006)

Organizations must consider both the subjective perceptions of the individuals involved with the data, and the objective measurements based on the data set in question. Data quality assessments reflect the needs and experiences of stakeholders such as the collectors, custodians, and data consumers (Pipino et al., 2002). Therefore, they tend to carry a subjective bias.

A Data Quality (DQ) dimension is a term used by data management professionals to describe a feature of data that can be measured or assessed against defined standards in order to determine the quality of data. However, even amongst the data quality community, the key assessment dimensions are not unanimously agreed. (DAMA UK Working Group, 2013). Some of data quality dimensions are presented in Table 2, including respective explanations.
<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>Data is easily retrievable</td>
</tr>
<tr>
<td>Believability</td>
<td>The credibility of the data</td>
</tr>
<tr>
<td>Completeness</td>
<td>Data is not missing</td>
</tr>
<tr>
<td>Consistent representation</td>
<td>Data is presented in the right format</td>
</tr>
<tr>
<td>Ease of Manipulation</td>
<td>Data is easy to manipulate and applicable to different tasks</td>
</tr>
<tr>
<td>Free of error</td>
<td>Data is correct and reliable</td>
</tr>
<tr>
<td>Interpretability</td>
<td>Data is represented with appropriate language and symbology</td>
</tr>
<tr>
<td>Objectivity</td>
<td>Data is unbiased and impartial</td>
</tr>
<tr>
<td>Timeliness</td>
<td>Data is up-to-date</td>
</tr>
<tr>
<td>Understandability</td>
<td>The ease to comprehend the data</td>
</tr>
</tbody>
</table>

Table 2: Data Quality Dimensions (Pipino et al., 2002)

Multiple dimensions have been developed and used in academia. In some cases, one dimension can represent two or more merged dimensions. However, it is evident that the selected data quality dimensions must be adapted for each case to effectively assess the quality of evaluated data.
3. Method

In this chapter, a description of how empirical data was acquired during the investigation is presented. The overall research design and the specific steps are displayed and the choices for research method and sources are described and motivated. The methods for answering research questions are presented, followed by criticism on the selected sources. Further, the research quality in terms of its validity, reliability and generalizability is analyzed. Lastly, a discussion around research ethics is outlined.

3.1 Case study as a research method

A case study is a qualitative research approach in which the researcher explores a bounded system (case) or multiple bounded systems over a period of time, through in-depth data collection involving multiple sources of information (Creswell, 2007). When applying the case study method, the phenomenon can be examined in its natural setting, leading to new insights and enabling the discovery of new dimensions (Collis & Hussey, 2014; Blomkvist & Hallin, 2015). The result of a case study can provide a comprehensive understanding of the phenomenon under investigation. Based on this understanding, theoretical statements should be possible to develop from the observed phenomena (Horowitz & Becker, 1971).

According to Yin (2009), a case study is an empirical enquiry that investigates a contemporary phenomenon in depth and within its real-life context. The research was carried out through a case study in collaboration with Cramo Group. Case studies are appropriate for investigating phenomena when several factors and relationships are involved, it is not clear which of them are of higher importance and these factors and relationships are easily observed (Fidel, 1984). Therefore, the aforementioned method was well-suited for this specific project since the company’s challenge was multifactorial, and the causes had to be investigated. However, through close cooperation with Cramo, it was possible to gather rich empirical data in a real-life context and investigate the importance of information quality in the purchasing of transport services. The continuous interaction with multiple Cramo stakeholders in the Swedish headquarters of the company, the access granted to company databases and depot field trips facilitated the understanding of the phenomenon.

Concluding, the case study research method was used to gather empirical data in the form of qualitative interviews (explanans) in order to understand the phenomenon stated in the purpose (explanandum) (Blomkvist & Hallin, 2015). This research method choice served as a base point for providing insights into a widely prevalent issue concerning the construction and equipment rental industry.

3.1.1 Equipment rental industry

The construction equipment rental industry is a service industry that offers various products, ranging from machinery, access equipment and tools to companies or private users. Companies operating in this market such as Cramo AB provide equipment on lease to construction companies for agreed periods. Renting equipment is a service, that rental equipment companies continuously aim to enrich.
It is worth mentioning that transportation is an additional service these companies provide to their clients. Transportation is a critical link in a supply chain that became increasingly important for organizations in the 21st century. Transportation can nowadays be viewed as the glue that is holding the whole supply chain together. However, although technological advancements have resulted into increased transport reliability, accessibility and security, transportation can also contribute to environmental problems such as pollution, poor air quality, and global climate changes (Coyle, 2011). Therefore, now that transportation networks have become more complex, it is of utmost importance that transport efficiency is increased and unnecessary shipments are avoided.

The rental equipment business is heavily reliant on transportation having 4 distinct types of it in the supply chain: inbound, internal, outbound and return. Spare parts are the inbound shipment to the company, between depot equipment movement is the internal transportation, outbound refers to client deliveries and return transport is the movement from the customer’s site back to the rental company. Regarding client deliveries, the rental company books the transport for the client and the equipment is directly delivered to the desired end location. This service allows the client to eliminate time spent handling heavy equipment. However, the transportation service results in the formation of a transport network consisting mainly of depots, transport companies and end-customers. In most cases, heavy machinery may require special trucks for the shipping, thus increasing complexity. This results in a challenge of achieving full compliance with the United Nations sustainable development goals. Specifically, Goal 9 calls for efficient transport as a sub target for promoting sustainable industrialization (United Nations Sustainable Development, 2018). Due to the level of dependency between equipment rental companies, transport suppliers and the end customers, an alignment in terms of sustainability standards expectations is necessary. To conclude, the selection of the industry could be argued for as it includes a 100% return rate for all deliveries. Therefore, the number of shipments greatly increases the contribution to the complexity of transport and associated data.

3.1.2 Company introduction

Cramo group is one of Europe’s leading companies in equipment rental services and rental of modular space. Modular space units are sold under the Cramo Adapteo brand and this part of Cramo group will not be covered in the investigation. The company is operating in 14 countries with sales of EUR 712 million and EBITA EUR 111 million in the year of 2016. Cramo’s 2550 employees serve over 150,000 customers. (Cramo, 2017)

The company’s offerings in terms of equipment rental can be split into 4 main categories: tools, construction machinery, access equipment and building site facilities. Tools comprise 27% of the total revenue, access equipment - 16%, construction equipment - 10% and other rental related services - 20%. Such services include transport, assembly of equipment in the client’s site and providing educational courses on how to properly use the equipment, the so-called ‘Cramo school’. Although the organization is serving all companies and private users regardless the industry they are operating in, the construction industry makes up for 55% of the total revenue. (Cramo, 2017) The rental process can be initiated in two main ways. The client can place an order either through an online company rental portal, alternatively, calling one of the depots, or by going directly to the nearest depot and requesting a necessary piece of equipment. The invoicing is performed after the rental period is over. (Cramo, 2017)
Cramo Group owns a network of 300 business units and a fleet of 230,000 rental units. These business units are served through a centralized logistics hub-structure. Every depot is a distinct profit center with a predetermined budget and profit goals to achieve. The hubs are larger business units that manage logistics for specific heavy machinery serving smaller scale depots in their proximity. There are also specific facilities to where equipment is shipped to be repaired, the so-called service centers.

Regarding the motivation for the choice of the company, it is important to stress that the research involved multiple case studies in terms of investigating different self-sufficient depots of the company served by different transport providers. Furthermore, the selected company is a good example of its represented industry having a broad product portfolio and geographical distribution. Therefore, it is a valid choice for the research project as the company has a large and complex transport network. Lastly, the latter renders the potential outcome generalizable due to the satisfactory sample size.

3.1.3 Systems perspective

To implement a change on a process that is of significant importance when delivering value to customers, all involved stakeholders must be considered, and a structured communication campaign carried out. This section discusses the system perspective and the particular focus on one of the distinct levels. The challenges investigated over the course of this project were of broad impact, therefore it was insignificant to evaluate the situation from only one perspective of the organization (Blomkvist & Hallin, 2015). On the contrary, the elaboration was performed on different system levels discussed by Blomkvist and Hallin (2015) - namely individual, functional and industrial. The individual level pertains to the perspective of staff, thus organizational culture and individual behaviors and routines were considered. Meanwhile, the functional level tackles the challenges resting in different corporate operational processes. Lastly, the industrial level considers particular challenges from a broad industry perspective, evaluating such fields as industrial dynamics and globalization (Blomkvist & Hallin, 2015).

As this paper concentrated on the internal processes of Cramo and its cooperation with transport providers, the focus was on the functional level. Meanwhile the industrial level remained uninvestigated. Even though there were multiple cases of cooperation between separate business units and respective carriers analyzed, the timeframe and the scope of the project did not allow for an extensive and thorough investigation involving different companies. Consequently, no claims of investigation on the industrial level can be made. Figure 1 displays the relation of the research design steps and levels of the system perspective.
The main focus of the research was on the functional level, since the data gathering, and analysis were performed on the data extracted from communication with the transport providers of the company and the scanning of operational documentation storage database. Eventually, the developed framework is expected to be utilized across the organization. This in turn would streamline the supplier selection process and render the choices of service providers better informed and more objective. Moreover, this implies the clarification of what lies under the discretion of depot managers and shall be communicated in an appropriate manner. Furthermore, this pertains an additional responsibility to Cramo business units as separate entities as they would have to track, maintain and issue alerts in case of decreased level of data quality when necessary.

Meanwhile, on the individual level, the benefits of demanding high-quality data from the transport suppliers would have a direct effect on Cramo employees at the business units. That can be explained by the currently present budget system, where each depot is functioning as a separate profit center and their compensation depends on their performance. Therefore, having communicated the relation between higher quality data and lower expenses should reinforce the understanding of its relation to improved financial performance of the depot.

3.2 Serving the dual client

In every thesis written in cooperation with a company, there is often a conflict of priorities for deliverables. The output of the work must be relevant both to academia and the focal company. In this case, Cramo requested the completion of a specific task - group-wide transport network mapping.
However, the nature of the master thesis had to be brought into an academic context, to assure contribution to an under-investigated research segment.

The complexity and the excessive time needed to carry out the manual data extraction necessary to complete the task of transport mapping was the inspiration for the agreed final focus of research. Continuous negotiations took place in the initial stages of the project to determine the scope that satisfied all stakeholders and was accomplishable within the given timeframe.

### 3.3 Research design

This section presents the research design of the study. It consists of the research steps necessary to render the problematization researchable (Blomkvist & Hallin, 2015). The research design of this study includes the following research steps displayed below in Figure 2.

![Figure 2: Research Design Steps](image)

An abductive approach was utilized throughout this report, meaning that existing theoretical concepts found in literature influenced the interpretation of the empirical material collected. This is the strength of the abductive approach - the mutual influence of empirical data and theoretical concepts. New theories were investigated in order to achieve a better understanding of the findings, so that they could be incorporated into the framework (Blomkvist & Hallin, 2015). An exploratory approach is employed to understand the existing theory and identify gaps in previous research (ibid) and consequently fulfil the purpose of this study. To understand and explain the phenomenon (explanandum) specified in the problematization, a four-step research design was developed.

In the early stages of the thesis work, the data gathering process consisted of a literature review complemented by interviews with Cramo employees related to how information is stored, managed and leveraged in making purchasing decisions. Throughout this process, a manual data extraction process was conducted to map the company’s transport network for a predetermined sample of depots. The data collected was brought into a unified format so that it could be imported into a software. Further on, the outlined data was analyzed, and information gaps were identified. Consequently, this allowed for distinguishing the improvement areas and acted as a catalyst for further development of the supplier data quality assessment framework. On the last stage of the thesis, the framework was applied on current transport providers to evaluate how well they matched the criteria for the cooperation with Cramo. Each of the steps are further outlined in this section.

### 3.3.1 Data gathering

Since the beginning of the project it was clarified that data sources would be various. The data gathering process consisted mainly of a literature review including academic articles, company documentation and interviews. The interviews can be split into three main categories:
1) the field trips to the company’s business units where Cramo personnel was interviewed while also observing the transport processing and information flows real-time;

2) face-to-face and skype interviews with other Cramo stakeholders such as office employees regarding ongoing and completed initiatives related to information management and utilization in purchasing of transport services;

3) contacting representatives of transport companies and finding out how they are serving Cramo as a customer and providing relevant transport service data.

3.3.2 Transport mapping

The transport data was manually extracted from multiple databases of Cramo and its’ transport providers. Subsequently, the data was aggregated into a unified form to achieve the same level of information depth for all investigated depots. Data was imported into a geographic information system software to visualize distances, directions, carriers, frequency, costs and truck types. Distance areas were further on built around the depots to identify potential zones regarding the pricing types of transport services.

3.3.3 Data analysis

The manual data extraction process and all the challenges associated with gathering the necessary data was the base for the analysis. The information gaps for certain carrier cases were identified and communicated to Cramo Fleet Management department. Consequently, it was confirmed that such missing information would be of strategic importance for Cramo. This set the foundation for the development of the transport supplier data quality assessment framework and the specific dimensions and metrics that it should include.

3.3.4 Framework development and application

The last research design step of the study consisted of multiple stages. In the initial stage of the framework development, a literature review on existing data quality dimensions presented in the previous chapter was conducted. The criteria selection pool is displayed in Table 2 in the theory chapter (Data quality dimensions). The framework criteria were selected based on three main factors:

- relevance to the case
- measurability
- realizability due to the existence or lack of data

Starting with the ease of manipulation, three different criteria from literature lied under it - namely ease of manipulation, consistent representation and understandability. *Ease of manipulation* refers to the extent to which data can be indexed and analyzed (Liu & Chi, 2002). During this investigation supplier data was presented in different formats. This criterion was considered highly relevant for the case investigated since the ease of bringing poorly structured data into useful insights was one of the major challenges throughout the research process. The second dimension of the framework is
accessibility which is the dimension reflecting the ease of data attainability (Pipino et al., 2002). This metric emphasizes the time aspect of accessibility and is defined as the period of time needed for the transport suppliers to provide the case company with a document including the requested data. In the case of this dimension, a direct match was identified between the criterion definition and the measured aspect - the transport company’s responsiveness. Furthermore, accuracy pertained to the extent to which data values stored in the database and/or documents correspond to the real-world values, are reliable and trustworthy (Sidi et al., 2012). In the case of transportation, accuracy was mainly determined by how well the addresses were defined. Accuracy was related to consistent and error-free representation and adapted to the company’s needs since an accurate transport network map requiring location data was requested. Lastly, the completeness dimension can be judged from many perspectives leading to different metrics depending on the areas of interest for those applying the framework. At the data level, one can define completeness as a function of the missing values in a column of a table (Pipino et al., 2002). Full completeness implies that no records are missing and that none of related data elements are missing. In the literature, entirely missing records are referred to as unit non-response and missing items as item non-response (Batini & Scannapieco, 2006). The criterion of completeness was a direct match to the original Pipino’s (2002) table as well. Meanwhile, excluded criteria include objectivity, interpretability and believability that were considered as not measurable for the case of interest since no empirical data would justify the creation of a scale. Lastly, timeliness was considered as neither measurable nor relevant for the case of investigation since the selected period of research was delimited to one specific month.

The second stage of the framework development included the classification of distinct categories for the selected dimensions. It was decided that the evaluation process should be based on score collection in different categories on a scale of 0 to 4. The classification for these categories was generated based on the empirical data collected during the stages of data gathering and transport mapping and their meaning is further elaborated in section 5.1. The last stage of the framework development pertained to the assignment of weights for the case company. Since, certain criteria were deemed as more important than other, weights had to be assigned to render the framework more practical.

The developed framework was further applied on current Cramo transport providers to determine their qualification for being a Cramo subcontractor by judging their ability to provide high quality data within a reasonable amount of time. The framework dimensions and metrics were brought into a questionnaire format to facilitate the extraction of information and minimize the scope of possible answers. This process of framework validation was conducted with the assistance of the company supervisor. His assistance mainly pertained to the input regarding the applicability and realizability of the metrics which led to adjustments in their nature and scale. This refining process ensured that the finalized version of the framework was of value for making well informed purchasing decisions.

To fulfill the purpose of the study a coefficient addressing the performance of purchasing transport services had to be developed. The coefficient $k_1$ is a ratio between depot’s transport expenditure on a heavily dominant carrier and the total revenue of that depot over a period of one year. In turn, the data quality scores generated by the supplier data quality assessment framework were scrutinized in relation to this coefficient.
3.4 Prior research

To gain a proper understanding of the research topic and to generate relevant ideas regarding the purpose of investigation, an extensive overall literature review was performed (‘über-reading’) (Blomkvist & Hallin, 2015). In the initial stages of the thesis, a broader literature review on the relation between information value and purchasing of services was conducted. In an attempt to narrow down the scope of the literature search and the thesis in general, the under-researched area related to the purchasing of transport services was identified. Literature review was a recurring process, revising the literature searching strategy according to the observations during the field trips to the depots and interviews.


3.5 Data collection tools

Empirical data for this study was collected through field trips and actual observation of the situation related to transport services and semi-structured interviews. The manual data extraction process from the company’s databases required for the transport mapping was also a rich source of empirical data. This section describes the different data collection tools.

3.5.1 Manual data extraction process

Transport network mapping was one of the requested deliverables from the company’s side. For that, transport data such as sender and delivery addresses, shipping costs, truck types and charge types were to be gathered from the carriers. The goal was to conduct mapping for a selected sample of depots in Sweden that were of strategic importance for Cramo.

The first step was to check the subcontractors’ responsiveness and willingness to provide data and the quality of it. In several cases the transport company provided the requested data, although some modifications had to be performed in order to transform it into the desired format. In cases that no data was provided due to carriers’ lack of information infrastructure, willingness to provide this data or responsiveness, the data was extracted from the company’s invoice management system. When the information in the invoices was not sufficient, it was looked up in the waybill - a document representing a proof of transaction. In order to understand specific waybills, the assistance of company’s supervisor was requested. In the case that he could not be of any help, a call directly to the respective depot was made to clarify the meaning of the recordings in the waybill. The process of contacting the transport providers and gathering transport data is illustrated in the following flow chart.
It is evident that the range of time potentially spent on investigating distinct transport providers was large. This greatly depended on situational factors, such as availability of provided contact person’s schedule and the quality of extracted data in case of lack of response.

3.5.2 Interviews

Interviews are interactive data collection tools interviewers can use for getting complete and unambiguous answers. Interviewing broadens the scope of the understanding of the investigated phenomenon, as it is naturalistic and less structured (Alshenqeeti, 2014). At the early stages of the project, qualitative interviews with Cramo employees and subcontractors were conducted to get a better understanding of how the transport operations function at Cramo, how does the information flow within the supply chain and how is it leveraged in purchasing of transport services. Interviews were also conducted with transport providers during the later stages of the investigation.

The interview process chosen for this investigation was of a semi-structured nature. These interviews included a set of questions determined prior to the actual interview (Collis & Hussey, 2014). This allowed for greater flexibility adapting the following questions according to the insights provided by the interviewee. Moreover, clarifying questions were asked to get a more thorough understanding of the situation. Field trips to different Cramo business units allowed for face-to-face interviews to take place that enabled adapting the predetermined questions according to the observations at the workplace. It is worth mentioning that employees of the Cramo business units were ensured that the investigation pertained to the transport providers service quality and not the audit of depot operations.
**Employees of business units**
Throughout the process of empirical data gathering and investigation of current transport situation 6 distinct business units in Sweden were visited. This provided a good fundamental understanding of the peculiarities and performance of different types of business units. It was a result of careful preselection by the project owner and the company supervisor in terms of locations and functions. The data gathered throughout the interviews and direct observation was immediately documented having received the consent from interviewed employees. The interviews with the aforementioned respondents are summarized in Table 3 below, denoting positions of the interviewed personnel members and dates when specific interviews were conducted.

<table>
<thead>
<tr>
<th>Business unit reference</th>
<th>Personnel interviewed</th>
<th>Date of visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BU1 (depot)</td>
<td>Salesmen</td>
<td>2018.01.18</td>
</tr>
<tr>
<td>BU2 (service center)</td>
<td>Depot Manager</td>
<td>2018.01.23</td>
</tr>
<tr>
<td>BU3 (depot)</td>
<td>Depot Manager, Salesmen</td>
<td>2018.01.25</td>
</tr>
<tr>
<td>BU4 (depot)</td>
<td>Salesmen, technicians</td>
<td>2018.01.31</td>
</tr>
<tr>
<td>BU5 (depot)</td>
<td>Depot Manager, Salesman</td>
<td>2018.02.22</td>
</tr>
<tr>
<td>BU6 (depot)</td>
<td>Depot Manager, Salesmen</td>
<td>2018.02.22</td>
</tr>
</tbody>
</table>

*Table 3: Business unit visits*

**Office staff**
In addition to the empirical data gathering process in field trips, a significant number of interviews was conducted at the Swedish head office of Cramo. The interviews are summarized in Table 4 below, displaying interviewee’s position in the company, area of contribution to our project referring to distinct research design steps and dates when the interviews were conducted.

<table>
<thead>
<tr>
<th>Interviewees reference number</th>
<th>Position in the company</th>
<th>Area of contribution</th>
<th>Date of interview(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>Head of Group Supply Chain (Project Owner)</td>
<td>Data Gathering, Transport Mapping</td>
<td>2018.01.16, 2018.02.05</td>
</tr>
<tr>
<td>I2</td>
<td>Strategic Purchaser for Transport (Project Sponsor &amp; Supervisor)</td>
<td>Data Gathering, Transport Mapping, Framework Development &amp; Application</td>
<td>Weekly interviews</td>
</tr>
<tr>
<td>I3</td>
<td>Program Manager, Business and Operations Development</td>
<td>Data Gathering, Transport Mapping</td>
<td>2018.02.02</td>
</tr>
<tr>
<td>I4</td>
<td>Process Manager, Repair and Maintenance</td>
<td>Framework Development</td>
<td>2018.03.16</td>
</tr>
</tbody>
</table>
These interviews included directive meetings in order to determine the scope of the research and expected contribution for the company’s benefit, weekly follow up meetings, and meetings with specific stakeholders who possessed knowledge in particular fields of Cramo operations. The meetings with interviewees I4 and I5 were held to assist with choosing data quality dimensions suitable for the framework, utilizing their experience in sourcing and control functions.

**Transport companies**
The last category of respondents interviewed were representatives of transport companies. These interviewees held different positions in their respective companies as summarized in Table 5.

<table>
<thead>
<tr>
<th>Interviewee’s reference</th>
<th>Position of interviewee</th>
<th>Date of interview(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I6</td>
<td>Driver</td>
<td>2018.01.28</td>
</tr>
<tr>
<td>I7</td>
<td>Sales representative</td>
<td>2018.02.01</td>
</tr>
<tr>
<td>I8</td>
<td>Transport Planner</td>
<td>2018.04.26</td>
</tr>
</tbody>
</table>

The respondents provided insights from different perspectives and on different system levels, namely functional and individual. These interviews contributed to the overall understanding of transport network functioning between the depots and the carriers. The interview with a driver aimed to elaborate on the individual level of the cooperation, namely the carrying out of the service itself. Meanwhile the interview with the sales representative pertained to the functional level, focusing on the generic structural quality of the ongoing partnership and identification of potential areas of improvement. Lastly, the interview with the transport planner was used to apply the framework in that specific transport company, assisting in refining and validation process of the framework. For the final interview, a standard questionnaire was used to determine the data quality score for the respondent company. The following template could be further utilized to elicit standard answers from other transport companies.

1. How detailed and complete information can you provide with regard to delivered services?

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>The names of Location are missing in the invoices and/or provided statistical data files</td>
</tr>
<tr>
<td>2</td>
<td>The names of Location are present in the invoices and/or provided statistical data files</td>
</tr>
<tr>
<td>0</td>
<td>The Charge Type description is missing in the invoices and/or provided statistical data files</td>
</tr>
<tr>
<td></td>
<td>The Charge Type description is present in the invoices and/or provided statistical data files</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>0</td>
<td>The Truck Type description is missing in the invoices and/or provided statistical data files</td>
</tr>
<tr>
<td>2</td>
<td>The Truck Type description is present in the invoices and/or provided statistical data files</td>
</tr>
</tbody>
</table>

2. How accurately the Location is described in operational documents? Which statements describes Location best:

<table>
<thead>
<tr>
<th></th>
<th>The Location is not specified in operational documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Location is denoted by local name of the object (example: ICA MAXI Täby)</td>
</tr>
<tr>
<td>2</td>
<td>The Location is denoted by a name of specific area (example: construction site Slussen)</td>
</tr>
<tr>
<td>3</td>
<td>The Location is denoted by a street name where the items were delivered</td>
</tr>
<tr>
<td>4</td>
<td>The Location is denoted by a full address including street name and number</td>
</tr>
</tbody>
</table>

3. In what format can you present operational data for further statistical analysis? Which statement describes the provided data best:

<table>
<thead>
<tr>
<th></th>
<th>Data requires manual extraction from handwritten invoices and waybills, no other documents are provided.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Data requires manual extraction from digital invoices and waybills submitted to our invoice management system, no other documents are provided.</td>
</tr>
<tr>
<td>3</td>
<td>Detailed information can be provided on demand, but not all operational data is present (lacking full addresses, charge types, truck types).</td>
</tr>
<tr>
<td>4</td>
<td>Detailed information is accessible real time for the user, with all operational data present.</td>
</tr>
</tbody>
</table>

*Table 6: Data Quality assessment questionnaire*

The questionnaire addresses 3 out of the 4 existing data quality dimensions - completeness, accuracy and ease of manipulation. Accessibility could not be assessed in a questionnaire format, since this metric was introduced based on experience of the responsiveness of the carriers participating in the investigation. However, it could be used for the case of assessing suppliers for renewal eligibility.
3.6 Methods for answering research questions

The research questions have been answered, in order to operationalize the purpose of this study (Blomkvist & Hallin, 2015). This was achieved by using a mix of selected methods to increase the validity and reliability of the study. The following table displays how the research questions were matched to data collection methods. Table 7 further indicates the research design steps and the corresponding chapters.

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Data Collection Method</th>
<th>Research Design Step</th>
<th>Corresponding Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ1: What are the challenges for achieving accurate shipping pricing?</td>
<td>Manual data extraction process, Interviews, Literature review</td>
<td>Data Gathering, Analysis</td>
<td>Chapter 4</td>
</tr>
<tr>
<td>RQ2: How can supply chain integration contribute to reduced total cost of shipping?</td>
<td>Interviews, Literature review</td>
<td>Data Gathering, Analysis</td>
<td>Chapter 4</td>
</tr>
<tr>
<td>RQ3: How can the supplier evaluation process be systematically performed?</td>
<td>Literature review, Interviews</td>
<td>Framework Development &amp; Application</td>
<td>Chapter 3, 5</td>
</tr>
</tbody>
</table>

Table 7: Methods for answering research questions

The manual data extraction process was the backbone for answering the RQ1 due to the challenges experienced throughout the empirical study. For answering the RQ2, interviews during the field trips to different business units and that with Cramo office employees were the main source of data. It provided insights on how supplier integration could facilitate achieving reduced total cost of shipping. Lastly, for RQ3, an extensive literature review on data quality assessment criteria was conducted. It was complemented by interviews with office staff working within strategic purchasing who suggested additional dimensions and metrics.

3.7 Source criticism

Critical thinking can be defined as the explaining, interpreting, and aspiring to understand the deeper significance of what is being criticized or critically reviewed. In scientific research it is not considered sufficient to understand something, it is also essential to have a critical attitude towards scientific papers and thus for a thesis project. (Blomkvist & Hallin, 2015)
Gathered information had to be filtered due to the individuals’ subjective perspectives. This pertained mainly to the data collected through interviews and more specifically the input regarding the realizability of certain data quality dimensions. It was also important to apply source criticism to the selected sources in order to see if they are suitable in a scientific context (Blomkvist & Hallin 2015). This applied especially for the case of data extraction of the company databases and the interviews with Cramo employees. In order to critically evaluate sources, the suitability and reliability of each source was determined by using the proposed evaluation criteria from Blomkvist & Hallin (2015). These are authenticity, proximity and dependence, representativity and tendency.

3.8 Research quality

In academia, critical thinking refers to trying to explain, interpret and understand the deeper significance of what is critically reviewed (Blomkvist & Hallin, 2015). In general, critical thinking is a reasonable and reflective way of deciding what to believe or not. It is considered ethically correct and necessary to keep a critical attitude towards data sources and theoretical concepts. That was specifically important in this project, when interviewing individuals and getting their input about their perspectives on potential improvement areas related to the purchasing of transport services. Therefore, thinking critically and filtering the obtained information was necessary to increase the reliability of the study. The quality of research can be assessed in different ways. Collis and Hussey (2014), for example, define validity, reliability and generalizability as the most important factors when evaluating an investigation’s credibility.

3.8.1 Validity

The validity of the research refers to whether the research truly measures what was intended to measure and how accurate the research results are (Golafshani, 2003). In other words, validity assesses whether the research is studying what it intends to study.

The validity of data obtained through interviews is highly dependent on the interview structure and documentation method. A potential source of validity bias in the interviews is the different interpretations of interview questions between interviewers and interviewees. However, several questions were deliberately left open-ended to allow the interviewee for the space to share their thoughts freely. Another source of validity bias usually stems from the interpretation of the answers in the interview. As a preventive tool, the interviewer always summarized and reiterated the answer to ensure correct understanding. Permission to take interview notes was always asked for. With regard to the framework, the relevance and realizability of data quality dimensions and their metrics were validated through interviews with strategic purchasers at Cramo. These metrics were triangulated using different methods, such as investigating the compatibility with already existing supplier data discovered in company’s databases, interviews with professionals and a pilot run on existing suppliers. The abductive approach utilized was further confirmed by the refining process that the framework went through.

In terms of literature, company documentation was critically processed, since companies, especially well-performing ones, tend to suffer from inertia, beautifying the current situation. Therefore, it can
be perceived that Cramo employees’ input was not always fully objective. They may have regarded the inclusion of certain criteria as simply not realizable without thorough analytical thinking. In addition, the validity of the prior academic research discovered can be argued as not up to date. This is because, rapid technological advancements within the past decades have shaped transport services and the importance of information (Grabara et al., 2014).

3.8.2 Reliability
Reliability refers to “the accuracy and precision of the measurements and the absence of differences if the research was repeated” (Collis & Hussey, 2014). It measures the degree to which a research would generate similar results if it would be conducted by other researchers. The reliability of the results was partially affected by situational factors. Such factors pertain to excessive workload at that specific period of study that might have led to lower accessibility rates. The month selected to be the time period of the study, was deliberately a “high season” month. This choice was made to elicit interesting findings regarding the transport suppliers’ responsiveness. Therefore, if the study was conducted during a low season, the results for the coefficient would be influenced due to the changes in the accessibility scoring.

The reliability of the semi-structured interviews can be assessed judging the consistency of the answers to similar questions. This was especially critical in interviews with employees in several Cramo business units. Hence, several employees were contacted in the same business unit to get different perspectives of the same situation. Moreover, follow-up and clarifying questions were asked to reduce the vagueness of some responses. Questions were formulated in a standardized way minimizing the scope of potential responses to reduce the level of ambiguity. The interviews were conducted with employees in key business units and office positions with expertise within the discussed topics. Therefore, no additional threats to reliability emerged from the interviewees’ expertise. A concern regarding the reliability of the findings was the number of business units investigated since a larger sample could reveal additional patterns. In addition to that, the interviews with employees were not recorded and thus transcribed due to their dynamic nature. This setting may have affected the reliability of the findings since information could have been partially missed. However, notes were taken both in written and digital format to mitigate this risk.

3.8.3 Generalizability
Generalizability refers to how well the findings can be applied to other cases (Cogt & Johanson, 2011). On the base of this embedded case study, we can speak of analytical generalizability. The finding that was generalized was the information gaps identified when observing supplier data quality. This practically means, that a satisfactory sample of business units was studied that represented the overall situation at the case company. The analytical generalizability is discussed in the conclusion chapter, with regard to which findings may be applicable to other similar companies or cases. An extrapolation is made discussing the managerial implications for the company, where the key learnings for companies with complex transport networks are presented and analyzed. This allows the reader to compare the case study of Cramo with another relevant case of interest and judge the relevance of the finding (Blomkvist & Hallin, 2015).
With regard to the framework, it is expected to apply to other businesses purchasing transport services and not just Cramo. Moreover, the framework can be perceived as a reference point for any company with a purchasing function since it highlights the need to assess supplier data quality systematically in order to make more informed purchasing decisions.

3.9 Research ethics

In social science research, it is important to account for ethical correctness (Blomkvist & Hallin, 2015). Therefore, the four ethical principles of Swedish Research Council, namely: information, consent, confidentiality and good use - were followed throughout this research (Sveriges Ingenjörer, 2017). The first principle was fulfilled by providing interviewees with a clear explanation of the purpose of the interview as well as their expected contribution for the research. The second principle of the Swedish Research Council refers to the consent of individuals involved (Sveriges Ingenjörer, 2017). This principle was followed by highlighting that the participation in the interviews is voluntary and that the information shared would be kept confidential if asked.

The third principle pertains to the confidentiality of entrusted information and material (Sveriges Ingenjörer, 2017). A confidentiality agreement was signed in the beginning of the thesis to stress on the importance to avoid revealing sensitive financial data. The principle was addressed by anonymizing interviewees and Cramo subcontractors. Moreover, collected data was stored in a secure manner and treated in accordance to the signed confidentiality agreement. Sensitive financial data regarding the profitability of business units were thus not included in the final report. The last ethical principle of good use refers to collected data only being used for the purpose of the study (Sveriges Ingenjörer, 2017). This principle was adhered by collecting and using data solely relevant for the purpose of this study. Data gathered and analyzed in this thesis stemmed from interviews that the participants gave their consent for inclusion in the final report.
4. Analysis

This chapter presents the empirical data gathered throughout the course of the project and the results of the case study. Firstly, the case company’s internal data management processes are discussed. Then, the transport network situation is investigated followed by an analysis regarding the level of supplier integration. Following, the underwent data extraction process is shared. Lastly, the purchasing situation of the focal company is scrutinized.

4.1 Internal alignment of data handling processes

The close interaction with both depot and office employees allowed for the first important observation. It pertained to the level of internal alignment of data handling in terms of transport related processes which was rather low. This pertained to several aspects, from the way of booking the transport services to the level of satisfaction regarding the respective transport suppliers. This however can be attributed to the difference of the nature of business units, with some depots handling only a certain type of equipment, some having a dedicated vehicle to serve its needs and others having to deal with less technologically advanced transport providers. As the company supervisor responsible for the purchasing of transport services confirmed: “Cramo may consist of 300 different Cramos in terms of transport services”.

An example accurately representing the situation, was the difference in the practices of two depots within a 40 kilometers distance used to order transport services. The main difference lied in the way transport services were booked. In an outsourced supply chain with multiple subcontractors, there are issues not just regarding data visibility, but also the inability of some suppliers to effectively execute or digitize key supply chain processes (Supply Chain Digest, 2016). In this case, the first depot sent emails to the transport company’s representatives to place an order, while the other depot sent pictures through imessages due to the transport provider’s unwillingness to handle emails. This was an initial indication about how different transport booking related practices were even within depots in close proximity. As a result, this created differences in the capabilities of the two depots to store and trace back data related to the transports.

An interesting pattern identified that led to the difference in quality and gaps in the database were the data storing methods of the Cramo depots. Some depots had their own systems developed to back up their historical data and trace it if needed. Other ones did not put any effort to store any data, and the information was virtually untraceable after the transaction was complete. Therefore, the existence of data in certain cases was left for the discretion of depot employees and their willingness to store data.

Another interesting finding worth mentioning is the differences related to the storing, managing and sharing of information. The fact that there are no incentives provided to employees of the Cramo business units to maintain a certain level of data quality, leaves the decision to their individual discretion. When visiting Cramo business units and explaining the project mission, Cramo staff appeared unaware about the importance of such data and how it could actually be valuable to the company for maintaining control of its transport network. In addition to that, product names were
nicknames widely known amongst employees of the business units. This information was enough to deliver the products to their end locations but created issues in maintaining control while mapping the transport network since the process becomes time-consuming and the accuracy decreases.

A potential area of improvement mentioned by the majority of employees at the Cramo business units was the cost visibility when booking transport services. Although, there were predetermined price lists from certain transport providers, they were in many cases not accessible to the employees booking the transport services. For instance, in the case of national providers, the unawareness of the price differentiation regarding the measurements of the load led to booking of euro pallets when half pallets or parcels would have been sufficient. This causes a decreased level of self-imposed responsibility regarding the transport expenses experienced by the company.

4.2 Transport network situation

The company uses a wide range of transport suppliers to move the equipment between depots and repair centers and for delivering them to the end-customers. Although national transport companies such as Postnord and Schenker are used by virtually every Cramo depot, the bulk of transport is handled by local transport providers. Typically, every depot uses large national carriers such as Postnord and Schenker on a limited scale for internal transportation and a local transport provider on a larger scale for client deliveries. Indicatively, the region of Sweden consisting of approximately 100 depots has 100 active transport suppliers. The transport network complexity is amplified by the aforementioned characteristic of the equipment rental business regarding the variation of the equipment size. Thus, there is often a need for special trucks that these items can be loaded on, and only a handful of suppliers have the capacity to serve such needs. Although, the bigger suppliers have signed necessary documents to comply with the supplier code of conduct, it is significantly more challenging and time-consuming to perform audits for all the small subcontractors.

Concluding the situation presented above, it is self-evident that while the case study theoretically investigated a single case of Cramo, in practice it was an embedded case of 300 different entities purchasing, interacting and cooperating with multiple transport providers studied. This complex transport network allowed to investigate several actors in the supply chain of Cramo and how they perceived, managed and utilized supplier data.

4.3 Current level of supplier integration

After looking at the internal alignment of data related processes and transport network situation, the level of supplier integration was analyzed. Most of the transport companies serving Cramo business units seemed to hold a close interaction with the respective employees, willing to help when schedule changes arose. This could be attributed to the nature of the business and the frequency of interaction between the two parties. The interaction between the two parties was at least daily, resulting into building a certain level of trust. Interviewing Cramo staff during the field trips, certain patterns about the levels of the transport suppliers’ integration were made evident. In addition, this was determined
witnessing the interaction between the salespeople and the transport company’s representatives and their ways of communication, drawing the picture regarding the overall satisfaction rates.

In a specific case, a company seemed to be integrated at an overwhelming level that caused reluctance and trust issues when actually requesting data. This was due to an ongoing negotiation with the same company in one of the served geographical areas. In other cases, the employees of the business units were feeling no connection with their transport company and viewed their relationship and communication as problematic. Only a certain company showed signs of an appropriate level of integration, willingly providing high quality data. In addition to that, Cramo personnel expressed their satisfaction when asked about the transport company’s professionalism, flexibility and overall collaboration.

When it came to data sharing and storage, transport suppliers were requested to input the transport data in a predetermined format in the invoices. However, differences in the format were noticed that led to a difficulty in interpreting the data. A certain pattern was identified when it came to either inputting the data in the invoices or writing them in the waybills. Location inputs in the majority of cases, were names of “known within the proximity locations” such as names of hospitals. This was partially understandable due to the nature of the construction business where some construction sites have no full addresses during the construction stage. In addition to that, even in the most recent contracts signed by certain transport providers, it is not specifically noted what a full address consists of, leaving room for ambiguity.

One of the patterns identified was the lack of responsiveness and willingness showed by transport providers. This was perceived as the clearest indication regarding the lack of supply chain integration. Even with the intervention of the company supervisor and after clarifications regarding the project mission and value to the company, data was either shared after a considerable amount of time or not shared at all. However, it can be argued that Cramo does not provide any incentives to its transport suppliers to store high quality data. Therefore, transport providers invested considerable amount of time to develop files from scratch or simply were unable to gather this data and share it with any stakeholders of the project.

During the course of the project, numerous interviews with different stakeholders were conducted in order to gain a broader perspective of the operations of the company, the functioning of the transport network and processes of serving the customers. These processes start from the order placement up to the return of the rented item and invoicing. When visiting different business units, all respondents were asked which transport providers they mainly used, what was the process of transport booking of these particular carriers and if they had any suggestions for improvement of existing operational set up. Basic information related to transport services during the interviews is presented below in Table 8, with focus to level of satisfaction regarding transport services received. The chosen rating scale range was: low, medium, high, very high. It is worth mentioning that ‘Fixed truck present’ indicates if a depot had a full time rented truck from a transport provider, allowing for full control of shipments and dispatch times.
Looking into specific findings, what draws attention is the information gathered from BU1, BU2 and BU6 business units. As stated by respondents from BU1, rental shipment should always be the priority, however, there are occasions when arriving pick-up trucks are occupied by items that are transported for the sake of stock balancing. In addition to that, more clarity in terms of arrival times of the local transport provider would contribute to improved customer service. What is more, the depot manager of BU2 service center pointed out that some unnecessary shipments are made when tools of specific brands are delivered there for repair. Meanwhile, these tools should be shipped directly to the representatives of the manufacturer while they are still on warranty period. Furthermore, the same happens occasionally with electrical equipment items. However, they should be delivered to a service center designated for the repair and maintenance of electrical equipment.

A drawback caused by lack of digitalization was experienced when visiting D6 depot. This particular depot was considerably dissatisfied with the level of service they receive from the local transport company, mostly stemming from the lack of application of digital solutions. From a data gathering point of view, the main problem was ununified and handwritten waybills what further on revealed
several cases of wrongful pricing in the period investigated. The type of charge was denoted
incorrectly when manually writing the invoices by hand.

Looking into an overall situation, generally, every commercial depot (BU1, BU3, BU4, BU5, BU6) visited
have unanimously expressed a wish for Cramo to have own trucks for client deliveries to assure
immediate availability and high delivery accuracy. Another potential area of improvement that was
identified by the majority of respondents (BU1, BU3, BU4, BU5) was the price visibility, which Cramo
is charged with, during the transport booking process. Currently, the prices of transportation service
are often denoted in printed price lists. However, sales people have expressed their opinion that it
would clarify and assure correct transport booking and client charge if the amount Cramo is charged
with was visible during booking.

Finally, Cramo staff in most cases (BU1, BU3, BU4, BU5, BU6) have shared collective deliveries as
having great potential to reduce the number of shipments. Currently, the transport providers manage
the fleet on their own and Cramo employees often noticed that there can be fewer individual
shipments in cases when there are multiple orders to be delivered the same day. Respondents have
identified situations where few orders are to be delivered in close proximity, but separate trucks come
to pick them up. They have further shared their opinion that this could be improved by having an in-
house transport company’s representative who would coordinate collective driving closely with depot
salespeople. According to them, this would also greatly decrease Cramo’s impact on the environment
due to the decreased CO2 emissions.

4.4 Data extraction process

In this section, the data extraction process is presented. This method was deployed when data was
not provided by the transport companies even when asked by the company supervisor. The two main
different internal systems that were used as sources are analyzed.

4.4.1 Invoice management system

When data was not delivered due to the lack of responsiveness, willingness or general information
infrastructure, a manual data extraction process was followed looking into the Cramo invoice
management system. A period of one busy month was selected in coordination with the company
supervisor to get an appropriate overview of the depot transportation in terms of number of carriers
used, volume of transportation and data quality.

A middle size depot in Sweden had approximately 110 transports within the period of one month. In
only a handful of cases, a full address was noted, with street number, postal code and the receiver’s
name. In the majority of transportations, there was either a street name without number or the name
of a local object only known to the drivers or local town people. Therefore, for the data collection to
be complete, estimations and google search were necessary to conduct to identify the full addresses
of these places denoted as the receivers. Even though Cramo demands the suppliers to present
invoices in a specific predetermined format, the main challenge laid in the difference of format of the
data provided. For instance, some transport providers included significantly accurate addresses, while
others put down only the names of the locations, known to local drivers but extremely difficult and time-consuming to assume for somebody less familiar with the particular area. The latter cases were clarified with the help of the company supervisor or relevant depot representatives. In most cases, at least one type of the requested data was not present, such as the truck type or the charge type.

In cases, where the information included in the transport service invoices were insignificant, attached waybill documents were scanned through to clarify the situation regarding the services Cramo was charged for. However, the most challenging combination was the case of a transport supplier, where insignificant information in the invoices was combined with hand written abbreviated locations in the waybills (see Appendix I). In that case, the help of an experienced salesperson of the respective depot who conducted day-to-day communication with the respective carrier was requested. In some occasions the necessary data was present neither in invoices nor in the waybills (see Appendix II).

4.4.2 Contract storage management system

Having such an extensive transport network, with several active transport suppliers means that contracts are continuously approaching expiration dates and demand immediate attention. After facing the challenges regarding the lack of or poor-quality data, the company contract storage management system was investigated to find out about the obligations pertaining to information signed by the company suppliers.

Cramo has acknowledged the value of information and has become eager to gather relevant data seeking to maintain control of its transport network. The company has incorporated a request regarding data in the standard contract agreement that states the following: “The transport company shall, when asked, send statistics to the buyer declaring as example; booking number, pick up date, delivery date, pick up place, delivery place and invoiced price (Cramo Agreement).” However, only a handful of companies have signed this relatively new agreement. There are different reasons explaining this situation. One of the most important ones pertains to the lack of considerable alternatives when it comes to transporting heavy units of equipment other than small subcontractors that however lack the technological expertise and information infrastructure.

4.5 Purchasing situation

The company of interest has been successfully operating in the business of equipment rental since the year of 1953 what led to the assumption that the contractual agreements with a part of transport providers were initiated at that time. The current practices applied in Cramo when purchasing the transport services comply with the concepts put forward by theorists Carr and Green (1998). This pertains to the relationship between a shipper and a carrier being based on the carrier’s performance that is measured based on criteria such as on-time delivery, reliability, efficiency and consistency. Further increase in productivity and higher level of customer satisfaction is achieved by good personal relationships.

Since the role of the Strategic Purchaser focusing only on transport services had been introduced rather recently, having in mind the existence period of the company, it demands for further alignment
of purchasing practices internally. A phenomenon identified in relation to the purchasing situation of transport services pertained to the contract arrangements with the companies serving different depots. Some depot managers continued to extend contracts with transport suppliers regardless the introduced responsible position. This can be attributed to the long-term relationships already established and the overall high level of the company’s financial performance. In addition to that, it might be caused by historically high level of independence and authority of the depot managers in decision making on behalf of the represented depot.

The vast majority of communication and information transfer is still conducted using manual communication methods, such as sending over spreadsheets and emails, making phone calls, and even fax. This can be traced back to the fact that construction industry is conservative and Cramo must comply with existing communication infrastructure to a great extent in order to be compatible with the businesses of its customers. On the other hand, it does not imply that Cramo cannot request higher levels of digitalization and integration from its suppliers. Traditionally, companies have selected suppliers only evaluating them with central focus on the pricing structure and the quality of services (Imeri et al., 2015). It is worth mentioning that services as a category compared to products are generally more difficult to achieve accurate pricing for. This stems from subjectivity in evaluation of the quality and personal perception of evaluating individuals. However, basing the decision process on additional criteria related to information quality can provide purchasers with a tool to assess suppliers qualification from a more general perspective, allowing for an objective overview of suppliers in the selection pool (Imeri et al., 2015).
5. Framework development and application

This chapter describes the development of the framework to be utilized for the assessment of transport suppliers’ data quality. Furthermore, the case specific application peculiarities and potential evaluation exceptions are discussed. The chapter begins with a thorough explanation of assessment criteria previously briefly introduced in the method chapter. Later on, the results of framework application are presented and discussed with scrutiny. Lastly, the relation between low data quality and higher transport expenditure is displayed.

5.1 Framework development

A framework was designed to assess the suppliers’ qualification for initiated or extended cooperation with Cramo, specifically in terms of providing information of sufficient quality. The scale and criteria were selected based on the practical experience gained during the data gathering process and confirmed with the Strategic Purchaser specialized in logistics and transport services. The latter criteria are plotted in Table 9 incorporating the score assigned for different levels of quality.

<table>
<thead>
<tr>
<th>Score</th>
<th>Ease of manipulation</th>
<th>Accessibility</th>
<th>Accuracy</th>
<th>Completeness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Location</td>
<td>Charge type</td>
</tr>
<tr>
<td>0</td>
<td>-</td>
<td>-</td>
<td>missing</td>
<td>missing</td>
</tr>
<tr>
<td>1</td>
<td>Requires manual extraction from handwritten documents</td>
<td>no response</td>
<td>Local name</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Requires manual extraction from digital documents</td>
<td>within 3 weeks</td>
<td>Area</td>
<td>exists</td>
</tr>
<tr>
<td>3</td>
<td>Detailed information requiring further modification</td>
<td>within 2 weeks</td>
<td>Street name</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>User-accessible platform with detailed information</td>
<td>within a week</td>
<td>Full address</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 9: Data Quality Assessment Framework - Grading Criteria
The total score of an ideal supplier in terms of provided data quality is 20 according to the introduced scale. The criteria used to determine the overall data quality of a supplier are further defined individually followed by an explanation of the chosen scale.

Regarding the first criterion of ease of manipulation, the worst score - ‘1’ represented the case where data requires manual extraction from handwritten documents. This in the case of Cramo referred to handwritten invoices, demanding assistance of Cramo personnel. The next score - ‘2’ indicated manual extraction of transport data from the company’s invoice management system. Data was traced and manually input into an excel spreadsheet. The score of ‘3’ was assigned to carriers that provided the documentation but not in the requested format, thus requiring further modifications. The highest score of ‘4’ referred to transport suppliers that were able to provide a document in the requested format with no adjustments needed or the user could independently extract such information.

In the accessibility criterion the responsiveness of the study participants was graded. It needs to be highlighted that the scoring in this metric is considered highly subjective since it was based on empirical experience. Therefore, a scale ranking the candidates in terms of the weeks it took to respond and deliver the requested data was used. One, two and three weeks were decided to differentiate distinct levels of accessibility. The lowest score was assigned when there was no response at all. However, the latter case, still allows for data extraction from existing documents. It is worth mentioning that the scale was confirmed by the company supervisor. Based on his practical knowledge, the scale used reflected the real responsiveness experienced during his interactions with transport suppliers regarding the supply of data samples.

The accuracy reflects the precision and level of detail with which the delivery address was denoted. The lowest score of ‘0’ was given in the case where no location was provided. In the ‘Local name’ was assigned the score of ‘1’ as it in many cases were known only to local depot staff. ‘Area’ pertained to construction site that occasionally might lack an address, one can be more certain about its location, therefore assigned score was ‘2’. ‘Street name’ provided sufficient accuracy in most of the cases, however sometimes the same street continues for kilometers, therefore it was assigned a score of ‘3’ and a full address - ‘4’.

With regard to the criterion of completeness, the components relevant in the decision-making process while purchasing transport services for the company of interest were the Truck Type, the Charge Type and the Location. Charge type was deemed of crucial importance because it directly displays what the company paid for when looking at an invoice, therefore absence of these aspect resulted in ‘0’ points and presence of it - ‘4’. Truck type and Location, however, were considered to be of lower significance, therefore ‘2’ points were accumulated in case of its presence.

The framework was drafted with an intention to apply it on a specific range of data. The focus was put on operational data specifically. Operational data refers to data necessary to conduct, maintain and improve the immediate cooperation between partners (Frenz, 2018). In the case of the investigated situation, these partners were the purchasing company and the transport providers. Therefore, operational data included information regarding the booking, carrying out and archiving of transport transactions.
Some criteria were considered to be of higher importance in terms of their significance in the decision-making process of purchasing transport services. Therefore, their weight in determining the overall score of data quality assessment had to be differentiated according to the requirements of the Strategic Purchaser responsible for transport services. The weight distribution is visualized in an illustration presented in Figure 4.

![Figure 4: Data quality evaluation criteria](image)

Completeness is a prerequisite for data quality, therefore it was naturally weighed as the most significant component. It was further split into several subcomponents, namely - location, charge type and truck type. The inclusion of delivery location was very important, but it only pertained to its presence in the completeness category, leaving its accuracy aside - thus had lower weight. Knowing the truck type used to deliver specific items was acknowledged as beneficial, since awareness of truck usage frequency can help the purchasing company in influencing the transport provider(s) on further fleet investments. In addition to that, it can lead to the investment of the purchasing company in a fixed truck for particular business units that frequently use certain type of trucks. However, the truck type used did not determine the cost of the service, since the purchasing entity agreed to pay according to the price of cheapest existing and sufficient option necessary to conduct a particular delivery. Further on, the accuracy, ease of manipulation and accessibility of relevant data were judged as equally important as they together summarize the overall quality. Although, accessibility could be applicable not only to contract renewals as according to the company supervisor it is possible to request data samples from potential transport suppliers.

Interaction with transport service providers allowed for evaluating them according to the previously introduced scale. Having investigated the provided data and recorded the scores of perceived quality levels, an overall evaluation could be summarized in a quantified format. However, only having evaluated the data quality on a superficial scale is insignificant. An attempt to proceed with creating the foundation for further well-informed purchasing decisions is discussed further.
5.2 Relation between data quality and transport expenditure

Seeking to evaluate the potential relation between quality of supplier operational data and the performance of transport purchasing, it was necessary to assign distinct numerical values to the latter activity. The performance quality of purchasing transport services can be generalized as the comparable expenditure on transport services of depots served by respective carriers. In order to proceed with the aforementioned comparison, sensitive financial information was necessary. The company supervisor provided the required data facilitating the evaluation of the performance of distinct business units based on their financial results.

The depots comprising the Cramo customer service network are of various size and located in areas with differentiated population and customer traffic. Therefore, it was necessary to eliminate the absolute values from the equation and consider ratios judging transport spend efficiency. In order to fulfil discussed criteria a coefficient was introduced, further referred to as $k1$. The coefficient $k1$ is a ratio between depot transport expenditure on a heavily dominant carrier and the total revenue of that depot over a period of one year. In order to increase readability and ease of usage, such ratio is further multiplied by 100. Aiming to maintain objectivity and avoid distortion of the results, only depots having a single main transport provider were included in the investigation. In addition to that, the selected business units showcased similar numbers in terms of amount of shipments and total revenue. Lastly, business units handling special equipment were excluded since their revenue would be incomparable to regular ones.

The analysis carried out resulted in an outcome indicating a relation between data quality score and $k1$. Meaning that depots that were served by transport companies able to provide higher quality data were paying less for the transport services in comparison to their sales revenue than depots served by carriers with lower quality data. A selection of cases is presented in Table 10 below.

<table>
<thead>
<tr>
<th>Depot ID</th>
<th>Transport company ID</th>
<th>Data quality score, Q</th>
<th>$k1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>T7</td>
<td>19</td>
<td>3,74</td>
</tr>
<tr>
<td>D15</td>
<td>T4</td>
<td>14</td>
<td>7,85</td>
</tr>
<tr>
<td>D16</td>
<td>T15</td>
<td>14</td>
<td>8,33</td>
</tr>
<tr>
<td>D17</td>
<td>T17</td>
<td>15</td>
<td>8,43</td>
</tr>
<tr>
<td>D18</td>
<td>T8</td>
<td>13</td>
<td>9,60</td>
</tr>
<tr>
<td>D27</td>
<td>T14</td>
<td>12</td>
<td>13,57</td>
</tr>
<tr>
<td>D28</td>
<td>T11</td>
<td>8</td>
<td>16,19</td>
</tr>
<tr>
<td>D29</td>
<td>T24</td>
<td>10</td>
<td>16,57</td>
</tr>
</tbody>
</table>

_table 10: A selection of relation analysis results_
To exemplify the results obtained from applying the framework three cases are to be detailed- the best score, the worst score and a medium one. Transport company T7 scored 19 out of 20 available data quality points, meaning that provided data was of high overall quality (see Appendix III). This particular carrier scored as follows: 4/4 in Ease of Manipulation, providing data in a format ready for usage; 4/4 in Accessibility, having responded within 1 week from request; 3/4 in Accuracy, denoting locations with a street name but missing the street number in some occasions; and scoring full points in Completeness, having the Location, Charge type and Truck type in their data files. This score was confirmed during the interview at the transport company’s office where a structured and organized approach to data management was witnessed. In the middle of the scale, lied companies with a data quality score around 14. One of such was T15, this carrier lost a fraction of points in all three qualitative criteria - Ease of Manipulation, Accessibility and Accuracy, while gathering full points in Completeness. The worst results were displayed by a carrier referred to as T11 in the research, collecting only 8 points out of 20 in data quality evaluation. The data provided by this transport company was incomplete, missing the Truck Type and the Charge Type, while also poor on qualitative measures mentioned previously.

It is important to stress, that the recorded results represent a situation at a specific point in time and can be used as an indicator of an overall landscape. However, to increase objectivity and prove or disprove suggested conclusions it is advisable to carry out the analysis periodically and visualize trends in a graphical and illustrative way. The depots served by transport companies able to provide higher quality data displayed a lower k1 coefficient, consequently, paying less for the transport services in comparison to their sales revenue than depots served by carriers with lower quality data. The results of investigating 29 depots served by 19 transport providers are presented in Figure 5.

![Figure 5: Coefficient k1 dependency on data quality score](image-url)
The red dotted trend line displays a relation between transport expenditure over sales and data quality. The depots are represented by the points with the x coordinate being the quality score and y coordinate the ratio of transport expenditure over sales. It became evident that depots served by the transport company outperforming competition in terms of data quality concentrated on the lower end of the expenditure scale. To showcase this distribution visually, the depots served by supplier T7 were marked. A full overview of results of the framework application is summarized in a table format in Appendix IV.

**Data quality effect on transport mapping**
The high quality of transport supplier data allowed for satisfactory level of detail in the transport network mapping of respective depots. Especially, the presence of detailed sender and receiver addresses influenced the accuracy of results. Such cases were depots served by T7 that scored the highest data quality score amongst the participating transport companies. It is important to stress that in the cases of depots served by carriers with low quality supplier data, mapping could not be performed. This is attributed mainly to the lack of accuracy of the sender and delivery addresses, since the geographic information system software used could not match the locations. The difficulties faced, and excessive time spent to collect the necessary data led to the exclusion of the aforementioned depots, such as D27 and D29.
6. Discussion

In this chapter, the results of this study including the relation between data quality and transport expenditure are elaborated. Then, the ethical considerations of the proposed solution are discussed. Further on, this section is followed by a discussion around the framework’s application with regards to sustainability. Lastly, the implications for each sustainability dimension are outlined.

6.1 Interpretation of results

Based on the investigation, transport suppliers were judged with a prevalent weight on the price criterion. Meanwhile, the other two main criteria presented by Thanaraksakul and Phruksaphanrat (2009) – namely delivery and quality, were considered as prerequisites in the initial stages of the supplier selection process. From a strategic perspective, the insights provided by the framework application show that even though certain carriers appear cheap on paper, their total cost of ownership can increase greatly due to poor quality data. This is supported by TCO theory claiming that cost of purchasing, holding, poor quality and delivery failure should all be included in the total price of acquisition (LaLonde et al., 1996). It practically means that suppliers with initially competitive price offers, may charge the purchasing company inaccurately due to poor data management practices. In such hypothetical case, they would be unaware of factual incurred own costs leading to inaccurate pricing for the buyer. The latter can be exemplified by hourly charges when the carrier does not have standardized tracking routines resulting in approximations of time spent conducting services. In addition to the extra costs explained before, indirect costs are incurred by the purchasing company when attempting to request, attain and handle data from such suppliers. This is because the time required to transform the operational data into usable information is excessive. It renders the effort unproportional to expected benefit since additional resources must be allocated to investigate the cases with poor quality data, adding up to increased total cost. Observations coincided with existing literature - distorted information exchange between supply chain stakeholders can lead to substantial inefficiencies (Lee et al., 2015). More specifically, if the operational data is not presented in the requested format, it is necessary to extract it manually from various databases and physical documents. This in turn causes time waste and subsequently lower efficiency. It mainly applies to cases when the company of interest aims to exercise control of its transport network.

Figure 5 (p.45) presenting the dependency of the developed coefficient $k_1$ over the data quality score displays a strong relation. The relation was further reinforced during discussions with the company supervisor who indicated potentially lower performance in terms of transport and data management in specific business units. However, certain acknowledgements about weaknesses of the framework must be made. The previously described coefficient ‘$k_1$’ is influenced by numerous factors aside from the data quality of the transport provider.

A significant factor influencing the results is the individual and team performance in different depots. Individual ability to organize, structure and optimize depot related transport transactions combined with more developed sales and customer service tacit skills can lead to a lower ‘$k_1$’ and diminish the importance of supplier data quality. However, since these factors were ununified and virtually impossible to quantify accurately, they were not taken into consideration. Another important factor that was not considered was the existence of a fixed truck devoted to the depot’s transport needs.
D29, D27, D21, D13, D18 and D19 were depots that controlled such a truck that performed the majority of depot transports and the services were charged on an hourly basis, 8 hours per day and 5 days per week. It is worth mentioning that the existence of a fixed truck does not automatically benefit these depots in the calculations since it mainly depends on how well the truck is utilized. Moreover, the metrics used for grading the transport companies were also influenced by situational factors, such as the accessibility dimension influenced by a specific individual’s capacity to respond. It is fair to assume that an investigation at another period of time would generate different scores for the participants in this specific criterion. Lastly, although the sample size of the participants seems satisfactory for the project timeframe, an increased number of transport companies assessed would possibly generate different results. This can be attributed to the dominance of a specific carrier (T7) in the quality score calculations.

6.2 Ethical considerations

Ethics are about complying with good praxis regarding scientific work so that nobody will be harmed by your work (Blomkvist & Hallin, 2015). Researchers conducting qualitative interviews should consider the principle of ‘no harm’ to participants. They should be aware of the potential harms that might be inflicted upon study subjects (Sanjari et al., 2014). Although asked by Cramo to conduct this study, the four different principal requirements in scientific work of the social sciences had to be considered. In the case of Cramo, the investigation of the transport companies and their cooperation with the depots created an ethically controversial setting. While acting in the best interest of Cramo, certain cases of wrongful pricing were identified which put the collaboration with respective suppliers into question. Although these cases were unveiled to the responsible individuals, it needs to be considered that observations were made on data provided by Cramo. Therefore, another explanation could potentially be discovered if the data of respective transport companies was investigated thoroughly. These explanations could range from extra services to specific routes taken explaining the difference from the standard pricing.

Ethics is a sensitive and important aspect for every research project (Blomkvist & Hallin, 2015). Especially when suggesting a solution such as a new way of selecting suppliers, the ethics behind the adoption of such a solution must be considered with regard to the current state. In the case of Cramo, this entails certain ethical considerations related to human discretion. As discussed in the description of current purchasing situation, contract extensions with transport suppliers were until recently handled by depot managers. The introduction of the role of the strategic purchaser focused on transport services resulted in an initial decrement of such discretion. However, established long term relationships with transport companies still play an important role in the decision making regarding contract extension. The supplier data quality assessment framework developed entails a more objective approach for the purchasing of transport services. Using this framework as a selection tool, the discretion regarding choosing their transport suppliers would be taken from depot managers. On the other hand, Cramo employees are encouraged to seek personal and professional growth through a skill development framework. Thus, it is evident, that responsibilities taken from employees could potentially cause controversy. Therefore, a careful approach must be deployed to communicate this change and its subsequent benefits to these employees.
6.3 Sustainability Considerations

The growing concerns for environmental and climate change, together with issues of poverty, increasing disparity between societies and the tension brought by social inequalities, have placed sustainable development under the spotlight (Giovannoni & Fabietti, 2013). Sustainable development is defined as the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations General Assembly, 1987). The 2030 Agenda for Sustainable Development consists of 17 Sustainable Development Goals (SDGs) that were adopted by world leaders and officially came into force in September 2015 (United Nations, 2018).

Supply chain leaders across the globe are attempting to build more sustainable supply chains. Ethical, business, waste elimination and cost savings goals are driving this work. Global supply chain executives understand that sustainability brings its own set of challenges related to sensitive matters such as social responsibility and respect for the environment (Bell et al., 2016). Whereas most companies already have social and environmental systems in place for internal operations, less than a third have similar structures to monitor the practices of their immediate and extended supplier network. As firms increasingly address issues of environmental and social sustainability, being transparent with their broader constituents provides a level of credibility and trust with customers and other interested parties (Supply Chain Digest, 2016).

Cramo has introduced a sustainability focused strategy for integrating sustainability step by step into all parts of the business and it is based on Cramo’s values. The company leads the way in advancing sustainability in the rental industry as well as meets the requirements of all stakeholders and internationally recognized standards. Cramo Care pertains to the Code of Conduct, business ethics and the Supplier Code of Conduct is based on UN Global Compact and ISO standards. (Cramo Group, 2018) Based on the definition by the United Nations (2015), sustainability consists of three dimensions: environmental, social and economic sustainability. The developed framework addresses the environmental and economic sustainability to some extent while the implications of the future use of the framework by purchasers would have an effect on social sustainability. Hence, they are discussed followingly in separate sections.

6.3.1 Economical Sustainability

Economic sustainability can be defined as the allocation of resources over time in a way that provides the highest level of well-being for current and future generations (Markulev & Long, 2013). From a business perspective, economic sustainability refers to using the assets efficiently to allow for long-term profitability. In the case investigated, the company is profitable performing particularly well, while always seeking to increase the competitive advantage over competitors with numerous change initiatives. The level of customer service and responsiveness is the differentiating factor in the industry. Thus, change initiatives pertaining to any component of customer service are treated with reluctance stemming from concerns regarding potential compromise of the service quality. This can lead to occasions where overpriced suppliers are used, disregarding their drawbacks in terms of price transparency with responsiveness, availability or interpersonal relations.
As discussed in subchapter 6.1 explaining the relation identified in this thesis, poor quality data can add up to the total cost of services provided by a supplier. Given the quality of data supplied by service providers is neglected, it leads to an immediate and accumulating challenge of data conversion to information at a later stage as experienced in the data gathering stage. In case the root cause of the problem is not solved, the costs of transforming the aforementioned data can become excessive and therefore eliminate the possibility to make well informed decisions in the cases of interest. In short, over time, the effort necessary to extract, filter, aggregate and unify historical data becomes increasingly non-proportional to value of the potential outcome.

Prioritizing the long-term profitability over short time savings should be the strategy while considering the acquirement and storage of operational data. Therefore, it is necessary to incorporate the proposed data quality assessment framework when selecting service providers. This, combined with the previously applied metrics should be utilized to select a well-balanced option, having all criteria considered. Thus, the potential risks would be mitigated, and overall value maximized, as discussed by Monczka (1998). Since the application of data quality assessment framework has an intended outcome of opening up the supply chain part of suppliers for scrutiny, it ought to increase price transparency which in turn leads to increasingly accurate pricing throughout the supply chain. Therefore, the economical sustainability of Cramo’s customers is also positively impacted.

### 6.3.2 Environmental Sustainability

“Environmental sustainability can be defined as a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity” (Morelli, 2011). Nowadays, purchasing managers are required to transform purchasing into a more strategic function while simultaneously considering the environmental issues in their decisions (Handfield et al., 2002). The process of formally integrating environmental issues and concerns into the purchasing process is known as “green purchasing” (Handfield & Melnyk, 1996).

Cramo puts a continuous focus on reducing its ecological footprint, taking a precautionary approach in terms of its environmental sustainability compliance strategy. Having the minimum possible impact on the environmental is a priority for Cramo, and the company’s aim is to maintain its position as the most climate- and resource-efficient rental solutions company (Cramo Group, 2018). However, while the internal compliance, awareness and control over the ecological footprint, is possible to cultivate and sustain, same does not necessarily apply with the company’s suppliers. In the case of transportation, Cramo’s extensive and complex transport network structure, interferes with the ability to exercise control over the suppliers’ alignment with the Cramo sustainability goals. The nature of the equipment rental industry entails the usage of special trucks which only certain transport suppliers have in their fleets. In several cases, the size of these transport companies, was considered a burden to justify an investment in information infrastructure. Given these facts, the company has been compelled to sign transport suppliers without the necessary information infrastructure and technology savviness necessary to track their CO2 emissions.
During the depot field trips, the lack of route optimization on behalf of the transport suppliers was also identified. It was noted as a suggestion for improvement from employees working at several business units that the transport suppliers should minimize the number of shipments. There were reported cases when the lack of transport planning led to multiple different trucks used for deliveries that could have fit on a single truck. The restructuring of logistics networks for many companies is a strategic decision to strive for cost reduction while improving customer service levels (Harris et al., 2011). In the context of transport, there has been a particular focus on reducing the distance vehicles travel. Such an internal initiative has started to take effect at Cramo with an even more centralized logistical approach. These changes result in internal benefits for companies and create benefits for society and the impact on the environment.

Sustainability is an inseparable pillar of Cramo’s growth strategy, thus the eco-footprint was considered a mandatory requirement and a separate metric in the completeness dimension throughout the initial phase of the framework development. However, the realizability of this metric led to its exclusion from the supplier data quality assessment framework. In all respects, the lack of sufficient information infrastructure was experienced throughout the data extraction process. After interacting with several transport suppliers and witnessing their inability to provide accurate locational data, the demand for eco-footprint related data was deemed as unreasonable. Only in the case of the highest scoring transport supplier, such information could be provided on demand due to the possession of an advanced information system. In general, companies would appreciate to be aware about the amount of CO2 emitted by their transport providers and their compliance with sustainability goals. This can be realized if the transport suppliers receive appropriate education or the non-compliant ones are released. Therefore, an extended framework, assessing the suppliers’ ability to provide high quality data, would put the company in a position to make better informed decisions about which suppliers to cooperate with.

6.3.3 Social Sustainability

The definition of corporate social responsibility (CSR) often advocates for ethical behavior with respect to the three aforementioned sustainability dimensions. With companies committing to sustainability and CSR policies, there is an increased focus on the social impacts throughout the supply chain (Hutchins & Sutherland, 2008). In the case of the proposed framework, social sustainability is addressed looking at business ethics. Business success is built on relationships with customers, competitors and suppliers. The key for these relationships to become long-term is integrity and trust. In the case of Cramo, the company delivers rental services according to high ethical standards. Therefore, the same high ethical standards are expected from the company’s suppliers (Cramo, 2018).

Supply chain management increasingly emphasizes an enterprise focus on core competencies with the effect being an increase in the number of entities involved in supply chains. This increase in complexity results in reduced control of the logistics network (Hutchins & Sutherland, 2008). Based on the investigation conducted that was focused on the company’s transport network, it was considered extremely difficult to run audits on multiple transport providers. Cramo collaborates with approximately 100 transport suppliers just in Sweden. The systematic approach proposed to assess supplier data quality gives the company a tool to exercise this control proactively. For example, in the case of a specific transport supplier participating in the case study, falsely charged invoices were
identified. Naturally, this behavior is unacceptable since it directly impacts the company’s expenses, but it also interferes with the company’s Supplier Code of Conduct. According to this document, suppliers must provide correct and consistent information to its stakeholders in a timely manner (Cramo, 2018). In the case of that transport company, none of the requirements were fulfilled, rendering them ineligible for further cooperation with Cramo. Therefore, being aware of non-compliant suppliers gives companies the power to make appropriate corrective decisions. In the case of Cramo, just by witnessing the willingness of transport suppliers, patterns were drawn which were confirmed during the depot visits.

Aside from the required regulatory compliance, companies nowadays have a strong interest in evaluating how transparent their supply chains are and having a clear understanding of the risks associated with their supply chains. However, rather than viewing transparency as a challenge, companies should leverage the opportunity to identify potential operational improvements while promoting corporate social responsibility and strengthen their brands. (Linich, 2014) Moreover, the willingness to share data must be developed collectively. This will allow for information to be used as a collaboration tool and not as a power tool. A culture where companies work united across the traditional process boundaries of a supply chain should be cultivated. (Alan, 2015)
7. Conclusions

In this chapter, each research question is addressed and answered in accordance with the findings, subsequent analysis and theories. Answering the research questions helps to fulfil the purpose of this work, to investigate the potential relation between information quality and performance in terms of purchasing transport services. Afterwards, the contribution to knowledge and research is discussed. Further on, the managerial implications for companies with complex transport networks are presented. Lastly the limitations and ideas for potential future research are denoted.

7.1 Answering RQs

This section revisits the research questions raised in the initial stage of this research project. The aforementioned questions are thoroughly answered, building upon the information generated during the research process and discussed in the preceding chapters.

RQ1: What are the challenges of achieving accurate shipping pricing?

Businesses operating at a large scale and thus showcasing complex supply chains are in some occasions obliged to cooperate with multiple small scale entrepreneurial transport companies due to lack of alternatives. Even though these partnerships effectively secure the delivery of the products to the customers, it comes at an expense of the poor quality operational data these companies can provide. Consequently, it leads to a low level of transparency into the cost structure of the services purchased, since it becomes significantly difficult to obtain and evaluate historical data and understand what exactly the purchasing side are paying for. In turn, the buying company cannot maintain control over the costs and is forced to trust that the suppliers charge with high accuracy and in the best interest of the client.

As confirmed by the case study conducted, there are occasions when suppliers that are difficult to monitor prove themselves untrustworthy. This may appear in the form of wrongful pricing or lack of compliance with agreed terms of cooperation. Such discrepancies are difficult to measure with high level of certainty as historical operational data is necessary to support these allegations. Therefore, there is ground to state that suppliers with a lack of digitalization manually producing accounting documents is one of the major challenges in achieving accurate shipping pricing. The challenge accumulates if such carriers are unwilling to invest in digitalization and compromise potential for future cooperation.

Moreover, another obstacle arises when transport providers have sufficient information but are reluctant to share it due to concerns of this data potentially being leveraged in negotiations. Thus, carrier’s low willingness to share operational data is another challenge for accurate pricing. It may stem from vaguely defined data supply requirements by the purchasing entity. The latter appears in case when it is defined ambiguously what the data is needed for.

Lastly, the lack of cultural cohesion in terms of performing certain data management related processes may create obstacles to achieving overall shipping pricing accuracy. The absence of a unified approach to requesting, storing, processing and management of operational data can result in supply chain
inefficiencies at the expense of the customer. This could result from insufficient communication of data handling related practices to raise awareness of those who should implement it.

**RQ2: How can supply chain integration contribute to improved shipping pricing?**

Supply chain integration and information sharing can contribute to better control over the purchased transport services. This is achieved through enabling the purchasing party to check if they are charged correctly and agreed prices are followed. Furthermore, given the supplier operational data is provided in full and of sufficient quality, the monitoring costs decrease in turn reducing the total cost of ownership of the whole cooperation. Followingly, this creates room for optimization of shipping pricing as the total cost of service is controlled. Moreover, information sharing allows for improved forecasting and optimization of processes. In the context of supply chain management, it requires achieving an integrated information system. In turn, having developed a good understanding of purchasing entity’s operations, transport providers can become capable of achieving higher level of customer service - further contributing to improved shipping pricing.

It is important to mention that supply chain transparency is a prerequisite for supply chain integration, contributing to improved shipping pricing. Increased supply chain transparency would result in more accurate insights into the price structure. This practically would alleviate the ambiguity regarding the specifications of services conducted and avoid invoices with generalized charges (see Appendix III). A potential measure to achieve higher supply chain integration and transparency is personnel of transport companies stationed at the business units these companies serve. In such a manner, better route optimization and shared deliveries could be realized, increasing transport efficiency and positively contributing to both optimal shipping pricing and decreased environmental impact.

**RQ3: How can the supplier evaluation process be systematically performed in purchasing of transport services?**

The criteria of cost, quality and delivery accuracy are widely used. However, it has become evident that in order to achieve enhanced overall business performance, efficient information management is required. Possession of high-quality and up-to-date data at all times is one of the most critical business assets (Tieto, 2013). Thus, it is of great importance that supplier data is convertible into actionable supplier information that empowers the purchasing organization to make more confident decisions across the supply chain (Lavante, 2018). Given the identified information gaps experienced throughout the data gathering process, a framework was developed in order to provide a tool to systematically assess carriers with regards to their ability to supply high quality data in a timely manner. A systematic approach with defined data quality dimensions and measurable metrics was developed. The criteria of ease of manipulation, accessibility, accuracy and completeness were selected as the most suitable for the case of interest. However, the framework remains adaptable - dimensions and metrics can be added or excluded according to situational factors and case peculiarities. The application of supplier data quality assessment framework allows for a more objective and streamlined supplier selection. This stresses on the overall costs experienced during the period of cooperation. Some suppliers may appear cheap on paper, however, the compromises on
data quality can induce higher costs than initially more expensive offerings as supported by the TCO calculation methodology.

7.2 Contribution to knowledge and research

The study of this thesis project demonstrates a relation between low-quality supplier data and higher transport expenses. The participating depots cooperating with transport suppliers providing high quality data showcased low transport expenses. This in general, adds to the knowledge and the hypothesized importance of information quality in decision making processes. In the era of information, evidence supporting that high quality can result in a decrement of operational costs can be already deemed a contribution to knowledge. Given that other researchers prove a similar relation in other industries with different cost structure as well, a change in the way of purchasing transport services could be initiated, starting to adopt a more holistic way of assessment. Moreover, an additional piece of contribution is the systematic approach developed to assess supplier data quality. Although, several metrics have been used across academia and in the business world, no unified approach with assigned weights was identified. Applying this framework, making the necessary adjustments for each specific case, supplier information quality can be assessed systematically and facilitate better informed decision making for purchasing of transport services.

A smaller area of contribution that can be argued for, is the display of the real situation of a modern company regarding its information management processes. The case company constituted a great example of an organization that is performing well overall but is still afflicted by individuals’ information management practices incompatible with the modern era of digitalization. For instance, even though detailed operational supplier data is agreed upon in the contracts, the implementation is not delivered completely as it depends on individuals. Showcasing the unbeautiful situation and exposing certain recurring issues, awareness is raised about the need to address the individual level by effectively utilizing change management practices.

7.3 Managerial implications

Information management and ensuring the quality of information are rapidly rising to the top of the management agenda in the majority of companies, since they are acknowledged as drivers of multiple aspects of business operations (Tieto, 2013). The knowledge obtained through the relation noted between coefficient $k_1$ and the scoring of transport suppliers in the data quality assessment framework already provides the company with the motive to proceed with change initiatives. The framework facilitates the process of purchasing by increasing the importance of suppliers’ information quality. The framework is flexible, and its criteria can be excluded, or their weights altered based on the case applied. It can be further modified by the personnel applying it with regard to the changing market situation and potential implications of upcoming regulations about to affect the business landscape.

An initial step prior to or in parallel with the use of the developed framework is the communication of the importance of operational data internally. Depot employees should be informed about the
strategic importance of requesting and managing supplier data and reporting when the quality is unsatisfactory. This can be initiated by allowing Cramo employees to see the cost of service paid by the depot while booking. In turn, this would stimulate a higher sense of responsibility and awareness of expenditure. Incentives to comply with the new data management related routines may be useful. After the culture is developed internally, the process of implementation pertaining to the increased standards of operational data can be reinforced across the supply chain. Eventually, when the supplier contracts are to be renewed, the new requirements for provided data quality should be incorporated in the contract agreement as standard prerequisites. The aforementioned upcoming upgrades in standard data quality requirements should be communicated to existing suppliers in advance to increase motivation for compliance by investing or upgrading their information infrastructure.

It is worth mentioning that the supplier data assessment framework is a part of an overall supplier selection process. The complete supplier assessment framework includes all the criteria used to select a transport supplier and was developed aside from the thesis project for company usage. This enables the company of interest to select its transport suppliers in an objective and confident way, putting greater focus on supplier data quality in the overall decision-making process.

7.4 Limitations and further research

The research conducted for this thesis project discusses the importance of supplier data quality in the decision making of purchasing transport services. However, there are several parameters that could be further investigated and incorporated in the framework developed, so that its reliability and credibility are increased. The first and most important metric is the eco footprint of transport suppliers as suggested by office staff (I2, I4, I5). The importance of this metric has been already highlighted in the discussion chapter and the reason of its exclusion had to do with its realizability since no local transport provider had relevant data available. Therefore, another research should investigate the impact of IoT and most specifically RFID chips on logistics planning as supported by interviewee I4. For example, Cramo has already introduced RFID chips in heavy machinery. The capability of incorporating this technology for all types of equipment and the impact on information infrastructure requirements could be studied. On a future state, when all transport companies would be lawfully obligated to provide environmental data, the incorporation of such a metric would render the decision-making process for purchasing transport services even more informed. The framework developed over the scope of this research was meant to assess potential or existing supplier data quality, however, this could be further applied for contract renewals. For these cases, the framework could be enhanced with the introduction of another metric - that of consistency. This metric would look into historical data and access their consistency, ultimately assessing the suppliers’ qualification for extended partnerships. In this investigation the willingness of transport providers to achieve procedural compliance with the company should be explored as well.

Another topic related to the ability to track transport data is the introduction of the GDPR law. This law will enforce several restrictions regarding the ability to track, acquire and share personal data. Therefore, when the law takes effect, practices need to change, since telematics will be considered personal data and subject to GDPR requirements (Irwin, 2018). Procedures need to be developed in every organization regarding data ownership and governance. These procedures related to
preparation for the introduction of GDPR are known as audit trails. They refer to the necessity to be aware of the type of data being held, where the data resides, who ‘owns’ the data, who has access to the data and with whom the data is shared. (ibid) A future research could investigate the difficulty to define and develop such procedures in traditionally conservative industries such as construction and equipment rental industries.
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Ovriga noteringar

Transporten - Leveransens godkännande

Datum: 3/11-2017

Underskrift

AT DEB. Grustag

Metall Tipplats

Exp. avgift och moms tillkommer. Bet.villkor 10 dgr. om inte annat överenskommits. Efter fakturans förfallstid debiteras drämpåförbilda enligt räntelagen samt påminnelseavgift.
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