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“Manufacturing sourcing decisions: Single versus Multiple Sourcing”

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Abstract

This thesis addresses sourcing issues in the manufacturing industry. With the guidance of a truck manufacturer, the researcher looks into how manufacturers make their sourcing decisions, with the ultimate goal to find out differences, similarities, advantages and disadvantages with single and multiple sourcing. In few words, this research tries to understand better in which situations single sourcing is more appropriate than multiple, and vice versa, in the context of a manufacturing company. A qualitative method of analysis was chosen for this case study, under which published related literature, as secondary data, and interviews with professional buyers, as primary data, were used to shed light on the single versus multiple sourcing dilemma. Specifically, to collect the primary data, the researcher interviewed buyers from both the truck manufacturer that initiated this research and from other manufacturing companies. It was found out that sourcing is a lengthy procedure, and that sourcing strategies must consider product and market characteristics, geography, and the particular circumstances under which a sourcing decision is taken. The final suggestion for the truck manufacturer is to incorporate multiple sourcing to a greater degree into their purchasing routines. The significance of this research lies primarily in the fact that it presents the main characteristics of the two approaches, and as such, it provides information, which can give clarifications to the truck manufacturer that initiated it. Other than that, it has potential use to any company investigating whether single or multiple sourcing is more appropriate for them.

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1. Introduction

This chapter introduces the concepts pertinent to this thesis. It starts with explaining purchasing, and its importance to the company. The main area of investigation in this thesis is sourcing issues, and since sourcing is a function of the purchasing department, it is appropriate to describe what purchasing entails, for a more holistic view to be formed. A detailed understanding of the role of purchasing can be important to a buyer, since comprehending its implications to the company, can lead to more educated sourcing decisions to be taken; specifically, decisions on whether single or multiple sourcing is more appropriate in each case. Basic terms are explained, followed by the background and the purpose of the study. Finally, the outline and the delimitations of the study are presented. This thesis is written with the guidance of a truck Original Equipment Manufacturer (OEM).

1.1 Purchasing

To purchase something means to buy it; to obtain something by paying the price or its equivalent, set by a seller. Depending on what type of purchase one is making, different procedures are followed. Consumer purchasing is done for personal consumption and is influenced by a range of factors, including product availability, disposable income, brand image and advertising. Industrial purchasing takes place when a company is the buyer. While not necessarily strictly industrial in character, the aim is to buy, to convert material into finished products, such as raw materials, components, tools, and equipment. Between the two purchase types, the industrial purchasing process is typically much more complex and large-scale (Fern and Brown, 1984). The focus here is on industrial purchasing when a company obtains items and services to achieve a production goal.

Once a company has identified the components required to manufacture the items that it disposes to the market, it needs to source them. The purchasing process and function include some steps, which once identified and specified, can be documented and repeated. It involves managing the resources that a company needs to be able to secure services, capabilities and a smooth supply of goods that are required for running, maintaining and managing a company's primary and support activities (Van Weele, 2014, p 3). Direct purchasing applies to procuring the materials needed to manufacture the final product, and indirect purchasing refers to activities not directly related to production, such as office equipment, staff catering, cleaning materials and housekeeping (Van Weele, 2014, p 6). The focus of this thesis is on direct purchasing.

The decision-making process starts with identifying alternatives and ends with choosing between these. Deciding between suppliers is one step of the process. After the right supplier has been selected, product quantities and delivery time and place are specified. Products must be of the required quality and at the right price. Decisions depend on production specifications and the capacity of the facilities among others. The economic factor obviously plays a significant role in buying decisions.

The person who takes decisions on acquiring materials and services for the employer is called a 'buyer' (Cheverton & van der Velde, 2011, p 1). Tasks include specifying, sourcing, negotiating, contracting and evaluating. For example, in the case of standardized items that are regularly needed, the buyer is authorized to place orders with the suppliers according to production needs.

Purchasing and logistics are two separate but complementary actions. In a simplified model, there is inbound logistics related to transporting items and materials towards the premises of the manufacturer, where they are typically stored until processed. Outbound logistics is related to transporting the ready production out of the premises. Therefore, purchasing and logistics play an integral role in establishing and managing the supply chain. Their cooperation assures a smooth product and information flow, as logistics assist purchasing in achieving improved coordination of transportation and warehousing. In this way, their cooperation accommodates the expansion of the company's relationships with other firms (Cooper and Ellram, 1993).

Procurement, another aspect related to the purchasing function, is the action of locating and subsequently obtaining something (e.g., equipment or supplies). The relationship of procurement with purchasing is that the purchasing department specifies what needs to be bought, and the procurement department makes sure that what is needed is actually sourced. Ideally, the purchasing and procurement departments work closely together and are mutually complementary. Procurement includes actions like planning, making, administration and control. Depending on how the company is organized, both functions can be under the responsibilities of a single department, or they can be separated (Cheverton and van der Velde, 2011, p 1).

Working with purchasing or procurement means working as part of the supply chain. The functions described above could be met in different job descriptions in the field. Sourcing is another piece of the chain, directly related to purchasing since once a supplier is chosen, it is then time to purchase.

1.1.2 The role of purchasing in an organization

Purchasing, as part of a company's activities, can have a significant effect on its robustness and prosperity. These activities can be influenced by the lack of services or materials, among others; therefore, the role of the buyer in the company is a central and essential one. The majority of companies today spend more than half of their sales turnover on purchasing, whether this is services or parts. It is therefore of paramount importance that careful consideration is put on what to purchase, how, at which price and from whom. Since most purchased items and services serve to a company's continuous needs, they become key components of production cost (Van Weele, 2014, p 3). This creates not only the need for establishing standardized processes but also optimized ones. Companies are similar to living organisms that can be affected by both internal and external factors, and processes must, therefore, be under constant evaluation. As businesses become increasingly competitive, purchasing, consequently, attracts growing attention.

In an organization, value-creating activities take place, all of which together constitute the value chain. Effective management of this value chain can give the organization a competitive advantage. The two main categories are 'primary' and 'support'

activities, each of which includes subcategories (Porter 1985, pp 39-40) (Table 1). All are separate but related functions. Purchasing is listed as a support activity in the value chain, alongside development and management. The point to highlight here is that value-creating activities should be perceived as interlinked and mutually supportive rather than hierarchical.

Table 1: Overview of value creating ‘primary’ and ‘support’ activities in a company.

<u>‘primary’ activities</u>	<u>‘support’ activities</u>
Inbound Logistics: Receiving, storing, vehicle scheduling, warehousing, inventory control, etc.	Procurement: Referring to the function of purchasing.
Operations: All functions related to transforming inputs to outputs, namely the final product.	Technology Development: Technologies related to the effort to improve the product and the process.
Outbound Logistics: Finished goods logistics, like order processing, delivering, etc.	Human Resource Management: Recruiting personnel, training, compensating, etc.
Marketing and Sales: Advertising, promotion, pricing, quoting, etc.	Firm Infrastructure: Activities related to management, planning, finance, accounting, legal, facilities management, etc.
Service: Services related to enhancing and maintaining the value of the product.	

Based on Porter (1985).

Purchasing, as part of the support activities, can have a significant impact on the overall cost, which is why optimized purchase execution should be pursued (Porter, 1985, p 41). That is not only because of the cost of the purchased items but also of their effect on the total quality of the output. Therefore, purchasing can be decisive in cost positioning.

1.1.3 The financial rationale behind purchasing

Purchasing costs often make up half the value of the goods sold. Optimized purchasing practices are therefore expected to increase sales margins greatly through cost savings. As Van Weele (2014, p 13) puts it: ‘a euro saved in purchasing is a euro added to the bottom line,’ generally meaning savings from the whole purchasing procedure. He goes on to argue that improved logistics related to purchasing processes, like refined planning and scheduling, can bring about working capital reductions, and save cost in this area as well. Finally, he mentions that the suppliers can positively influence the company’s innovation processes if this message is communicated to them properly. Understanding the economic role of purchasing in an organization is vital because sourcing strategies are directly related to costs.

Notable cost reduction can be achieved when organizations reach purchasing maturity. 'Maturity' in this sense relates to the degree of formality and optimization of processes: from ad hoc practices, to formally defined steps, to active optimization of the processes. This is related to the level of purchasing professionalism and how effective the purchasing department is in regards to the company's needs. An improvement in the skills of the employees sitting behind purchasing functions could lead to a progression from a simple supplies ordering model to a managed supply chain model (Rozemeijer, Van Weele and Weggeman, 2003). That would mean to not only just order supplies at designated quantities and delivery times, but also to see past that simple function. It would mean to be able to recognize significant patterns in suppliers and compare them to the company's requirements, maintain the company's standards, manage and try to reduce risks, planning and controlling. The higher this level of maturity is, the higher the chances of reducing cost. Although not explicitly stated in the literature, it is implied that a company has reached purchasing maturity when costs have been reduced. Purchasing maturity can develop best practices, which can lead to superior performance, resulting in cost reduction (Ubeda, Alsua and Carrasco, 2015). Through audits performed by Schiele (2007), it was concluded that purchasing maturity is positively correlated to cost reductions. The more developed the organization is, the larger are the saving potentials.

A useful tool for assessing the effects of purchasing savings on the company's return on capital employed (ROCE) is the DuPont analysis. ROCE is a measure for assessing shareholder value and can be used to track the company's performance for the specific period that it is calculated. ROCE measures the productivity (the return) of the capital, which was utilized during the examined period, such as employees, materials, buildings or various investments (Harrison, van Hoek and Skipworth, 2014, pp 84-87). The DuPont analysis can show that savings on purchasing cost can lead to improvement on the ROCE, and it is helpful in demonstrating exactly how money can be saved from a reduction in purchasing activities, or other related activities. As a financial diagnostic tool, it can be useful for managers in providing both specific numbers, and an explanation for the outcome of the analysis (Van Weele, 2014, p 12). Another tool for estimating the financial impact and supply risk represented by a specific product category is the 'Kraljick purchasing portfolio analysis,' a tool for analyzing the company's purchasing spend per product category (Van Weele, 2014, p 163).

The objective for companies is to maximize profit. This is achieved via sales increase or cost decrease. Sales increase is a marketing issue mainly, but cost decrease can occur on many levels, and through purchasing, significant cost savings can occur. Effective purchasing management can contribute to the general growth of a company. The proposition that a company's survival may hinge on cost savings in the purchasing process was accepted by Krause, Vachon and Klassen (2009), who observed that 'a company is no more sustainable than its supply chain.'

1.2 Background of the study

Among the world's largest truck manufacturers are Daimler Trucks, Isuzu Motors, MAN Truck & Bus, Mitsubishi Fuso Truck & Bus, Volvo Trucks & Buses, Scania

and others (Automotive World, 2016). All these manufacturers have extended brand portfolios, and their production facilities are spread all over the world. One example is Volvo Trucks & Buses, which has production facilities in 18 countries and sell their products in 190 markets worldwide (Volvo Group, 2017). Daimler is also an example of a company with production facilities located throughout most continents (Figures 1 and 2).

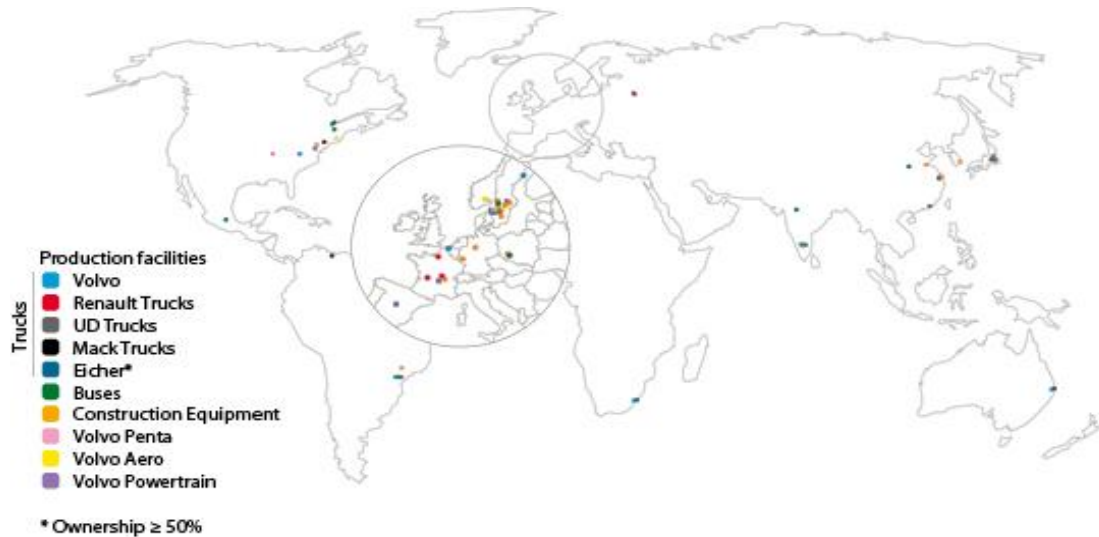


Figure 1: Worldwide distribution of Volvo production facilities (Volvo Group, 2011).

DAIMLER

International presence: ... Daimler Trucks



Figure 2: Worldwide distribution of Daimler production facilities (Daimler, 2010).

The distribution maps in Figures 1 and 2 indicate the potential complexity of sourcing in companies operating on different continents. Decisions on whether to use one or

more supplier can be challenging to begin with and can be even more complicated when the production facilities are spread around the world since the same dilemma can apply to each facility, country, region or continent. While each facility generally has autonomy regarding indirect purchasing, decisions regarding direct purchasing are usually performed centrally in the company, where potential suppliers can bid via global tenders. Attending to all the facilities' needs can be more challenging for the buyer making this decision on a global basis.

Manufacturers are dependent on their suppliers, who are likewise dependent on their own suppliers. Any disruptions at any part of the chain can lead to problems ranging from minor delays to production stoppage. A risk of supply chain disruption refers to disruptions caused by natural or man-made disasters, for example, earthquakes and floods, or economic crises and currency fluctuations (Tang, 2006). If the supplier is unable to deliver to the manufacturer, it is imperative that an alternative strategy is in place. Manufacturers must always be prepared and take precautions to prevent a potential production stop.

Since purchasing represents a significant amount of yearly spend, it is important that there is a balance between how much money is spent and how much is earned. Moreover, with markets continuously expanding, it is crucial that the company keeps track of changes in the purchasing world, and that different scenarios in the supply chain are perceived as effectively as possible. Buyers are required to be in control of the situation and aware of those potential changes.

The common sourcing options for a buying company are single and multiple sourcing. The dilemma of choosing between the two led the specific truck OEM to commence this investigation. Finding an answer to the dilemma may have practical benefits to the truck OEM's operations, and increase their improvement potentials. Interest for this analysis could extend beyond this single truck OEM since it can potentially have a wider application to other OEMs.

1.3 Purpose Statement

The purpose of this thesis is to investigate the advantages and disadvantages of single and multiple sourcing in the specific truck OEM. Based on them, suggestions on which strategy is more suitable are made accordingly.

1.4 Research questions

The main research questions in this report are:

RQ1: What are the benefits and disadvantages of single and multiple sourcing in the context of manufacturing companies?

The aim is to formulate tools on how to better prepare for choosing between the two strategies, by compiling and formulating an index of checkpoints that could be

consulted when making sourcing decisions. For that to be possible, the motives behind each decision must be identified. Therefore, a related research question is:

RQ2: What is the basis for decision-making in manufacturing companies during sourcing?

Critical to answering the above questions is to investigate how other companies deal with sourcing issues. It is expected that looking into how other manufacturers take decisions can provide an improved understanding of the issue. This is reflected in the third research question:

RQ3: What lessons can be learned from other manufacturing companies in regards to the same dilemma?

Following this introductory part, a literature review and the main theories in regards to sourcing are presented, followed by the methodology chapter, which describes the motivation for the application of the approach used to identify, select, and analyze information applied to understanding the research problem. The interview data summarize the main results gathered during this investigation, and the analysis part provides an evaluation of the data. The thesis is concluded with suggestions to the company and with a description of the research limitations.

1.5 Delimitations of the study

As mentioned at the beginning of this chapter, only decisions in regards to direct purchasing are investigated in this thesis. Moreover, the companies looked into, are strictly manufacturing. Since it is a manufacturing company that initiated this project, it would not add value to the company if sourcing strategies from a wider industry were investigated. As much information as possible was gathered from vehicle manufacturers since it is the closest market to the truck OEM.

Decisions on acquiring materials are investigated in this thesis. Some services in regards to these materials are integral to operations, such as sourcing the transport provider or renting warehouse facilities, if applicable. Parts' requisition necessitates consideration of transportation costs. Logistics operations and costs are key factors; nevertheless, they are not the focus of this thesis.

To investigate all commodity types included in truck building, each of which consists of categories of specific items, is deemed too ambitious for a single research study. In addition, the results would be uncertain, as each commodity is characterized by its specific features. Therefore, half the interview data regard one specific commodity.

2. Literature review and theoretical framework

This chapter reviews the relevant theories to this study, as found in published literature. It starts by explaining the steps ahead of single or multiple sourcing, namely by shedding light on the industrial buying behavior, as both the variables affecting it and the actual supplier selection procedure, can have a weight on sourcing decisions. Right after, the theoretical foundation is developed from ideas on the single sourcing approach, followed by the same in regards to the multiple sourcing approach. The sourcing strategies are then compared, taking into consideration both their advantages and disadvantages. Supplier relationship management and assessment come next. It is stressed that these concepts are integral parts in any sourcing case since the number of suppliers employed can be affected by the buyer-supplier relationship. Finally, the concept of the total cost of ownership is considered, as all costs related to selecting a supplier need to be taken into consideration, before any decisions are taken.

Many articles were surveyed for relevant information to this chapter. Few papers employed complex computational or numerical analyses to explain supplier or sourcing strategy selection, and to calculate the probabilities of supply chain disruption risks, with single and with multiple sourcing. Such sources can only be as reliable as the methodologies and as accurate as the inputs that produced the results. As the author of this thesis does not have detailed knowledge of these methods, the conclusions of these sources were accepted at face value.

2.1 Industrial buying behavior

Selecting suppliers can be a lengthy procedure because of the many steps that it includes, and decisions that need to be taken at each stage. Apart from the money involved in buying parts for manufacturing, it is also the man-hours that need to be invested, from the employee or employees sitting behind buying decisions. It is important to look into what kind of variables affect the buying process and decisions, as well as the individual supplier selection steps, because decisions on sourcing from one or more suppliers can be based on the products' characteristics, on the market characteristics and on the time and resources that the company allocates to the decision process.

2.1.1 Variables affecting the buying process

According to Van Weele (2014, p 24), the buying process is affected by a number of variables. These must be considered before the purchasing process and the supplier selection procedure starts. One of the most obvious is the characteristics of the product. When building a truck, for example, all parts are of equal importance, since nothing can be omitted from the original design of the vehicle. The difference though is in the commercial importance of each part, namely, how each part affects the price of the final product. This economic importance could furthermore be influenced by

the technical complexity of the part. Also, the decision to purchase raw materials can be different from that of spare parts. Manufacturers purchase raw materials as well. The variables that affect the buying decision and process in regards to raw materials are: 1) their changing prices, 2) the availability of new materials, 3) materials that might need to be replaced due to discontinuation and 4) potential changes in the attributes of the final product (Muteki & MacGregor, 2008).

Other variables include the sums of money involved in the purchases, the role of the purchasing department in the organization, which has to do with how big or small the company is, and the degree of risk related to the purchase. Specifically, the risk decreases as the decision process becomes shorter when the organization has more experience with one specific part or supplier. Therefore, the risk related to the purchasing process time is smaller with one supplier and increases with every new supplier added. Finally, the characteristics of the purchasing market can affect the approach towards the suppliers. For example, in a monopolistic market, there is no dilemma whether to buy from one or more suppliers. However, in an oligopolistic market, negotiations are more complex than in markets characterized by free competition (Van Weele, 2014, p 25).

2.1.2 The basic purchasing process and supplier selection procedure

The purchasing process includes some specific and interrelated steps (Figure 3). Drawing upon Van Weele's book on purchasing (2014, pp 32-42), as a staple cornerstone for this thesis, the researcher accepts as the necessary steps being: 1) the specification phase, which includes clarifying the functional and technical specifications of the items that need to be sourced, 2) supplier selection and supplier assessment. After the supplier/s have been chosen the following steps are 3) negotiation and contracting, which includes clarifying the commercial and legal terms and conditions between the parties, 4) ordering process and expediting, and finally, 5) follow-up and evaluation of the buying process.



Figure 3: The purchasing process (inspired by Van Weele, 2014, pp 32-42)

All the above steps can be related to choosing a buying strategy. The specification phase will clarify whether there are many suppliers available to choose from, or not, depending on the part characteristics. The negotiating and contracting phase can have a weight on the future cooperation between the parties. As this phase includes terms of payment, penalty clauses and warranty conditions (Van Weele, 2014, p 37), it could be decisive in future collaboration between the companies, if any of them does not honor any part of the agreement. During the ordering and expediting phase, the buyer and seller relationship might be affected, if everything is not as agreed. If for example after the delivered products have been inspected, they do not meet the specified requirements. The follow-up and the evaluation phase are related to the supplier assessment procedure, as the supplier is evaluated before and after the delivery. If during any of these steps something does not go as planned, the buying

company might have to consider stopping the collaboration with the particular supplier, thus reducing the supply base.

The traditional supplier selection model is described by Van Weele (2014, p 34). The first step is determining the method of subcontracting - whether the company wants to buy a complete product, that is ready for immediate use, or whether the company wants to buy parts to assemble the final needed part. In the first case, one supplier is needed to fulfill the assignment and in the second potentially more than one. Therefore, that settles the dilemma of using one or more suppliers. The second step includes compiling the bidders' long list, which are the candidate suppliers. For the list to become shorter, request for information (RFI) must be sent, and possibly some visits or audits conducted. The next stage is to decide who from the long list will receive a request for quotation (RFQ), a tender, and send it to them. The candidates now constitute the suppliers' short list. Price is a decisive factor in selecting a supplier; nevertheless, it is advisable that the Total Cost of Ownership (TCO) is taken into consideration, which is explained in detail later. After all these steps have taken place, a supplier is selected.

For a manufacturer, to be competitive, it is important that the whole supply chain be considered, not just an individual supplier at a time, as the simplified supplier selection model implies. For this to happen, Chen (2011) proposes that the company establishes its supply chain, starting by performing a SWOT analysis (strengths, weaknesses, opportunities, threats) of each potential supplier. When the primary selection indicators are identified, the potential suppliers can be screened through a data envelopment analysis (DEA). For more accurate supplier evaluation, the 'technique for order preference by similarity to ideal solution' (TOPSIS) is recommended. This method would require that the buyer has the relevant training. Nevertheless, a basic SWOT analysis can be performed by most of the purchasing personnel. Houshyar and Lyth (1992) also suggested a computational selection method, based on defining critical, objective and subjective supplier performance factors. Supplier selection problems have been suggested to be solved via other alternative methods such as mathematical programming methods, cost-based methods, statistical methods, multiple attribute decision methods, combined methodologies, etc. (Önüt, Kara and Isik, 2009).

Using tools like the above to support the supplier selection procedure could decrease the uncertainty that human judgment can bring to the process, which could also be the reason for conflicts within a company (Matawale, Datta and Mahaparta, 2016). Whether it is a software that assists the decision or not, a supplier selection procedure can claim a lot of time and resources from a company.

2.2 Single sourcing

With single sourcing, the buying company is purchasing specific items from one supplier. This single supplier is directly related to the core competences of the buying company (Skjøtt-Larsen et al., 2007, p 234).

Japanese car manufacturers used mainly single sourcing, during the 1990's. The most prominent example is Toyota, which adopted single sourcing, to be able to establish long-term relationships with the supplier, with the aim of improving their supply chain performance. The Japanese manufacturers increased the purchase volumes from their suppliers and committed to invest in them, through development schemes, accepting as well the risk of dependency on one supplier. At the same time, the suppliers gained from the economies of scale (as the volumes increase the cost per unit decreases) of volume concentration. The manufacturers could purchase at lower prices, and cut other underlying supply chain costs. Transaction costs could also be reduced because dealing with one supplier, and keeping a smaller supplier base, reduces the negotiation and management times and resources, compared to those needed when dealing with an increased supplier base (Johnsen, Howard, Miemczyk, 2014, pp 96-101). With single sourcing, the duplication of operations, such as setup, can also be reduced, something which might be necessary when sourcing from different suppliers (Benton, 2010, p 176).

For the sake of clarification, single sourcing is different from sole sourcing. Single sourcing means that a buying company chooses to work with one supplier, even though there are other comparable suppliers in the market. Sole sourcing refers to the relationship between parties when there is only one supplier in the supply base (Yu, Zeng and Zhao, 2009). For the purpose of this thesis, they are considered within the same category.

Single sourcing allows a more streamlined supply chain network to be established between the parties, via successful just-in-time (JIT) inventory initiatives (Burke, Carrillo and Vakharia, 2007; Yu, Zeng and Zhao, 2009). The benefits of single sourcing also include suppliers being linked to higher levels of buyer-supplier cooperation. In addition, total order lead-times and logistics costs are reduced because of the decreased supply base (Larson and Kulchitsky, 1998).

The supplier's uncertainty is decreased with single sourcing since long-term contracts are usually signed. This provides the security that business will not be lost over the competition, at least as long as the contract lasts. There is, therefore, more willingness to invest in new equipment, or to modify some of the operations according to the buying company's requirements, resulting in faster product design and better product quality among others (Benton, 2010, p 176). Communication time is saved because the buying company deals with one company, which results in better responsiveness between the parties. The buying company's inspection costs are also reduced because only one supplier has to be inspected (Mathusek, 2010).

Companies prefer single sourcing when they are interested in building partnerships with the suppliers. The reason why this might be imperative could be related to the nature of the sourced items and the kind of technical support the buying company might need in the future. For complex products with high tooling cost or for highly specialized components, it is important that the supplier's technological knowledge is available. Support should be at the buying company's disposal if they intend on concentrating the orders with one supplier in the long run. The advantage with that strategy is that the quality of the final product could be improved with time (Owens Swift, 1995).

Companies can improve at performing a specific function, the more they repeat it and increase their experience. The same applies to a selling company; their learning curve progresses, and their production cost decreases with experience. This is more likely to happen with single sourcing because the supplier is focused on producing one specific item. From the buying company's side though, this progress means more dependence on the specific supplier, since other alternative supply sources might be getting by the time less competitive comparatively. If this situation is not balanced, the buying firm might not benefit much from the supplier's production cost reduction in the end. That is the trade-off that the buying company should consider, and find a balance where a 'learning by doing' situation benefits all the parties. For a stronger buying company, with powerful bargaining capabilities, single sourcing can offer this balance and can be proven a better option. With single sourcing system profitability, the aggregate surplus of the selling and the buying company can be maximized (Heese, 2015).

2.3 Multiple sourcing

With multiple sourcing, more than one supplier is used for the same item or component. The main benefit for the buying company is that they can have alternative supply options. Dependency on one supplier is evaded, and any risk related to dependency on the suppliers is spread. Some companies choose even to purchase from several suppliers at different prices, to diversify these risks even more (Horowitz, 1986). With multiple sourcing vendor competition is stimulated, leading potentially to total price reductions. Multiple sourcing has been claimed to create an antagonistic tone between the buying and the selling company. However, as buying companies require more collaborative relations with their suppliers, this claim has changed over time (Johnsen, Howard, Miemczyk, 2014, p 97).

Economies of scale might be achieved with multiple sourcing since volume can be spread over fixed costs. This spreading might mean that the per-unit savings can be subject to diminishing returns. If the volumes are large enough though, multiple sourcing might get the returns diminished enough to be comparable with that of single sourcing (Benton, 2010, p 176). Diminishing returns in production, for example, occur when the amount of a variable factor is incrementally increased, and as a result, the incremental output of the production decreases (CFA Institute, 2011, p 138).

Multiple sourcing increases the learning opportunities for the buying firm more than what single sourcing does (Mathusek, 2010). Dual sourcing, using two suppliers for specific components, is recommended, to avoid supply bottleneck or congestions (Schuh et al., 2012, p 66). With dual sourcing, there is one main supplier, which gets the biggest amount of business from the buying company, and another, to create competition, but also to be a back-up, in case of problems with the main one. The percentages of the shared business between the suppliers are not necessarily fixed. Depending on the situation and the contracts, they might change (Yu, Zeng and Zhao, 2009). Dual sourcing could be cost effective when there is high uncertainty in lead times, and it can even reduce this uncertainty because orders are placed with two suppliers at the same time (Ramasesh et al., 1991).

Multiple sourcing improves market intelligence. When a buying company collaborates with many suppliers, it can get more informed on new technologies and developments, attain expertise and knowledge, and can even decrease product launch time. The supplier evaluation and appraisal effectiveness also increase, because the buying company can compare production information and cost between suppliers (Benton, 2010, p 176). Maintaining a close supplier collaboration relationship is pursued by buying companies, and multiple sourcing can strengthen this partnership, and maintain a balance between the suppliers (Kirytopoulos et al., 2010).

Toyota and Honda (car manufacturers) do not use single sourcing, to avoid dependency on one source; they opt for dual or multiple sourcing instead. Competition between the suppliers is encouraged, already from the product development step. The suppliers they work with receive long-term contracts, for the life of a vehicle model. If their performance is not sufficient for the manufacturer's standards, the next contract is given to a competitor. To enhance supplier relationship, both manufacturers follow six well-defined steps. The first step is to understand how their suppliers work, by visiting them often and engaging to common success. The second step is to try to turn the competition between the suppliers into a favorable situation, by gaining knowledge from establishing joint ventures with them. The third step is to monitor their suppliers, by frequently sending reports and constantly feedback. The fourth step is to help their suppliers to grow their technical capabilities, by supporting them to sharpen their core innovation competences. The fifth step is related to the third step, and it includes information sharing, based on accurate data collection and structured formats. Finally, the sixth step is organizing and carrying out general improvement activities, like arranging study groups with the suppliers, or by inducting kaizen projects [(continuous improvement) (Jacobs and Chase, 2010, p 461)] at their facilities (Liker and Choi, 2004).

One multiple sourcing category is the network sourcing, which is using many suppliers for the same components type (Hines, 1995). This type considers not only the direct suppliers and their relationships with the buying firm, but also the indirect ones and how they collaborate among themselves. Indirect suppliers are the suppliers of the buying firm's suppliers. Thus, competition is maintained both between direct and indirect suppliers. Japanese car manufacturers followed this unique subcontracting system. Their cooperation with their suppliers includes a tiered supply structure, risk sharing, staff cross-exchange between buying and supplying company, trust relationships and supplier coordination and development (Skjøtt-Larsen et al., 2007, p 237).

Another multiple sourcing category is the triadic sourcing. With triadic sourcing, the buying company creates interdependencies between two suppliers. As the name implies, the buying company with the two suppliers create a triad, in which all parties are interdependent and share a common network (Dubois and Fredriksson, 2008).

Parallel sourcing is another multiple sourcing category. It is a hybrid sourcing form, where the advantages of longer-term relationships with fewer suppliers are maintained, while at the same time supplier competition is encouraged (Richardson, 1993). In parallel sourcing, one supplier supplies one component to one plant, and another supplies the same component to another plant. This type of sourcing ensures

that similar suppliers act as single suppliers of the same component. The manufacturer can compare their performance and maintain a competitive pressure between them, encouraging them indirectly for continuous improvement (Skjøtt-Larsen et al., 2007, p 235).

Multiple sourcing provides chances to reduce the transactions uncertainties between the parties, to avoid dependency on one technology, and to pressure for a price reduction. The decrease in the transactions uncertainties is related to the reduction of the delivery failure risk. If one supplier does not manage to deliver when supposed to, the others can contribute to fulfilling the order (Tullous and Utrecht, 1992). When the buying company is not dependent on one specific technology, they might manage to introduce their product to the market faster, since they can rely on more suppliers to provide the said part. The pressure for price reductions stems from competition between the suppliers (Gadde, Håkansson and Persson, 2010). A computational analysis performed from Sawik (2014) concluded that multiple sourcing better mitigates the risks related to increased cost for the buying company, stemming from disruption risk, and to decreased service levels for its customers, referring to fulfilling orders after the due date. In a similar spirit, Meena, Sarmah and Sarkar (2011) claimed that a reduced supply base increases the risks of supply disruptions, because the failure of a single supplier to produce and deliver the needed items to the buying company, will negatively affect the performance of the whole supply chain.

The advantages of multiple sourcing do not necessarily take place at the same time and apply to every situation (Gadde, Håkansson and Persson, 2010). For example, the fact that the suppliers are competing against each other is not always a guarantee that the buying company can get a lower price. Nevertheless, many authors advocate for the individual benefits of multiple sourcing for the buying company.

The selection of a sourcing strategy is a complex issue for every organization. The challenges in regards to both strategies that are described below can give a more holistic view and might be helpful for professional buyers to decide which approach is more suitable. Weighing all factors before making a sourcing decision is advised.

2.4 Challenges with single sourcing

Single sourcing's main advantage is the establishment of close collaboration between the manufacturer and the supplier. On the downside, it establishes a dependency on a single source, which increases the risk of supply chain disruption (Chopra and Sodhi, 2004).

One example of a manufacturer failing to produce, because the supplier did not deliver parts, is that of 'Ericsson,' the mobile telephone manufacturer. In 2000, lightning hit a power line in New Mexico. This affected the electricity in the whole area, and started a fire at a local 'Philips Electronics' plant, which was producing microchips for mobile telephones, Ericsson included, destroying millions of them. As a result, the plant had to close down for an extended period. Even after production started again, it took time to produce enough microchips to supply/saturate the market

once again. Ericsson was forced to stop their production for months, as they had adopted a single sourcing strategy at the time. The results were detrimental and ended up in a \$400 million loss in sales. 'Nokia' on the other hand, a competing mobile telephone manufacturer, who was also sourcing from the same plant in New Mexico, started sourcing immediately after the incident from other Philips plants and other suppliers in Japan and USA. It was because of Nokia's multiple supplier strategy that the company did not suffer as much as Ericsson did. Ericsson since then has followed Nokia's example (Chopra and Sodhi, 2004).

Toyota's brake valve crisis in 1997, which started when the supplier failed to deliver the components when it was supposed to, is another example. The single sourcing strategy that Toyota had followed in that case, to achieve JIT deliveries, did not work for the company. The supply chain was disrupted as a result. An earthquake in Taiwan in 1999 caused many plants to stop their production, which affected all companies sourcing anything from that area. Supply chain disruptions due to supplier problems, can also cause a price increase of the final product. A flu vaccine shortage in the USA in 2004, because of one of the two suppliers not delivering due to batch contamination, caused a significant price increase in most states. These examples show that supply chains can be vulnerable. Dependence on a single supplier could during adverse circumstances cause a company to use up their stock and thus lose the inventory buffer that allows it to continue production relatively undisturbed (Yu, Zeng and Zhao, 2009). It follows from this, that sourcing from several suppliers becomes an insurance for buying firms against supplier failures caused by fire, strikes, quality or delivery problems (Skjøtt-Larsen et al., 2007, p 236).

Working with one supplier might have the advantage of JIT deliveries, but there are some negative aspects related to it. Coordination and operations alignment bears some extra cost, which the buying company would not have otherwise. This could be stemming from the possible need for extra personnel, and from likely longer reaction times, since more functions need to be coordinated, increasing this way the administration cost. In other words, there is less flexibility and adaptability with this integration, which could impede coordination (Horwitch and Thietart, 1987). It is suggested that continuous investments in integration might not yield similar performance improvements. Apart from employees, investments can be technology initiatives, such as electronic data interchange (EDI) or similar systems, or software like enterprise resource planning (ERP). Like any investment, they are subject to diminishing returns and may eventually decline to negative returns (Das, Narasimhan and Talluri, 2006).

The cost incurred from close collaboration with one supplier is not always measurable. Interdependence between two parties can have a long-term negative effect, because it could result in both companies reducing their learning capabilities, through limited contacts with their external environment. The economies of experience that companies enjoy via a 'learning-by-doing' process might not have the result that they were initially aiming for (Sorenson, 2003).

The sense of stability and reliability that a buying company gets from doing exclusive business with one supplier might prove to be false since the supplier can decide to stop collaborating with the buying firm. Changes in the relationship might occur if strategic goals change. The innovation-based changes that the buying company might

want to invest in, to become more competitive, might not be included in the supplier's immediate plans. This conflict could result in reduced autonomy, competencies, and identity for the buying company. Reduced autonomy means that the buying company can be dependent on the supplier's goals. Reduced competencies are related to the fact that when the buying company purchases an item that the supplier is not willing to change, it might end up having to purchase other items or activities related to the initial item, thus reducing the firm's possibilities to increase its competencies. Finally, a feeling of reduced identity might occur since the buying firm may not be able to proceed with what they had set their minds to if their only supplier is not willing to follow (Lewi, Hayward and Kasi, 2013).

Single sourcing's relationship management costs, regarding capital and time, might excel the specific strategy's performance benefits (Bhote, 1987). That is because single sourcing requires the buying firm to develop a relationship with the supplier, based on trust. Trust in the sense that a contractual agreement in certain cases can be "bypassed" by informal arrangements. Of course, trust should ideally be built also when collaborating with multiple suppliers. In the case of single sourcing though, this becomes more important, especially when something unpredictable happens, that might not be covered by the contract (Burke, Carrillo and Vakharia, 2007). However, trust is difficult to gauge since it cannot be measured on specific factors.

High involvement between the parties requires that both invest time to adjust to each other's functions. For processes to be coordinated, time to develop a relationship is required from both parties (Gadde, Håkansson and Persson 2010). Another single sourcing related risk is the fact the supplier might overcharge the buying company, knowing that there is no competition. A buying company would be hesitant to switch to another supplier since that would be time-consuming and costly. A supplier might take advantage of a situation like that (Kirytopoulos et al., 2010).

2.5 Challenges with multiple sourcing

Some challenges associated with single sourcing can be mitigated if the buying company chooses to collaborate with more than one supplier. However, multiple sourcing has a set of challenges, some of which are mentioned here below.

Managing several suppliers can present challenges to the buying firm in regards to choosing transportation mode. The general dilemma is whether to choose short lead times with high transportation costs, like airfreight, or opt for longer lead times and lower transportation costs, such as sea freight, or a combination of both (Minner, 2002). For items, whose dimensions are too large to fit in an airplane, transport by sea freight would be the obvious choice. Apart from obvious cases where the mode of transportation is non-optional, the specific dilemma pertains to both single and multiple sourcing. However, coordinating shipments from several suppliers can be more time and resource consuming for the buyer, which is why choosing the right transportation mode bears greater weight.

Although sourcing from more than one supplier can reduce the stock-out risks, it is imperative that the buyer consider splitting the order carefully, so that a balanced inventory is kept. A common challenge facing a company is, on the one hand, to balance how much inventory should be kept to prevent a production stop, and on the other hand making sure that not too much working capital is tied up in inventory (Glock and Ries, 2013). While relying on multiple suppliers could prevent a potential production stop, the complexity and challenges in dealing with several partners must be carefully addressed, all the way down to inventory replenishment processes.

The manufacturer faces uncertainties in regards to predicting the demand, which provides a lead as to the quantities to order. Once a prediction is made on how many items to manufacture, there should be standard operating procedures dictating how many pieces of each commodity to order. In the case of multiple suppliers though, the risk increases for the manufacturer, because apart from demand uncertainties, also exchange rates uncertainties could be of relevance when purchasing overseas. Combining purchasing and selling uncertainties in regards to when an order should be placed and at what quantity, was investigated by Hu and Motwani (2014), who analyzed how to minimize the risks of multiple supply candidates from different countries.

The buying company's involvement with the suppliers decreases as their number increases. As a result, supplier commitment could diminish, and a reluctance to invest in new technologies could develop. A supplier's awareness of existing competition could hinder any extra effort and dedication, to develop the relationship with the buying company (Constantino and Pellegrino, 2010). The low involvement level decreases the cooperation efficiency. The buying company cannot necessarily assess the product quality since information on the supplier and their products might not be enough (Skjøtt-Larsen et al., 2007, p 216).

Another negative aspect of multiple sourcing is the increased administrative cost that it can bring for the buying company. This includes both the initial cost of choosing the supplier and the ongoing cost of collaboration, throughout the duration of the buyer-supplier relationship. The latter would depend on how many employees are dedicated to each supplier, how many telephone calls need to be made, how much record needs to be kept and so on. It is therefore related to the managerial effort required by the buying company. This cost can be incremental, until it reaches a plateau, something that happens with all the suppliers, no matter how many the buyer collaborates with (Costantino and Pellegrino, 2010). Nevertheless, the more suppliers, the higher the administration cost to be expected. For better multiple source management, investments in web-based supply chain management applications are suggested (Burke, Carrillo and Vakharia, 2007).

When looking into following multiple sourcing, the buying company should consider the ideal number of suppliers, for the same or similar products. In other words, to examine how many suppliers might be too many. This decision might not be relevant in the case of specialized parts, where the buyer might not have many sourcing options. When there are options though, also concerning the practicalities around the logistics, this is a decision that needs to be taken. Berger, Gerstenfeld and Zeng (2004) proposed an analysis approach based on the technique of decision flow diagrams and probability modeling, to tackle this issue. The probability refers to the

likelihood of events happening that may affect the suppliers. Ruiz-Torres and Mahmoodi (2007) suggest a similar method of deciding, based on a model that considers the suppliers' failure probability and reliability. They all suggest using algebra in the decision process, also in regards to the initial dilemma, single or multiple. If using advanced modeling is not an option for the purchasing manager, deciding can be challenging.

Sawik (2013) summarizes the main issues that purchasing managers need to consider in regards to multiple sourcing that were also analyzed by most of the authors above. These include a) from which supplier to purchase parts, b) how many suppliers to use, c) order quantity allocation and d) order scheduling.

2.6 Comparison of the two approaches

During the last two decades, the differences between single and multiple sourcing have been discussed a lot (Skjøtt-Larsen et al., 2007, p 234). This subsection compares the two approaches and overviews some of their advantages and disadvantages.

To repeat some of the benefits of single sourcing, one is the increased confidentiality between the parties and a stronger, long-lasting buyer-supplier relationship. For the buying company, it is less challenging to cooperate with one supplier on product and service development, than with many. As a disadvantage, from the supplier's side, any potential order fluctuation from the buying company might bring instability. This could be more apparent to the single supplier since all the orders are supposed to be fulfilled by this single company. If they were to be fulfilled by more, and would, therefore, be divided, the individual suppliers would not necessarily feel any potential fluctuations (Slack, Chambers and Johnston, 2004, p 453).

With multiple sourcing, the buying company can use tendering to obtain the best possible price from the candidate suppliers. This method can allow for a clearer view on market prices to be formed. Using tendering in a successful way requires careful attention and knowledge of each step. These are usually identification of potential suppliers, preparation to send the tender documents, bids analysis and final negotiations with the potential suppliers (Schuh et al., 2012, pp 25-26). On the downside, the buying company would need to increase the effort in regards to communicating with many suppliers. Lower involvement between the parties hinders trust development. Assuring supplier quality can also be more strenuous since there are more companies to deal with. Economies of scale are less easily achieved when orders are divided between many suppliers (Slack, Chambers and Johnston, 2004, p 453).

The circumstances under which one firm switches the entire or partial quantity to an alternative supplier, and the cost related to this switch was examined by Wagner and Friedl (2007). The authors claim that choosing between single or multiple sourcing depends mainly on the buying firm's belief on the alternative supplier's unit cost, on the switching cost, or the price offered by the initial supplier.

Figure 4 summarizes the advantages and disadvantages of both single and multiple sourcing.

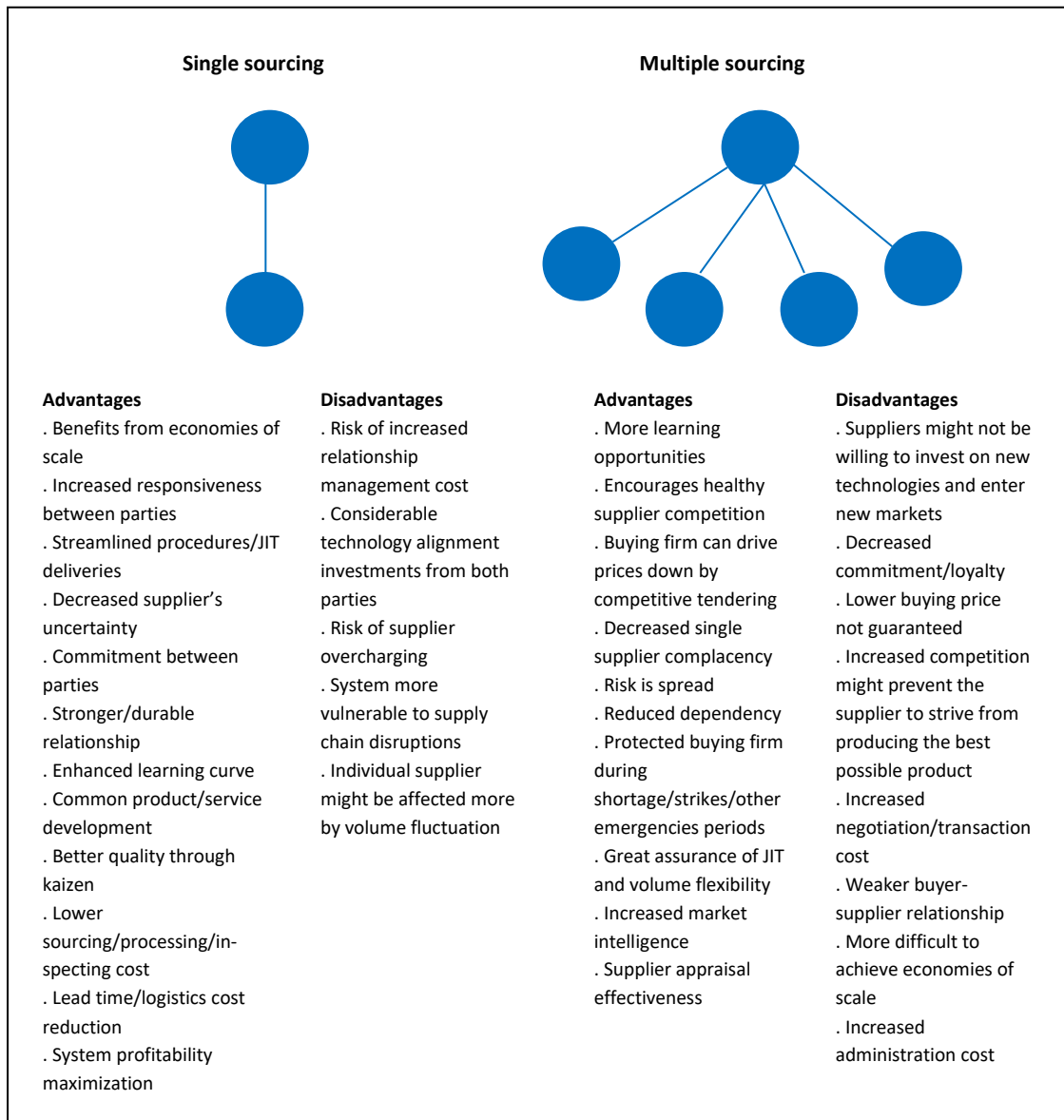


Figure 4: Advantages and disadvantages with single and multiple sourcing (based on Johnsen, Howard, Miemczyk, 2014, p 99; Slack, Chambers and Johnston, 2004, p 453)

Sometimes, the dilemma of single versus multiple sourcing can be easily settled. The laws of supply and demand can provide a straightforward answer (Figure 5). When there is high demand power from the buying firm, the company can exploit competition to their advantage, since there are many suppliers that can meet the specified requirements. Multiple sourcing is possible in this case. On the other hand, when there is high supply power, in oligopolistic conditions, the buying firm does not have a high degree of control, and single sourcing is the solution (Schuh et al., 2010, p 13). The monopolistic or oligopolistic situation from the supplier's side might have to do with technical knowledge or other capabilities that only the specific supplier

possesses. The buying firm can change the nature of demand instead, by modifying some of their technical specifications, which could allow more suppliers to enter the market. That can be achieved by innovation breakthrough, technical data mining, re-specification, and risk management (Schuh et al., 2010, p 20-23).

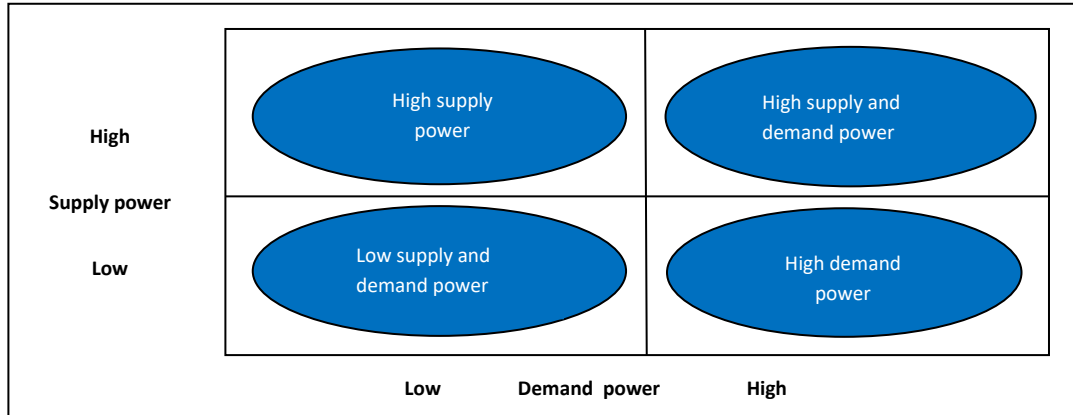


Figure 5: Supply and demand in purchasing (Schuh et al., 2012, p 12)

When there is both high demand and supply power, both parties are dependent on each other, and securing joint long-term advantages is the best option, leading to single sourcing to some extent. However, when there is low supply and demand, the buying firm can choose between which costs can be avoided since there is no urgent need for the specific products. In other words, the buying firm can manipulate the demand to an extent (Schuh et al., 2012, pp 13-14).

Each sourcing case may be a combination of a few or more of the characteristics mentioned in the previous sections. It might therefore not always be clear which sourcing strategy fits best. This implies that additional parameters are examined jointly before any decisions are taken.

2.7 Supplier relationship management and supplier assessment

At the center of successful purchasing lies the supplier relationship management, as an essential component to creating competitive advantage. To avoid any form of dependency on one supplier and to minimize risk exposure, purchasers opt for multiple sourcing. However, the more resources are allocated to suppliers, the higher the buying company's dependence on them, which makes it more imperative to manage them effectively (Kannan and Tan, 2002). Instead of multiple sourcing, some companies use 'partnership sourcing,' which is a single sourcing type that focuses on close long-term supplier relationships (Johnsen, Howard, Miemczyk, 2014, p 129). This subsection focuses on supplier relationships management and supplier assessment, as issues, which could be decisive in choosing between single or multiple sourcing.

2.7.1 Supplier relationship management (SRM)

A contract signed between a buying company and a supplier needs to be put into practice. An important element to this is alignment of both parties' needs. Managing the contract agreement is critical for the purchasing process to generate value (Harrison, van Hoek and Skipworth, 2014, p 368). The supplier relationship management aims for efficient cooperation with the suppliers, which can allow the buying firm to develop new products competitively. The suggested steps to supplier relationship management are: 1) decrease the supply base, 2) divide the supply base, 3) initiate guidelines per division, 4) apply supplier rating and development organization, 5) allocate category managers to the most important suppliers to encourage a closer relationship and 6) manage towards a status of 'customer of choice'. Supplier relationship management is a process of continuous development, made possible by the alignment of both company's needs, via a long-term collaboration, assisted by supplier assessment (Park et al., 2010) (Figure 6).

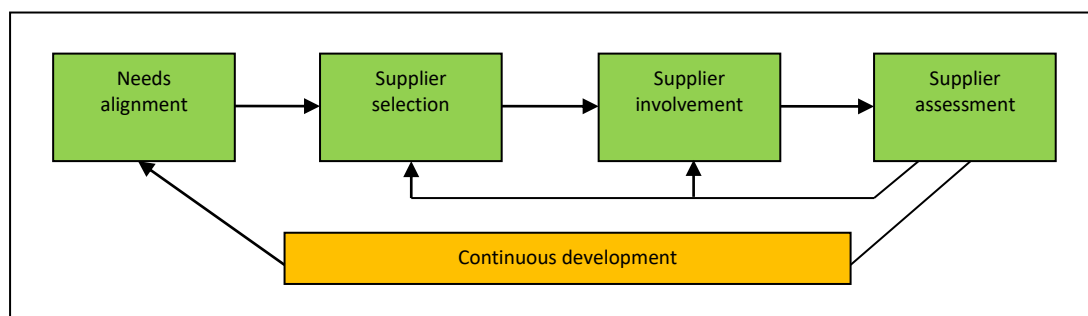


Figure 6: Supplier Relationship Management (SRM) (Park et al., 2010)

The relationship is more effectively managed when regular contact between the parties is established. This is even more crucial with strategic suppliers, whose regular and thorough monitoring and evaluation is necessary. Compiling each supplier's individual profile is a good way to keeping up with them. Points that can be included are company profiles, main contact persons, a SWOT analysis, some financial data, company management and employee structures, contractual details, and names of their suppliers. Other departments related to purchasing functions can have access to these profiles. The buying companies need to express clearly their anticipations to their suppliers, on future product development and other plans and provide them with frequent, constructive feedback. This can be achieved via a combination of supplier self-assessment with the buying company's ratings. To encourage not only acceptable but also robust supplier performance, reward and punishment systems can also be introduced. Whatever supplier relationship management scheme the buying company chooses, it is advisable to be compiled on an annual basis (Benton, 2010, pp 167-172). Despite the fact that this would be time-consuming and costly with regards to administration, it might prove useful to the company. The supplier base must be kept 'clean', by for example removing inactive suppliers regularly, so that administration time is reduced. Regular supplier assessments can assist with that.

2.7.2 Challenges with SRM

Challenges with SRM can be integration cost, lack of willingness, of common tools, goals and language, lack of trust and commitment, lack of standardized tools, problems with IT system integration, lack of formality, or impact of the SRM program on the supplier's flexibility. Especially the lack of goal alignment and lack of commitment from suppliers can be crucial potential barriers. However, these challenges can be overcome, if the manufacturer manages to establish the mechanism that would give the supplier the sense of belonging to a bigger 'industrial family.' This can encourage the supplier to align their goals with the manufacturer's, commit to common operations and trust the manufacturer more. For the manufacturer to prove its intentions to the suppliers, it is recommended to provide them with motivations, such as financial incentives, technology and knowledge transfer, and information sharing (Oghazi et al., 2016). Firms' relationships are the main aspects to driving corporate performance, and it can be a managerial challenge for companies to actively manage supplier relationships (Forkmann et al., 2016).

2.7.3 Supplier assessment

Supplier assessment is critical for companies and their competitiveness, as they are confronted by the difficult task of identifying reliable suppliers. Supplier assessment has been traditionally based mainly on favorable price conditions. However, quality has also been considered a critical product attribute, and as a result, buying firms started to select suppliers, which hold quality certifications such as ISO9001 or ISO9002 [the ISO series are quality assurance standards and belong in the category of systems audits, which compare the quality system to external standards (Van Weele, 2014, p 230)]. Price and quality are important factors, but supplier assessment is an undertaking, based on many standards (Kwong, Ip and Chan, 2002).

A way of assessing the supplier can be to compile a list of questions, related to the attributes that constitute an ideal supplier. Some important factors that could inspire the questions are issues of delivery, quality and reliability, price, responsiveness, lead-time, location, technical capabilities, R&D (research and development) investment plan and financial and business stability. The answer options that could be given to the suppliers can be 'yes' or 'no.' The total answers can be counted and summarized in a report (Schorr, 1992).

A supplier-rating plot, consisting of three assessments, can also be used. They are 1) the full business assessment, which evaluates issues on cost, quality, delivery, leadership, and technology 2) the quality system survey, which focuses, as the name implies, on the supplier quality system and 3) the quarterly quality and delivery assessment, which is more generic and examines more supplier information. All these assessments can include related questions, and the answers can be rated as 'excellent,' 'satisfactory,' 'minor deficiencies,' 'major deficiencies' or 'unacceptable.' The total score of each supplier would be the sum of the total calculations of each set of answers, multiplied by a weight, based on the degree of significance that the buying company assigns to each factor. For example 20 percent for cost, 18 percent for quality, and ten percent for delivery (Feldman, 1994).

The scoring method is common for assessing supplier but is not easy to apply. It can yield score inconsistencies from different respondents because each person might conceive same topics in slightly different ways. For example, a question like “How good is the supplier delivery system?” might be asked, with ten being the highest score, and one respondent may give eight out of ten, and the other seven out of ten, although both might have the same answer in mind (Kwong, Ip, Chan, 2002).

It has also become increasingly important that the suppliers perform effectively from an environmental point of view. Since companies are forced to develop their environmental performance, it becomes imperative to assess the same for their suppliers. Some measures to do that can be based on the supplier’s environmental efficiency, on their ‘green’ image and strategy, and can be both qualitative and quantitative. Practically, issues like availability of clean technologies, materials type, air emissions, waste quantity, and energy consumption, can be investigated and the supplier can be rated accordingly (Noci, 1997).

Assessing a supplier has to do both with ‘hard,’ quantifiable criteria and ‘soft,’ non-quantifiable (Ellram, 1990). Hard are those that companies have regularly been relying on regarding assessing a supplier, like price, delivery time, quality and service (Hahn, Watts and Kim, 1990). Soft criteria include management compatibility and strategic direction of the supplier (or strategic commitment), qualities that can make the difference between strategic partnership and just doing business together. Kannan and Tan (2002) proved that supplier management could influence a buying firm’s business performance and that soft criteria can have a greater impact on performance than hard. The buying firm can stimulate an improved supplier performance, by regularly visiting the supplier’s premises, by organizing training sessions for them, or by using alternative suppliers (Krause, 1997).

2.8 Total cost of ownership

Buyers have traditionally been focusing on procuring at the lowest prices possible since savings have always been the center of purchasing. The buying price, although vital, it does not reveal the total cost. Delivery speed, reliability, product quality, maintenance cost and durability among others can be as decisive factors as price. Some costs also occur over time during the product’s lifecycle, like warranty cost. Total Cost of Ownership (TCO) means going below the purchase price and recognizing all the other costs incurred over the product’s lifecycle (Harrison, A., van Hoek, R. and Skipworth, 2014, p 365-366). In the end, following single or multiple sourcing can be a decision based on the TCO. Therefore, shedding light on this concept is deemed appropriate.

TCO, as the name implies, includes all the costs that are related to the lifetime of a product; attaining it, using and disposing of it. Apart from the buying price, the rest are based on estimation. Therefore, TCO refers to acquisition cost, which is the purchase price, ownership cost, which is the related to product use, and post-ownership cost, which is related to potential recycling or scrapping cost (Jacobs and

Chase, 2010, pp 423-424) (Figure 7). Sometimes using a product can be more costly than the initial buying price, and can influence the total cost summation.

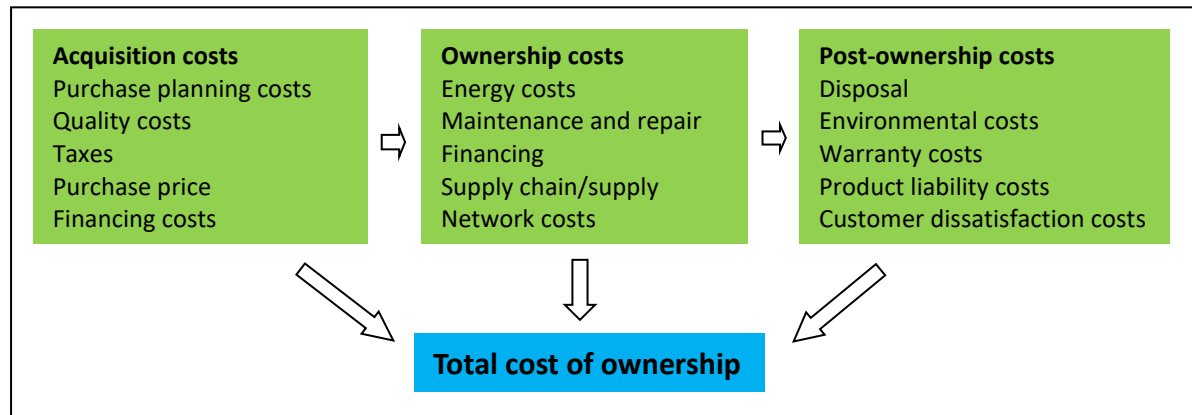


Figure 7: Total cost of ownership (Jacobs and Chase, 2010, p 424)

The TCO as a tool allows professional buyers to combine value and price when making their sourcing decision. It is considered an extension of another cost-calculating tool, the activity-based costing (ABC). The aim with ABC is to break any business down into major processes, break the processes into activities, and identify what drives cost for each activity (Harrison, van Hoek and Skipworth, 2014, p 104). The cost drivers in ABC are: 1) on a unit level, referring to the purchase price and quality control cost during inspection, 2) on a batch level, referring to the costs of creating a purchase order, 3) on a supplier sustaining level, referring to the cost of supplier identification and certification and 4) on a product or part sustaining level, referring to the cost of maintaining technical product information (Wouters, Anderson and Wynstra, 2005). The more suppliers examined, the more the total cost that needs to be apprehended.

Since there are different cost categories, it is recommended that they are divided and sorted out, so that it is decided which one plays the most decisive role in each sourcing case. Some main categories are product design, facility, geography, and operations (Table 2). The costs in any one of these categories might outweigh that of the others. Buyers need to consider all the different cost drivers before making a choice (Ask and Laseter, 1998).

Table 2: Cost drivers categories

Category	Description	Examples
Design	Costs related to product design	Material specifications Product line complexity
Facility	Costs related to the size of the facility equipment and the employed process technology	Facility scale Use of automation
Geography	Costs related to the facility location	Location-related wage differences Transportation costs
Operations	Costs that differentiate a well-run facility from a poorly run facility	Labor productivity Facility utilization Rejection rates

(Ask and Laseter, 1998)

Sometimes purchasing professionals misjudge ‘lower cost’ with ‘lower price,’ which results in the suppliers trying to constantly reduce their price (Anderson, Thomson and Wynstra, 2000). While cost reduction constitutes one aspect, buying firms should also be aware of designing products that provide the lowest TCO to their customers as well (Jacobs and Chase, 2010, p 425).

Being aware of the TCO (or ABC) helps buyers to understand all relevant costs when they do business with suppliers. TCO could assist buyers to discover which suppliers are more costly, something that could result in stopping the cooperation with some, thus reducing the suppliers’ base, which would mean to move closer to a more exclusive collaboration with a limited number of suppliers. Looking at the TCO should also be applied in regards to the relationship with a supplier. If for example one supplier is not performing well enough during the ordering and expediting process, working with the particular company might end up to be too expensive; the time spent on administration should also be considered. Decisions on whether to use one or more suppliers should also be taken with the TCO in mind.

2.9 Chapter conclusion

In the first part of this chapter, the basic purchasing process, and the supplier selection procedure, some initial thoughts are presented in regards to how companies choose their sourcing strategies. The nature of the products sought to be bought, and the market characteristics can provide a direction of an answer towards the dilemma.

Choosing to collaborate with one supplier or more for a specific item can be challenging. This chapter summarized some advantages and disadvantages of single and multiple sourcing, as recorded in published literature. Some of them can be more evident to the reader, and others can create more questions. For example, some authors claim that single sourcing can lower the acquisition cost for buyers, because of the economies of scale that they can achieve from ordering increased quantities. The same is claimed in the case of multiple sourcing if there are enough volumes to

be spread out over fixed costs. JIT deliveries are claimed to be advantages both for single and for multiple sourcing. Reduction in the transaction activities and better responsiveness seem to be able to be achieved with either single or multiple sourcing.

Regarding their disadvantages, both strategies seem to be sharing some as well. For example, it is mentioned that both single sourcing can increase the administration cost, in the form of cost for coordination and cooperation alignment, and multiple sourcing, since there are more suppliers to deal with. These concurring advantages and disadvantages can be confusing for a buyer. For that reason, a comparison between the two approaches was added. At this part, the reader can see, for example, that it is less easy to achieve economies of scale with multiple sourcing than with single.

To elaborate further on how companies make their sourcing decisions, a part on supplier relationship management was added. The relationship with a supplier and how this is managed, the hard and soft criteria in supplier assessment, can all point towards a direction as well. In the end, the TCO determines whether a supplier is worth collaborating with, and consecutively how many should the company employ. Information attained from professional buyers, at chapter four of this thesis, can validate whether what has been mentioned in the literature, also applies in practical settings.

3. Methodology

The purpose of this chapter is to provide the reader with an overview of the methods that the author used to perform the research. First, the research design is explained and the four different phases of the project. The research methodology is identified afterward, and the paradigm under which the research was conducted. An overview of the data collection methods follows, as well as the data analysis method. Finally, a short discussion is presented on the reliability and validity of the research as well as the potential generalizability.

3.1 Research design

The issue of investigation in this thesis is the dilemma of using single or multiple sourcing. As this is not merely a matter of choosing either the one strategy or the other, a more thorough investigation is deemed appropriate. The project was initiated by a truck OEM, to get as close to an answer to the above dilemma as possible. For that reason, the researcher, and author of this thesis, who was chosen to look into it, has been in close collaboration with the experts working for the specific company, in regards to purchasing matters. The author selected the specific case since it deals with issues that were covered during the training/education received at the University of Gothenburg.

Because a specific company created this project, it fits the methodology of a case study. A case study investigates a contemporary phenomenon in depth, from the angle of a real-life context, which reflects exactly the nature of this project. Multiple sources of evidence need to be researched combined with previous theoretical propositions (Yin, 2009, p 18). A case study is separated from other research designs because the focus is on a given situation. Even though some of the findings might represent the OEM industry in general, this project is aimed at providing answers and tools only to the specific truck OEM. The emphasis is on an intensive examination of a specific setting (Bryman and Bell, 2011, p 60). The goal of this thesis is to provide an as much as possible comprehensive examination of sourcing strategies, utilizing evidence submitted by interviews among others, and to potentially shed light on a larger class of sourcing cases (Gerring, 2006, p 17-20). This could be possible because characteristics, strengths, and weaknesses of both single and multiple sourcing are exhibited (Gerring, 2006, p 37).

Several types of case studies have been looked into to categorize the specific research conducted in this thesis. Since there is no agreed convention for classifying case studies, and classification furthermore is situation-dependent, several definitions may fit this research. One definition could be the 'evaluation case study,' which aims at determining the value of the case, and at reporting findings to a range of stakeholders in ways that they can use (Leavy, 2014). It could also be categorized as a 'representative or typical case study,' as it seeks to explore a case that demonstrates an everyday situation (Yin, 2003). Finally, this case could also belong to the 'opportunistic case study' category because the opportunity to explore the sourcing

issue arose to the researcher because of access granted to the specific business (Otley and Berry, 1994).

The main stages in a case study are 1) selecting the case, 2) preliminary investigations, 3) data collection, 4) data analysis, 5) writing the report (Collis and Hussey, 2013, p 69). Following this, the author employed four main phases to execute the work. The first phase was used to gather information regarding the topic, to define the scope of the research and to formulate the research questions. At the second phase, the relevant theories were reviewed in regards to sourcing strategies. In the same phase, the interview respondents were identified and interviewed. In the third phase, the data were analyzed and evaluated. Finally, the research questions were answered, and recommendations were given to the OEM. Table 3 summarizes the four phases of this project.

Table 3: The phases of the project.

Phase 1	Phase 2	Phase 3	Phase 4
Research purpose	Data collection	Data analysis	Conclusion
<ul style="list-style-type: none"> • Comprehend the dilemma • Define the scope of the research 	<ul style="list-style-type: none"> • Theoretical framework and literature review • Interview data 	<ul style="list-style-type: none"> • Data evaluation (primary and secondary) 	<ul style="list-style-type: none"> • Answers to the research questions • Further recommendations

Case studies have typically been linked to qualitative methods of analysis (Gerring, 2006, p 10). For this thesis, a qualitative analysis has been chosen under the interpretivism paradigm. This meets better the needs of the thesis, as qualitative, rather than quantitative data, were gathered. Qualitative data are transitory, are understood only within the context, and are in a non-numerical form (Collis and Hussey, 2013, p 130). Qualitative research is an appropriate approach to business research, when no quantitative data are selected or generated (Bryman and Bell, 2011, p 386), hence rendering it the most suitable approach to this thesis. The main steps in qualitative research usually are: 1) formulating the research questions, 2) selecting the organizations to be studied, 3) collecting the data, 4) interpreting the data, 5) specifying tighter the research questions and collecting further data if needed, 6) compiling findings and conclusions in a written form (Bryman and Bell, p 390). The author of this thesis had the above steps in mind when conducting the research.

The interpretivism research paradigm is the philosophical framework that guided how the research for this thesis was conducted. The general aim of the research is to provide a better understanding of sourcing strategies within a particular context, namely the truck OEM. Since interpretivism argues that reality is highly subjective, rather than objective, and aims at gaining an interpretive understanding of the examined phenomenon (Collis and Hussey, 2013, p 44-45), it is the most appropriate paradigm to follow.

3.2 Data collection

The researcher collected secondary and primary data to answer the three research questions. Secondary data were collected from published literature and primary data from semi-structured interviews.

3.2.1 Published literature

The three stated research questions could not have been answered only with primary (interview) data. Secondary data needed to be included as well, for identifying what is already known about the topic of interest, and which are the relevant concepts, principles, and theories that have been formulated about this specific field of study (Bryman and Bell, 2011, p 92).

A literature research relies on collecting the appropriate information from articles, books, reports and journals (Collis and Hussey, 2013, p 76). First, the researcher identified keywords that helped to define some boundaries in the searching process. The most obvious keywords used were 'single sourcing' and 'multiple sourcing,' but also 'advantages,' 'gains,' 'disadvantages,' 'perils,' 'challenges' with the two sourcing categories, as well as other synonyms that were helpful. Other simple search keywords that were used are 'industrial buying behavior,' 'supplier/vendor selection procedure,' 'supplier/vendor relationships management,' 'supplier/vendor assessment,' 'total cost of ownership,' and so on. These simple searches brought about more keywords that were useful to the research. The electronic version of the library of the University of Gothenburg was the main search engine platform that was used, along with the suggested literature from courses attended during the author's studies. This platform led to other databases that were used, like Scopus, Elsevier, Science Direct and Emerald Insight among others.

The survey and interpretation of the theories included in the literature review facilitated a fundamental understanding of important ideas and models within this subject. In this way, the literature review led to a sharper focus on relevant information, which was used as a basis for the formulation of the interview questions.

3.2.2 Interview data

Semi-structured interviews were chosen for this thesis. As the researcher intended to encourage the interviewees to discuss the main points of interest (Collis and Hussey, 2013, p 133) and to stimulate a conversation within a specific, yet open, structure (Spender, 1989, p 79), this interview type was deemed the most appropriate. All the questions were prepared in advance, and they were open in nature, allowing the respondent to provide longer and developed answers. Although the order in which the questions were planned to be asked was organized in a specific concept path and was predetermined by the researcher, this was not followed strictly. Some of the prepared questions were not asked at all since the respondent happened to have provided relevant information while answering to another question (Collis and Hussey, 2013, p 134), while some additional questions arose during the interviews. The questions were sent in advance by e-mail to the respondents, to allow them some time to prepare answers, and to introduce them in more detail to the topic.

The interview guide outlined by the interviewer, namely the list of specific issues to be covered (Bryman and Bell, 2011, p 473), was drafted to allow the respondents to reply the way they saw fit. For that reason, leading questions were avoided. Moreover, its design allowed for some flexibility in regards to asking questions. The researcher tried to formulate the interview guide in an understandable and relevant way for all the interviewees (Bryman and Bell, 2011, p 475). All the questions were formulated identically, apart from those that arose during the interview, and were not included in the interview guide. That is because, during a semi-structured interview, the interviewer often picks up things said by interviewees, which can give the lead to an extended conversation (Bryman and Bell, 2011, p 467). Depending on the time limits set by the respondents, this was the case with all the interviews.

Eight interviews were conducted in total; approximate time of duration was one hour each. Four of them were face-to-face, and the rest were conducted via Skype. As some respondents were based in other countries, it was impossible for the researcher to conduct face-to-face interviews with all of them, due to logistics and resource reasons. The interviews were recorded, so that all vital information was logged. This allowed the researcher to listen to the interviews again. Recording took place only after the respondents' permission to do so was given.

To generate more data from the interviews, reference to particular events was occasionally made, to encourage narratives that are more detailed. In other words, the respondents were asked to recall examples of specific incidents, an approach referred to as 'critical incident technique' (Bryman and Bell, 2011, 472). One particular instance was when the researcher used the examples of 'Ericsson' and 'Toyota,' stated in chapter two, to guide the respondents to recall similar incidents. However, since the researcher's knowledge of the phenomenon under study was evolving during the time the interviews took place, it was not on all occasions clear what constitutes a critical incident; therefore the technique was used with caution (Collis and Hussey, 2013, p 141).

Rather than transcribing the interviews word-by-word, summaries and detailed notes were made during the interviews, and by subsequently listening to the audio recordings. A word-by-word transcription is a time-consuming process that requires meticulous work (Bryman and Bell, 2011, p 583). For about every hour of an interview, five to six hours for transcription are required (Bryman and Bell, 2011, p 483). Further work is necessary for coding. Coding is a process where the data is broken down into parts, and names are given to categorize them according to their attributes (Bryman and Bell, 2011, p 577). At some point during an interview, the interviewee starts to repeat concepts, and new information or perspectives are not added (Strauss and Corbin, 1998, p 212). Beyond the technical issues of coding, it is possible that when an interview is 'saturated' in this way, a complete transcription will be inefficient (within a time-consuming – cost/benefit perspective). Instead, the interview summaries and extensive notes outlined the interview content, highlighting portions relevant to the sourcing problem of the project. Thus, the accuracy of the primary data is not thought to be compromised in any way. The interview guide containing the interview questions is included in the appendix of this thesis, and the interview recordings are stored as audio files.

3.3 Data analysis

In analyzing the data gathered during this thesis work, an inductive approach was used. This means that the theory was developed from the empirical reality; in other words, the researcher moved from observations to statements (Collis and Hussey, 2013, p 7). The inductive approach to analyzing data is associated with the interpretivism paradigm (Collis and Hussey, 2013, p 44) and a qualitative research approach (Bryman and Bell, 2011, p 13). A case study tends to take an inductive approach as well, in regards to the relationship between theory and research (Bryman and Bell, 2011, p 60). Nevertheless, since the researcher had already studied a significant amount of existing theory and literature on the researched topic by the time the interviews took place, an initial approach to data collection had been formed beforehand. This agrees with the fact that research is very seldom exclusively inductive (Bryman and Bell, 2011, p 573).

3.4 Reliability and validity

Reliability and validity are important measures for evaluating the business research quality (Bryman and Bell, 2011, p 40). Interpretivism tends to produce findings with low reliability and high validity (Collis and Hussey, 2013, p 52).

Reliability refers to whether a study can be replicable, producing the same results if it was to be repeated (Bryman and Bell, 2011, p 41). There is no way of knowing whether the same results, as with this thesis, would have been produced, if the single versus multiple sourcing research was to be repeated unless another research was conducted. As this thesis investigates the said topic within the specific settings of the truck OEM, it is more likely that the results would not have been the same, under different settings, reducing like that the reliability.

Validity assesses the integrity of the conclusions generated by the research (Bryman and Bell, 2011, p 42) and tests whether the results reflect the phenomenon under study (Collis and Hussey, 2013, p 53). Validity is usually separated into internal and external. Internal validity refers to validity that is internal to the sample (Gerring, 2006, p 43) and to whether the researcher achieved a match between the theoretical ideas reviewed and the observations (Bryman and Bell, 2011, p 395). In this thesis, there was an identification between concepts and observations. Therefore the internal validity is considered high. External validity refers to the extent that the empirical data can be generalized to other settings or business cases (Bryman and Bell, 2011, p 395) or can be applied to a broader population (Gerring, 2006, p 43). Even though the empirical data refer to the truck industry, some generalization is possible to other OEMs, as some rules in regards to sourcing strategies can apply to more than one industry.

4. Results from the interview data

The purpose of this chapter is to present the data that the author gathered from the interviews. The first four interviews were conducted with buyers within the truck OEM that initiated this investigation. These buyers are responsible for sourcing a specific commodity, but each one of them is an expert within a specific portfolio of products under the same commodity category. They are corporate buyers (Van Weele, 2014, p 280), situated in different offices around the world and are responsible for their respective portfolios globally. The other four interviews were held with buyers from other OEMs. A confidentiality agreement signed by the author prohibits from mentioning the truck OEM's name and the commodity under investigation. The respondents of the other OEMs also asked for confidentiality and therefore, no names are mentioned in this chapter.

4.1 Respondents from within the truck OEM

The below supplier selection procedure (Figure 8) is common for the first four buyers. Average duration is 16 week, according to Buyer A, who provided the details, and it is divided into seven steps.

The first step is called 'Market Survey.' After the marketing department has identified a new market, which the company should expand to, they inform the engineering department to identify the necessary parts. The buyer is then informed, and a market research begins, during which the potential suppliers are listed. The second step is divided into two phases: a) the 'Short Supplier Evaluation Method' (SSEM), during which the potential suppliers are audited on issues like their financials, quality and deliveries, and b) the RFI. During the third step, the list of suppliers becomes shorter, which is termed 'Potential Supplier List' (PSL). Then, a presentation to the interested stakeholders is made (engineering, quality, logistics, manufacturing, purchasing, after-market departments), justifying the reasons why those that qualified did so. During the fourth step, an RFQ is sent as well as a 'Review of Technical Specifications' (RTS) form to the short-listed suppliers, to confirm that they understand the technical requirements. Another presentation is held during step five to the stakeholders, justifying the buyers' final choice. Step six deals with the final negotiation, if everyone approves the supplier, and finally, the contract is signed at step seven.



Figure 8: Supplier Selection Procedure (Truck OEM)

This procedure can be a considerable investment for both the buying company and the suppliers, mainly because of the many man-hours required from both sides, of highly skilled and educated personnel. However, if a competitive supplier is to be selected, this investment is justifiable, as Buyer A points out.

4.1.1 Buyer A

For Buyer A, the supplier that won over the other candidates is the one that can present better commercials than the rest. This is checked through their turnover, their latest investments, what other companies they supply and their audited financial reports among others. It is important that the supplier holds quality certifications, specifically the ISO TS and the ISO 9001, which are mandatory in the automotive industry. The chosen supplier received the highest financial rating score of all the candidates and it meets the technical, quality, delivery and logistics requirements.

Buyer A's department is mainly following a single sourcing strategy, representing around 70-80 percent of the products bought. That is due to the low availability of substitution products for the specific segment. The parts are very particular, sourcing them is a significant investment in terms of time, and the supplier they work with is restricting technically everyone else since it is the only company globally that manufactures most of them. The supplier has to make everything new, according to the buyer's requirements, which includes the cost of tooling and development, at the charge of the buying company.

Single sourcing has its advantages, in regards to monitoring, tracking and managing the supplier. The plant experiences JIT deliveries, and the general administration cost is lower since no designated employees are working only with the specific supplier. However, there have been occasions when the supplier was facing financial or quality issues that the OEM's production had to stop. That is a severe issue, where the buying company has to wait until the supplier's problems are solved since immediate substitution is practically impossible.

The remainder 20-30 percent is sourced from multiple suppliers. If geography allows, products are delivered locally. Thus export duties and taxes are avoided, otherwise sourced from within the same continent where the plants are. Decision time increases according to the number of suppliers. Sourcing from many suppliers, though, is worthwhile, because intercontinental transportation can be avoided. With multiple sourcing, there is always a back-up solution, as it is considered a risk mitigation activity, and the buying firm is commercially a bit stronger because the suppliers are aware that there is competition. Market intelligence also increases because the buying company can get information on what different suppliers do.

When choosing to work with a supplier, the TCO is considered, which includes apart from the buying price, the exchange rates, the logistics cost, the quality and delivery among others. The suppliers are evaluated and whether a new contract will be signed with them is considered already one year before the existing one expires. Nevertheless, these issues do not affect the number of suppliers employed much. Buyer A concludes by adding that 'the life of a purchaser is much easier when there are a lot of suppliers' since there is always a back-up solution.

4.1.2 Buyer B

As a senior sourcing Buyer, respondent B can ascertain that the purchasing department plays a prominent role in an OEM, as it relates to large amounts of money spent. In regards to the characteristics of an ideal supplier, quality plays the most important role. A competitive price is always considered, as well as the suppliers'

certifications and the local content requirements for each country. The latter refers to governmental regulations that need to be fulfilled by the OEM in regards to the minimum amount of locally produced items that need to be used in a truck. There is, therefore, governmental pressure to source a minimum percentage of products locally to where the production facilities are situated. These requirements need to be met by the OEM, and the number of the suppliers employed is also affected by that factor.

Buyer B's department works exclusively with multiple sourcing, as it is considered a superior solution to single sourcing. Single sourcing is not preferred as it is related to considerably high risk. Buyer B argues that throughout his career as a buyer, single sourcing was never supported, as it barely has any advantages. By sourcing the same part from multiple locations, the supply risk decreases, because if something prevents one supplier from delivering, the other or others will. This also increases a healthy supplier competition and can improve the market intelligence, since the buying company has access to the supplier's technologies. The buyer can also take advantage of currency exchange rates, depending on which one is advantageous at the given time. In regards to administration, though, it can be more costly. In addition, the initial tooling cost is higher, and if there are differences in the facilities' machinery, maintenance cost can occur. This would not happen with single sourcing since the suppliers' machinery is adjusted to only producing the items for one buying company.

Administrative cost can be lower with single sourcing, but it can become difficult to manage a supplier that is hired only for one specific product unless the buying company always has new business to offer. Buyer B goes on to argue that it is the nature and the characteristics of the department's specific products that does not allow single sourcing. They are big and heavy pieces of equipment and transporting them from one continent to another can be very expensive.

Despite the fact there are many suppliers to deal with, the level of involvement is high. Feedback is sent once a year on issues like quality, cost, and delivery. Some adjustment period is allowed, if a supplier is not performing the utmost, and if there is room for improvement. This is necessary, as high tooling cost does not allow shifting from one supplier to another easily. This level of collaboration achieved between the parties allows common product development and progress. The OEM can rely on the supplier's knowledge and still have the intellectual property rights.

The number of suppliers that the company employs depends on all the factors mentioned in this section. From the initial tooling and development cost, the logistics and transportation cost, the quality and delivery, the inventory cost to the final production.

4.1.3 Buyer C

For buyer C, the most important attributes of a supplier are related to supplying quality products that meet the technical requirements, and to a healthy financial status. In regards to the department's sourcing strategy, it is 40-45 percent single sourcing, while 55-60 per cent is multiple. Sourcing decisions are taken depending on the project's requirements.

If the project's investment is considerable, it is cheaper for the OEM to use one supplier, since investing in more would increase the cost accordingly. The ideal scenario for single sourcing is when smaller parts are needed, but in large volumes, because the buyer can get the advantage of the economies of scale, and get a better price from one supplier. This increased leverage power, the lower administration cost, and accurate deliveries were mentioned again as advantages from single sourcing. The advantage of being able to standardize the products more was mentioned as well, something that means easier operations. The disadvantages mentioned were the same as those cited by the other buyers, with increased supply risk and dependency on one supplier being the most prominent. For these reasons, the OEM is always on the lookout for new suppliers, who can also fulfill the least of the OEM's expectations. Despite the fact that it takes time for a new supplier to develop the tools to produce the items needed from the OEM, it is worth waiting, because innovations are easier spotted like that.

If the tooling investment is low, multiple sourcing is preferred. In addition, when big items are needed, it is preferable to have multiple suppliers around the world, to avoid excess transportation and logistics cost. Multiple sourcing develops healthy competition between the suppliers, which leads to the buyer ending up with the best price in the market. In addition, it can improve market intelligence via product benchmarking and knowledge and can provide a sense of security, because there is a back-up option, as mentioned before. The main disadvantage is that since volumes are being distributed between the suppliers, the leverage goes down unless the buyer has good volumes to offer. In addition, more work is required, in regards to volume allocation decisions. The buyer suggests how to split the business between the suppliers, and a cross-functional committee consisting of different stakeholders (see Buyer A), takes the final decision. Apart from that, though, administration cost is not significantly higher, because the same products would have been sourced in any case, whether from one supplier or more. Regardless of any additional administration cost, it is advisable always to have at least one supplier situated in the same continent as the production facilities.

Changing suppliers for some parts is easier than others, depending on the tooling development cost and the quality. Therefore, the chosen strategy depends on the specific product. The same applies to the level of involvement of the OEM with the supplier. If the investment is significant or if the part is complicated, the relationship is closer, or the opposite. All of the suppliers participate once a year in a meeting with the OEM's top management, and the buyer pays them visits as deemed necessary. Regular audits also take place, to confirm whether the supplier still qualifies to do business with the OEM. In the end, this affects how many suppliers the OEM employs, depending not only on the scores of the audits but also on the strategy of the respective segment.

The TCO is the ultimate factor in deciding how many suppliers to collaborate with. Every part of the cost is important in the decision-making process, from the buying price to the ongoing relationship with the supplier, the product quality and the proximity of the supplier to the plant.

4.1.4 Buyer D

The parts that Buyer D is responsible for represent the biggest spend area in Europe, supplying the biggest plant in Europe. Therefore, it is of utmost importance that careful purchasing decisions are taken.

Single sourcing is the main strategy for this department; around 80 percent of the total items bought. The characteristics of the products are the main driver for this strategy. They are small dimension wise, making transportation not challenging, and while substitution and tooling can be relatively easy, it takes a significant amount of time, since everything needs to be validated first by the engineering department. Standing by a single sourcing strategy has its advantages; volume concentration can increase the leverage in the OEM's negotiating power, the relationship/partnership with the supplier becomes closer, there is a higher level of cooperation, reliability and trust, lower administrative cost, and JIT deliveries. The disadvantage is not having so much control over the supplier, especially for monopolistic markets. In addition, there is always the risk of production stoppage, in the case of delivery failure. Poor delivery performance is a reason to stop collaboration with a supplier.

If the needed products are classified of strategic importance and high priority, then multiple sourcing is preferred (for the remainder 20 percent). The reason is that the company always needs to have a back-up. By collaborating with more than one supplier, the product can be potentially introduced faster to the market, since access to the supplier's capabilities and increased product knowledge can be gained. Moreover, the OEM can use the market share to leverage the suppliers, leading to a healthy competition. As a drawback, though, dealing with more than one supplier can be associated with additional work, since the items need to be tested from each supplier separately. This can affect the manufacturing cost since competing companies might produce different batches with different standards and cost. In regards to volume allocations, it depends on the product, and on how many 'players' are in the market. For less strategic products, for example, volumes are split equally between the suppliers. For more strategic products, the biggest and most reliable supplier takes the highest percentage.

Suppliers' performance is regularly assessed, and every supplier is visited twice a year without exception. Assessing the supplier thoroughly is of particular importance for Buyer D since the supplier is involved in the product development, as they do some final additions to the released finished machine parts of the specific items. For that reason, it takes time to change suppliers, since every potential new one has to go through a test period of six months. Existing suppliers are evaluated according to their so-called 'QDCA,' quality, delivery, cost, and features (for example durability, lifetime, and various other characteristics). The OEM eventually stops collaborating with the suppliers that consecutively do not score very well in the QDCA. Before that, though, the OEM makes sure that they are properly informed by sending out alert letters.

Product price is not enough to decide on which supplier to collaborate with. Everything related to logistics is taken into consideration, but also the particular local content requirements. If they are met, the OEM can get some tax refund, while if not, a fine needs to be paid. That can influence the sourcing strategy accordingly. Finally,

despite the fact that the majority of products are sourced from one supplier, there is always a consideration for back-up suppliers, for protection against unpleasant situations.

4.2 Respondents from other OEMs

Interviewing buyers only from the truck OEM would mean that partial knowledge is attained. To avoid this, interviews from buyers working with other OEMs were conducted. Apart from shedding more light into how sourcing strategies are decided, these interviews provide material to answering the third research question of this thesis.

4.2.1 Buyer I

Project Buyer I works for a car OEM and describes that the purchasing department is responsible for nominating all the suppliers. All alignment and communication with the other related departments in the company go via them. Minimizing cost is the main objective of the department.

Five steps constitute the supplier selection procedure (Figure 9). During the first step, the Target Evaluation Request (TAR), the buyers meet with other employees involved in the project and discuss issues of cost, quality, and other specifications. Next step is designing and developing the concept, and the research and development (R&D) department takes over. After they feel confident with the design, the volumes and prices of the needed products are set, according to the 'cost estimator' team, and a meeting with the management, called 'sourcing approach,' takes place, where some potential suppliers are presented, to receive RFQs. During the fourth step, 'Global Council,' global alignment with the other markets is achieved. Finally, the 'supplier choice meeting' (SCM) takes place, where top management takes final decisions. The whole procedure can take up to one year, and while many teams are involved in it, many projects are running at the same time. The nominated supplier wins over the rest in technical issues, quality, price, and savings, according to specific saving goal set by the company for every year, called the 'long term agreement' LTA.



Figure 9: Supplier selection procedure (first Car OEM)

Single sourcing is the majority of the cases, around 90 percent of the products bought. That is because most of them are high-tech, and excessive tooling cost prohibits the OEM from changing supplier. Working with the same supplier also means that the same technology can be maintained and even improved. The supplier needs to have facilities and shipping locations near the OEM's production facilities because they are shipping on FCA terms (free carrier). The goods are handed over, cleared for export, into the disposal of the first carrier, named by the buyer (Van Weele, 2014, p 39). The

supplier, therefore, is a big company with many facilities around the world, so that shipments are 'local-to-local,' whenever possible.

One of the main advantages with single sourcing is that contract agreements can be made on annual price reductions with the supplier, as a motivation for long-term collaboration. In addition, because of the strict requirements that car manufacturers have on lean operations, JIT deliveries are pursued and achieved with single sourcing. Since no key account managers are used for specific suppliers, it is cheaper to use only one. As long Buyer I has been working at the specific OEM, the supplier has always delivered on time. That is due to a prior risk assessment from the OEMs side, where geographic positions are considered, the country's political stability, their potential supplier's financial credibility, and their corporate government structure. All this risk assessment takes time, and generally, the buyer has to work harder to pressure the supplier, on both the supplier's performance and the sought price reductions. With multiple sourcing, these issues are somewhat self-regulated because of competition. In the case of single sourcing, though, the buyer needs to play the role that the competing company would.

Multiple sourcing is used in the area of around ten percent, for less technologically advanced products. With multiple sourcing, the buying company can enjoy the fact that the free market is driving the competition, while at the same time the suppliers do not get 'too confident,' as Buyer I puts it. Nevertheless, since the more suppliers the company works with, the more man-hours are required for handling, communicating and so on, it is usually not more than two suppliers used for the same item; namely, dual sourcing is as far as the OEM goes. Market intelligence is not necessarily increased with multiple sourcing since most of the sourced items are 'built-to-print.' The buying company decides on the product design, and the selling company produces it according to the said specifications. It can increase, though, in the case of those products that the suppliers have a say in the design. Since the specific OEM is conducting a thorough supplier risk evaluation, multiple sourcing is not considered a risk mitigation strategy. Finally, volume allocation is almost even between the suppliers, with the one that can offer the lowest price or best business case, winning slightly more volume percentage than the other.

The buyer's responsibility is to treat all suppliers equally and maintain a close relationship with them. Continuous feedback is given, through daily communication, and the OEM's Supplier Quality Management team (SQM) is investigating the supplier's potential quality issues via monthly target audits. This means visits to the supplier's production facilities, where measurements of each production line are made, to check whether they 'run at rate' and their 'normal weekly capacity' is measured, in regards to production, shipping, and delivery issues. If a supplier is not performing as required, the OEM proactively works with them to improve that, or they renegotiate the price accordingly. The supplier relationship management in this OEM does not affect much the number of the suppliers.

Every aspect of sourcing decisions in this OEM is cost driven. Single sourcing is preferred, to avoid excessive tooling cost. Suppliers are not replaced easily, to avoid having to move and change the tools from one supplier to another and increase the cost. Inventory is not kept because this can affect the lean concept that they follow (hence the FCA Incoterm). In the case of multiple sourcing, more employees will be

hired if needed, since encouraging healthy competition between the suppliers, might prove to be more beneficial for the company, than what it would cost them for any additional salaries. As Buyer I concludes, the ‘Global Council’ makes decisions on the ‘Total Business Case’ (TBC), epitomizing like that the concept of the TCO.

4.2.2 Buyer II

Buyer II works at the purchasing department of another car OEM. The company’s supplier selections procedure (Figure 10), also concludes in five steps, but usually, includes a set of pre-approved suppliers. The company’s supply base is developed mainly by companies that already have worked with them before, and hence have some understanding of the products that the OEM needs. To begin with, these suppliers receive an RFI. Because of their prior experience with the OEM, they are somewhat prepared for the following step, the RFQ. This goes through approval from the OEM’s quality, tooling cost validating and investment team, the purchasing manager, the local manufacturer and finally the purchasing director. All of them need to approve so that the phase can move on to the next step, the final negotiation with the short-listed suppliers. A sourcing meeting follows with the stakeholders and the supplier committee, which if approved, leads to the final nomination. The ideal supplier has production facilities near those of the OEM and can produce quality products, at an acceptable for the OEM price.



Figure 10: Supplier selection procedure (second car OEM)

The procedure takes seven to eight weeks. This short lead-time, compared to the first car manufacturer, is a direct result of the pre-existing relationship of the suppliers with the OEM. Fast product launch is a priority because new ‘face-lifts’ of the car models should be available to the market sometimes as often as every six months. The changes that are done every year, with the combination of the high number of cars sold, would make it challenging to ‘shop around’ for new suppliers regularly since that would require investment in time. Therefore, it is crucial for the OEM to develop strong relationships with the suppliers.

A big part of this relationship is providing feedback and assessing the suppliers. The OEM’s purchasing and quality team attend a quarterly meeting with the suppliers that show the biggest spend. For the rest, meetings take place when the situation necessitates. The suppliers receive all their orders via a joint with the OEM electronic data interchange system (EDI). Everything that the supplier needs to know, on common handling issues and more, including performance feedback, is noted in the system. A long-term relationship with the supplier is actively pursued. This is also in the best interest of the supplier since the amount of business they get from the OEM is quite big. Maintaining a good relationship is a salient issue for both parties.

Buyer II’s department is exclusively using a single sourcing strategy; all the items under the specific portfolio are sourced from one supplier. The close collaboration described before has a lot to do with this decision. To some extent, there is common product development, since the OEM is also relying on the supplier to keep up with

the needed new ‘face-lifts’ that the market dictates. Single sourcing is also a one-way solution for those parts that require some customization, for example, items that need to be in specific dimensions, since other suppliers might not even be able to provide such specific items, making substitution availability close to zero. In addition, for confidential parts, for example, specific engine parts that control how the engine is performing or working, it is imperative that the supplier is only one since the OEM does not want to risk sharing commercial secrets with other companies as well.

Buyer II recognized the same advantages and disadvantages with single sourcing as the rest of the respondents. To point out though the effects that a delivery fail can have on production, the example of a fire in the supplier’s production facilities was mentioned. Despite the fact that the supplier could substitute with a production batch from another facility, there was a one-day delay. The OEM’s factory was forced to close for that day, which meant consecutively that around 2000 employees did not go to work that day. Buyer II also elaborated further on the annual price reduction agreement with the supplier, explaining that the reason why the buyer can ask that from the supplier, is production efficiency improvements from the supplier’s side.

Per car model, Buyer II would estimate that around 70 percent of the products bought are single sourced. The rest represent a portfolio of products that are required in vast quantities and are sourced from multiple suppliers. For example, every car needs five tires. With the number of cars manufactured, it is almost impossible to find a single supplier who can provide the market with such a big number of tires, at the specific timeframes that they are needed every time. Multiple sourcing is, therefore, the only solution. In regards to advantages and disadvantages, Buyer II did not mention any that the other respondents did not.

In conclusion, Buyer II mentioned that the TCO is taken into consideration and that it affects the number of hired suppliers. The EDI alignment, useful tool though it may be, required an initial investment from the OEM, and despite the fact that it is not for only one supplier, it would require additional adjustments for a new supplier to start using it, translating in extra cost. Logistics related costs, like transportation, are limited when there is one supplier because less coordination is required, since the buyer only has to deal with one company, which would also mean less total shipments. Regarding the specific portfolio of items that Buyer II deals with, it is supported that it is not easy to change from single sourcing to multiple, not even dual. Since the frequency of design modification in the car industry is so big, it can become a considerable investment to have to collaborate with more than one supplier in regards to, apart from daily operational issues, co-developing products.

4.2.3 Buyer III

Buyer III works for another car OEM. The role of the purchasing department, at least for the specific OEM, is verified with numbers this time. One billion dollars is spent every year for direct (40 percent) and indirect purchasing (60 percent). The company’s supplier selection procedure consists of six steps in total (Figure 11). The first step is receiving the technical information of the needed parts from the ‘mother company.’ The second step includes conducting a market research, during which old and potential new suppliers are considered to receive an RFQ, which is the third step. During the fourth step, the potential suppliers are interviewed on technical issues,

from the OEM's quality, production, product development, testing, logistics and purchasing departments, and costs are received. The quotations are received at the fifth step, and the technical information from the previous step is validated from the purchasing, costing and project department this time. The sixth step is final negotiation and nomination.



Figure 11: Supplier selection procedure (third car OEM)

This company shows a strong preference towards single sourcing. Ninety percent of Buyer III's portfolio is single sourced, as is the 80 percent of a typical car model. The supplier selection procedure takes up to one year and is very meticulous since the company wants to employ the best possible suppliers. Every step of the process is scrutinized since the idea is eventually to develop such a close relationship with the supplier that it feels as if the OEM owns them, and that there should not be any worry about JIT deliveries. Especially for strategic segments, single sourcing is preferred because the supplier can be managed easier since the aim is to get to know them 'in and out,' as Buyer III puts it. Production cooperation and development are very close, and like that, the OEM can work itself towards the best possible price. Hence the supplier selection procedure reflects the chosen strategy and vice versa.

The most important attribute of a supplier is transparency in sharing everything with the OEM, from potential doubts whether the requirements can be met, to any changing financial situation. To prevent potential production stoppage, after delivery failure, the OEM has developed knowledge about the so-called 'risk triggers.' These refer to the level of awareness if something goes wrong with the supplier. They are divided into 'risks,' referring to potential issues that could lead to something happening, and to 'issues,' referring to if something already happened. To eliminate single sourcing risks, the OEM tries always to have some back-up inventory, investigate the market for other suppliers, or look into options for parallel sourcing.

Usually, this OEM goes for dual sourcing with cases where more suppliers are needed, like for sourcing tires. The main advantage of this strategy is that the buyer can drive the competition between the suppliers, to the buying firm's benefit. The buying company is at the commanding sit, and in the end, if the buyer has done the job right, there could be significant price differences between the suppliers, which would also determine the order volume allocation. For this to happen, though, the buyer needs to know in detail the characteristics of the items that need to be bought, how they are produced and how each supplier works. The buyer needs to get involved as much as possible, also to be able to check if the prices are realistic, or not.

The aim of every buyer is to save the company money with the purchasing decisions. To become a better professional, the buyer needs to visit the suppliers regularly, to attain insight. Buyer III recommends ABC as a cost calculating tool. While for single sourcing, this includes identifying the supplier's profit margin and coming up with a price suggestion, for multiple sourcing, ABC is a more time-consuming process.

4.2.4 Buyer IV

Buyer IV is head of material procurement for a catalyst manufacturing company. Free competition allows for multiple sourcing, which is the company's preferred sourcing strategy. The estimated percentage split is 80 percent multiple and 20 percent single sourcing.

The supplier selection procedure, which can take from few weeks to many months, does not affect the number of suppliers since the main purpose is to employ multiple. After the reasons why a new supplier is needed are identified, the procurement department follows a set of specific steps, and with the support of mainly the logistics department, and then the quality, R&D, and product management departments, a decision is taken. The ideal supplier profile is not always the same but depends on the parameters that the buyer chooses to focus on, at the beginning of the process. The decision can be cost driven, volume, capability, delivery or quality driven. In cases, it might be that the supplier is willing to carry some inventory for the OEM. It all depends on a combination of what is important for the company, and what is available on the market at the given time.

Multiple sourcing is considered a superior solution, mainly because single sourcing bears an inherent supply chain disruption risk. Multiple sourcing averts this risk and can bring about competition between the suppliers, which always ends up in the best buying price for the OEM. In addition, the company can gain more insight and knowledge on the bought material, via feedback from different suppliers, and can choose which suppliers to work with, depending on price, delivery location, and currency at the given point and time. In some cases, multiple sourcing might mean that more handling time is required. Though, Buyer IV argues that there are few downsides with it, except that volume has to be split and that in a strategic perspective it takes more effort to handle more suppliers, because of the more supplier relationship meetings the buyer has to attend. The ideal scenario is to have so many suppliers that risk is spread as much as possible, but not too many where there might be some supplier who does not get enough volumes. Three suppliers is a good balance because even if one of them decides not to do business with the OEM, multiple sourcing is still an option. As a rule of thumb, the ideal number of suppliers is decided with time, as the company's business develops.

Single sourcing is used only in monopolistic cases, or when the volumes and the related risk are so little, for items that are very easy to procure, and are 'off the shelf.' Buyer IV does not see many advantages with single sourcing, only maybe that handling one supplier is easier. Nevertheless, the costs related to the supplier relationship management are higher than with multiple, where some leniency is allowed. More focus is required on developing a closer relationship with a single supplier, because it is more important that the OEM knows at all times the situation and the developments, if any, at the supplier. Any leverage that the OEM might have because of volume consolidation within one supplier fades out according to Buyer IV, because of the non-existent competition.

4.3 Chapter summary

For this chapter, eight professional buyers were interviewed. Their supplier selection procedure was described, as well as their department's sourcing strategy, among others. It needs to be noted that the purchasing processes described do not happen every single time a sourcing decision is taken, but only when new suppliers are needed. Like in every purchasing case, after the first-time purchase, most transactions involve straight rebuys (Van Weele, 2014, p 30). Table 4 summarizes the duration of time for each of the represented manufacturers' supplier selection procedure. Buyer IV's company was deliberately omitted from the table, as it was claimed that the selection procedure does not affect the sourcing approach, and its duration can vary greatly, depending on the project.

Table 4: Buyers' estimates for the duration of the supplier selection procedure.

SSP	Period
Buyer A,B,C,D	Ca. 16 weeks
Buyer I	Up to 1 year
Buyer II	7-8 weeks
Buyer III	Up to 1 year

Regarding the sourcing strategies, it is derived from the interviews that single sourcing is preferred, within at least the OEMs that granted the researcher with an interview. Only two buyers were strongly opposed to exclusively following a single sourcing strategy, and one mentioned that their department opts for a combination of both strategies, with a slight tendency towards multiple. Table 5 summarizes the findings. The percentages are rough estimations provided by the buyers and do not represent official company statistics.

Table 5: Buyers' estimates of percentages of volumes bought through single and multiple sourcing.

Buyer	Single sourcing	Multiple sourcing
A	70-80%	20-30%
B	0%	100%
C	40-45%	55-60%
D	80%	20%
I	90%	10%
II	100% (70% per car model)	0% (30% per car model)
III	90% (80% per car model)	10% (20% per car model)
IV	20%	80%

5. Analysis

This chapter analyzes the interview data. Examining the data in the light of the concepts and theories explored in the theoretical framework chapter provides a better understanding of how sourcing decisions are taken. In the first part, an analysis of the benefits and disadvantages of single and multiple sourcing is carried out, in the context of manufacturing companies. The same primary data is scrutinized to understand the basis for (and variations in) sourcing decision-making. Finally, the last part of the interview data (Buyer I, II, III and IV) explain how other manufacturers respond in regards to the single versus multiple sourcing dilemma and are analyzed below. Based on the analysis, conclusions and recommendations are reported in the last chapter.

5.1 Benefits and disadvantages of single and multiple sourcing for manufacturing companies

In chapter two, the main advantages and disadvantages of single and multiple sourcing were analyzed, as presented in the published literature. It is assumed that not all possible pros and cons were covered, and that further relevant literature can be found. It should also be pointed out that some of the benefits and disadvantages of both strategies refer to not only buying firms but also selling firms. Since this investigation was initiated from a buying firm, and interviews were carried out with buyers, in this section only the advantages and disadvantages of both strategies in regards to manufacturers are analyzed, while for suppliers are not further looked into.

5.1.1 Analyzing single sourcing

The interviews conducted for this thesis reveal that the majority of the represented companies prefer single sourcing. As mentioned in the first chapter, there are doubtless many advantages to single sourcing. The question is, whether most companies that seem to prefer single to multiple sourcing have simply gotten used to this practice, or whether it is a decision that is being evaluated on a regular basis. It is not hereby implied that getting used to something is necessarily wrong. It is speculated rather, whether single sourcing is a practice that buyers had adopted when they started working in the company, and rarely questioned since. Buyers are company employees, and like any employee, there is only so much sway they can have on decisions and deeply ingrained practices. For any buyer who might be interested in looking further than what has been presented to them as the norm in the company, this deeper analysis of the advantages and disadvantages of single sourcing might be interesting to read, as it might present some ‘food for thought.’

The most commonly mentioned advantage of single sourcing is the JIT deliveries. All the respondents but one, who exclusively follows a multiple sourcing strategy, replied that they experience JIT deliveries, as an immediate result of single sourcing. Single sourcing results in tighter process coordination between the buyer and the supplier (Burke, Carrillo and Vakharia, 2007; Yu, Zeng and Zhao, 2009). This can be the

result of a closer collaboration, where shared benefits are aimed to be optimized. The buyer-seller relationship is encouraged to move towards single sourcing so that processes can be streamlined easier, and JIT deliveries achieved. After all, JIT purchasing, as Hong and Hayya call it (1992), requires a reduction in the number of suppliers. Buyer III provided the most original example of a company aiming to such a close collaboration, where even the supplier selection procedure is geared towards single sourcing. Working with one supplier reduces lead times (Larson and Kulchitsky, 1998; Lewi, Hayward and Kasi 2013). However, this is also related to the geographical position of the supplier. As Buyer I and II mentioned, the selected supplier has production facilities close to those of the OEM, to simplify the logistics operations, and to reduce the related cost.

This close collaboration leads to related advantages, one being the close relationship between the parties (Skjøtt-Larsen et al., 2007, p 237). The supplier can feel that they belong in a wider industrial family, rather than just doing business with a manufacturer (Oghazi et al., 2016). Goals and objectives are aligned towards mutual benefit, which means specifically for the manufacturer that the supplier is more willing to adjust according to the buying firm's needs (Benton, 2010, p176). As Buyer A mentioned, managing, monitoring and tracking one supplier is easier, and as Buyer D supported, single sourcing leads to increased trust between the parties.

All the interviewed buyers, who mostly follow a single sourcing strategy (A, D, I, II, III), agreed that employing one supplier increases the manufacturer's negotiation leverage, translating in reduced buying cost. That is because the buying company can concentrate volumes, and consolidate orders with one supplier, which allows them to claim lower prices. The achieved economies of scale benefit not only the vendors but also the manufacturers. The buying company can claim that prices are further reduced with each year of collaboration, since the supplier's production processes are improved with time (Buyer I & II), due to them gaining better knowledge on the produced item (Constantino and Pellegrino, 2010).

All the interviewed buyers agreed that there is always a risk of supply chain disruption when using only one supplier. Theoretically, if something unpredictable happens to the supplier, the buying firm also has to bear the consequences (Chopra and Sodhi, 2004; Yu, Zeng and Zhao, 2009). Buyer I mentioned that this does not constitute a high risk for the OEM since the company goes through a meticulous supplier selection procedure and a detailed supplier risk assessment takes place. Nevertheless, it can happen that some accident in the production facilities causes production stoppage within the supplier, transferring the problem to the OEM (Buyer II). Such incidents can also happen during transportation. The increased dependency on one source can render the OEM vulnerable to internal to the supplier problems (Chopra and Sodhi, 2004) and can reduce the OEM's autonomy (Lewi, Hayward and Kasi, 2013). Buyer C and D attest to that. In addition, if the buying company is so dependent on the supplier, they might not have so much negotiating power after all, especially if the supplier knows that the buyer does not have many options, and decides to take advantage of this new 'monopoly' situation (Kirytopoulos et al., 2010; Treleven and Bergman Schweikhart, 1988).

Another disadvantage with single sourcing is that there has to be some EDI alignment between the buying and the selling company. Otherwise, operations and processes

coordination would be challenging. With EDI, response times are reduced, and both parties can combine their internal processes (Tan et al., 2010). This EDI investment might not necessarily be negligible, and should be considered carefully. Buyer II and III mentioned that there is a common electronic platform for the buying and the selling company, and although they praised the benefits that come with these EDI solutions, they could not be certain of the initial amount of resources invested in this IT asset.

5.1.2 Analyzing multiple sourcing

The strongest advocate of multiple sourcing was Buyer B and IV, followed by Buyer C, whose buying habits are shared almost equally between the two strategies. This does not mean that the rest of the buyers, who support either mostly or completely single sourcing, reject multiple sourcing altogether. In some cases, single sourcing is part of the company's long-term strategy, but in other cases, the nature of the commodity does not allow multiple sourcing (more details on this in the next part of this chapter). All the interviewed professional buyers recognized the advantages and disadvantages of multiple sourcing.

Buyer A mentioned that the life of a purchaser is much easier when there is more than one supplier. The buyer's stress levels, related to the possibility that the company's single supplier might fail to deliver, are decreased when the company moves to multiple sourcing. Multiple sourcing allows for a back-up solution, and thus increases the sense of security. The risk of supply chain disruption, which could potentially lead to production stoppage, is consecutively decreased (Sawik, 2014; Meena, Sarmah and Sarkar, 2011). With multiple sourcing, the buying company is not dependent on one source, and the risk that is related to this dependency is reduced since it is spread among the number of suppliers (Skjøtt-Larsen et al., 2007, p 237). In other words, the specific disadvantage with single sourcing (see the previous section) is mitigated with multiple sourcing, and all the interviewed buyers agreed to that.

With multiple sourcing, there is a power shift to the buying company (Buyer III). When there is more than one buying option, it is up to the buyer's discretion to choose how business is shared amongst the suppliers. According to all the buyers, the free market laws can trigger a healthy competition between the suppliers. Because of that, the buyer can end up with the best possible price, without having to compromise product quality. This might happen even in an oligopoly case. A good method to leverage competition among suppliers is tendering (Buyer IV). This can be in the form of 1) Supplier market intelligence: systematic gathering and evaluation of all information gathered on the suppliers, 2) RFI/RFP (request for information/request for proposal): preparing, sending and evaluating suppliers' information and offers, 3) Reverse auctions: using web-based tools to receive offers, starting off with the buyer setting a starting price that the suppliers need to meet, 4) Expressive bidding: allowing 'if-then' conditions. For example, if a supplier is awarded part A and part B, then a further price reduction of one of the two items will occur (Schuh et al., 2012, p 26).

Cooperating with more suppliers can allow the buying company to perform product benchmarking, which can lead to increased market intelligence, and to spotting easier more innovations (Buyer D). When a company works with a supplier, they can get access to the supplier's capabilities and technology. The more suppliers, the more the knowledge that can be earned, about the products that need to be sourced. Buyer IV

added that this also facilitates the final product pricing. This product benchmarking might not be relevant in cases where the sourced components are built-to-print (Buyer I). Nevertheless, even in such cases, the buying company can benefit from getting to learn how different companies are producing the same or similar items. The economies of experience (Sorenson, 2003) and learning capabilities of the manufacturer can be said to be proportional to the number of parties in contact with the manufacturer.

Another benefit that an OEM can gain from multiple sourcing is getting to decide which supplier to source from, depending on the currency exchange rate, which practically means getting to choose to decrease cost. Additional practical, positive implication with multiple sourcing is that the buyer can get to decide to decrease transportation costs, depending on the geographical location of each supplier. Of course, the fact that a buyer needs to keep in mind the exchange rates may add to the complexity of the operations, and to the buyer's workload. The same may happen when having to coordinate shipments from different suppliers. According to the buyers who mentioned these advantages though (A, B, IV), the additional amount of time and effort are not significant.

All the interviewed buyers agreed that administration cost increases as the number of suppliers increases since more decision time is required (Costantino and Pellegrino, 2010). Buyer C mentioned this as insignificant since the same items need to be bought in any case. Therefore, a buyer should not feel substantial workload intensification (Buyer IV). Increased decision time is not only pertinent to shipments' coordination but also before that, when the items need to be tested before bought. This may correspond to additional workload since equipment testing is advisable to take place for every supplier separately. In addition, initial cost related to what the manufacturer needs for their production line to run smoothly may be higher, since adjustments might be necessary for items sourced from different suppliers.

Finally, when working with many suppliers, the buying company's leverage goes down, unless there are good order volumes (Buyer C). What are good volumes depends on each company separately and is not directly definable. Nevertheless, it seems reasonable for a selling company to commit less to a buying company's needs, when the volumes are not sustaining a remarkably profitable business; in other words, if the buying company is not their main customer, commitment is difficult to encourage (Slack, Chambers and Johnston, 2004, p 453), and negotiation leverage decreases.

Table 6 summarizes the benefits and disadvantages of single and multiple sourcing for manufacturing companies.

Table 6: Summary of pros and cons of single and multiple sourcing for OEMs.

	Advantages	Disadvantages
Single sourcing	<ul style="list-style-type: none"> • JIT deliveries • Closer relationship/trust • Increased negotiation leverage=decreased cost 	<ul style="list-style-type: none"> • Supply chain disruption risk • Cost for EDI alignment
Multiple sourcing	<ul style="list-style-type: none"> • Backup solution • Decreased supplier dependency • Healthy competition between suppliers • Increased market intelligence • Buyer can decide depending on currency rates fluctuation 	<ul style="list-style-type: none"> • Increased workload • Decreased supplier commitment

5.2 Sourcing decision-making in manufacturing companies

Carefully weighing the advantages and disadvantages of single and multiple sourcing is not always sufficient to decide which strategy fits best in each situation. From the interviews, it became clearer that there are specific items' characteristics and occasions, under which different sourcing strategies are decided upon. OEMs can be better prepared for sourcing decisions when they consider these characteristics, and the context of the specific occasions when sourcing decisions are taken. In this section, the principal drivers of the decision behind each strategy are presented.

5.2.1 Basis for decision-making for single sourcing

The nature of the sourcing project can show the direction for the sourcing decision. If the project is a considerable investment, it is advisable that the buying company invests in one supplier. In the context of a manufacturer, a considerable investment would be excessive tooling or set-up cost (Mishra and Tadikamalla, 2006). The buying company has to provide capital for the selling company so that the needed parts are produced. The development cost needs to be considered and estimated accordingly (Slack, Chambers and Johnston, 2004, p 453) since it also has to be provided for by the manufacturer. If the project is complicated, the investment in time is also not to be neglected. Therefore, depending on how quickly the manufacturer has to put out its product in the market, it can be calculated whether there is enough time to look into having more than one supplier, or not. A combination of increased tooling and development cost, with short lead times, directs towards single sourcing (Buyer A, C, I, II).

If the tooling to produce a specific product is relatively simple, if the machinery can easily be adjusted, it would be advisable to maintain one source. It is less time-

consuming for the buying company to have one supplier when something can be easily manufactured, and it decreases the transaction cost. This includes the cost of incoming materials' inspection, vendor evaluation, correcting problems at the supplier and communication with them (Stuart and McCutcheon, 2000). Easy tooling means that whenever the manufacturer feels they should change supplier, it would not be challenging to do so, anytime they feel it is necessary. Therefore, the buying company does not have to bother with managing more than one supplier. This is related to the easy product substitution. If it is simple to change suppliers because there is an abundance of the same or similar products in the market, it should be easier to have one source, and change to another if needed (Buyer D, IV).

The more technically complex a part is, the more advisable it is to use one supplier. For high-tech parts, it is recommended to have one supplier, because changing the tooling can be challenging and expensive (Buyer C, I). That applies to the level of customization as well (Buyer II). Specifically, in the truck industry, the level of customization can be higher, since, for example, the same truck model might have to change according to the different countries' requirements, or its color has to be specific for specific purposes (Buyer A). Any variations of standard configurations in response to specific orders (Jacobs and Chase, 2010, p 81), like for example parts with specific dimensions, would increase the complexity accordingly. Unless the buyer is an engineer, it can be challenging to evaluate the technological complexity of a part. Buyers are generalists, while engineers are specialists (Van Weele, 2014, p 222). Nevertheless, a buyer with a different background than engineering might be able to evaluate this, by estimating along with the supplier, the number of steps required to produce the part. The more steps, compared to the standard configuration, the higher the complexity (Jacobs and Chase, 2010, p 93). The complexity level of the product can affect the sourcing decisions (Muteki & MacGregor, 2008).

Another part attribute that affects the sourcing decision is its confidentiality. Buyer II mentioned that within a car, there are items that control the engine, or other integral car sections, influencing its total performance. These items could represent very sensitive commercial information, or be copyright protected. If the manufacturer cannot produce the specific items themselves, they have to source them. It is of utmost significance that commercial information like that is not shared with many parties, making parts like that, ideal for single sourcing. The buying company should allow information sharing of critical inputs with only a restricted segment of suppliers. On the one hand, this can improve the OEM's competitive positioning, since they can be granted access to the supplier's proprietary technological innovations, to produce the specific part (Stuart and McCutcheon, 2000). On the other hand, it may prevent scandals, if the technology leaks to other parties that might manipulate it to their best interest (Krall and Peng, 2015).

Some companies have a long supplier selection procedure, like those described by Buyer I and III. One of the reasons for its duration is that it is very meticulous. Both companies are diligent in the selection process, and, as a rule of thumb, end up selecting a single supplier. If they were to select more than one, it would significantly extend the selection procedure. Therefore, it is suggested, if steps cannot be omitted, that single sourcing is more appropriate. It also depends on how much time the company has until product launch. On the other hand, Buyer II described a faster supplier selection procedure, compared to the rest, which also leads to a single

sourcing strategy. That it is a procedure, which mainly involves suppliers with some preexisting relationship with the company, suggests that the same procedure would have been longer, should they choose to cooperate with new suppliers. It seems, therefore, that the same would apply to Buyer II's company as well.

The sourcing practicalities may also provide a direction. If there are big volumes, for example, some companies choose single sourcing, because they can ask for quantity discounts from the supplier, since they can consolidate their orders with one (Mishra and Tadikamalla, 2006; Buyer C,D, I, II). Especially if the parts are small, and can be shipped in large numbers, it may be that no more than one shipment at the time is needed (Buyer C, D). Therefore, there is no need for multiple sourcing.

Finally, some circumstances do not allow the buying company to have more than one supplier. That would be when only one company owns the specific technology that the manufacturer needs (Buyer A). In monopolistic situations, single sourcing is inevitable. Also, when the needed quantity is so small that it would not make sense to split it to more than one supplier (Buyer IV). Finally, if there is a plan to change a specific part, there is no point to find more than one supplier, if the said part is soon to be replaced (Buyer A).

5.2.2 Basis for decision-making for multiple sourcing

Based on the previous section, it can be derived that in some cases, a manufacturer chooses multiple sourcing, in the opposite situations described above. For example, if the tooling investment is not significant, having multiple suppliers is better, since the cost of adding more suppliers is not very high, and can be counterbalanced by a decreased supply chain disruption risk (Buyer C). For low-tech parts, multiple sourcing is also recommended. For those parts that are situated too close to the fine line between what is considered high and low-tech, Buyer I recommends to start increasing the supply base, starting with dual sourcing, and then moving on to more suppliers if needed. For low complexity, low product variety and slow technology clockspeed items, namely functional products (Simchi-Levi, Kaminsky and Simchi-Levi, 2007, p 339), the manufacturer can employ multiple suppliers. When the needed items are big in size, it can be quite costly to transport them throughout continents; therefore, it is advisable that more suppliers be procured (Buyer B, C). If the company's main supplier does not have production facilities near one or more the OEM's production facilities, increasing the supply base can be beneficial for the manufacturer.

For high priority products that the buying company cannot do without, it is advisable to have multiple suppliers, to eliminate any potential supply chain risk (Buyer D). The best-in-class suppliers need to be hired to source products of strategic importance. The purchasing requirements and volumes should ideally be evenly spread over several suppliers and geographic regions (Van Weele, 2014, p 162), to make completely sure that there is always a back-up option for all the production facilities. Usually, these kinds of products are supplied to customer specification. In the automotive industry, the power of balance between the parties inclines towards the manufacturer, since they usually dictate the demands to the suppliers (Van Weele, 2014, pp 164-165). That power can give the manufacturer the option to have more than one supplier, and since the products are so important, is it also safer to have

more. Nevertheless, Buyer III mentioned that especially for strategic segments they prefer single sourcing, because the close relationship that is developed with the supplier, can allow the OEM to manage them easier. This though does not decrease supply chain disruption risk.

Multiple sourcing is also sometimes inevitable. When significantly large quantities are needed, it would be challenging to source them from only one supplier, for example, vehicle seats and wheels (Buyer II, III). Especially for bigger vehicles, like buses, the number of seats needed per piece can be quite large, and if the manufacturer buys complete parts, and does not assemble them for example, it would most likely be impossible for only one supplier to provide them. Finally, if the manufacturer is obliged by law to have a minimum amount of locally sourced parts per produced product, the local content requirement that Buyer B and D mentioned, it would also be challenging to have only one supplier.

5.2.3 Choosing between strategies

The previous sections of this chapter show that choosing between the two strategies is not always straightforward. Unless there are strict instructions from the company, a buyer can look into each sourcing case's parameters individually, and make an informed decision. Based on the interviews and the literature review, an index of checkpoints can be suggested (Table 7), should the buyer wants to look further into a particular sourcing case.

Table 7: Recommendations for the use of either single or multiple sourcing about project types, product characteristics, and other factors.

Single sourcing	Multiple sourcing
For projects involving significant investment (tooling, set-up, development cost).	For projects not involving a significant investment.
For projects with little time available before product launch.	For big and heavy parts (to avoid excessive transportation costs).
If product substitution is relatively easy (change to multiple sourcing whenever appropriate).	For parts considered to be of strategic importance and high priority.
If products are high-tech/complex.	For large volumes.
For customized products.	If local content requirements is a factor.
For highly confidential products.	If products are low-tech.
If the supplier selection procedure is long.	
For small parts that can be shipped in large quantities.	

5.3 Lessons learned from other manufacturing companies

The last four interviews of the previous section provided further insight on how sourcing decisions are taken. Three companies manufacture cars, and one company manufactures catalysts for industrial uses. It was understood that in car manufacturing the production time is more pressing. As Buyer III mentioned, a finished car comes out of the production line every five minutes. A typical part arrives at the plant one and a half hour before it is needed, and within 22 hours, it is fitted in the car and out of the plant; it does not even stay at the facilities for one day. Considering also the fact that the market dictates frequent restyling, as Buyer II mentioned, in combination with the meticulous supplier selection procedure (see Buyer I and III), creates a situation where using multiple sourcing would be challenging. An alternative, according to Buyer III, would be to use parallel sourcing, which is the closest multiple sourcing version to single sourcing (Skjøtt-Larsen et al., 2007, p 235). If the situation is similar in the heavier vehicle industry, like trucks and buses, then a higher percentage of single sourcing seems reasonable. Nevertheless, investigating options for parallel and multiple sourcing for some parts could also be worth exploring.

Buyer IV from the catalyst manufacturing company mentioned that they produce-to-order. This means that the order decoupling point, the point that determines where inventory is positioned, could either be in raw materials at the manufacturing site or with the supplier's inventory. In the case of vehicles though, since the response to customer demand needs to be quicker, there is greater inventory investment in finished goods, which is more expensive than raw materials inventory (Jacobs and Chase, 2010, pp 197-198). Therefore, it would potentially be more costly for a vehicle manufacturer to keep inventory from different suppliers, on top of the inventory kept in finished goods. This fact, combined with the pressing production times, suggests that dealing with multiple parties in a vehicle manufacturing company can be challenging in the least, or even fruitless.

Single sourcing can decrease the so-called bullwhip effect, which means increased variability as we travel up in the supply chain (Simchi-Levi, Kaminsky and Simchi-Levi, 2007, p 154). Reducing the parties involved in any transaction would mean less complexity. Depending on how much margin there is for a manufacturer to allow this variability, the number of suppliers can be decided. It seems that in the car manufacturing industry (Buyer I, II, III) this margin is narrower, because of the pressing lead times, than in the catalyst manufacturing company (Buyer IV). Reducing the bullwhip effect is connected to efficient supplier integration (Simchi-Levi, Kaminsky and Simchi-Levi, 2007, p 188), and a reduced supply base could be related to this integration.

The above does not mean that in car manufacturing single sourcing is preferred altogether. It all depends on the situation and the part in question. Buyer I mentioned that there are many high-tech items in a vehicle, and Buyer II pointed out that some of them are quite confidential. For these items, it was agreed that single sourcing is better than multiple sourcing. For items that do not bear these characteristics though, a manufacturer could reduce disruption risks, by using multiple suppliers.

In the end, it is all a matter of saving company resources, via a balanced sourcing strategy. Calculating the TCO might not work as the ideal costing guide when the manufacturer has to deal with many parties. Buyer IV pointed out that, while the TCO should be kept in mind, overanalyzing individual decisions might consume too much time and resources. Buyer III suggested ABC as a more appropriate tool for sourcing decisions, as it provides more accurate cost information for strategic decision-making processes (Özbayrak, Akgün and Türker, 2004), while with the TCO, costs need to be realized at a more detailed level (Ellram, 1995). In sum, it seems to be sensible to review sourcing decisions when a new project is initiated. However, introducing a methodology to keep track of the TCO of each project might be too complex.

6. Conclusion

In the final chapter of this thesis, a summary is presented of what has been found in regards to each research question. Suggestions about potential adjustments in the sourcing process are made to the truck OEM, and the value of the research is briefly discussed. Limitations of the results are highlighted afterwards, and some suggestions for future research complete this thesis.

6.1 Answers to the research questions

The research presented here was initiated because a truck manufacturing company wished to investigate their sourcing strategy options. As a company with production facilities spread in different regions of the world, it is of paramount importance that sourcing decisions are taken wisely.

As demonstrated in chapter two, the two sourcing options for the manufacturer are single and multiple sourcing, with the latter including some different versions of collaborating with more than one supplier, for the same part/product. The purpose of this thesis was to investigate the advantages and disadvantages of single and multiple sourcing in the specific truck OEM, for relevant suggestions to be made accordingly.

Three research questions were formulated in regards to the purpose above. 1) *What are the benefits and disadvantages of single and multiple sourcing in the context of manufacturing companies?*

The most commonly acclaimed advantage of single sourcing, from both the literature and the interviews, is the increased potentials for operations alignment between the selling and the buying company. The production at the supplier is coordinated with the production at the buying company, which results in JIT deliveries. A close relationship between the parties is a prerequisite for this, and as the partnership evolves in time, so does the mutual trust. This is related to mutual understanding and to common corporate goals' pursuit, where the buying company can negotiate lower prices, and the selling company can consent to them. The main advantages to single sourcing are interrelated and usually long lasting.

On the downside, this coordination, which is usually in the form of some EDI alignment, bears the additional cost, an investment that is not negligible. The most striking disadvantage with single sourcing though is the manufacturer's increased dependence on the supplier. Any reason that would obstruct delivery translates to zero alternatives for the manufacturer.

With multiple sourcing, the manufacturer has alternatives, because there is always a back-up solution in response to unanticipated events. There is no dependency on a single source, and stress levels are decreased because of that. The market laws set in, and healthy supplier competition is encouraged, an environment in which the manufacturer can enhance its product knowledge base. Nevertheless, multiple

sourcing can lead to increased workload, compared to single sourcing, and a buyer's every-day routines may be harder to automate. In addition, supplier commitment is not as high as with single sourcing.

Since inquiring only into the advantages and disadvantages of both strategies is not a sufficient basis for the buyer on which to take sourcing decisions, it was necessary to shed further light on what other aspects influence a buyer's choices. Therefore, a second research question was formulated:

2) *What is the basis for decision-making in manufacturing companies during sourcing?* It was demonstrated that there are specific circumstances, project types and product characteristics that settle the dilemma of single or multiple sourcing. Specifically, single sourcing has been supported to be more appropriate when the sourcing project involves a significant investment, when there is little time available before product launch, when the supplier selection procedure is long, and for high-tech, customized, confidential or easy to substitute products. Multiple sourcing is considered more fitting for low-cost projects, for big and heavy parts, for low-tech products, for large volumes, when the products are considered to be of strategic importance, and when there are local content requirements. Sourcing decisions in manufacturing companies are influenced by geographical, technological, financial and circumstantial factors. The basis for decision-making during sourcing is related to 'hard,' tangible criteria, like what kind of products need to be sourced, their size and volume, and to 'soft,' but equally decisive criteria, like transport distance, and project complexity.

The third research question had to do with gaining knowledge, from other than the truck manufacturer companies, on how the single versus multiple sourcing quandary is resolved and was formulated as such:

3) *What lessons can be learned from other manufacturing companies in regards to the same dilemma?* Professional buyers from four additional companies were interviewed, including three from car manufacturers and one from a catalyst manufacturing company. In addition to replying to research questions one and two, the buyers were helpful in clarifying that in the vehicle manufacturing industry, single sourcing is more common. This also seems to be the case with the truck manufacturer in question, based on the information provided by the interviewed buyers. The car manufacturers indicated that their version of multiple sourcing, where applicable, is dual or parallel sourcing. Interviewing a buyer from a manufacturing company that does not produce vehicles, proved helpful in making a basic comparison between two distinct types of industries. The latter company has a strong preference for multiple sourcing.

6.2 Suggestions and value of the research

Half of the respondents from within the truck OEM, at least for the commodity investigated in this thesis, assert that single sourcing is preferred. Since there are production facilities on different continents, for some cases logistics cost, including

transportation and storage, is higher than what it would be with multiple sourcing, where more options would be available. When the department follows a single sourcing strategy, there is little chance that analysis is done on how far items travel, and the related cost, since there is little chance of any buyer questioning any current strategy, as employees are usually preoccupied with performing their daily tasks. With multiple sourcing, this cost could be decreased if solutions are found to sourcing items locally or closer to where they are needed. In addition, the JIT deliveries that are claimed to be single sourcing's greatest attribute can also be achieved with multiple sourcing, since if the buyer has everything under control, there should be traceability, and operations can be aligned to some extent. Order volume consolidation through single sourcing increases the buyer's negotiation leverage, which can result in lower buying prices. Lower prices can also be achieved with multiple sourcing due to competition.

The odds that an incident causes complications with delivery are not different with single from multiple sourcing. With multiple sourcing though, the buying company can react right away, while with single sourcing the options are limited. Therefore, the recommendation in this thesis is multiple sourcing to be considered to a greater extent with this specific commodity segment. It might not be appropriate, possible or even successful all the times, but as a strategy, it could potentially save the company time, effort and consecutively money. If this were to be put into practice, maybe guidance from Buyer B would be accommodating. In the transition from single to multiple sourcing, it can be advantageous to start with dual or parallel sourcing, as recommended by Buyer I and III. When multiple sourcing is favored, Buyer IV recommends using three suppliers.

Deciding between single and multiple sourcing is situation-dependent. Therefore, it cannot be said with certainty whether one approach is more appropriate for the specific commodity than the other is. However, the existing employees could be motivated to use multiple sourcing for items where they traditionally have been using single, if some of the factors in favor of multiple sourcing apply. Buyers who are interested in investigating sourcing scenarios and the issues that affect sourcing decisions may wish to consult this thesis.

6.3 Limitations of the results

Further comparative data would have been gathered should interviews with buyers from more than the four other manufacturers had been conducted. Additional interviews and input from other truck manufacturers would potentially have added nuanced information. However, the possibility that competing truck manufacturers would have granted the researcher with an interview is low compared to other types of manufacturers, because of their potential reluctance to share information with rivals.

The interviews included almost all the buyers working for the truck OEM and with the same commodity. However, two buyers (out of six) were not interviewed, and the reader must, therefore, keep in mind that the conclusions may not be completely representative of the entire department.

6.4 Suggestions for future research

The dilemma of single versus multiple sourcing cannot be eliminated, but careful attention to the components of each strategy can mitigate the potential costs of deciding on the wrong game plan. Specific tools towards showing a clearer sourcing path may include a classification of the commodity based on the Kraljick purchasing portfolio analysis. The empirically based DuPont analysis could indicate if increased use of multiple sourcing might result in savings on purchasing cost for the OEM. That would mean to explore the company's own internal systems to investigate a numerical contribution of one approach over the other to profitability. Another suggestion is to apply computational analysis, namely creating an algorithm, to show how many suppliers would be ideal for each sourcing case. Finally, extending the research to other sectors than the vehicle manufacturing industry is likely to generate inspiration and stimulate new possibilities

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Appendix

Interviews Questions

- 1) What is your job title and your main area of responsibility? How big is the role of the purchasing department in an OEM?
- 2) What would you say the market that the specific commodity you are responsible for is? Monopolistic, oligopolistic or free competition?

Supplier selection procedure

- 1) Which are the specific steps in your supplier selection procedure?
- 2) How long is your supplier selection procedure and how much does it cost for the company? Would you say it is a considerable investment?
- 3) Which are the factors that an ideal supplier profile should be based on? What are the main characteristics that you look for in a supplier?

Single sourcing

- 1) Which are the main drivers of selecting a single supplier for one item?
- 2) What do you consider the advantages and disadvantages of having a single supplier?
- 3) Do you experience JIT deliveries when you use a single supplier?
- 4) Have you experienced any production stoppage because you were using one supplier who could not deliver when supposed to?
- 5) Is it cheaper for you to have one supplier in regards to administration, communication, handling etc, or not? Do you have dedicated employees to deal with one supplier (provided that it is a major account for your company)?
- 6) Where there other suppliers in the market that you decided not to collaborate with, because you had an exclusive collaboration with one specific?
- 7) What is the availability of substitution products? How easy is it to switch to another product if your one supplier fails to deliver?
- 8) What would be the total percentage of components you source from single suppliers?

Multiple sourcing

- 1) Which are the main drivers of selecting multiple suppliers for one item?
- 2) What do you consider the advantages and disadvantages of having multiple suppliers?
- 3) Do you think that multiple sourcing can increase a healthy competition between the suppliers?
- 4) Is it more expensive to deal with more than one supplier in regards to administration, or not?
- 5) How do you allocate volumes of the same item when you have more than one supplier?
- 6) Does multiple sourcing provide improved market intelligence? In which way?
- 7) Do you consider multiple sourcing as a risk mitigation activity? Why?

- 8) What would be the total percentage of components you source from multiple suppliers?

Challenges with the two approaches / comparison

- 1) What do you see as the major risks/challenges related to single and multiple sourcing?
- 2) What do you think is the best way to eliminate those risks (for each strategy separately)?
- 3) Can you please give an example on which according to you, from your work experience, could be the ideal scenario for single or multiple sourcing?
- 4) Which general strategy would you say you use? Single or multiple sourcing?

Supplier relationship management and supplier assessment

- 1) How close is your relationship with a supplier (when it is a single supplier and when there are many suppliers)?
- 2) Do you give feedback to your suppliers if they should improve their performance? If they need to make major improvements, do you allow them a period to adjust and improve or do you stop using the specific supplier and move on to someone else?
- 3) What is the level of collaboration in regards to product development when you have one supplier and when you have many?
- 4) How do you assess your suppliers? Do you use any specific method? How often do you do that? Does this procedure affect the decision of the number of suppliers you use (for every item)?
- 5) How do you manage product quality when you work with multiple suppliers for the same item? Does this procedure affect the number of suppliers you employ?
- 6) How easy is it for your company to change suppliers?

Total cost of ownership

- 1) What other factors do you take into consideration when you source an item, apart from the buying price? (transport, logistics, warehousing, inventory cost etc)?
- 2) When you choose a supplier, do you consider the TCO both in attaining the supplier and throughout your relationship?

Respondent A: Interviewed 2017/02/22, Gothenburg, Sweden.

Respondent B: Interviewed 2017/02/23, via Skype, Gothenburg, Sweden.

Respondent C: Interviewed 2017/02/24, via Skype, Gothenburg, Sweden.

Respondent D: Interviewed 2017/02/27, via Skype, Gothenburg, Sweden.

Respondent I: Interviewed 2017/02/24, Gothenburg, Sweden.

Respondent II: Interviewed 2017/03/06, via Skype, Gothenburg, Sweden.

Respondent III: Interviewed 2017/03/17, Gothenburg, Sweden.

Respondent IV: Interviewed 2017/03/28, Copenhagen, Denmark.