



LUND UNIVERSITY  
School of Economics and Management

# **Strategic Procurement in the German Automotive Industry**

Key Criteria for the Supplier Selection in the Truck Sector

by

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June 2019

Master's Programme in International Strategic Management

*Lund University*

*The School of Economics and Management*

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## Key Criteria for the Supplier Selection in the Truck Sector

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03/06/2019

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Lund, Sweden

# Abstract

**Title:** Strategic Procurement in the German Automotive Industry: Key Criteria for the Supplier Selection in the Truck Sector.

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**Issue of Study:** In the automotive sector purchasing plays a key role in strategic management, as most companies are pressured by constant innovation and cost pressure. Hence, most companies focus on lean management and outsource many of their business activities to stay competitive. The supplier selection is crucial to be able to efficiently and effectively carry out business operations. Therefore, in order to establish a successful framework for the selection of new suppliers, it is vital to understand how suppliers are selected and what the key criteria are within the selection process.

**Purpose:** The aim is to investigate how suppliers are selected within the truck industry and to determine the most critical selection criteria of the selection process. As the supply chain in the truck industry is complex, this thesis will focus on how tier 1 suppliers chose tier two suppliers.

**Method:** A literature review was conducted focusing on the selection process and established frameworks for selection criteria. To apply the gathered information in business, empirical data was collected through semi-structured interviews with purchasers and managers at a tier 1 supplier within the German truck industry.

**Conclusions:** Quality, delivery, cost, technology, flexibility, supplier strategy, capacity, sustainability and contract compliance are the most important choice criteria concerning supplier selection.

**Key Words:** Strategic management – purchasing - supplier selection – selection criteria – German automotive - truck industry.

# Acknowledgements

We would like to thank every person that has supported us in conducting this research and writing this Master thesis.

First and foremost, we would like to thank our supervisor Devrim Göktepe-Hultén for the commitment and effort she has contributed to help us conduct a research that is of quality and for all the knowledge she shared with us to improve the value of this Master thesis. We are thankful for her constructive feedback and passion in regard to the topic of innovation and research. Further, we would like to thank her for her overall support, her thought-provoking impulses and her engagement in wanting us to have a product of high quality as well as achieve a high learning-output for us as students. We would like to thank her for all the time she has contributed to this research and the quality that her guidance has added to the thesis.

Moreover, we would like to thank each person that has helped us to push our ambitions and minds to conduct this research, as well as everyone who has contributed to this thesis through discussion and intellectual exchange.

Further, we would like to thank Knorr-Bremse and employees who enriched this study to a great extent, for enabling this case study and supporting us with valuable input and information.

Thank you all.

Lea-Victoria & Marina

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# Glossary

**Bill of Materials:** List of all raw materials, parts and components needed for production (Chartered Institute for Procurement and Supply (CIPS), 2015).

**Bottlenecks:** A process in a chain of processes, such that its limited capacity reduces the capacity of the whole chain, which results in stalls in production, supply overstock etc. (Timilsina, 2012).

**Business Partner (Procurement):** Refers to a supplier with whom the company has ongoing business, involving normally, a long-term relationship with clear commitment from both sides, sharing, information, risks and benefits from the partnership (van Weele, 2010).

**Components:** Manufactured goods, which will not be transformed further but will be integrated in the end product into a system to generate a functional relationship with other components. Specific, customized components: manufactured according to the design or specification of the customer; Standard components: produced according to specification of the supplier or industry norm. (lamp units, batteries, engine parts, electronic parts and transmissions) (van Weele, 2010).

**Direct Spend:** refers to the purchase of goods and services that are directly related to the manufacturing of the products (van Weele, 2010).

**Finished products or trade items:** All products that are purchased to be sold individually or with other finished products after value is added by the company (van Weele, 2010).

**Lean Manufacturing:** Focusing on the core business, while reducing all activities that waste resources without adding respective value (Gabler Wirtschaftslexikon , 2019).

**OEM:** Original equipment manufacturing (E.g.: cars and truck companies) (van Weele, 2010).

**Purchasing Management:** *”All activities necessary to manage supplier relationships in a way that their activities are aligned with the company’s overall business strategies and interests”* (van Weele, 2010).

**R&D:** Refers to the department of Research & Development, which develops and introduces new products and services (van Weele, 2010).

**Raw materials:** Materials that have not or minimally been transformed to serve as the basic material for the production process. Physical raw material (iron ore, copper ore, coal) or natural raw materials (grains, coffee, wood) (van Weele, 2010).

**Request for Information (RFI):** Buyers send out RFI to prospective suppliers in order to gather more information, to analyze if they are qualified to participate in a potential tender (van Weele, 2010).

**Request for Quotation (RFQ):** Suppliers are invited to submit an offer for a respective tender, concluding a detailed description of costs, prices, delivery time and fulfilling the client's formal requirements (van Weele, 2010).

**Semi-manufactured products:** Products that have already been processed once or more times, destined to be processed another time later on in the process. These products are physically present in the end product (steel plates, plastic foils or rolled wire) (van Weele, 2010).

**Serial production:** a technique used in manufacturing to produce products in series made in the same way (Ceopedia, 2019).

**Sourcing:** Finding, selecting, contracting, and managing the best possible source of supply on a worldwide basis (van Weele, 2010).

**Sourcing Strategy:** Identify from how many suppliers to buy, what type of relationships to pursue, contract duration and type, and whether to source locally, regionally or globally (van Weele, 2010).

**Supplementary materials:** Materials that are not being physically absorbed in the end product, yet used and consumed during the production process (lubricating oil, cooling water or polishing materials) (van Weele, 2010).

**Supplier awarding:** The final selection of a supplier to produce the components needed (van Weele, 2010).

**Technical specifications:** *“describes the technical properties and characteristics of the product as well as the activities to be performed by the supplier”* (van Weele, 2010).

**Tender:** Situation in which a buyer asks for bids from different suppliers. It is a bidding process (van Weele, 2010).

**Tier 1 Supplier:** Companies that supply OEM's with components and semi-manufactured goods (van Weele, 2010).

**Tier 2 supplier:** Companies that supply tier one suppliers which are the ones that supply directly OEMS (van Weele, 2010).

**Total Cost of Ownership (TCO):** The sum of all the cost that a company will absorb over the life time of a product that is purchased (Verma, R; Pullman, M.E., 1998).

**Quotation:** a formal statement setting out the estimated cost for a particular job or service (Chartered Institute for Procurement and Supply (CIPS), 2015).

# 1 Introduction

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*This chapter begins with an introduction, explaining the importance of the addressed topic. Later on, aim and objectives of this study are stated. Thereafter, the research question is introduced and in the last section the limitations of the study are discussed.*

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The automotive industry is not only a leading sector worldwide, but it is also an important actor in the German economy. More than 20% of the total domestic industry revenue is generated by the automotive industry alone (GTAI, 2018). Nevertheless, the automotive industry, once called “the industry of the industries” by Peter Drucker (Drucker, 1995), is facing a lot of disruptions. Shortened innovation life cycle, cost pressure and globalization are changing the way companies manage their supply chains. Consequently, automobile companies choose to focus in their core competences and to outsource what it is not considered as a core activity. As a result, specialized suppliers can produce the required products at a lower cost, with better quality and more efficiently. Therefore, outsourcing becomes a central part of the strategy of companies.

As more and more activities and production are outsourced to external parties, companies become more dependent on their suppliers. Therefore, purchasing, and specially supplier selection, gains a central role. The strategic value of purchasing lies in selecting a world class supplier base, developing and maintaining strategic relationships and managing these in a more efficient way than the company’s main competitors (Van Weele, 2005).

For the reasons stated above automotive suppliers are also gaining an important role. German tier one suppliers within the automotive industry have been expanding their strong position over the last years and increased drastically in revenue and profitability (GTAI, 2018). Some companies such as the brake supplier, Knorr-Bremse, even achieved an increase in revenue by 16% in 2017 (Berylls, 2017). The supplier industry in general has performed more successfully than the OEM’s, which increases the importance to pay more attention to this limitedly researched fraction of the industry (Berylls, 2017).

Some scholars, such as Dickson (1966), Bayraktar (2003) Nauman Abbasi (2015) or Galankashi (2016), have conducted valuable research on the selection process and selection criteria within manufacturing and the automotive industry. Yet, the literature within the topic of supplier selection in the automotive industry focuses mainly on the car manufacturers and

OEM's themselves and the selection of tier 1 suppliers. No research can be found that states the selection of tier 2 suppliers specifically. Moreover, according to our best knowledge, there is no research to be found on the selection process within the truck industry specifically in the German context.

Considering the above mentioned situation as a research gap, this master thesis aims to identify the supplier selection criteria used by German tier one suppliers to choose tier two suppliers, especially in the truck sector. The ultimate goal is to produce worth mentioning insights for practitioners and academics, which could lead to further research on this topic.

## 1.1 Aim and Objectives

The aim of this master thesis is to examine and understand the key supplier selection criteria that German tier 1 suppliers use for selecting tier 2 suppliers in the truck industry.

Particularly, this master thesis aims to: understand the supplier selection process conducted in automobile tier one suppliers; to map activities developed during this process and to identify supplier selection criteria, the decision-makers and their roles. The ultimate objective is to bring more insight into academia regarding the supplier selection process of tier 2 suppliers.

## 1.2 Research Question

In order to fulfill the previously mentioned objective, the following research question is defined:

Within the supplier selection process conducted in German tier one truck companies, which are the key decision criteria for the selection of tier two suppliers?

To support the research question, the following sub-questions have been established:

- a- What are the activities executed during the supplier selection process in a German tier one truck supplier?
- b- Who is involved in the supplier selection process of a German tier one truck supplier and what are their roles?

## 1.3 Research Limitations

This thesis will center itself in the purchase of key raw materials or components needed for production, denominated direct materials and will exclude the indirect spend which is composed by all goods and items that a company purchases that are not related with the main business of the company (examples of these goods are office desktop, maintenance goods and consulting services).

Moreover, the sourcing process is very broad and complex in the automotive industry. Therefore, this master thesis will only focus in one stage of the purchasing process, the supplier selection, and the criteria used in this process.

This research paper is set up as a study on the German automotive truck industry and focuses on the selection process of tier 2 suppliers as conducted by tier 1 suppliers. Hence, the selection process and the criteria set out for this will only be applicable to this particular setting. The findings will only be able to be comparable to companies within the German truck industry.

The limitations further include the applicability to companies with a different set up, processes and structures than the ones present at the company that facilitated the collection of the empirical data, as other structures may entail a different set of selection criteria and an adapted decision-making process.

## 1.4 Outline of the Thesis

This research study is divided into six chapters. The first chapter presents the topic, the research question and the issue that is aimed to be addressed and the objectives, as well as the limitations of the study. The second chapter describes the literature review and the theory that was used as a background to the empirical study and displays theoretical concepts and models used in practice. The third chapter describes the methodological approach used to answer the research question, including the research design, approach of data collection and analysis. The fourth chapter introduces the results of the empirical study. Chapter five includes a discussion of the results based on the literature review and the empirical study. The last chapter contains the conclusions and the contribution of the thesis, as well as suggestions for future areas of research.

## 2 Literature Review

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*In this chapter the frame of reference used in this thesis is described. The chapter starts with a characterization of procurement as a strategic function (2.1). In the following sub-section, the purchasing process (2.2) is presented. Thereafter, the role of the decision makers (2.3) is explained. Following in sequence, supplier selection methods (2.4) are explored. The chapter finishes with a summary (2.5) of the topics included.*

---

Within the automotive industry, as well as within other manufacturing industries, companies are confronted by the situation of having to make a strategic choice between producing a product or component internally or having another company produce it for them and buy it externally. General definitions differ between the terms of in-house production and outsourcing (Balakrishnan & Cheng, 2005). Outsourcing describes the act of obtaining services, semi-finished or finished products from an external source (Proth, 2010). Tier 1 suppliers must take that strategic decision on a continuous basis. Either they just purchase the raw materials and produce all semi-manufactured products themselves or they outsource and have them manufactured elsewhere with a tier 2 supplier. When making this decision, the companies need to consider additional aspects on the criteria that their products need to fulfill, such as the level of quality. They have to decide whether this factor needs more control by being produced in-house or if the level of trust in the supplier is high enough to contract the production outside (Wisner, et al., 2005). Wisner (2005) further states, that outsourcing becomes an aspect that companies should carefully think about. Cost considerations, as well as the use of excess capacity are factors that could drive companies towards in-house manufacturing. Yet, companies often outsource because of the lack of resources or capacity associated with the manufacturing process. Other firms might often have deeper knowledge, better technology or more experience, besides the cost considerations.

Lately, there has been a shift towards lean manufacturing within manufacturing industries, which has resulted in an increase in the choice of companies to outsource their production efforts. From 2000 to 2018, the global market size of outsourced services rose from \$45.6 billion to \$85.6 billion (Statista, 2019). The habit of outsourcing led to complex supply chain within the automotive industry, which generally includes five parties: Tier 3 (raw material) suppliers, Tier 2 suppliers, Tier 1 suppliers, Truck manufacturers, retailers and the end

consumer. For example, Volvo trucks places an order with Knorr Bremse for a certain quantity of braking systems for their trucks. Knorr Bremse, as a tier 1 supplier purchases pistons from DT as a tier 2 supplier to integrate them into the braking systems for trucks. Consequently, DT, purchases a type of plastic called PP6 from another company named Ems-C, which produces plastic as a raw material. In the last step, Volvo truck, receives the braking systems which are made with components from tier one, tier 2 and tier 3 suppliers and integrates them into their truck production. The finished product, the truck is then delivered to retail partners in order to distribute them to the market. (For an overview of the supply chain, please see 8.1: Appendix A)

Within this supply chain, there are multiple partnerships resulting in a broad network of tier 1, tier 2 and tier 3 suppliers linked to an automotive manufacturer, which ultimately generates a vast network of distributors again and an even bigger network of customers. Within these networks, there is a constant flow of products down the supply chain and a continuous flow of information up the supply chain. (Sadraoui, 2014)

Over the years, with an emerge of globalization and trade, the supplier networks became broader and decision-making within the supplier selection increased in complexity (Petroni, 2000). Companies, such as tier 1 suppliers, are part of a network that entails vast amounts of suppliers and customers, resulting in a more complex supply chain that needs to be managed properly. (Sharma et al., 2018) Supply chain management is defined as the management of information, knowledge, resources and activities linked to the flow and transformation of goods and services within the supply chain, from the raw material supplier to the end user (Mentzer, et al., 2011). Van Weele (2010) supports this definition and adds that supply chain management not only includes procurement but also encompasses all logistics activities. Hence, procurement entails a lot of processes that will be emphasized in the following chapters.

## 2.1 Procurement as a strategic function

Procurement is defined as the act of acquiring goods or services from an external source (Chartered Institute for Procurement and Supply (CIPS), 2015). Purchasing and sourcing are related concepts that are used as synonyms in this master thesis.

Following the classic value chain model from Porter (1985) purchasing is classified as a support activity. However, Van Weele (2005) challenges Porter's approach of procurement as a support activity and states that there are mainly two types of procurement with distinctive implications for managers. Purchasing for a primary activity: "direct purchasing" with its main function to secure the materials and components for daily operations. This is generally the biggest spend in manufacturing companies and includes all the parts and components needed for production. Purchasing as a support activity: "indirect purchasing" involves the purchase of items that are not related to the company's main business. Examples of these items include but are not limited to equipment and machinery; computers hardware and software; office equipment; cleaning materials and maintenance goods. Direct spend, the type of purchasing that this thesis will focus on, is the most strategic spend and this area gets most of the attention from management. According to Van Weele (2005) the largest cost of goods sold (COGS) is taken by procurement in many manufacturing industries. In the typical production, purchasing goods represents 50% of the production parts. However, retail and automotive are the industries in which procurement takes respectively 85% and 80% of the total cost of goods, giving this function in those industries a particularly important role (8.2: Appendix B).

The final price of a vehicle derives greatly from the cost of the components and materials used in the production. Particularly in the truck business unit, 75% of the final price of a truck is based on the price of its components (Leo, 2019). Hence, the cost pressure is mirrored to not only tier 1 but also to tier 2 and tier 3 suppliers.

Suppliers are expected to face a few challenges in the future that they will have to deal with in order to stay competitive. Slowing growth will be a factor that will put pressure on margins, further there is an accelerated change of technological focus into new technologies, increasing the cost with unclear Return over Investment (ROI) (Berger, 2018). The emergence of software will act as a key differentiator between the suppliers, resulting in intense competition due to existing competencies becoming obsolete. Additional cost pressure will come from the commoditization of hardware parts and disaggregation of systems, as suppliers will be forced to increase their operational level of efficiency. Further is there the factor of growing investor pressure to increase the shareholder value perceived. (Berger, 2018)

Under these circumstances cost reduction is part of the corporate strategy with the aim to secure competitiveness. As a result of the cost pressure and the complex supply chain, procurement gained a more important role in the company's strategy, especially in the automotive industry.

Within strategic procurement multiple processes take place. How these processes look like is explained in the following chapter.

## 2.2 Purchasing Process

The purchasing process is composed out of many steps and usually starts with the requirement of a firm for a new component or good, a request that is often given by the R&D department, and ends with the final step of an evaluation of the received goods from an outside supplier (Rozemeijer & Van der Valk, 2009).

The following figure presents the different activities that have to be done in each step of the sourcing process and the elements and documents needed in each stage. Each of the following six steps will be explored in detail in this section.

Figure 1: Interfaces in the Purchasing Process

	Define specification	Select supplier	Contract agreement	Ordering	Expediting	Evaluation
P&S Role	<ul style="list-style-type: none"> <li>• Get specification</li> </ul>	<ul style="list-style-type: none"> <li>• Assure adequate supplier selection</li> </ul>	<ul style="list-style-type: none"> <li>• Prepare contract</li> </ul>	<ul style="list-style-type: none"> <li>• Establish order routine</li> </ul>	<ul style="list-style-type: none"> <li>• Establish expediting routine</li> </ul>	<ul style="list-style-type: none"> <li>• Assess supplier</li> </ul>
Elements	<ul style="list-style-type: none"> <li>• Functional specification</li> <li>• Technical changes</li> <li>• Bring supplier-knowledge to engineering</li> </ul>	<ul style="list-style-type: none"> <li>• Prequalification of suppliers</li> <li>• Request for quotation</li> </ul>	<ul style="list-style-type: none"> <li>• Contracting expertise</li> <li>• Negotiating expertise</li> </ul>	<ul style="list-style-type: none"> <li>• Develop order routines</li> <li>• Order handling</li> </ul>	<ul style="list-style-type: none"> <li>• Expediting</li> <li>• 'Trouble-shooting'</li> </ul>	<ul style="list-style-type: none"> <li>• Supplier evaluation</li> <li>• Supplier rating</li> </ul>
Documents	<ul style="list-style-type: none"> <li>• Functional specification</li> <li>• Norm/spec control</li> </ul>	<ul style="list-style-type: none"> <li>• Supplier selection proposal</li> </ul>	<ul style="list-style-type: none"> <li>• Contract</li> </ul>	<ul style="list-style-type: none"> <li>• Order</li> </ul>	<ul style="list-style-type: none"> <li>• Exception report</li> <li>• Due date listings</li> <li>• Invoices</li> </ul>	<ul style="list-style-type: none"> <li>• Preferred supplier list</li> <li>• Supplier ranking scheme</li> </ul>

Source: van Weele (2010)

Before explaining each step, some considerations will be discussed.

The purchasing process is initiated by a business need, which in the case of a manufacturing company could be identified as a new component for serial production. In order to meet the business's need successfully, technical specifications are determined by the engineering, technical or R&D department. This works as a guideline on what is the right equipment or component to be bought by the firm. Rozemeijer (2009) points out that the specifications set the starting point for the supplier selection. To select an appropriate supplier, the market is

being assessed in regard to who can deliver the service, component or machinery and who of these suppliers is the best alternative in fulfilling the technical specifications for the manufacturing company (Rozemeijer & Van der Valk, 2009). In this framework, purchasing is considered as a process and the quality of the output of each step is related with the quality of the input from the step before. Malfunctions in one of the steps may negatively impact the output of the following step. Each interface of the process should be defined, and activities should be possible to be tracked (van Weele, 2010).

Many departments are included in the sourcing process, hence purchasing can be seen as a cross-functional responsibility within the organization. The sales department provides forecasts which are translated into purchasing quantities to be ordered. Engineering and R&D departments provides specifications that set a guideline to be followed. (Toppari, 2009) Wynstra (1998) developed a framework explaining the relationship between engineering departments and purchasing departments that can be found in 8.3: Appendix C. The way specifications are established is crucial as it may lead to monopolistic suppliers. Restriction in the specifications is a very common bottleneck in the automotive industry. For a deeper overview about common bottlenecks in the industry, please check 8.4: Appendix D.

The management team also has an important role because it evaluates spend and approves the budget for materials and resources necessary. Therefore, clear communication is essential, responsibilities should be defined in each department and cross functional team should be set in order to avoid conflicts and bottlenecks (van Weele, 2010).

The last comment about the purchasing process is that only limited times the process is made completely. That only happens in first-time purchasing. Regardless if the purchase is related with direct or indirect materials, purchasing transactions differ. According to Robinson et al. (1967) first time purchases are not the most common ones. The author identified three purchasing situations of different nature: new-task situation, modified rebuy and straight rebuy.

**New task situation.** This situation occurs when the company decides to buy a new product or component from a new supplier. This purchase is characterized by a high degree of uncertainty and risk-taking. Employees involved in this task normally deal with a lot of problem-solving situations and time pressure.

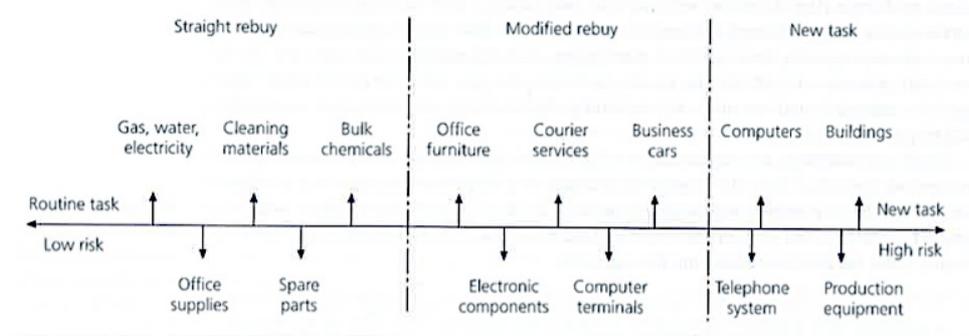
**Modified rebuy.** This situation is present when a new product will be purchased from a known supplier or a current product will be sourced by a new supplier. In this situation uncertainty is lower than in the case before.

**Straight rebuy.** This is the most common situation and occurs when a serial product is purchased frequently from the same known suppliers. In this case the uncertainty is low because the conditions with the suppliers have been previously set and the supplier has experience supplying the part or component. These items are ordered automatically by the system directly from the department without intervention of the purchasing department.

This framework clearly shows that the uncertainty level that the buyer deals with is strongly related with the type of purchase. As higher spend and technical complexity, the risk of the purchase also increases, which is translated into more decision makers. If the decision makers are not well organized in the Decision-Making Unit (DMU) problems may arise.

Some examples of these three purchasing situations can be observed in the figure below.

Figure 2: Task Situation and Degree of Risk involved



Source: (van Weele, 2010)

After covering all the notes about the purchasing process, this process will be explained in detail below.

**A- The specification Phase**

In this stage of the process the company has to decide which activities will be performed and which ones will be outsourced to other parties. In other words, the company has to face the

question “to make or to buy”. After this phase, the part or components that are decided to be contracted externally are chosen. In order to proceed to select the supplier, specifications are designed. (Munthiu, 2009) Specifications can be either functional or technical. Functional specifications describe the functionality that the product must have for the user. The user could be either the person who uses the product or the person that has to take the financial decision about the product. It is the person who approves the budget. On the other hand, technical specifications describe the technical properties and characteristics of the purchase as well as the activities to be performed by the supplier (van Weele, 2010). Both documents, functional and technical specifications, are part of a bigger document called “purchase order specification”. This document also contains quality specifications, logistics specifications, maintenance specification, legal and environment requirements, and optionally a target budget. (van Weele, 2010) After the business needs has been translated into technical and functional specifications, the following stage starts.

### **B- Supplier Selection and Supplier Assessment**

As most supplier selection frameworks point out, supplier selection encompasses several activities. To begin with, the subcontracting method has to be defined (van Weele, 2010). Secondly, the alternatives within the market are being assessed, suppliers are analyzed, and the preliminary bidding list is created (Galankashi, et al., 2016). Third, the request of quotations (RFQ) are sent and the bids received are evaluated. Forth, the selection of the supplier is made.

Subcontracting methods can be either Turnkey Subcontracting or partial subcontracting. Turnkey subcontracting is characterized by the allocation of the full assignment (even including design) to the supplier. On the other hand, partial subcontracting offers the possibility to divide the whole task and allocate it to different suppliers. The coordination between the tasks is the buyer’s responsibility. In the following figure, advantages and disadvantages of both methods are shown. (van Weele, 2010).

Table 1: Advantages and Disadvantages of Turnkey and Partial Subcontracting

	Advantages	Disadvantages
Turnkey Subcontracting	Limited interference by principal during project execution	No insight in cost/price structure of project
	No experience in similar projects required from principal	Limited influence only on materials used (quality and quantities)
	Limited efforts from principal required	
Partial subcontracting	Better insights in cost/price structure of project by principal	In-depth knowledge and experience from principal required
	Better grip on suppliers and material used	Much time and effort required for project coordination and monitoring
	Lower overall project costs in general	Risk that communication problems may delay project activities

Source: Adapted from van Weele (2010)

In the second step, suppliers are analyzed. To begin with, a long list of bidders is made. Normally included are the best suppliers, which the company has experience with and those who are reliable. These suppliers will be invited to submit a request for information (RFI). This information submitted by vendors will be used to assess if the supplier has the capabilities to provide the part of product. Suppliers that are classified as capable are short-listed and they receive a Request for Quotation (RFQ) in order to submit an offer. Usually the bids should be sent electronically in a system allowing the buyer to compare offers easily. These activities are part of the tender process. This tender can be open or closed. An open tender is a bidding process in which supplier qualifications are not required. A closed tender is characterized for inviting only a small number of suppliers, which had been carefully shortlisted. (van Weele, 2010) After the offers are received, they are carefully revised, and a comparison is made based on the chosen supplier selection framework that best matches the specifications of the company. (Galankashi, et al., 2016)

After the supplier is chosen, the delivery conditions will be negotiated with the supplier. It can be possible that for certain parts or products more than one supplier is chosen and the volumes are split between them. This is known as dual or multiple sourcing. Suppliers that had not been selected, receive feedback why their proposal was rejected by the company in order to be able to improve their offer for upcoming bids. (van Weele, 2010)

**C- Contract Agreement**

After the supplier is selected, the contract should be negotiated. The contract varies greatly according to the product, the industry and the company. However, there are certain aspects that

are essential. These are price and delivery conditions, penalty clauses, warranty conditions and terms of payments. (van Weele, 2010)

Van Weele (2010) further states different kinds of contracts used in purchasing agreements to set prices, which include: fixed price plus incentive fee; cost-plus contract; cost-reimbursable contracts and agreement with price adjustment (escalation clauses). This contract is particularly used in the automotive industry and preferred when there is a long-term delivery or when the market is sensitive to some of the materials needed. The price is linked to a price index based on external factors like labor costs and material sub-charges (van Weele, 2010).

Regarding terms of payment, it varies greatly according to the purchasing power of the client, but in general some payments are accepted in advance, because the supplier needs resources in order to produce the product. The preferred method of payment is based on supplier performance. For instance, 20% of the payment when 25% of the work is done (van Weele, 2010).

Penalty clauses and warranty conditions are always present in the contract. Suppliers must assure that they will provide goods that are of good quality in accordance with the specifications. Moreover, these goods have to be new and free of defects. The ranking of the supplier will depend partially on how many parts with defects are sent by a million pieces. This is known as parts per millions (PPM). Another important aspect is system responsibility. It is common to demand from the supplier that the product should be delivered during its economic or technical lifespan. Therefore, maintenance and spare parts should be available during this period, as truck producers are required to maintain their vehicles sometimes up to 20 years. This means that the suppliers should be able to deliver parts for the same period of time. (van Weele, 2010)

#### **D- Ordering Process**

After the contract is in place, a purchase order is placed. For serial production and inventory items, the alert is generated automatically for requirements planning systems that matches the volume needed for production and the available inventory (van Weele, 2010). When inventories get lower than a minimum acceptable level, an alert is sent to the purchasing department to place an order. This is normally not made by the strategic procurement department but rather by service centers of the company located in the plant or outside of the headquarters. Normally, a purchase order contains the following: order number, product description, unit price, numbers

of units required, delivery time, delivery plant or address and invoice address (van Weele, 2010). All this information should be included in the invoice generated by the supplier in order to facilitate quicker matching of the information. When delivery times or required quality levels are not respected by the supplier, this should be immediately communicated to the supplier in order to be improved for future deliveries (van Weele, 2010).

#### **E- Follow up and evaluation of the buying process**

According to van Weele (2010) the purchaser's role continues even after the part is delivered. Problems may arise and prices and delivery conditions may be re-negotiated. Furthermore, in case of investment goods, maintenance activities should be done. In case of serial parts, follow-up tools may be ordered after the lifespan of the tool has reached its end. Another task particularly important in the automotive industry, is to secure the supply of spare parts. Finally, the cycle is closed when supplier quality and delivery time are recorded in order to rank supplier for future business award (van Weele, 2010).

## **Variables that Affect the Purchasing Process and the Supplier Selection**

There are several factors that influence the outcome and the process of purchasing. The most relevant for the manufacturing industry are the ones characterized below (van Weele, 2010).

**Characteristics of the product.** There are different types of products that can be purchased in the manufacturing industry and each of them entails a set of particularities. For example, it is not the same to buy raw materials, highly technical semi-manufactured products or aftermarket products. Raw materials and commodities are characterized by big purchase orders and fierce price negotiations. Therefore, this task is normally made by commercial purchasing executives or top management. Complex products entail more technical professionals and purchasers are supported by engineers and R&D departments because these professionals know the complexity of the part better. Aftermarket products are characterized by low quantities and low levels of negotiation. The challenge here is to secure the low quantity production made by suppliers. These parts are normally not attractive to suppliers but completely needed by the clients. Therefore, commercial purchasers are normally in charge of managing the relationships with suppliers.

**Strategic Importance of the purchase.** Not all the purchases have the same level of urgency or importance. The degree of importance of an item is not only defined by the amount of money spent but also by the quality and security. Maybe there are parts or components that are not specifically expensive, but their right functioning affects the security of a certain product. There are other items that may not seem that relevant but without that parts bottleneck could be created or the production could be stopped. In manufacturing companies, the stop of production should be avoided at almost any cost. Therefore, management of the company is involved in these procurement decisions.

**Sums of money involved in the purchase.** In most of the companies higher spends means higher executives involved in the decision process and more and more employees have to approve the transaction in order to be finalized. Therefore, in raw material negotiations, big investment capital discussions and expensive products, the top management participates in the negotiations.

**Characteristics of the purchasing market.** Relationships with suppliers and external stakeholders are very different in highly regulated industries like pharma and less controlled

industries like retail. Moreover, negotiations in oligopoly or monopolies industries have a different dynamic than negotiations in more competitive markets. As a result, the supplier relationship will differ based on the characteristics of the purchasing market.

**Degree of risk related with the purchase.** Risk is not only related to the product but also to the suppliers. Normally, when the product is new and has not reached the serial status or if the supplier is new, the risk is higher and more observed by management. With time there are certain suppliers that are trusted, and the supply is considered as low risk.

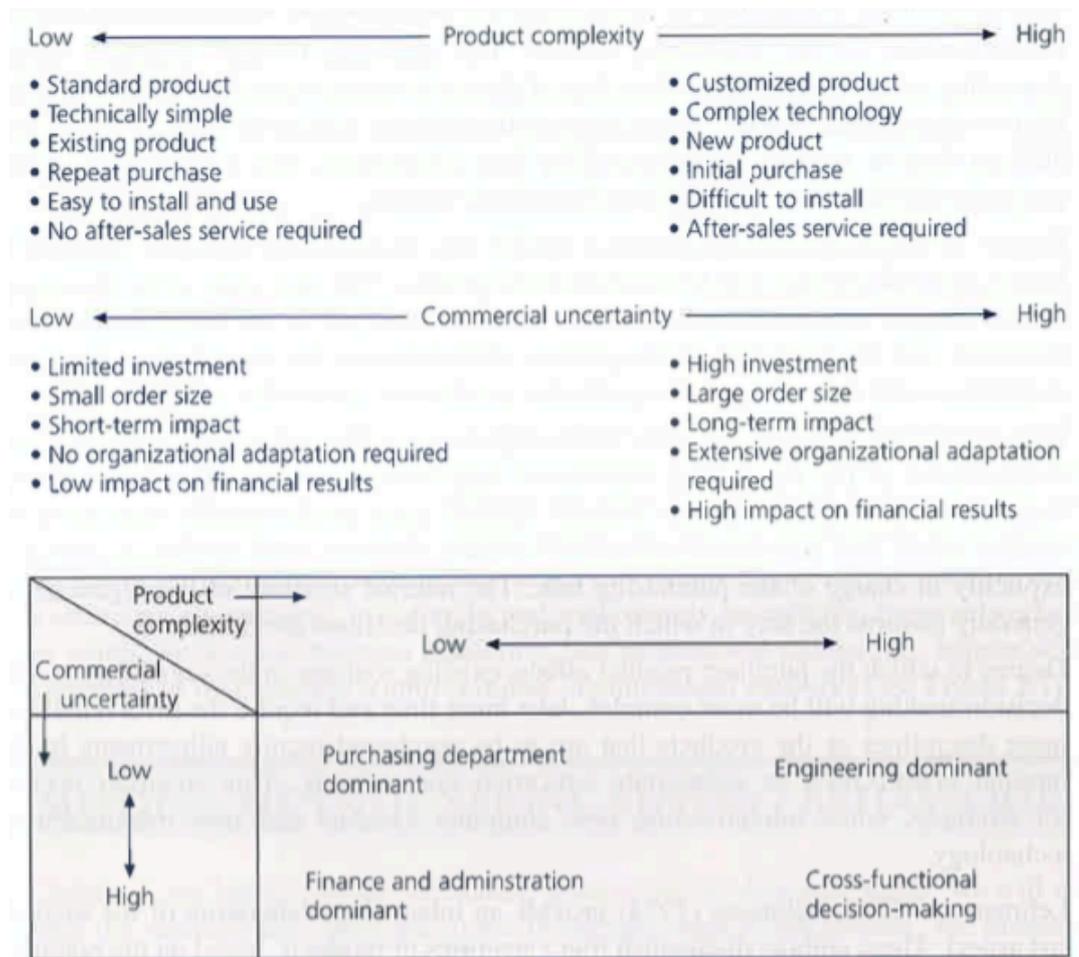
**Role of the purchasing department in the organization.** The role of the purchasing department in an organization depends mainly on two factors, the size of the organization and the industry in which the company is immerse. Big companies normally have more professional purchasing departments because the expenditure is higher and small firms divide the tasks between administrative professionals. The industry is also important because it will establish which kind of purchasing (direct or indirect) is the more prevalent one. For example, in pharma companies indirect spend is extremely higher than direct spend. In contrast in automotive industry direct spend is the biggest and most important. As direct spend can affect the competitiveness of the company substantially and affects its bottom line directly, in automotive companies the role of the purchasing department is more predominant than in pharma industry.

**Degree to which the purchase product affects the existing routines in the organization.** Purchases that alter the daily duties of employees will require the involvement of more decision-makers in its approval than other purchases. Examples of this are new software or manufacturing technologies.

In the academic world there are different opinions about factors that alter the purchasing decision process. According to Fisher (1970) there are mainly two variables that influenced this process. The first one is the complexity of the product and the second one is the commercial uncertainty.

The characterization of these two variables can be seen in the following figure.

Figure 3: Typology of Buying Situations



Source: Fisher (1970)

## 2.3 The Role of Decision-Makers

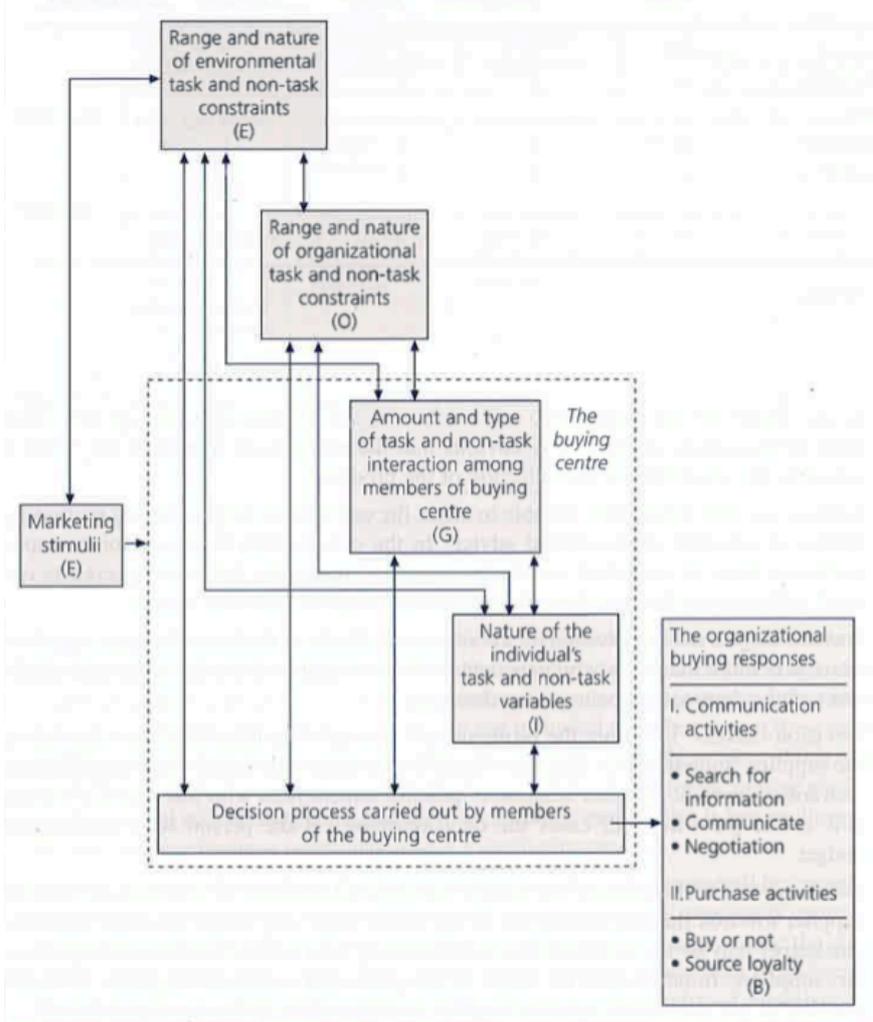
The variables mentioned before are mainly logical but there are other authors that mention psychological, cultural and subjective factors that affect the buying decisions. According to Wester and Wind (1972) individuals that make buying decisions are influenced by task and non-task variables. Task variables are all commitments, goals and objectives related to the role that a person fulfills in an organization. For example, quality engineers will focus on quality targets without considering price as a decision variable while purchasers will take exactly the opposite approach. Non-task variables are attributes of the personality of the individuals involved in the decision process like risk aversion, willingness to negotiate, tolerance to uncertainty, willingness to avoid or accept supplier confrontation, between others. Wester and

Wind (1972) also state that these attributes can be seen not only on a personal level but on a department or even company level. This perspective is also shared by Sheth (1973).

In regard to the people involvement in the purchasing process, Wester and Wind (1972) presented another interesting observation which states that due to the high complexity of organizational purchasing, these decisions always involve more than one person. The authors define this group as “buying center”. This concept was also explored by Robinson et al (1967), yet the author refers to this group as “decision making unit” (DMU).

This model developed by Wester and Wind (1972) in which the buying center is described can be seen in the following figure.

Figure 4: Model of Organizational Buying Behavior



Source: Wester and Wind (1972)

Each of the members has a defined role with different tasks in the purchasing center. The decision stages and roles can be observed in the following table.

*Table 2: Decision Stages and Roles in the Decision- Making Unit*

	User	Influencer	Buyer	Decider	Gatekeeper
Identification of need	X	X			
Establishing specifications and scheduling the purchase	X	X	X	X	
Identifying buying alternatives	X	X	X		X
Evaluating alternative buying actions	X	X	X		
Selecting the supplier	X	X	X	X	

Source: adapted from Wester and Wind (1972)

As developed by Wester and Wind (1972) the roles in a decision-making unit are users, influencers, buyers, deciders and gatekeepers. Users are the people that are going to work directly with the product or component. Influencers are people that are able to influence the outcome of the purchasing process, for example cost analyst can advise about the price of a product and foster or prevent its purchase. Buyers are the people in charge of placing the orders and negotiating the contracts and delivery conditions with suppliers. Decision makers are normally directors or managers that can sponsor the supplier selected through the sourcing committee. Gatekeepers are people that control the flow of information from suppliers to the buying center. One example could be a director’s secretary or an operational buyer.

Decision-makers within the supplier selection process share a high level of responsibility. The supplier selection is set out as a fixed yet flexible process that needs to be managed efficiently to have a successful and sustainable supplier-buyer relationship in place in the end. All the variables affecting the decision-process need to be considered. Furthermore, the process is also facilitated by set frameworks and decision variables that help the DMU to assign the most appropriate supplier as an alternative within the market. The following chapter will explain in detail, what process the DMU has to conduct to successfully carry out a supplier selection and what variables they have to take into account.

## 2.4 Supplier Selection Methods

Supplier selection is the second step in the purchasing process and involves the activity of selecting a supplier in order to acquire the necessary raw materials and goods to use as an input in the client firm's businesses (Mettler, 2009).

To select a supplier, scholars have developed a broad selection of methods that aim to be used in practice to make the supplier decision process more objective and systematic. These methods can be classified as mathematical/statistical, Total Cost Approaches (TCA) or categorical. Regarding the mathematical approaches, literature names the Principal Component Analysis (PCA) and the Artificial Neural Network (ANN) (Bello, 2003). The most relevant total cost approaches include the Cost Ratio Approach introduced by Timmerman (1986) and Total Cost of Ownership developed by Ellram (1990). Categorical models include but are not limited to the Analytical Hierarchy Process (AHP) developed by Saaty (1988). Explaining in detail how these methods work in practice is not relevant to the aim of this study and exceeds the scope of this master thesis. However, it is considered that it is important for the reader to understand the existence of these methods.

In the following section, supplier selection criteria used in these methods are explained.

### **Supplier Selection Criteria**

Once the decision method is chosen, the decision criteria that must be included in the model, must be also selected. How these criteria is chosen and which criteria to choose, is a topic that has been covered by several authors. As this topic is the center of this master thesis, an overview of the most relevant theory is explained below.

The first one to introduce criteria for the evaluation of supplier was Dickson in 1966 (Dickson, 1966). He established a set of 23 criteria to facilitate the evaluation and selection of supplier that were split into four different levels of importance. With high importance, the criteria of quality, delivery, performance history and warranties & claims policies were established. Ranked within the section of great importance were production facilities and capabilities, price, technical capability, financial position, procedural compliance, communication system, reputation and position within the industry, desire for business, management and organization and operating controls. The criteria that scored medium importance were repair service,

attitude, impression, packaging ability, labor relations record, geographical location, amount of past business, and training aids. The only criteria that was considered low importance was reciprocal arrangements. (Dickson, 1966) For an overview of the selection criteria, please see appendix E: 8.5.1

Ellram (1990) took another approach than Dickson and had the focus set on more qualitative criteria to enable the development of long-term cooperation between supplier and purchaser. The set of criteria he developed was divided into four categories as well, yet not related to an importance score: financial aspects, organizational culture and strategic issues, technology issues and other factors. The financial aspects included the economic performance and the financial stability of the supplier. Within Organizational culture and strategy issues, the criteria were trust, management attitude/outlook for the future, strategic fit, top management capability, capability across levels and functions of buyer and supplier firms and the supplier's organizational structure and personnel. The technology issues incorporated criteria such as the assessment of current manufacturing facilities/capabilities, the assessment of future manufacturing capabilities, the supplier's design capabilities and the supplier's speed of development. Other factors of criteria included the safety record of the supplier, its business references and the supplier's customer base. All of these criteria were selected by Ellram (1990) with the objective to enable and stimulate the creation of long-term partnerships to secure sources of supply on a constant basis. For an overview of the selection criteria, please see appendix E: 8.5.2.

Weber et al. (1991) took an approach to set criteria for the selection process specifically tailored to the manufacturing and retail industry. The authors follow a similar approach set by Dickson and differentiate between great and low importance of the criteria. While net price, delivery and quality are considered the dominant criteria, other criteria rank less high in importance and include the production facilities and capabilities, geographical location, technical capabilities, management and position in the industry, reputation and position in the industry, financial position and performance history. (Weber, et al., 1991) For an overview of the selection criteria, please see appendix E: 8.5.3.

Another criteria framework by Cebi & Bayraktar (2003) is related to the work of Ellram (1990) and sorts the criteria into the four categories of logistics, technology, business and relationship. The criteria of logistics include the sub-criteria of delivery time, support lots, flexibility and reliability. Technology entails the capacity to meet demand, the involvement to formulating

new products, the improvement effort in their products and processes and problem-solving capability. Within business, the sub-criteria are reputation and position, financial stability and management skills and compatibility. The last aspect of relationship is made up of the sub-criteria of easy communication, past experience and sales representative's competence. (Cebi & Bayraktar, 2003). For an overview of the selection criteria, please see appendix E: 8.5.4.

Another set of criteria that takes a similar approach than Ellram (1990) and Cebi & Bayraktar (2003), can be found within the research of Galankashi et al. (2016). The set criteria are divided into Financial, Customer, Internal Business and Learning & Growth. Under these categories, sub-criteria applicable to the automotive industry are shaped according to different scholars and include the price of product, quality of product, distance to manufacturer and economic value added within the financial criteria; service and delivery, reputation, rate of sales return, supply chain collaboration level and market share within the customer criteria. The criterion of internal business entails the technical capability, productivity, production capability, inventory turnover and flexibility (design, make, delivery); while competitiveness, employee satisfaction, knowledge sharing, standards consideration and health and safety issue level complete the criteria of learning & growth. (Galankashi, et al., 2016) For an overview of the selection criteria, please see appendix E: 8.5.5.

Using four criteria is a common approach among researchers as other divide the criteria in e.g. technical capacity, quality, warranty period and innovation (Shen, 2013); or quality, closeness of the relationship with suppliers, delivery on time and price (Boran et al. , 2009). While other used more criteria in their frameworks, such as technical capacity, quality price, financial position, production performance etc. (Büyükožkan & Çifçi, 2011). Hence, it can be assumed that the scholars have based their work on the previous work established for this topic.

The selection criteria chosen to test in this master thesis have been developed by Nauman Abbasi et al. (2015) specially designed for the automotive industry in Pakistan. The aim of the authors is to explore if these supplier selection criteria can be applicable to the automotive sector in Germany.

Nauman Abbasi et al. (2015) criteria was selected because it includes a wide set of variables and it was specially designed for the automotive industry, making this framework the most relevant for this master thesis. Additionally, this framework includes the best aspects from other scholar's work. To begin with Nauman Abbasi et al. (2015) takes a criteria and sub-criteria

approach, which was already used by Ellram (1990); Cebi & Bayraktar (2003), and Galankashi (2016). This gives a deeper understanding of the criteria and sub-criteria can be adapted easily for different companies. Another point that makes Naumar Abbasi's framework superior is that it includes financial and subjective attributes together. It includes subjective criteria like cultural match and financial criteria like cost and quality. These financial aspects are missing in other academic frameworks like the one's from Cebi & Bayraktar (2003), and Ellram (1990). However, other authors like Dickson (1966) and Weber (1991) recognize the high importance of these financial attributes. Lastly, Naumar Abbasi's set of criteria was based on criteria repeatedly cited in the most relevant studies in supply chain. Later on these criteria were prioritized by purchasing managers especially from the automotive industry. In the empirical part of this master thesis, these criteria and sub-criteria is examined and prioritized by purchasing managers of the automotive industry in Germany.

According to the model, ten major supplier selection criteria and forty-two sub criteria were identified and prioritized. The criteria and sub-criteria can be visualized below.

Table 3: Variables for Supplier Selection Framework by Nauman Abbasi et al. (2015)

Criteria	Sub-Criteria	Importance
Quality	ISO9000	High
	Continuous improvement	
	Operation improvement	
	Quality inspection	
	Internal rating system	
Delivery	Lead time	High
	Delivery capacity	
	Meeting due date	
	Consistent delivery	
	Meet random fluctuation in	
Cost	Inspection cost	High
	Order placement cost	
	Research cost	
	Transportation cost	
	Holding and disposal cost	
	Purchase price of material	
Technology	Technical expertise level	Medium
	Availability of testing facility	
	Automatic partner selection	
	Technical compatibility	
	Order entry and invoicing system	
Communication	Frequent communication	High
	Use of EDI, internet etc.	
	Sharing confidential information	
Services	Repair services	Medium
	Warranties and claims	
	Efforts in eliminating waste	
Integration and Relation	Impression of supplier firm	Medium
	Supplier Strategic importance	
	Extra advantage	
	Cultural match	
	Labor Relations	
	Attitude towards order	
	Effort in promoting JIT	
Capability	Personal capability	Low
	Process capability	
	Financial capability	
	Market share	
	Top management capability	
Flexibility	Procedural flexibility	Low
	Flexibility to meet the unexpected	
Safety	Safe delivery	Low
	Transit safety measures	
	Safe staking/packaging	

Source: Nauman Abbasi et al. (2015)

These ten criteria were prioritized and grouped in critical, supportive and maintaining. Critical are the most significant in the supplier selection, supportive are moderately significant and

maintaining are least significant (Nauman Abbasi, et al., 2015). As a conclusion quality, cost, delivery of goods and communication were ranked as the most important criteria. Technology, integration, relationship and services were classified as moderately significant. Lastly, capability, flexibility and safety has been declares as maintaining criteria.

This study concludes that Quality is the most relevant criteria to select a supplier in the automotive industry. Price is allocated in the second position and delivery in the third place. These findings are contrasted in the empirical work section of this master thesis.

## 2.5 Chapter Summary

Globalization is a process that has emerged over the years and is now shaping most industries. Supply chains have become broader and more complex. Companies now do not handle a few supplier-buyer relationships but are rather part of a complex network of extensive size. Business is done cross-borders and there is an increasing innovation and cost pressure in the automotive industry. As a result, many automotive companies opt for outsourcing non-core activities in order to stay competitive. Hence, supply chain management became an essential topic for firms.

Consequently, procurement gained a more protagonist role in the company's strategy, especially in the automotive industry. Managers focus on direct spend of the company, as this directly impacts the financial result of the firm. The purchasing process in manufacturing companies is divided into five phases: the specification phase, supplier selection and assessment phase, contract agreement, ordering process and the follow up phase. Supplier selection is the most critical phase in the purchasing process. Therefore, choosing the right supplier is essential.

This decision is not made by an individual but rather by a Decision-Making Unit (DMU). Hence, it is important to consider the role of each participant. Literature suggests that the decision-making process is facilitated by the use of a supplier selection framework and established sets of supplier selection criteria. Several scholars have developed frameworks and criteria sets mostly focused on manufacturing industries in general and only a few focuses on the automotive industry. However, these theories focus on specific industries or countries and therefore their applicability in other contexts, that differ from the studied one, is limited.

# 3 Methodology

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*The following chapter provides a disclosure of the methodological choices made to conduct this research and starts with a description of the research approach (3.1). Thereafter, the research design (3.2) is explained, followed by the unit of analysis (3.3) and data collection method (3.4) of this study. Subsequently, a description of the data analysis (3.5), the ethical aspect of the study (3.6) and the reliability and validity (3.7) is provided.*

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## 3.1 Research Approach

When approaching a research topic, the researcher has an option of three different approaches, namely a deductive, inductive or abductive approach. The deductive approach starts with developing a hypothesis based on an existing preselected theory and then setting up a strategic research that proves that hypothesis (Saunders, et al., 2009). Opposed to this, the inductive approach is defined as first gathering the necessary data and subsequently looking for theories that explain the set of data (Collins, 2010). The abductive approach can be described as taking elements of both, the deductive and inductive approach, and explaining incomplete observation with the best explanation derived from theory (Gadde & Dubois, 2002).

For this study an abductive approach was chosen, due to the benefits of combining a deductive and an inductive approach and its suitability to the research. The desk research highlights concepts related to the topic of procurement and strategic management, the purchasing process, supplier selection methods and selection criteria. To answer the research question a framework by Nauman Abbasi et al. (2015) was chosen that emphasizes a set of supplier selection criteria that was established for the Pakistani automotive industry. This mater thesis assesses if the aforementioned framework can be applied in a different geographic setting: in the German automotive truck sector. Moreover, improvements of the framework are presented in the discussion chapter (5.0).

The research is set up as a single case study that follows a qualitative approach, in order to answer the following research question: “Within the supplier selection process conducted in German tier one truck companies, which are the key decision criteria for the selection of tier

two suppliers?” This approach was chosen because the research question of this study has an explorative and open-ended nature, therefore taking this approach is beneficial as research is conducted in a business area (McManus & Edmonson, 2007). A relevant case company was chosen and interviewed in regard to their purchasing process. The aim is to observe what supplier selection method they apply, what supplier selection criteria are used and who the decision-makers involved are. In chapter five empirical results are contrasted to Nauman Abbasi et al. (2015) framework to observe the applicability of this study in a different geographic set-up.

### **Limitations**

This study is established as a single case study due to the short timeline scope of this research. Therefore, the results of this study cannot be generalized. Another limitation is the level of confidentiality that the employees of the case company are bound to. Therefore, secondary data from the framework will be used to fill eventual gaps.

Additionally, the framework developed by Nauman Abbasi et al. in 2015, was originally a research study on the Pakistani automotive industry. Pakistan is a developing country, which entails different needs and requirements than those emphasized in developed countries. Therefore, our research will also test if this factor has an influence on the findings of the selection criteria.

## **3.2 Research Design**

The research design as such is a general description of how the researchers aim to answer the outlined research question and how to address the research topic. The research design highlights all research activities undertaken to generate the final findings, such as the approach chosen to collect the data needed to fulfill the aim of the study. (Yin, 2013)

A framework was chosen, that emphasizes the supplier selection criteria within the Pakistani automotive industry. The research aims to assess whether it is feasible to apply this framework to the German automotive truck industry.

This research is designed as a single case study with a qualitative methodology approach. The research design chosen for this study is a combination of collecting secondary data as well as

choosing a qualitative method by conducting interviews. As this research is of exploratory nature, the qualitative method approach is more suitable than a quantitative one, as the data deriving from this approach can be considered richer and more detailed (Yin, 2013).

In facilitating this study secondary data has been collected through databases, relevant scientific articles, scientific books, websites, case studies and company reports. The primary data will be collected through a semi-structured interview process conducted with employees from Knorr-Bremse AG.

### 3.3 Unit of Analysis

The research unit is considered the unit to which the results of this study apply, namely the sample unit used in this study is a German tier 1 supplier in the automotive truck industry, Knorr-Bremse AG. The company was selected using a sampling approach.

As a sampling technique, non-probability sampling has been used. Due to the short-term nature of this study, convenience sampling was applied. This means the sample population was chosen based on availability (Trochim, 2002).

The research method used is of qualitative nature, therefore employees of Knorr-Bremse AG have been interviewed regarding the topics of supplier selection and the selection criteria used.

The interviewees were chosen based on their work position and experience within the company and occupation. Each interviewee presented in this study is occupied within a managerial or buyer position at Knorr-Bremse AG, that entails a respective amount of responsibility and power of decision. Further, each interviewee has been working for the case company for a period of at least 5 years. Choosing the interviewees based on their position within the hierarchical pyramid and their work experience is beneficial. It enables an enhancement in reliability of the collected data due to profound experience and knowledge of the participating interviewees.

The empirical findings of this research are based on the contribution of 7 interviewees, all employees of Knorr-Bremse AG. The number of interviews was chosen based on availability of selected employees. The employees who have been interviewed have a different amount of work experience within Knorr-Bremse and the automotive industry in general. The respondents

were divided into different professional occupations. The respondents were one Category Buyer, one Project Purchaser, three Global Category Director and one head of Supplier Delivery Assurance (SDA) and one Global Sourcing Manager.

### 3.4 Data Collection Method

The data collected within this research study is both of primary and secondary nature. The secondary data was collected through desk research, while the primary data was the result of semi-structure interviews conducted at the tier 1 supplier Knorr-Bremse AG.

The secondary data is displayed within the theoretical framework and is mainly derived from literature review. The topics address concepts such as the purchasing process models, supplier selection methods as well as selection criteria.

Primary data was collected through semi-structured interviews guided by an interview outline (please see appendix F: 8.6). Nauman Abbasi (2015) framework was showed to the respondents and used as a guideline for discussions. Following this approach was considered the most preferred method, as the research is of exploratory nature and a qualitative methodology has been chosen (Saunders, et al., 2009).

The interview style was chosen to facilitate the flow of in-depth information and follow up questions to avoid misunderstandings and achieve a more detailed knowledge of the topics addressed, as well as generating a more extensive set of data to generate more satisfying findings. The interviewees were addressed with open questions, allowing them to answer them more freely and to express more personal experience, to generate deep insights and subsequently a rich set of data (Saunders, et al., 2009).

The interview guide was used as a broad guideline to follow during the interview, to provide the interviewee with the questions beforehand and to ensure an active discussion without losing the focus of the topics covered in this study. The interview guide is divided into three sections, all covering individual topics. Section A starts with the background information on the interviewee, such as its position and experience. Section B continuous with questions covering the theory, such as asking the interviewee about fixed processes and theoretical concepts present at Knorr Bremse. It further introduces the criteria set by Nauman Abbasi et al. (2015). The last section, Section C, will address the interviewees opinion on topics related to the study.

The questions stated in the interview guide gave the interview a direction, nevertheless, follow up question were asked and the order of the questions were altered to some extent during the interviews to allow a natural flow of the conversation and to gain access to knowledge that the questions of the interview would have not generated eventually. Additionally, the follow up question allowed for a steering of the interview into details that were considered of high relevance to answer the research question.

Before the interview, the interviewees were informed of the nature of this study, its aim and provided with the criteria framework of Nauman Abbasi et al. (2015). The interviews itself lasted between approximately 45 to 75 minutes and were conducted over the phone. To ensure an optimal processing of the data captured, the interviews were recorded after permission of the interviewees was granted. Furthermore, notes were taken during the interview to enable follow up questions.

### 3.5 Data Analysis

The analysis of the data gathered started with taking the recordings of the interviews and transcribing them into written text. Vast amounts of empirical data were collected through the qualitative approach and have been organized into individual transcripts of each interview (Saunders, et al., 2009)

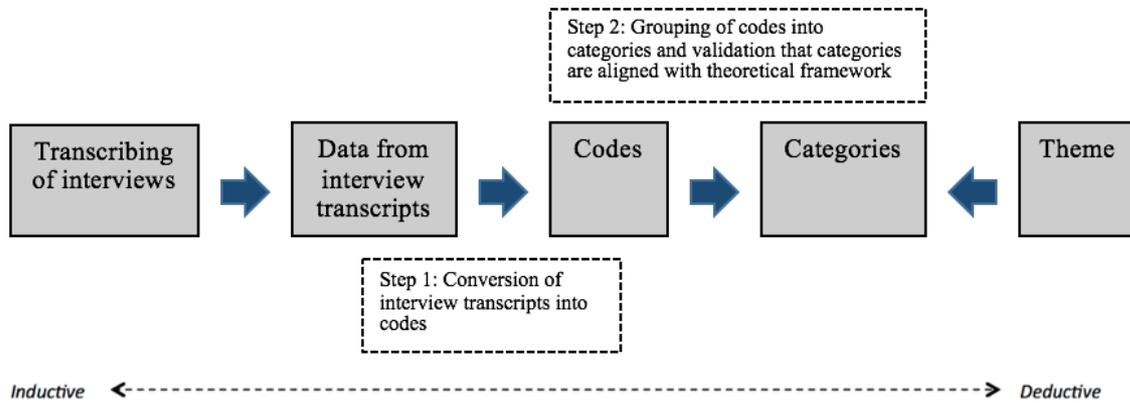
The first step in analyzing the data collected through the interviews was to convert the transcripts into codes. The codes were categorized in a way not related to the theoretical findings yet, but to what the interviewees stated as categories of information that can be used to answer the research question in general.

The next step of analysis included grouping the codes established before into categories that match the theoretical framework based on the theme of the study. By doing so, relevant relationships within the collected information is recognized. This deductive analysis approach enables to identify whether the theoretical perspectives covered in chapter two, capture the identified codes of the primary data from the interview.

The categories for analyzing the data are the following:

- Supplier Selection Process
- Supplier Selection Criteria
- Decision-Making Unit

Figure 5: Data Analysis Approach



Source: Own compilation based on desk research

### 3.6 Research Ethics

Ethics are a great deal to the process of data analysis. Procurement is highly influenced by a company’s strategy and companies want to protect their capital of unique processes and techniques. Therefore, a high level of confidentiality throughout the research is maintained.

The employees of Knorr-Bremse are bound by the confidentiality contract of the company, which needs to be taken into account. The interviews will be conducted anonymously, and no information of the employees will be stated except for their work experience and their occupation. Further person-related information will not be given. The privacy of the employees will be maintained at any times.

### 3.7 Validity and Reliability

External reliability takes into account that the results of a research have to be inherently repeatable and the same results may be generated by others who conduct the research under the same circumstances (Explorable, 2017). Validity can be divided into several sections and

describes if the results of a research are truthful and if the purpose of the research has been fulfilled. Internal validity states the degree to which a research result can be manipulated, while external validity refers to the degree to which research results can be generalized (Institute for Work and Health, 2017).

The internal validity is affected by the biases that the sample unit presents within the decision-making process. Therefore, in order to improve the data credibility and multiple data sources were used to collect the primary and secondary data. Moreover, is the primary data collected through multiple interviews to minimize the influence of biases.

The qualitative approach used in this study entails some disadvantage in regards to the external validity, as the generalization of the results is to some degree limited (Yin, 2013). Furthermore, this research is conducted as a single case study, hence there will be discrepancies applying the findings to companies within the same field of business or even other industries.

### 3.8 Chapter Summary

To conclude, the approach taken to fulfill the aim of this research was considered to be adequate. In order to answer the research question, a vast amount of rich data was needed that could have been only generated through the combination of secondary data and a qualitative method.

The framework of Nauman Abbasi et al. (2015), has helped in facilitate a successful conduction of semi-structured interviews at Knorr-Bremse. The interview guideline has helped in achieving the results and amount of rich data needed to address the research question.

The approach chosen for the data analysis seems straightforward, nevertheless was the process of analyzing the data a constant back and forth across the entire data set limited by some confidential information not disclosed by Knorr-Bremse's employees. The analyzed data showcased in the following chapters is the result of research, persistence and a constant review of the interview transcripts to ensure that all relevant aspects covered in the interviews are displayed within this study.

# 4 Findings

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*The following chapter provides the findings observed after conducting the empirical work. The findings are divided into the categories of purchasing process (4.2), supplier selection Tool (4.3), Supplier selection criteria (4.4), and Decision- Making Unit (4.5).*

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## 4.1 Knorr-Bremse

Knorr-Bremse is a German braking systems manufacturer. The company was founded 1905 in Berlin and is headquartered in Munich, Germany. Currently, the organization employs a number of about 27.500 employees, that enabled the company to generate a revenue of over €6.0 billion in 2018. Knorr-Bremse is present in over 30 countries, selling its product portfolio which includes intelligent door systems, transmission control systems and many more. (Knorr-Bremse AG, 2019) The company is further expanding its success and aims to grow further which is proven by an increase in revenue by 16% in 2017 (Berylls, 2017).

The company was chosen using a convenience sampling method and based on an existing network with the company.

Knorr Bremse is an automotive tier 1 supplier. This means that the company is client for tier 2 supplier, but it is also a supplier for big OEMs companies. This dual role has implications in the design of the sourcing activities. From now on Knorr Bremse will be called the “Case company”.

## 4.2 Purchasing Process

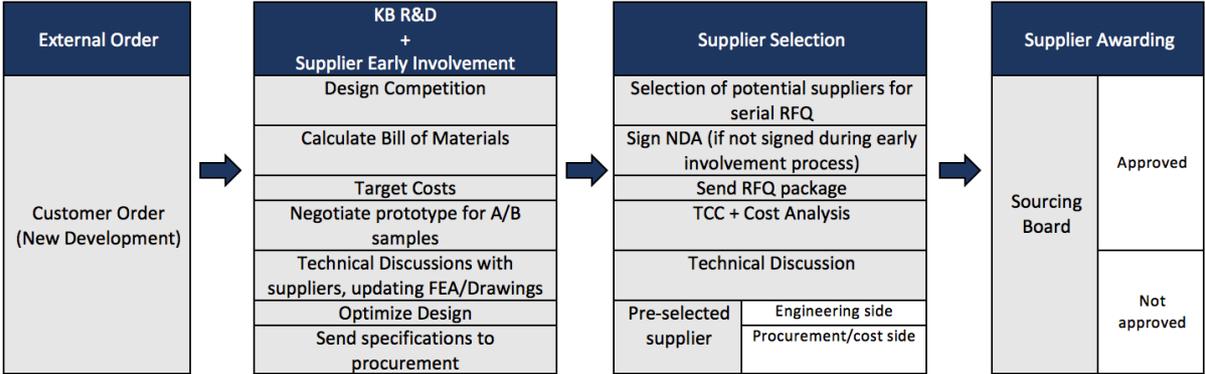
The empirical work showed that the purchasing process activities in the case company are organized differently according the type of purchase. In direct purchasing, the case company mainly distinguish between three types of purchase: Development projects, VA/VE projects and Resourcing projects.

### **Development Projects and VA/VE projects**

A development project is a project that is completely new and starting from the very beginning. An example of this is an order of an adapted brake system that it is not yet in the case company’s

portfolio by a new or current customer. The company has to develop this product for this specific customer. This is the starting of the sourcing process. In this type of process R&D department and procurement department work together very closely. A simplified overview of the process can be seen below.

Figure 6: Purchasing Process of Development and VA/VE Projects at the Case Company



Source: Own compilation based on empirical data.

The process starts with the customer’s order for a new development. As the case company is an automotive tier one supplier, its customers are OEMs. After the order is placed, the first step is the “supplier early involvement” in the development of the project. At this stage, design competitions could be done, and the suppliers collaborate with the case company in order to design some parts of the project. During this stage the company draws up the Bill of Materials (BOM)<sup>3</sup>. Furthermore, during this stage, technical discussions are made with suppliers in order to improve the design of the parts. Once the specification<sup>4</sup> is ready, it is submitted to the procurement department. It is important to notice that this specification can still change.

Once the procurement department receives the specifications, the second stage of the process “supplier selection” starts. The procurement team proceeds to check in the Supplier Master List<sup>5</sup>, which suppliers are considered capable to produce this part. Once the potential suppliers

<sup>3</sup> The Bill of Materials (BOM) is a list with all the raw materials, parts or components that are need it for elaborating a certain product.

<sup>4</sup> A specification is a technical document, a drawing of the part. In this document there are stated all the technical qualifications that the parts or components must fulfill. This document is intended to be read by engineers or technical experts. Technical Specifications, specifications and drawings are used as synonym in this master thesis.

<sup>5</sup> The Vendor Master List is a listing of all vendors entered into the company internal system

are identified, they are including in a bidding list and the RFQ is prepared. The RFQ is a package of documents that is submitted through an internal system. The objective is that the suppliers receive all the information possible in order to understand the part. Once the part is understood, suppliers know whether they are able to produce this part and at which price.

Before sending the RFQ for a new development, suppliers have to sign a Non-Disclosure Agreement (NDA) (if they have not signed it already during the supplier early involvement phase) in order to receive detailed information about the parts that they are required to quote. After the NDA is signed by the supplier and by the case company, the RFQ is submitted to the potential suppliers. Supplier evaluate the RFQ and, in a specified period, normally two weeks, the supplier submits an offer or decline to quote the part and states the reasons why.

After all the suppliers have submitted their quotations or when the deadline for submitting quotations expires, the next task starts. In the following step, quotations are compared in a total cost base approach (not all aspects of the theoretical TCA are implemented) and the best suppliers are selected for a technical discussion. The technical discussion is organized by the purchasing department. The engineering team from the case company and the suppliers discuss and align technical aspects. Simultaneously to these activities, the purchasing department starts the negotiation of prices, tooling costs and commercial conditions. After these activities took place, one supplier is selected jointly by the engineering department (technical aspects) and the purchasing department (cost and commercial aspects). Once the supplier is chosen this stage ends. The following stage is the awarding process. During this stage the pre-selected supplier is approved or not approved formally in a process called “sourcing board”. This process is explained in the following section (4.3).

It is important to notice that the same purchasing process stated above applies for VA/VE<sup>6</sup> projects. VA/VE stands for Value Analysis/Value Engineering. This is a manufacturing process commonly used in automotive with the aim of increasing process efficiency, design improvements, and better use of resources. As a result, cost is also reduced.

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<sup>6</sup> VA/VE is a process first developed by General Electric Co. during World War II for improving manufacturing and reducing costs (VaVe , 2016).

## Resourcing Projects

Resourcing, in the context of automotive purchasing, means exchanging the current supplier for another one. An example of a resourcing project is when a component currently sourced by a supplier became too expensive and then a new supplier is needed.

A resourcing project differs from a new development project, as the supplier’s early involvement is not needed. Therefore, the simplified purchasing process for a resourcing project can be visualized below.

Figure 7: Purchasing Process of a Resourcing Project at the Case Company



Source: Own compilation based on empirical work

This process starts with an internal need. This internal need can be, between others, that the current supplier is not competitive anymore, that the supplier has a lack of capacity or that it is not fulfilling the quality or delivery obligations. Therefore, a new supplier is needed.

The supplier selection process starts with the creation of the RFQ package. Later on, target prices<sup>7</sup> are defined and the bidding list<sup>8</sup> is created by the procurement team. After this task, the RFQ package is submitted to the suppliers with a limited timeline to submit their quotations. When suppliers send back their quotations or the deadline expires, the offers are analyzed based on a total cost approach. This means that according to the case company “logistics, transportation, packaging, warehousing and quality-related costs are important line items that influence our sourcing decision”. After costs are analyzed, the purchasing department start negotiations with the suppliers to obtain the target prices. After this process, one supplier is pre-selected and similar to “development projects”, this supplier moves forward to the following stage: the awarding. During this step, the supplier is approved or not approved during a

<sup>7</sup> Target prices are the prices that a company is willing to pay for a certain part or component

<sup>8</sup> Bidding List is a list where the potential suppliers are combined. These suppliers will receive the RFQ.

decision-making process called “sourcing board”. This process is explained in detail in the following chapter.

### 4.3 Supplier Selection Tool

The formal supplier selection procedure is called “sourcing board”. During this process, an already pre-selected supplier<sup>9</sup> is evaluated by different decision-makers based on several criteria. The sourcing board can be local, regional or global and it is conducted in a virtual space where all the stakeholders participate. More information about the participants it is explored in section 4.5. The frequency of the sourcing board varies depending on the type of it and the business needs. The outcome of this process is that the pre-selected supplier is approved or not approved. In order for the sourcing board to be approved, not every participant has to approve it. There are certain actors at higher levels of the hierarchy that can overrule others.

Is important to mention that further details about the sourcing board or the dynamics of the process are sensitive information for the case company and therefore cannot be disclosed.

Also, it is important to notice that according to respondents, the case company does not have any mathematical or statistic models for the selection of suppliers. The selection is based on the fulfillment of a set of certain criteria that are priory established by the company itself. These criteria used by managers are covered in the following section.

### 4.4 Supplier Selection Criteria

After the empirical work had been conducted at the case company, the supplier selection criteria were prioritized. The prioritization of the criteria can be observed in the following figure.

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<sup>9</sup> Please refers to section 4.2 to learn how this pre-selected supplier is chosen.

Figure 8: Prioritization of Supplier Selection Criteria by the Case Company

High Importance	Medium Importance	Low Importance
Quality	Communication	Capability
Delivery		
Cost		
Technology	Services	Integration & Relation
Flexibility		
Capacity	Safety	
Sustainability		
Supplier Strategy		
Contract Compliance		

Source: Own compilation based on empirical work.

**High Importance Criteria**

Cost is a high importance criterion because the price of automotive vehicles is highly influenced by the price of the purchased components. This means that procurement in the automotive industry is extremely cost driven and “*low purchase costs are critical to stay competitive in the market*”.

Delivery time is also considered as a high importance criterion. Respondents classified delivery as another essential feature. According to them, one of the worst scenarios is if parts/components do not arrive on time to the case company’s plants on time because that can cause a “stop in our customer’s productions”. The case company’s clients are big truck manufacturing companies. When KB does not fulfill their contractual delivery times, the client could face stops and delays in production as well. This is a high cost for the case company, which according to one interviewed employees, “*has to be avoided at all costs*”.

Another highly important criterion is quality. All respondents highlighted this criterion as critical. In the automotive industry, quality is not a luxury feature but a safety one. The quality of the parts assures that the semi-manufactured product function correctly. A global category director explained that in the case of the case company, who produces brakes for trucks, there

are certain parts that are critical, because if they fail in their intended function, it can cause that the brake does not work properly. Moreover, another respondent stated that either for critical or not critical parts, “quality is a cost”. Several respondents expressed that all the parts or components that arrive at the case company and do not fulfill the quality standard cannot be used and must be returned, causing a waste of money and time.

The empirical findings showed that technology is another key feature of high importance, because in the automotive industry several developments are shared with the suppliers. A respondent explained “*we as a company request a product or component that fulfills certain functions and it is up to the supplier to design the right solution for us*”. In these cases, the development is shared and a “manufacturing design contract” must be signed in advance.

Flexibility is a critical criterion, because sales forecasts are not always available or accurate and the case company is expected to be flexible regarding the demand of their customers. Therefore, the case company’s suppliers must be flexible as well concerning quantities. As one respondent stated “*by contract, requested volumes can increase or decrease by a certain percentage*”.

### **Medium Importance Variables**

Communication is a medium important variable, as frequent communication and readiness to serve the client’s needs are a feature that is essential not only for the client but also for the supplier. Which means that, as the case company is a huge client and a big player in the market, suppliers want to keep it as a client. A respondent stated, “*good communication is a “given feature” by the supplier. Normally that requirement is fulfilled by all suppliers and it doesn’t represent a competitive advantage*”.

Services are considered medium importance in the automotive, as warranties must be fulfilled. In the case of the truck sector, the case company is obliged to provide its products for sometimes “*as long as twenty years or even more*” according to one respondent. The truck industry does not develop new models each year causing the same model being in the market for a long time. Therefore, aftermarket products<sup>10</sup> have to be available even longer than the product is produced. For this reason, suppliers of the case company also have to follow this regulation.

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<sup>10</sup> Aftermarket parts are vehicles parts, equipment and accessories that are sold after the sale of the vehicle.

## Low Importance Variables

At the case company, integration and relation is considered as a criterion of low importance, because the “impression of the supplier firm” is not ranked per se but it is measured by performance. The sub-criterion of cultural match is also not considered as a criterion at the case company. A respondent had the following statement: “*In the automotive industry, especially as a big client, we expect our suppliers to deliver globally*”. Which means that the supplier does not have to have a cultural match, but rather the ability to adapt to different working cultures. Moreover, sub-criteria included in this criterion, such as “extra advantage”, “labor relations”, and “attitude toward orders” were not recognized by the respondents as typical sub-criteria variables in the automotive sector.

Capability of the employees is a criterion that is considered of low importance within the criteria set of the case company. This is since it is up to the supplier to ensure that processes and employees are performing well to fulfill the client’s requirements. A respondent pointed out that the case company “*cannot check this criterion*”, therefore it is not relevant for the supplier selection criteria.

## Improvements to the framework

According to the respondents, the two least important supplier selection criteria, integration and relation and capability, can be deleted from the framework. The capability of the supplier’s employees is something the case company cannot test. In regard to integration and relation it was also consider not relevant besides only one sub-criteria which is “supplier strategic importance”.

The respondents further identified additional relevant supplier selection criteria that had not been included in the framework. One of the respondents, a global category director with 15 years of experience in purchasing in the automotive industry and 10 years of experience in the case company expressed that contract compliance was missing. The respondent stated: “*We have several contracts like Master Supply Agreement, Liability Contract, Logistic Contract, EDI Contract, Tooling Contract<sup>11</sup> and Non-Disclosure Agreement (NDA), that were not*

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<sup>11</sup> Master Supply Agreement, Liability Contract, Logistic Contract, EDI Contract, Tooling Contract are contracts used frequently in purchasing in the automotive industry. Each company may have different names for that but its function is the same, which is to regulate different commercial and technical aspects.

considered within the framework, you showed me. A supplier that fails to fulfill the contract compliance will not be selected". Therefore, this criterion was evaluated as a high priority by the case company.

The same respondent also identified a number of sub-criteria that were missing in the quality criteria. The first one is the quality scalation level, which is internally called PAVE level at case company. This criterion measures the capability and speed in which the supplier can correct quality issues.

Another global category director with 15 years of experience in purchasing in the automotive industry and 9 years of experience in KB, expressed that capacity is another criterion that is missing in the framework. Capacity measures the ability or inability of the supplier to increase their production efforts. Related to the aspect of capacity, the supplier has to sign a "feasibility agreement" in which it is stated that he knows the specifications related to the product and that he is able to produce it accordingly.

It was highlighted that another criterion called "supplier strategy" should be included in the criteria framework as well. In the automotive industry, suppliers are internally classified as strategic, preferred or standards. Suppliers that are classified as strategic are more likely to be selected. Therefore, this criterion should be valuated as of high importance. The respondent suggestion is in accordance with the supplier evaluation process conducted internally. According to the supplier competitiveness and performance, the supplier is strategically classified. This classification can be seen below.

Figure 9: Supplier Classification done by the Case Company



Source: Knorr Bremse (2013)

Four interviewees also mentioned that sustainability should be included as an additional criterion. They stated the case company's clients are requesting more and more compliance with sustainable aspects, measured in several ways. Therefore, suppliers should comply with some sustainability KPIs and code of conduct.

Another interviewee, Global sourcing director with 27 years of experience in purchasing in the automotive industry and 25 years of experience in the case company, pointed out some other relevant features: *“For us the location of the manufacturing plants of the supplier is relevant. We operate globally and we have to know that our supplier is able to meet our needs at this level”*. Another factor to consider is whether the supplier is only an automotive supplier or not and whether the countries in which the supplier has production facilities are considered low cost countries or not.

Another respondent identified another two important criteria related to the interdependency rate that the supplier and the case company have. The respondent stated that the supplier dependency rate was an important factor, as the case company is a major customer and that there are small or medium companies, that center their business around the case company. Hence, Knorr-Bremse as a company cannot represent more than 30% of the total sales of the supplier. This regulation is in place to avoid risks.

## 4.5 Decision-Making Unit

As it was described in section 4.3, the supplier selection process at the case company is called “Sourcing Board“. During this process several decision-makers and stakeholders from different departments are involved. The responsible departments include Category Purchasing, COC purchasing<sup>12</sup>, Quality and Supply Management. Below these departments are characterized. Thereafter, their roles in the decision-making process is explained.

Category purchasing is in charge of purchasing products that are in serial production. This department is the main contact point for the sale's department of the supplier. Category

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<sup>12</sup> COC stands for Center of Excellence and it is comparable what in other companies is called a “Business Unit”.

purchasing is in charge of building and managing the relationship with suppliers and also to negotiate contracts and prices between other commercial activities.

COC purchasing, is known as “project purchasing”. This department is in charge of assuring the right sourcing<sup>13</sup> of materials or components for new projects or developments. Their function is to be the connecting point between R&D and category purchasing. This department is further in charge of moving projects forward to pre-established milestones and to allocate the sourcing budget. The difference between category purchasing and COC purchasing is that category purchasing is in charge for products that are in serial production, while COC purchasing is in charge for new products that are still in development but not yet in production.

The Quality department is in charge of doing all the activities required to guarantee that the quality of the part or product is according to the business needs. Quality is more involved in the late stages of the sourcing process when the supplier is already awarded. This department is mainly responsible for technical discussions with the supplier regarding quality. Also, it is in charge of assuring that the quality documentation is available.

The Supply Management department is in charge of assuring that deliveries are according to business needs. Taking into account not only to the delivery time but also to delivery locations. Some products are produced simultaneously in different plants worldwide. Hence, the supplier should be able to cope with shipping their products globally.

### **Decision making in each department**

Category purchasing is in charge of presenting the business case<sup>14</sup> in the sourcing board. This means that the supplier that will be evaluated is presented by this department and most of the relevant information about the supplier is gathered by this team. The objective is to get the approval of the other decision makers in the remaining departments. Inside category purchasing, the leader is the “global category manager”, who is in charge of developing the sourcing strategy. He is the presenter of the business case in the regional and global sourcing board.

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<sup>13</sup> Purchasing, procurement and sourcing are used as synonyms in this master thesis.

<sup>14</sup> The pre-selected supplier is presented as a “business case”.

COC purchasing, is known as “project purchasing”. This department supports category purchasing. The decision-makers are the “global directors COC purchasing”. Quality is in charge to assure that the selected suppliers fulfill all the specifications provided by the case company. The decision-makers are “plant quality managers”. Supply Management is in charge of assuring that deliveries are according to business needs. The decision-makers are “head of material excellence/supply chain management”.

More detailed information about each of the participants of the sourcing board and the roles and responsibilities that each of them entail, is considered as sensitive information by the company and hence, not disclosed.

# 5 Discussion

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*The aim of this research paper was to assess how the supplier selection process is being conducted in tier 1 supplier companies within the German automotive industry with a specific focus on the truck industry. This chapter discusses the findings stated in chapter 4.0 in contrast to the existing literature presented in chapter 2.0, that was examined as part of this research paper.*

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## 5.1 Complex Supply Chain

Knorr Bremse is situated right in the middle of a complex supply chain. The case company acts as a customer to tier 2 suppliers as well as being a supplier itself to OEM's. Which means that the case company has big responsibilities with their clients as well as high requirements to their suppliers.

Knorr Bremse customers are big OEMs which produce heavy vehicles in an industry in which safety is critical. The case company produces complete brake systems for OEMs. This means that right functioning of this product is critical for the overall safety of the truck. As a result the case company has to follow high quality, performing and safety standards while simultaneously has to keep competitive prices to not lose market share with its main competitor WABCO.<sup>15</sup> On top, the case company has recently become public through an IPO<sup>16</sup>, hence there is an internal performance pressure to fulfil investors' expectations.

Under this context, the pressure that the case company receives from their clients and internally is transmitted to their suppliers. These compete fiercely in order to not lose a big stable customer which orders big quantities. As a result, supplier selection in an automotive becomes a critical strategic activity not only for OEMs but also for tier one suppliers as well.

The right supplier selection is also critical to mitigate risks. An underperforming supplier can not only affect the quality of the final product but can also create inconvenience in several internal departments. A bad supplier can cause that operations and manufacturing cannot proceed

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<sup>15</sup> WABCO is an American provider of braking systems for heavy duty vehicles.

<sup>16</sup> IPO stands for Initial Public offering and it is the process of offering shares of a private corporation to the public.

production; R&D cannot execute further joint development; Controlling cannot register the correct spend and so on. Therefore, the supplier selection criteria is essential, as by using the right set of criteria the risk will be minimized. These aspects are further discussed in the sections below

## 5.2 Purchasing Process

In general, our findings regarding the purchasing process show that in practice the process is more complex and entails more steps than the literature expresses.

The literature usually covers a standard purchasing process that is applied to all sets of product purchases. In practice, the case company makes a distinction between different purchasing processes that are dependent on the type of purchase that is being made. The case company distinguishes between the purchasing process of development projects and VA/VE projects and the process conducted for resourcing projects. Development projects and VA/VE projects are comparable what scholars calls “new task situation” characterized by high uncertainty and risk. On the other hand, resourcing project purchases are called in literature as “modify rebuy”. At the case company it was not found a case comparable with the one called in the literature as “straight rebuy”. The explanation could be that this process is done automatically by logistic systems in the plants and therefore it is not a responsibility of the purchasing department.

Literature suggests that the purchasing process is initiated by the need of the case company for a new component. The case company states two sources as initiators, namely an external order when a customer has a new development (development & VA/VE projects) or an internal need, when the case company sees a cost saving opportunity or faces the issue of an underperforming supplier (resourcing project).

The next step within the literature is to define the specifications that the product needs to fulfill and to draw up the “purchase order specification”. In practice, this only applies to one type of purchase within the case company: the development and VA/VE projects. What is a whole step in the literature, is one activity included in a bigger phase called “supplier’s early involvement” in the case company. Yet, this phase within the purchasing process includes multiple steps more than theory suggests.

The following step within the theoretical concept is the supplier selection, which is also backed up by the case company. Scholars established that first suppliers are analyzed and a preliminary bidding list is created. Then the case company sends out the RFQ and all the offers are received. What is missing in the framework is a more exhaustive and detailed identification of all the activities that are conducted during the supplier selection process. The case company has different procedures for different types of purchases that are not reflected in the literature.

As the final step the company points out an additional phase within every purchasing process they conduct, the supplier awarding. In the literature this is included within the phase of supplier selection. Theoretically, this is facilitated by the use of a supplier selection framework which have been established by numerous scholars. The case company, however, uses a tool called the sourcing board. This tool results in a decision to either approve or disapprove the pre-selected supplier based on a number of selection criteria.

It is important to highlight that even though, the literature recognizes different types of purchases, it presents the same process for all of them. The only different is that in the simplest purchases some steps of the process are excluded. In practice, in simplest purchases (resourcing projects) the process is not only shorter but also different.

The literature explains the purchasing process as much simpler as it is done in practice. Moreover, purchasing in automotive industry is more complex than in other industries and this is not reflected in the literature. The purchases within automotive are different to the ones made in textile, pharma or other industries. In automotive many parts, components and technologies are developed jointly with suppliers. Hence, the complexity of the purchasing process is higher, several department are involved and more customized phases are need it according to the needs of the company, making for scholars difficult to generalize and to map the complete process.

### 5.3 Supplier Selection Tool

While conducting the empirical work of this research, it was assessed that no supplier selection frameworks that were stated within the examined literature were used in practice by the case company. Research suggests a multiple number of frameworks that entail different approaches on how to select a supplier in practice. Those frameworks can be either of mathematical or categorical nature. Available research is rich in mathematical models and poor in categorical

models. Neither a weighting process nor a framework is being used by Knorr-Bremse. The case company makes use of a tool called Sourcing Board. The tool is a type of categorical approach but highly adapted to the requirements of the case company. Most of the categorical models still include measures that decrease the level of subjectivity, by setting up a list of weights. This is not the case with the Sourcing Board. The tool evaluates one single supplier that was appointed by the engineering and the purchasing department, which meets the requirements of what is needed. The supplier is evaluated using a set of criteria established by the case company. The result of the Sourcing Board is either approved or not approved and the decision is made by top management. Yet, not all criteria on the sourcing board must be fulfilled. We assessed a relevant limitation of the supplier selection tool, as management can overrule the selection process. In order to avoid biases or an extensive influence of subjectivity, it would be beneficial to set up some measures and requirements within the sourcing board that diminish the influence of subjectivity. Those measures could be, if some certain sub-criteria of high importance are not approved but the criterion in general is, the supplier will not be approved. Another could be, if a certain % of the management does not approve a certain % of the sub-criteria of the criteria, the supplier will not be approved.

As this is a single-case study, the findings cannot be generalized to every tier 1 supplier within this industry. There is a possibility that other companies may use the proposed frameworks for the selection of suppliers. Yet, during the conduction of the research we have not encountered one research that states the application to a company. It can be argued that the models established in theory, specially the complex mathematical ones have limited application in practice. Reasons for this may be that the frameworks are so complex that they would take too much resources and time to be implemented successfully. Further, some of them would entail the application of control mechanisms to diminish the influence of the broad number of decision-makers involved.

## 5.4 Supplier Selection Criteria

The focus of this master thesis was to find the key criteria for supplier selection in the automotive industry. Therefore, a framework of supplier selection criteria was chosen and contrasted in the empirical work with a case study. The chosen framework was originally developed by Nauman Abbasi et al. (2015) for the automotive industry in Pakistan, and then

applied to a relevant German tier one supplier to discover if this framework could also be applicable in this setting.

The empirical data has shown that there are multiple differences and gaps in relation to the application of the framework by Nauman Abbasi et al. The chart below presents an overview of the differences in level of importance of each criterion, as stated by Nauman Abbasi et al. and Knorr-Bremse. The level of importance is shown as score and is divided into high importance (3), medium importance (2), low importance (1) and no importance (0).

Figure 10: Comparison of Level of Importance of Selection Criteria



Source: Own compilation based on empirical data and Nauman Abbasi et al. (2015)

It was examined, that the variables set by Nauman Abbasi et al. (2015) are still relevant, but the prioritization presents some differences. The most profound differences were in the perceived importance of communication, technology, integration & relation, safety and flexibility. Further, the case company stated additional criteria of high and medium importance that were not included in the framework.

To begin with, the high importance criteria from the framework such as quality, cost and delivery of goods are still considered critical, but added to this group are technology and flexibility, which were categorized differently by Nauman Abbasi et al. The criteria of quality, cost and delivery are essential within manufacturing business in general. Yet, in a market such

as Germany or a developed country per se, it is expected of companies to be at the forefront of technology, connectivity and design. Technology plays a vital role in the success of a company. If they are not up to date with the developments in technology, customers will opt for another supplier to achieve the value they want to add to the end product. Flexibility is a criterion that might be of more importance in a fast-paced environment such as the German market. Companies are expected to adapt to changes more easily to stay competitive and meet market demands fast. Therefore, their suppliers must be able to deliver the same degree of flexibility.

Contrasting Nauman Abbasi et al (2015) at the case company communication was considered of medium importance instead of being critical. The reason could be that interviewed managers have a supplier base in which communication is not a problem. Therefore, good communication could be considered as an environmental factor. Which means if it is not presented could be very problematic but if it is present it is not considered a competitive advantage but rather something “given in the market” as it was stated by one respondent.

Safety, instead of being low important as proposed in the framework, is considered as a medium important criterion at the case company. Should the goods be packaged in an unsafe manner or should safety regulations be ignored, it could be the case that an increased number of received goods would be damaged and useless for the case company.

The interviewees at the case company included some additional criteria into its set of supplier selection criteria, namely Contract Compliance, Capacity, Sustainability and Supplier Strategy. These criteria are all defined as highly important as a selection requirement. Contract compliance is a criterion of high importance as every important and relevant factor of the supplier-buyer relationship is bounded by a legal agreement. With a contract in place, if the supplier does not comply with its obligations, legal actions could be taken immediately. Developed countries usually have well sorted legal systems in place that facilitate the successful management of contracts. Sustainability is another criterion that is being paid tremendous attention to in especially the developed markets, which could be a reason why it is not included in the framework. Customers expect greener products and are more aware of the implications of pollution. Further, developed country governments enforce more regulations towards sustainability than the ones in developing countries. Hence, companies need to comply to stay in business and expect their suppliers to also comply.

Supplier strategy is a criterion that companies can consider within their supplier selection, as it measures how strategic the supplier is for the company. For the case company this aspect is

essential and the suppliers are classified according performance and competitiveness. Yet within the framework of Nauman Abbasi et al. this criterion is not stated.

Services and capability are criteria considered of the same level of importance to the case company as well as to Nauman Abbasi et al. framework.

Integration & relation however are perceived of low importance at the case company while the framework suggests a medium importance. With the increase of globalization most companies expect the business partners and suppliers to be able to adapt to their needs in the market. This is considered as a standard within many markets if a company operates multinational.

It can be concluded that the differences in perceived level of importance of the criteria in Nauman Abbasi framework and in the empirical work is associated with the context in which the study was conducted. The framework developed by Nauman Abbasi et al. (2015) has been developed based on the Pakistani automotive industry. It is important to notice that Pakistan does not have strong history in automotive. In contrast the empirical work was performed in Germany, the leading automotive industry in Europe. The requirements for suppliers in the automotive industry can be seen as similar within many countries, as there are specifications that are standard for the industry. Yet, the empirical work shows that companies established in more developed economies prioritize the supplier selection criteria in a different way and also include more aspects to consider. Therefore, this highlights the need of further research applied to this specific context.

## 5.5 Decision-Making Unit

At the case company it was observed that the supplier decision process is not taken by a single actor or department but rather by a cross-functional team of several decision makers. Therefore, it can be stated that at the case company there is a decision-making unit (DMU) as it was stated by several scholars. This is in line with the framework developed by Fischer (1970). As the case company has very high product complexity and high commercial uncertainty, there is a cross-functional decision-making in place. That means that the decision is not made only by the purchasing department but rather by a DMU composed by key actors from Quality, Supply Management and Purchasing.

Academics also identified several roles inside the DMU, but these roles could not be compared to the case company. Employees of Knorr Bremse considered that this information is sensitive

for the company and therefore roles and responsibilities of decision makers were not disclosed. Therefore, further research in this area is to be done.

### 5.6 Proposition for a Supplier Selection Tool

Considering that in practice the decision is subjective and based on fulfillment or non-fulfillment of certain criteria, the following supplier selection decision matrix is presented. The criteria and sub-criteria represented in the matrix are adapted from Nauman Abbasi et al. and information gathered in the interviews with purchasing leaders of Knorr Bremse. In order to minimize the influence of subjectivity perceived through the DMU, the following framework present an approval condition rule that can be adapted to the needs of each company.

Table 4:Supplier selection Decision Matrix

Criteria	Approval Condition	Sub- Criteria	Approval
Total Cost	-Tooling price and piece price should be accepted by Cost calculation team. -Cannot be approved if - insert condition-	Piece price	Example
		Tooling cost	Example
		Logistic cost	
		Development cost	
		Productivity (yes/no)	
		Bonus (yes/no)	
Status	APPROVED( example)		
Quality Compliance	Cannot be approved if - insert condition-	Internal quality rating system	
		Quality Certification	
		Audit	
		Quality Escalation Level (QEL)	
Status	NOT APPROVED (example)		
Delivery	Cannot be approved if the consistent delivery rate is under X%	Lead time	
		Delivery capacity	
		Meeting due date	
		Consistent delivery	
		Meet random fluctuation in	
Status	APPROVED/NOT APPROVED		
Contracts Compliance	Cannot be approved if - insert condition-	Master Supply Agreement (MSA)	
		Liability	
		Logistics	
		Tooling	

		Financial risk	
		EDI	
		NDA	
<i>Status</i>	<i>APPROVED/NOT APPROVED</i>		
Technology	Cannot be approved if - insert condition-	Technical expertise level	
		Availability of testing facility	
		Automatic partner selection	
		Technical compatibility	
		Order entry and invoicing system	
<i>Status</i>	<i>APPROVED/NOT APPROVED</i>		
Capacity	Cannot be approved if - insert condition-	Feasibility agreement signed	
		Capacity increase(yes/no)	
<i>Status</i>	<i>APPROVED/NOT APPROVED</i>		
Supplier strategy	Cannot be approved if - insert condition-	Supplier classification (strategic, preferred, standard)	
		Current Annual Purchasing Volume (APV)	
		New Annual Purchasing Volume (APV)	
		Supplier Dependency rate	
<i>Status</i>	<i>APPROVED/NOT APPROVED</i>		
Flexibility	Cannot be approved if - insert condition-	Procedural flexibility	
		Flexibility to meet the unexpected	
<i>Status</i>	<i>APPROVED/NOT APPROVED</i>		
Sustainability	Cannot be approved if - insert condition-	Code of conduct	
		ISO 14001	
<i>Status</i>	<i>APPROVED/NOT APPROVED</i>		
Communication	Cannot be approved if - insert condition-	Response readiness	
		RFQ response rate	
<i>Status</i>	<i>APPROVED/NOT APPROVED</i>		
Risk Analysis	Cannot be approved if - insert condition-	Delivery risk	
		Bankruptcy risk	
		Price increase risk	
<i>Status</i>	<i>APPROVED/NOT APPROVED</i>		
Supplier Footprint	Cannot be approved if - insert condition-	Manufacturing locations	
		Automotive supplier	
		LCC country	
<i>Status</i>	<i>APPROVED/NOT APPROVED</i>		
Services	Cannot be approved if - insert condition-	Repair services	
		Warranties and claims	
		Efforts in eliminating waste	

<i>Status</i>	<i>APPROVED/NOT APPROVED</i>	
	<i>Approved</i>	
	<i>Not approved</i>	

Source: Own compilation based on empirical work and framework of Nauman Abbasi et al.

The following matrix should be applied after the first decision matrix is completed. This matrix only contains the criteria and the status. The sub-criteria are excluded. The purpose of this matrix is to summarize the decision criteria and their respective status. Therefore, it can be assessed more easily (after reading the approval conditions) if the supplier is appropriate for selection or not.

*Table 5: Supplier Selection Decision Matrix Summary*

Criteria	Status	Condition
Total cost	Example	If criteria X, W and Z are not approved, the supplier cannot be approved.
Contracts Compliance	Example	
Quality Compliance		
Capacity		
Supplier Strategy		
Sustainability		
Delivery		
Supplier Footprint		
Purchase Volume		
Communication		
Risk Involve		
<b>Final Decision</b>	<i>APPROVED/NOT APPROVED</i>	
	<i>Approved</i>	
	<i>Not approved</i>	

Source: Own compilation based on empirical work and framework of Nauman Abbasi et al.

If the supplier is then approved within this matrix by the decision-makers, contracts are signed, and the supplier is ready for starting the production.

In conclusion it can be observed that the established frameworks within the literature lack in their ability to be applied in practice. Companies have to choose fragments of the existing frameworks and mold them into their own model to be applied in the selection process to match their requirements. The matrices shown above, aim to contribute to the academia to understand how supplier selection is made by tier one German automotive suppliers and delivers a framework to facilitate the process. Therefore, this research represents a connection of academia and practice, as it enables further research in the establishment of frameworks for the truck industry as such and gives companies a guideline for their selection process.

## 6 Conclusion

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*The final chapter concludes this research paper by stating the most relevant findings of the study and providing guideline for further research.*

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Considering the increasing complexity of supply chain networks, managing the supply base efficiently has become essential to a firm's strategy. Therefore, strategic procurement has gained a centric role. This study has centered in the most critical phase of the purchasing process: the supplier selection. Efforts have been made in order to empirically identify the most important supplier selection criteria in the German Automotive Industry with special focus on the truck sector.

The outcome of this study discloses that Cost, Quality, Delivery, Contract Compliance, Technology, Capacity, Supplier Strategy, Sustainability, Flexibility are considered high importance supplier selection criteria. Services, Safety and Communication are considered medium importance criteria, while Capability and Integration & Relation are considered low importance criteria. These results are different than the prioritization made by Nauman Abbasi et al. (2015) but in line with other international researches. For example Nydick and Hill (1992) suggested that cost, quality, delivery are the most relevant criteria, including services. Likewise, Verma and Pullman (1998) found quality the principal criteria, followed by cost and delivery time. However, we would like to highlight that some criteria are considered interdependent and it is not possible to rank some over the others. That is particularly the case with cost, quality and delivery performance. Regarding the purchasing process, it could be observed that the supplier selection process is highly dependent on the company, industry and its main products. As it could be illustrated empirically, even a company itself has different situation-specific purchasing processes. It is important to mention that no mathematical supplier selection method was used in practice. That is an important finding, as most of the literature is focusing on these methods and apparently, they have limited use in practice. Empirical work showed that the decision method in place is more of a categorical nature. Hence, we would like to highlight as a managerial implication that this process can be affected by the subjectivity of the decision makers and their hierarchical level in the company. In order to mitigate this risk, the present study introduces a decision matrix in order to make the decision process less subjective and more efficient.

The major contributions of this study are twofold. Firstly, it provides a clear set of criteria for the supplier selection in the automotive industry relevant for the German context in the truck sector. Secondly, it introduces a supplier selection matrix to make the supplier selection process more transparent and less subjective. This contribution is important because it provides practitioners with a clear tool of relevant criteria and provides more insights to scholars to understand the supplier selection process in the German automotive industry.

### **Limitations and Future Research**

Since we chose an exploratory approach to our research, the case study revealed several interesting findings that were not directly related to the research questions. While these findings are important, addressing each finding in depth goes beyond the scope of this thesis. Hence, we acknowledge three limitations to our research and base suggestions for future research on these.

Most of supplier selection studies within automotive industry focus on OEMs and a few studies focus on how tier 1, tier 2 and tier 3 suppliers select their own supplier. The scope of this master thesis allowed us to focus only on tier 1 supplier, therefore we encourage future researchers to focus on how tier 2 and tier 3 suppliers choose their suppliers.

The literature review revealed that academia focuses mainly on the study and development of mathematical models for supplier selection, however empirical work showed that practitioners use more categorical models. Due to the short time scope of this master thesis, supplier selection methods were outside of the scope of this master thesis. Hence, we recommend future research on these models, especially on categorical ones by fellow scholars.

As this master thesis is a single case study based on a specific geographic setting namely Germany, results cannot be generalized. We acknowledge that as a limitation and invite fellow scholars to investigate the application of our findings in others geographical settings.

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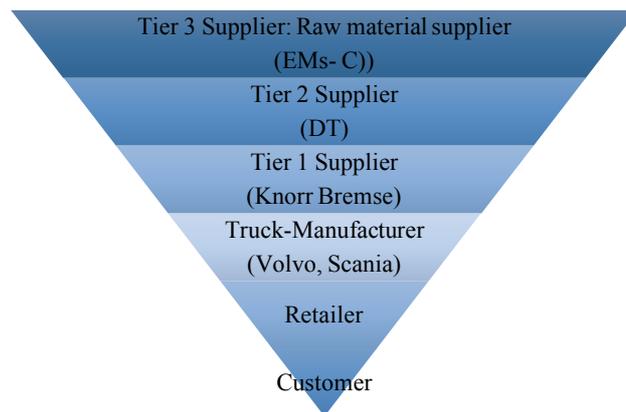
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# 8 Appendix

## 8.1 Appendix A: Supply Chain in the Automotive Industry

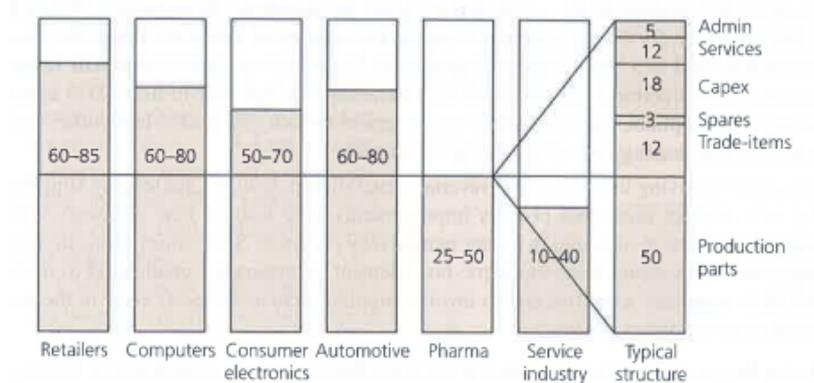
Figure 101: Supply chain in the automotive industry



Source: Own compilation based on empirical work

## 8.2 Appendix B: Purchased goods and services as % of Cost of Goods Sold (COGS)

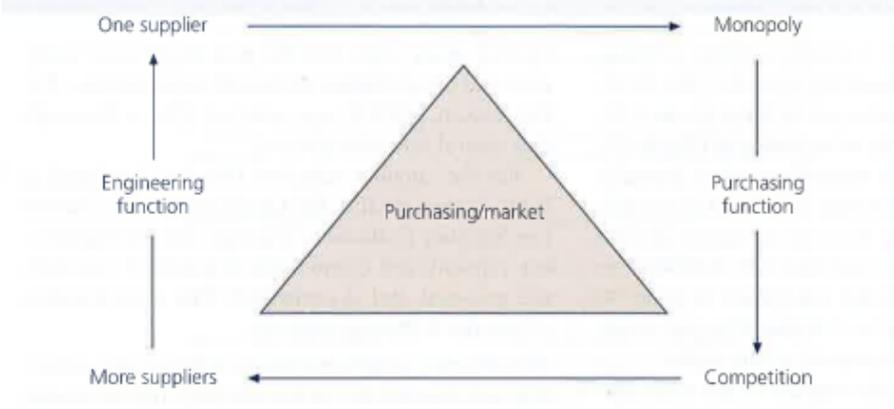
Figure 12: Purchased Goods and Services as a Percentage of Cost of Goods Sold



Source: Van Weele (2005)

### 8.3 Appendix C: Interaction between purchasing and engineering activities

Figure 13: Interaction between Purchasing and Engineering Activities



Source: (Wynstra, 1998)

## 8.4 Appendix D: Bottlenecks in the Supplier Selection in the Automotive Industry

There are some major bottlenecks and problems that may occur during the supplier selection in the automotive industry that will be explained in the following chapter. These aspects had been identified by van Weele (2010).

**Supplier or brand specifications.** Specifications are created by technical departments like R&D, and sometimes are written for some specific supplier. The problem is that the purchasing department has virtually no power of negotiation with the supplier, because the vendor is aware of this situation. Choosing a supplier only from a technical expertise point of view can lead to problems in which the supplier lacks capacity to produce the product or it is far away in price of the company budget.

**Inadequate supplier selection.** Selection of a supplier that is not qualified enough may lead to unpleasant situations like not in time deliveries, lack of capacity to produce goods, bankruptcy of the supplier, quality issues or unwillingness to keep warranty obligations.

**Personal relationship.** Order are placed considering personal relationship with the supplier or in extreme situations buyers may be suborned by suppliers. That is why many big companies have strict rules that purchaser cannot receive any gifts from suppliers.

**Lack of good contracts agreements.** In some cases, contracts are incomplete, not updated or even drafted by the supplier's own terms and conditions. In some extreme cases there are even situation in which contracts are non-existent and the businesses are based on the mutual trust between client and supplier.

**Over emphasis on price.** Sometimes decisions are made only based on price per unit rather than being based on the total cost of ownership (TCO). This is particularly relevant in equipment in which lifecycle costs of the equipment should be considered.

**Deficient administrative process.** Some purchasing processes are sometimes not made efficiently in practice. One example of this is when invoices are paid without proper match with the original purchase order and delivery document.

**Delivery problems.** This issues usually derives from unclear specifications made by the client company or because of a bad decision of the supplier. Regardless of the case not in time deliveries or products that not fulfill the quality requirements can put the production of the client company in real danger.

# 8.5 Appendix E: Supplier Selection Criteria

## 8.5.1 Supplier Selection Criteria by Dickson

Table 6: Supplier Selection Criteria by Dickson

Number	Criterion	The importance of criterion
1.	Quality	Very high importance
2.	Delivery	
3.	Performance History	
4.	Warranties & Claims Policies	
5.	Production Facilities and Capacity	Great importance
6.	Price	
7.	Technical Capability	
8.	Financial Position	
9.	Procedural Compliance	
10.	Communication System	
11.	Reputation and Position in Industry	
12.	Desire for Business	
13.	Management and Organization	
14.	Operating Controls	
15.	Repair Service	Medium importance
16.	Attitude	
17.	Impression	
18.	Packaging Ability	
19.	Labor Relations Record	
20.	Geographical Location	
21.	Amount of Past Business	
22.	Training Aids	
23.	Reciprocal Arrangements	Low importance

Source: (Dickson, 1966)

## 8.5.2 Supplier Selection Criteria by Ellram

Table 7: Supplier Selection Criteria by Ellram

Number	Criterion	Number	Subcriterion
1.	<b>Financial aspects</b>	1.1.	Economic performance
		1.2.	Financial stability
2.	<b>Organizational culture and strategy issues</b>	2.1.	Trust
		2.2.	Management attitude/outlook for the future
		2.3.	Strategic fit
		2.4.	Top management capability
		2.5.	Capability across levels and functions of buyer and supplier firms
		2.6.	Supplier's organizational structure and personnel
3.	<b>Technology issues</b>	3.1.	Assessment of current manufacturing facilities/capabilities
		3.2.	Assessment of future manufacturing capabilities
		3.3.	Supplier's design capabilities
		3.4.	Supplier's speed in development
4.	<b>Other factors</b>	4.1.	Safety record of the supplier
		4.2.	Business references
		4.3.	Supplier's customer base

Source: (Ellram, 1990)

## 8.5.3 Supplier Selection Criteria by Weber

Table 8: Supplier Selection Criteria by Weber

Number	Criterion	The importance of criterion
1.	Net price	Great importance
2.	Delivery	
3.	Quality	
4.	Production facilities and capabilities	Low importance
5.	Geographical location	
6.	Technical capabilities	
7.	Management and position in the industry	
8.	Reputation and position in the industry	
9.	Financial position	
10.	Performance history	

Source: (Weber, et al., 1991)

### 8.5.4 Supplier Selection Criteria by Cebi & Bayraktar

Table 9: Supplier Selection Criteria by Cebi & Bayraktar

Number	Criterion	Number	Subcriterion
1.	<b>Logistics</b>	1.1.	Delivery time
		1.2.	Support lots
		1.3.	Flexibility
		1.4.	Reliability
2.	<b>Technology</b>	2.1.	Capacity to meet demand
		2.2.	Involvement to formulating new products
		2.3.	Improvement effort in their products and processes
		2.4.	Problem solving capability
3.	<b>Business</b>	3.1.	Reputation and position
		3.2.	Financial stability
		3.3.	Management skills and compatibility
4.	<b>Relationship</b>	4.1.	Easy communication
		4.2.	Past experience
		4.3.	Sales representative's competence

Source: (Cebi & Bayraktar, 2003)

### 8.5.5 Selection Criteria by Galankashi

Table 10: Selection Criteria by Galankashi

Financial	Customer
Price of product	Service and delivery
Quality of product	Reputation
Distance to manufacturer	Supply chain collaboration level
Economic value added	Market share
Economic value-added (EVA)	Rate of sales return
Internal business	Learning and growth
Technical capability	Competitiveness
Production capacity	Employee satisfaction
Flexibility (design, make, delivery)	Knowledge sharing
Inventory turnover	Health and safety issues level
Productivity	Standards consideration

Source: (Galankashi, et al., 2016)

## 8.6 Appendix F: Interview guide

### Section A: Interviewee Background

Q: What is your occupation/position within Knorr-Bremse?

Q: How long have you been working for Knorr-Bremse?

### Section B: Theory

Topic	Question
<b>Supplier Selection</b>	What steps do you take when choosing a new supplier?
	Within theory many frameworks for the selection process are proposed, do you use any of these framework, such as mathematical or categorical models?
	If not, what does the selection process look like?
	Is there a weighting system in place for the suppliers?
	Are there requirements for the supplier to be fulfilled before being approved?
<b>Criteria</b>	Do you have an established set of criteria for the selection in place?
	Theory proposes a set of criteria divided into the categories of quality, delivery, cost, technology, communication, services, capability, flexibility, safety and integration & relation. Can you align with this set of criteria?
	How do the variables at KB differ to these criteria?
	How would you rank the importance of these criteria present at Knorr-Bremse?
	What are the most important variables in the selection process and why?

	Are there other features additionally to the criteria that are taken into account within the supplier selection process?
<b>Decision-Making Unit</b>	How many people are usually involved in the decision-making process of selecting a new supplier?
	What are the roles of the people involved in the decision-making process?
	Who has most power of decision in the selection process?
	What challenges do you encounter within the decision-making process?

**Section C: Opinion**

Q: Do you think the supplier selection process present at KB is easy to implement, yet efficient and successful?

Q: How do you think KB could tackle the challenges encountered in the process?