

Bachelor's Thesis

Industrial Management and Engineering

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Low-cost countries sourcing and competitiveness comparison



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The objective is to find a turnkey supplier for a air supply unit. Therefore decreasing the number of suppliers needed.

The research uses purchasing power standard which is a artificial currency based on gross domestic product value to compare countries. As the workforce cost consist of a large percentage of the product price, it has been taken into account in the evaluation.

Methods used are supplier evaluation using the fuzzy model, total cost of ownership, and strengths, weaknesses, opportunities and threat analysis on the suppliers.

The commissioner is advised to select a supplier from a low-cost country with previous relationship to the purchasing department. Using the network sourcing strategy the commissioner would have competitiveness and a turnkey solution.

Keywords:

Supply Chain Management, PPS, GDP, procurement, purchasing, low-cost country, strategy

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Tavoitteena on löytää avaimet käteen -periaatteella toimiva toimittaja ilmansyöttöyksikölle. Siten tarvittavien toimittajien määrä vähenee.

Tutkimus käyttää ostovoima standardia, joka on bruttokansantuotteen arvoon perustuva keinotekoinen valuutta maiden vertailua varten. Koska työvoimakustannukset muodostavat suuren osan tuotteen hinnasta, se on huomioitu arvioinnissa.

Käytetyt menetelmät ovat toimittajan arviointi fuzzy-mallilla, kokonaisomistuskustannusmalli sekä toimittajien vahvuudet, heikkoudet, mahdollisuudet ja uhka -analyysi SWOT menetelmällä.

Toimeksiantajaa neuvotaan valitsemaan halvan maan toimittajaa, jolla on aiempi suhde omaan hankintaosastoon. Verkkohankintastrategiaa käyttämällä toimeksiantaja olisi kilpailukykyinen ja saavuttaisi avaimet käteen -ratkaisun.

Asiasanat:

Supply Chain Management, PPS, GDP, procurement, purchasing, low-cost country, strategy

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List of abbreviations (or) symbols

BOM	Bill Of Materials
COGS	Cost of Goods Sold
GDP	Gross Domestic Product
MCDM	Multi-Criteria Decision Making
NACE	Statistical Classification of Economic Activities in the European Community
PPP	Purchasing Power Parity are indicators of price level differences across countries for comparison of gross domestic product
PPS	Purchasing Power Standard is an artificial currency unit which Eurostat uses to compare countries with PPP
TCO	Total Cost of Ownership
RFI	Request For Information
RFQ	Request For Quotation
SWOT	Strengths, Weaknesses, Opportunities and Threats
SRM	Supplier Relationship Management
WBCSD	World Business Council on Sustainable Development
WRI	World Resources Institute

1 Introduction

The current situation for the commissioner is that they have a wide range of suppliers supplying different items/elements/parts for same larger end product. To ease the management needed regarding the production of the larger units, the commissioner is considering a “turnkey” solution from a single source. This would mean that a single supplier would work on the detail drawings, manufacturing, packaging and even installations that are bound to the supply air units sold overall. The other possibility is to switch from several smaller parts into larger modules to reduce the number of suppliers needed to be purchased to gain a single supply air unit. Both options will reduce the workload and therefore cost in the procurement department. The turnkey solution from a single supplier would also reduce the workload and the lead time from commissioner’s design department, as the design drawing would be done by the supplier. As the end clients manufacturing halls demand a large amount of supply air units it would have a large effect on the procurement managing level with the result of reducing the suppliers needed. The purpose is to achieve a long-term partnership with the selected supplier. The commissioner’s target area to find suppliers in Europe are focused on the Eastern Europe. This focus to use low-cost countries so that the costs can be decreased. It is part of the commissioner’s procurement strategy.

The objective of the thesis is to find a suitable supplier to produce the supply air unit by reducing the amount of suppliers needed and reducing cost for the commissioner of this thesis. The research document is divided in three parts. In chapter two the relevant theory related to strategic sourcing and supplier selection will be introduced. Chapter three includes the research in practice and its process. Chapter four includes the conclusion from the chapter three and the proposal to the commissioner.

This research process will help towards the decision making by reducing the number of suppliers needed or if possible, to select a single supplier that would provide a turnkey solution as the company currently would prefer. In cost related issues the previous Project X has been sold and installed the same supply air

units to the end client and therefore this purchasing information will be used to compare the cost savings overall. Regarding the selection of the suppliers, previous procurement market research is used to find a suitable candidate(s) and the previous suppliers would also be considered to the selection phase. With the supplier evaluation method the supplier will be processed. Microsoft Excel will be used as a database for the information gathering. The evaluation calculations would be executed using Excel. Cost valuation would be calculated using the COGS method. SWOT and risk analysis is used to determine the benefits and possible risks involved. Evaluation methods would be combined to present the overall best solution within the information used in the research. The research will be using purchasing and supply chain management literature. Research commissioner's databases and resources are used to gather information.

As the reserved time for this research is limited the previous procurement market research of new suppliers would be used, and therefore new suppliers will not be added to the list. There will be suppliers without a purchasing history and those will be evaluated with the offer they would provide. This paper will not be proceeding to the purchasing phase. The commissioner's division for this paper doesn't have their own manufacturing facility meaning there won't be a need for "make-buy decision", as everything is purchased. The product is divided into three parts. These three parts are the air intake at the roof, the air handling equipment and finally the air distribution unit inside the building. The paper will be focusing on the final part which is the air distribution unit. Critical information will be left out of the published version or modified from the original data, as it consists confidential information regarding the research commissioner. The process of the research will be written, and methods will be demonstrated in this document, with confidentiality in mind for the published version.

2 Strategic Sourcing

The relevant theories for this research will be introduced in this chapter. First, various strategic sourcing models will be explained to use later in the conclusion phase. The strategic sourcing models are the purpose to be used by the commissioner combined with the results.

As described in the introductions the intend is to lower the supplier number. The supply base reduction theories are described how it will affect the commissioner's costs, when the supplier number is reduced.

Supplier assessing theories describes different supplier assessing and is combined with the supplier evaluation later as the potential suppliers need to be assessed and give then ratings. At the researched moment the commissioner uses SRM system for potential supplier approval, but it isn't made for a specific product. Evaluation will be used to the specific supply air unit product.

The task was bound by the commissioner to the low-cost countries. For this purpose theories of PPP are explained. PPP enables comparison of goods and services of different countries. This is used as one base assessment in the results phase. With PPP the low-cost countries can be determined.

The commissioner uses in the time of this thesis a COGS method to calculate costs. This method is described briefly in theory. The more extensive method TCO is described in theory and used in the assessment phase. It provides a wider costs calculation on the purchasing of goods/services.

Risks and potentials on each supplier needed to be determined and SWOT analysis was used for this purpose. The last theory explains the SWOT method to the reader.

2.1 Different sourcing strategies

To determine which suppliers would be suitable for long-term relationships Kraljic developed a positioning matrix in 1983. (Peter Baily, 2015, p. 19) Kraljic suggested that the best purchasing strategy is a function of the level of supply exposure, technical risk and the value/cost of product or service bought (Sunil Chopra, 2016, p. 47). As the figure 1 arrows illustrates below the matrix framework is categorizing products into four sections depending on the profit impact (costs) and supply risk (complexity): strategic (high profit impact – high supply risk), bottleneck (low profit impact – high supply risk), leverage (high profit impact – low supply risk) and non-critical (low profit impact – low supply risk) (Grant David B., 2017, p. 165). These four categories give different strategies how buyers should manage the suppliers and are divided by their supply risk and profit impact in figure 1. Non-critical products require efficient manufacturing, standardization, and high volume. Leverage requires the full purchasing power through competition, target pricing and product substitution. Bottleneck products have the highest risk, unique specifications and low demand, therefore requires supply continuity, security inventory, vendor control and backup plans. (Gees J. Gelderman, 2003, p. 207) Strategic products are custom design or unique specification, which make them difficult or costly to change source of supply and substitute (Cousins Paul, 2008, p. 47). Analysis is used how to proceed on each product and from there selected the three supplier strategies to minimize the risk and get most of the buying power: balance, exploit and diversity (Gees J. Gelderman, 2003, p. 207). Each category has two strategic directions:

1. To hold the current product category position
2. To pursue other product categories

These are illustrated in nine different options and is called Purchasing & Supply Management 9. It helps procurement to determine the strategy for each product category and how to proceed. (Gees J. Gelderman, 2003, p. 213) The nine different options are described in the figure below.

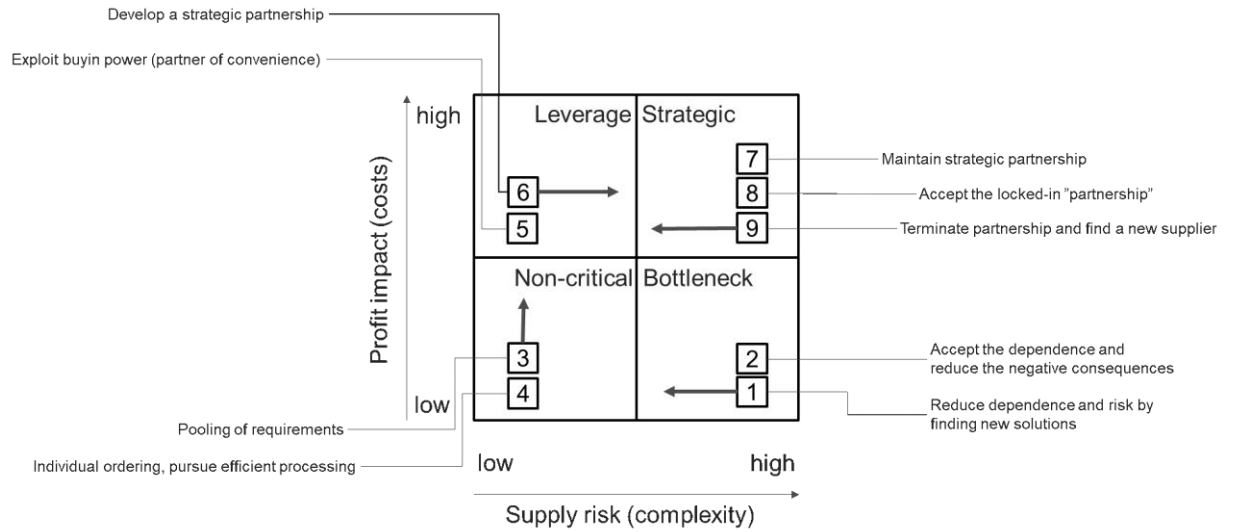
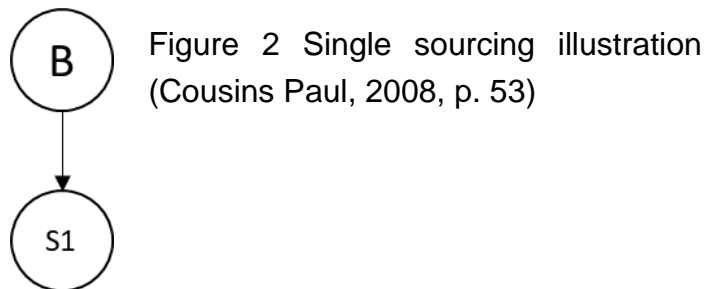


Figure 1. Overview of strategic directions for all categories (Gees J. Gelderman, 2003, p. 212)

2.1.1 Single sourcing

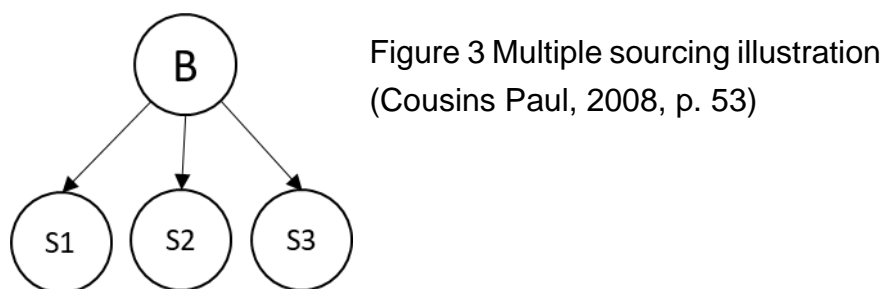
The buyer has only one supplier in this option as illustrated in the figure 2 below. There may be many reasons why the buyer would select only one supplier. For example, it can be that the price is higher everywhere else, or it has a strategic importance. (Cousins Paul, 2008, p. 52) Single supplier has its benefits. It's easier to establish a strategic alliance relationship and manage the supply chain with the supplier. The quality level has less variables as its focused on one supplier rather than multiple ones. It lowers the cost by concentrating the purchases to a single supplier and lowers the fixed costs on more complex parts. In transportation the procurement has the possibility to use full truckloads which lowers the costs. (Joel D. Wisner, 2017, p. 62) By providing sufficient business to the supplier, they may make investments on the plant and equipment design to produce the products specially to the buyers needs (Sunil Chopra, 2016, p. 446).

In Kraljic matrix this type sourcing is likely to be found in the non-critical or bottleneck category (Cousins Paul, 2008, p. 52).



2.1.2 Multiple sourcing

Multiple sourcing works best in the marketplace with high supply market competition, low switching costs and low level of technology knowhow is required. For the buyer it usually means the best price is achieved by competition between the suppliers for the offer. The buyer must balance with capacity constraints and each supplier performance. (Cousins Paul, 2008, p. 54) This type of sourcing enables flexibility to change suppliers in short time as required. These are standard items that are bought in high volume. The buyer has a strong negotiation edge by combining high spend value with competitive suppliers. As the figure 3 shows the buyer has many optional suppliers. This strategy is found in the Kraljic's leverage products category (Peter Baily, 2015, pp. 22-23)



2.1.3 Delegated sourcing

This strategy was pioneered by the aerospace and automotive industries around the mid 1990's as an efficient way for managing supply (Cousins Paul, 2008, p. 54). The buying company delegates authority to a 1st tier supplier to produce a product by sub-suppliers as the figure 4 represents (Louise, 2015, p. 597). This enables the buyer to focus on the first-tier supplier on resources and developing the relationship (Cousins Paul, 2008, p. 54). Delegated sourcing has advantages for the buyer as it reduces the number of suppliers that demand close relationship and therefore can reduce transaction costs (Louise, 2015, p. 597). This strategic provides the circumstances for the supplier to grow into a major player and potentially may become a threat for the buyer. In these situations, it's usually seen in price increase. In the Kraljic matrix this is found usually in the leverage category which proceeds towards non-critical category. (Cousins Paul, 2008, p. 55)

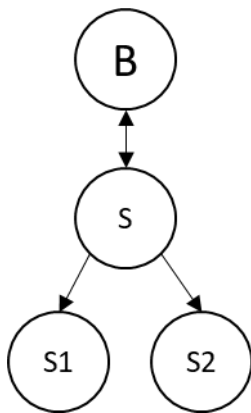


Figure 4 Delegated sourcing illustration (Cousins Paul, 2008, p. 54)

2.1.4 Parallel sourcing

This strategy is studied and tested in the Japanese automotive by Richardson in 1993. It describes how the Japanese automotive manage their suppliers. (Nojan Najafi, 2014, s. 4) Having a couple of groups for one product. Each group contains a minimum number of suppliers. Both suppliers have the same parts to be supplier. (Cousins Paul, 2008, pp. 55-56) To explain the figure 5 let's take an example that an industry company produces model P1. P1 would have a single source supplier S1 which supplies the necessary parts A1 and B1. If any problems arisen with S1 there is another supplier, let's call it S2 which can supply also A1 and B1 parts. Each single supplier competes to gain more orders depending on their performance. The continually best performed supplier would be primarily the single supplier and would develop into a long-term relationship. This allows the buyer to have price competition, reduces complacency, ensures capacity, and make a deeper relationship with the supplier. On the Kraljic matrix this strategy has less risks and costs than delegated sourcing, but still is part of the strategic category.

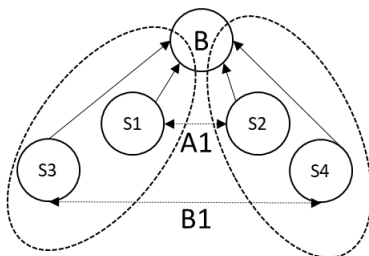


Figure 5 Parallel sourcing illustration
(Cousins Paul, 2008, p. 56)

2.1.5 Network sourcing: a hybrid approach

This sourcing strategy is like parallel sourcing and originated from the Japanese automotive industry. It was first described by Hines in 1995. The idea is that there are several suppliers for the same products. (Nojan Najafi, 2014, s. 4)

It is developed by organizing associations on each tier groups connected to the upper group. With this method the suppliers are locked into a long-term

arrangement. The first-tier suppliers are invited into Kyoryoku Kai which is the associate with the final assembler as described in the figure 7. (Hines, 2006, p. 21)

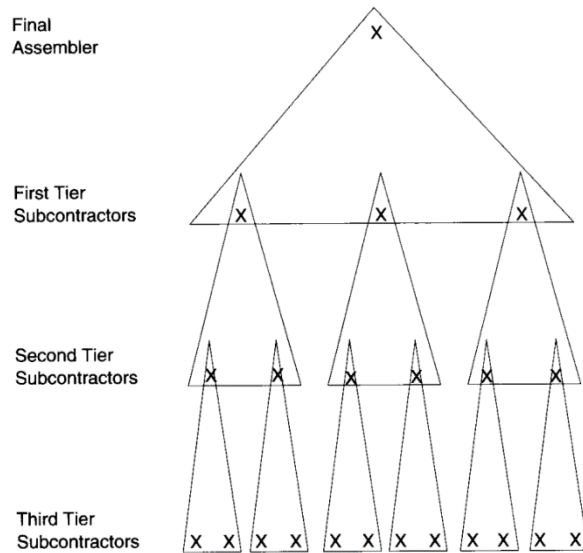


Figure 7 Typical Japanese subcontracting pyramid with its cascading supplier associations (Kyoryoku Kai) (Hines, 2006, p. 21)

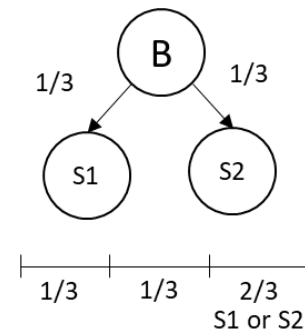


Figure 6 Network sourcing illustration (Nojan Najafi, 2014, p. 4)

For the example let's say there are two suppliers S1 and S2. Each of the supplier would have minimum of 1/3 of the total volume, and they must compete for the last 1/3 which depends on the past performance. This means that the supplier that has performed best gets awarded 2/3 volume of the product. This works as the two suppliers are in the same Kyoryoku Kai association. They are in constant connection with each other,

2.1.6 Triadic sourcing

This strategy is made with two suppliers. The buyer develops a long-term relationship with both suppliers and at the same time the suppliers create between themselves a long-term relationship. This is more complex as the suppliers are competing and at the same time cooperation partners. This puts

more focus on the buyer to balance and sustain the relationship with both suppliers. (Nojan Najafi, 2014, s. 44)

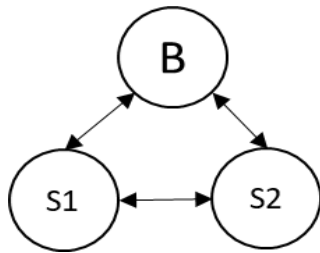


Figure 8 Triadic sourcing illustration (Nojan Najafi, 2014, p. 5)

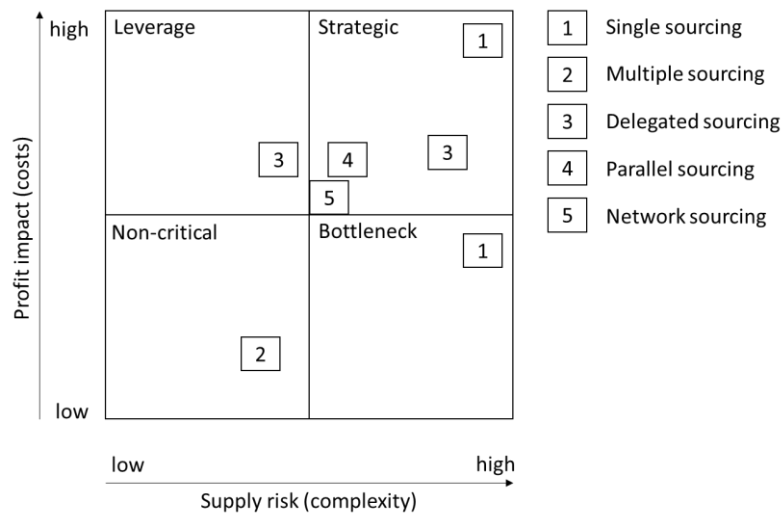


Figure 9 Mapping sourcing strategy with Kraljic matrix (Paul Cousins, 2008, p. 56)

The figure above illustrates the previously described sourcing strategies and where they are demonstrated in the Kraljic matrix. Risk and profit can be demonstrated for each strategic selection.

2.2 Supply base reduction

The principle of supply base reduction or supply base optimization is to concentrate on the best performing and suitable for the buyer (Joel D. Wisner, 2017, p. 124). By minimizing to fewer suppliers, the buyer can manage its limited

resources by focusing on these few suppliers. This strategy method started in the early 1990s. (Cousins Paul, 2008, p. 44) This aims to improve the relationship between the buyer-supplier and increases the performance and value of the supplier. The purchase prices are reduced due to quantity discounts, supply chain management savings, improved collaboration from buyer and supplier, quality levels increase, and delivery reliability increases by selecting the best suppliers. (Joel D. Wisner, 2017, p. 124) To measure the effectiveness of supply base reduction there are three main types of cost used:

1. Operational costs: day-to-day relationship, production of purchase order, invoicing etc. This should be reduced during time.
2. Managerial costs: problem solving, visiting the supplier, quality control, supplier conferences etc.
3. Strategic costs: strategic risks/costs, as the suppliers are reduced the risk increases and so does the strategic costs. (Cousins Paul, 2008, p. 45)

Companies can use the supplier reduction based in ethical and sustainable performance requirements. This brings the supplier-buyer relationships closer and focuses on environmental and ethical performance. The two international standards used are World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD), these are known as the Greenhouse gas protocols. (Joel D. Wisner, 2017, p. 124) It should be also supported by manufacturing systems such as lean manufacturing to improve production (Cousins Paul, 2008, p. 44).

2.3 Supplier assessment: Fuzzy model

The effective selection and assessment of the suppliers is crucial to the competitiveness of a company. Many assessments rely in ISO9001, price and quality, instead of a multi-criteria evaluation. (Kwong C.K, 2001, p. 512) Dickson in 1966 identified 23 criterias for assessing suppliers performance. The criterias were gathered from 170 managers and purchasing agents with a importance value for each criteria on a five-point scale. (Sharon, 2009, p. 314) Schorr in 1992

introduced a material purchasing tool that consists of questions that could be answered “yes” or “no”. These questions had nine criterias for ideal supplier: delivery, quality and reability, price, responsiveness, lead time, location, technical capabilities, R&D investment plan and financial/business stability. These “yes” or “no” answers could be counted mathematically. (Kwong C.K, 2001) Both methods are called fuzzy models. They use mathematical calculations for rating of the result. Fuzzy set theory was introduced in 1965 by Zadeh and represents the vagueness of human thinking (Sharon, 2009, p. 315).

Supplier assessment and selection must be considered in the decision making process. By using the multi-criteria in the decision making process, the multiple-criteria decision making technique (MCDM) is used by purchasing for supplier selection. (Simićllija Dragan, 2016, p. 87) As Kwong describes in the publiced case that the existing suppliers can be assessed in the same fuzzy model aswell (Kwong C.K, 2001, p. 514).

The fuzzy membership model includes the importance of attributes. It weights the criteria answers in for stages in a scale of 0-1. These are low importance, moderate importance, high importance, and very high importance. From the answers would be given in words in a scale of excellent, very good, good, poor. These words would be represented by number values. (Sharon, 2009, p. 319) The rating method is determined by the developer of the fuzzy model, meaning that the answer words and pointing values vary depending on the developer. For example the method by Chui in 1996 consist of rating called excellent, satisfactory, minor deficiencies, major deficiencies and unacceptable (Kwong C.K, 2001, p. 512). The Chui method had also four stages to certificate the supplier. These are meeting, factory visit, evaluation report and management review.

The physical visit to the supplier is to ensure the quality requirements. Procurement and quality staff would assess the quality of the supplier by examining the production techniques, equipment, documentation, production facilities, policies, attitudes, and standards. Usually these are short visits but may be expensive depending on the time and complexity of the visits. This can be

made by a third-party certification, which means the visits and appraisals is bought by the buyer to conduct the supplier assessment. (Peter Baily, 2015, p. 181) It gives the possibility to assesst towards the fuzzy model as answers are gathered face to face.

The SRM system is used to manage the supply sources (Sunil Chopra, 2016, p. 13). The shorten name comes from Supply Relationship Management. It usually includes evaluation, selection, negations, communication information about the suppliers and the products they offer (Sunil Chopra, 2016, p. 13). The success of e-procurement created the need for SRM for managing the supply chain in organizations (Joel D. Wisner, 2017, p. 89). An important part of SRM is the evaluation and selection process by gathering information from the supplier.

The commissioner SRM is used to manage and approve the potential suppliers to their system. That approval would enable the purchasing of goods/services form the supplier. The SRM does have a product specification options, but lack the potential to evaluate for a specific turnkey solution from a single supplier.

The used method in the thesis takes some characteristics on the Carter's 10C model. It consists of 10 criteria's that are competency, capacity, consistency, control of process, price, culture and relationship, cash/finance and communication (Ray, 2021). It combines the Carter's 10C characteristics and the fuzzy model to enable a more flexible approach to the supplier evaluation result.

2.4 PPP

PPP comes from the words Purchasing Power Parities. It indicates the value of different services and goods with one sum value. This makes it possible to compare the different countries value on goods and services (Grant David B., 2017, p. 51). The PPP includes the gross domestic product (GDP) value from each country which means it changes in time. For example, if a 0,5 liter of a bottle of water would cost in Germany 1 euro and in the US 0,80 dollars. The ratio would be 1 euro to 0,8 dollars or 1,25 euros to the dollar. It means that the Germany would need to use 1,25 euros to obtain that same quantity and quality of the bottle

of water (European Commission, 2012, p. 2/11). As it uses a value to representative the GDP at PPP it can be used as an indicator for country comparisons. The EU uses PPS that represents euros in the whole European Union for country comparison (European Commission, 2021, p. 9/11). PPS stands for Purchasing Power Standards which is an artificial currency (European Commission, 2014).

2.5 Total Cost of Ownership

TCO (Total Cost of Ownership) is used to calculate the overall cost of the supply chain of goods or services from a supplier (Sunil Chopra, 2016, p. 443). The TCO can be describe with the value pyramid iceberg. The purchase price is 10% of the overall cost. The other 80% consist of installation costs, operation costs, maintenance costs, transportation costs, opportunity costs, salvage costs, disposal costs and many others depending on the product or service. (Sower, 2011).

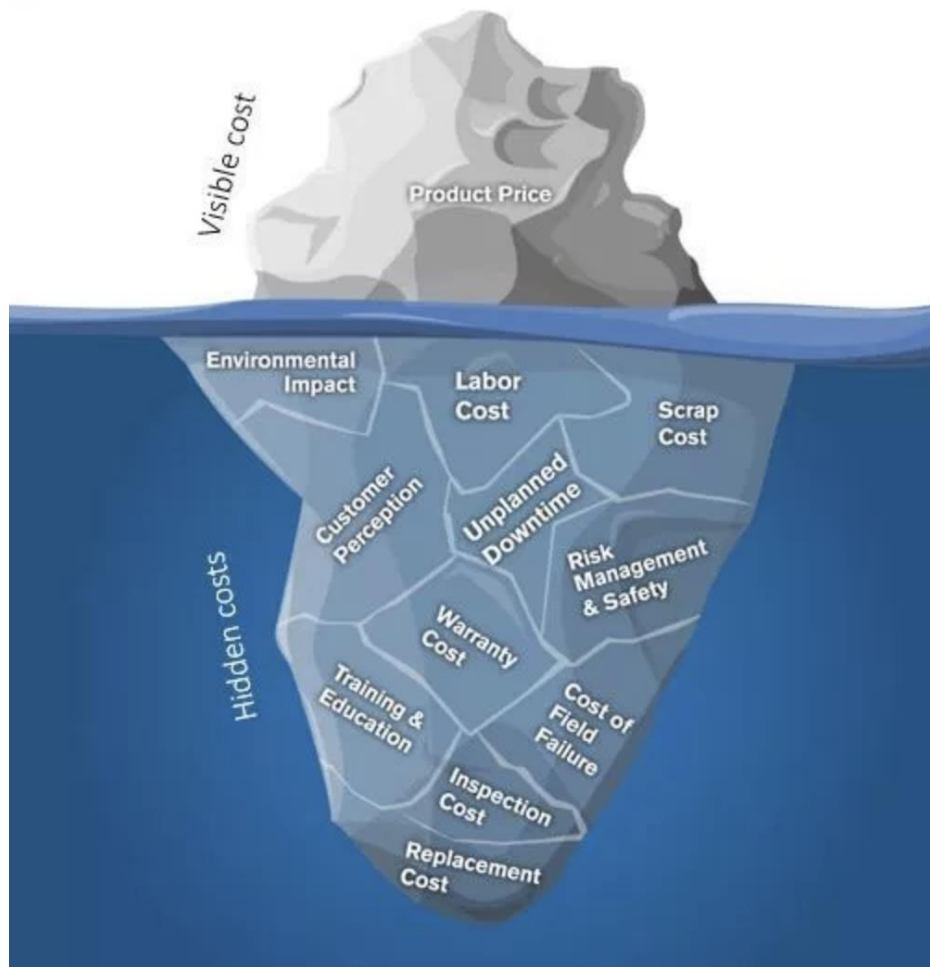


Figure 10 TCO iceberg (Procurement Express, 2019)

The three main parts are divided into acquisition costs, ownership costs and post ownership costs. (Sunil Chopra, 2016, p. 443)

Acquisition costs are prior to the order. It includes evaluation, inspections, managing, planning, delivery, training and traveling costs between the buyer and the supplier.

Ownership costs comes from the actual order. The costs of the goods/services, inventory costs, quality control from the buyer, preparing the order and delivery cost are all included in the ownership costs.

Post ownership costs are incurred after the buyer, company, customer has received the goods/services. These could be the warranty costs, maintenance costs, reputation impact, environmental costs, or field of failures.

TCO gives a proactive point of view on the overall cost on the supply chain and enables to see the performance of the supplier which can lead to cost reduction. (Joel D. Wisner, 2017, pp. 87-88) It's a more advance way compared to just focusing on the suppliers offers price, because it includes the indirect and direct costs in procurement.

There are three levels of detail for cost analysis that determine the accuracy of the costs. "Roundtable" level is made from an estimate of the costs. This usually doesn't have the bill of raw materials (BOM), detailed drawings and overall has limited information about the specifications. "Comparison" level has historical costs information or a similar product and can be projected historical costs for future costs. "Detailed" level is the most accurate. It included all the components, processes, and assembly costs. Detail level requires significant amount of time and is the costliest to develop. Each of the three levels has its ups and downs, as the table below shows. (Mena Carlos, 2018, p. 141)

	<i>Roundtable</i>	<i>Comparison</i>	<i>Detailed</i>
<i>Relative accuracy</i>	LOW , because limited data used	MODERATE/HIGH , depending on data, technique, and estimator	HIGH , based on engineering principles
<i>Relative estimator consistency</i>	LOW , different experts give different judgements	MODERATE/HIGH , depending on data, technique, and estimator	HIGH , based on uniform application of principles
<i>Relative speed of development</i>	FAST , little detailed analysis	MODERATELY FAST , especially with repetitive use	SLOW , requires detailed design

			and analysis cost
<i>Relative development cost</i>	LOW , fast, and little data development cost	MODERATE , depending on need for data collection and analysis	HIGH , detailed design and analysis cost
<i>Relative data required</i>	LOW , based on expert judgement	MODERATE , only requires historical data	HIGH , requires detailed design and analysis

2.6 COGS

Costs of goods sold includes the direct costs of goods and services from manufacturing, materials, and administration (Hofmann Erik, 2011, p. 9). This is usually used in net sales to calculate the estimate costs. In procurement the inventory costs are linked to the materials and therefore effected to the COGS amount. By balancing the inventory rate between the supplier and the buyer, the COGS rate can be reduced (Hofmann Erik, 2011, p. 63). If the materials costs more than estimated, so does the COGS increase, which are the performance of procurement (Hofmann Erik, 2011, p. 84).

2.7 SWOT

The basic SWOT comes from the words Strengths, Weaknesses, Opportunities and Threats. Using from every word the first letter to make the shorten name SWOT. These are used to evaluate the company's internal strengths and weaknesses with the company's external opportunities and threats. It is a strategic tool to identify the company's internal advantages in an external situation. (Peter Baily, 2015, p. 58) This requires the need to collect internal

information about the company to determine its strengths and weaknesses and the external information to determine the opportunities and threats. SWOT analysis can be used as a tool for the procurement function. (Mena C., 2018, p. 45)

Internal	<p>Strengths</p> <ul style="list-style-type: none"> • Buying power for most categories • Strong brand that suppliers want to be associated with • Global footprint • Clear strategic direction • Young workforce ready for change 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Limited influence on organizational strategy • Very high workloads • Limited IT support • Decentralized structure weakens bargaining power • Non-compliance and maverik buying in some regions
External	<p>Opportunities</p> <ul style="list-style-type: none"> • Develop partnerships with key suppliers • Supplier rationalization for non-critical items • Leverage power of supply chain • Engage supply base to reduce CO2 emissions 	<p>Threats</p> <ul style="list-style-type: none"> • Competition for resources from developing economies • Economic recession puts pressure on costs • High staff turnover/retention • Limited support from logistics funtions

Figure 11 Example of SWOT in procurement (Mena C., 2018, p. 45)

1 Supplier assessment in company X

Firstly, the potential suppliers must be identified. The Project X suppliers would be reviewed and using the previous procurement market research new suppliers can be identified. On both situations the commissioner's own SRM system would be used to gather their information. The identified potential suppliers would be asked directly their capability and willingness to design, produce and install the commissioner's product.

From their approval and commitment, they would be evaluated further. The evaluation would be done using the SRM system information that the commissioner currently uses with specific criteria connected to the product and its intentions to obtain a turnkey supplier. The current SRM system is new compared to the overall age of the commissioner's company. This means that the long-term relationship suppliers would have less information in SRM, as the previous system didn't require same documents. These had been assessed with a continuous supplier audit during the relationship.

From both potential suppliers a RFI was asked to determine the price. The price would be only one value of the whole TCO calculation. TCO would include Project X standard values, labor costs and additional estimations.

SWOT would be used on each potential supplier which analyses the potentials and risks internally and externally. The analysis is done by applying the subjects related to quality control, capabilities, cost, and willingness.

1.1 Supplier identification

The commissioner doesn't have their own manufacturing facility in this unit. This means that everything is purchased from their suppliers using their vast supplier network in a global scale. The suppliers needed for the researched product required an engineering to order approach as the product variates on the end customers facility limitations and customer requirements.

The first potential supplier was found from the previous procurement market research. By observing the GDP per capita in PPS (European Commission, 2021) and the mean labor cost in manufacturing (ILOSTAT, 2021) from 2020, the potential supplier was searched from Czechia. It had the 12 lowest median hourly labor pay and 20 lowest GDP for capita in PPS, with the same value as Italy. It has a geographical strategic position in the center of Europe, with borders to Poland, Germany, Austria, and Slovakia. The first connection to the new potential supplier which we will call as Supplier A, was done when new offers were needed to a project site in Czech Republic. The normal potential supplier process demanded documentation to be filled by the new supplier with a visit to their facilities was done. While making the visit to their facilities, their capacity and willingness was determined, and Supplier A was identified as a potential supplier for the intended Supply air Unit.

The second potential supplier was identified from the purchase history of Project X. It had the largest volume of purchases regarding the Supply air Units in previously mentioned project. As it already was a long-term supplier to the company with knowledge of the product from the previous project, the company was therefore contacted towards a meeting in attempt to further improve the relationship and the amount of responsibility. Let's call this potential supplier as Supplier B. The lever from the commissioner side was to increase the purchase volume for Supplier B by showing the list of the number suppliers and items from Project X and presenting the number of suppliers that the Supplier B replace comparing to the Project X. Using the history of purchase pricing from Project X, it was calculated that in overall purchases the Supplier B would have in the future 94% responsibility of Supply air Unit production, instead of the 80% that it had in the previous Project X. This increased amount was connected to the need and demand of detail design and installation services from their part. As the Supplier B would obtain the majority parts of the Supply air Unit, it's more convenient for them to take the role of detail design therefore increasing their manufacturing efficiency. The other important factor was the Supplier B location as a manufacturing facility. Their facility is in Latvia. Latvia has the sixth lowest hourly labor pay in Europe, and the GDP per capita in PPS being the 10 lowest in

Europe. Meaning the labor cost is significantly lower compared to the other Europe countries and therefore makes it attractive as a location for a manufacturing supplier. The Supplier B agreed on the design and production of Supply air Unit, with the demand that there would be enough time to design before it enters production and the measurements for the detail design would be provided to them. The possibility of installing the Supply air Units were a future possibility for the company as well because they already have a branch that specialized in installation of projects.

1.2 Supplier pre-evaluation

Both suppliers have potential with distinctive differences. Supplier B has previous relationship with the commissioner going back for more than 10 years. For this reason, performance history can be applied to evaluate this supplier. And Supplier A is a new supplier for the company, and has a smaller organization, which means it has less organizational costs. This makes the Supplier A with more potential to grow as a company and modify their developments towards the buyer’s needs.

Supplier evaluation

Product name		Supply air unit		Supplier		Suppliers Country*	Revenue M€ (Latest)	Overall rate
Product code*		CODE*****		Supplier A	B			
				Czechia	Latvia			
				0,6	6,43			
		Total Weight	100 %	3,49	4,06			
Criteria	Design	5 %		Good	Good			
Criteria	Duckwork	5 %		Good	Low			
Criteria	Heavy Metal	7 %		Good	Excellent			
Criteria	Light Metal	7 %		Low	Low			
Criteria	Machinery	7 %		Mid	Good			
Criteria	Installation	2 %		Good	Good			
Criteria	PPS	6 %		82 %	63 %			Automatic

Criteria	Hourly Labor Eastern	10 %	38 %	27 %	Automatic
Criteria	Europe	10 %	Good	Good	Automatic
Criteria	Reputation Quality	5 %	Good	Excellent	References
Criteria	Control	8 %	Good	Good	ISO9000
Criteria	Sustainable	5 %	Good	Good	ISO14001
Criteria	Maturity	5 %	Good	Excellent	Maturity Stage
Criteria	Finance	8 %	Mid	Excellent	Revenue Profit
Criteria	Technology	5 %	Mid	Good	
Criteria	English	5 %	Mid	Mid	

Figure 12 Supplier analysis table

Supplier evaluation’s criteria were selected by the demand of the commissioner’s head of procurement, project manager, senior designer, procurement quality engineer, product requirements and supplier geographic requirements. The values from bad to excellent are selected manually, where 1 point is bad, and 5 points is excellent. The information was gathered from SRM, visit to the supplier and internal information gathering towards the suppliers. Each criterion has a weight that is affected on the points it receives. This affects the importance of each criteria for the overall rating.

The PPS and Hourly labor were rated automatically compared on the commissioner’s HQ to the supplier’s country. This percentage different gives a better point if its lower than the commissioner’s value. They are automatically compared when the supplier’s countries are selected. The same is with the “Eastern Europe” rated which includes Baltic countries. It takes the information from the NATO stats to verify and gives the rating from there.

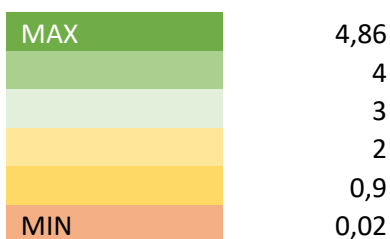


Figure 13 Supplier analysis overall rating scale

Both suppliers had about average rating overall. The Supplier B had an advanced rating even though it did lack light metal and duckwork requirements compared

to Supplier A. The Supplier A has a smaller workshop which limited the machinery, and the technology is an average. Still maintaining the quality in a good rate, because it is used to work in the power industry where documentation is vital. On the overall rating scale even having over 4 rating would be considered extremely high. As the Eastern Europe rating, PPS and Hourly Labor will lower the overall points, meaning that max 5 points is unlikely to be achieve. Similar is noticeable from the lower rating. The lowest rating would be in between 0,9 to 1,99. As the suppliers where preselected from the intended areas and with the criteria of low labor which gives good base values to them.

1.3 Price

The commissioner uses COGS to calculate costs overall. By using the total cost of ownership method as described previously the costs are gathering on the supply chain scale rather than the production scale. In the following calculations the commissioner’s standard values are used in some degree, meaning its more towards a roundtable level in cost analysis. To build the TCO cost structure, the procurement phases had to be determined and the estimated costs for each phase. This was done by using the internal framework of procurement by management and adding additional phases from the interviews of procurement staff. The internal framework is an internal and therefore classified document from the commissioner.

Figure 14 TCO labor hours and cost

	Hours (Q)	Quality €	Hours (P)	Procurement €	Hours (L)	Logistics €
TOTAL	0	0	0	0	0	0
Evaluation						
Inspection						
Management						
Planning						
Training						
Traveling						
Accommodation						

TOTAL	0	0	0	0	0	0
Good/Services offer						
Packaging						
Inventory						
Quality control						
Transportation						
Order preparation						
Inbound transportation						
TOTAL	0	0	0	0	0	0
Warranty						
Cost Of Quality						
Rework						

Category	Cost name	Input	Unit	Reference
Direct	Labor cost		€/h	Project X
Travel	Rental car		€/1day	estimated
Travel	Accommodation		€/1day	average estimate
Travel	Flight		€/1day	flight (October price)
Travel	People		ppl/trip	estimated
Post ownership	Warranty factor		decimal	Project X
Travel	Travel allowance		€/h	Project X
Transportation	Product weight		kg	Project X
Transportation	Inbound price FCA EU		€/kg	Project X
Transportation	Inventory		€	estimated
Transportation	inventory factor		decimal	estimated

Figure 15 TCO Standard information

The TCO was firstly divided into each role to calculate and estimate the inhouse labor hours for each phase. Labor hours could be then calculated for each role using the internal standard payment value that is also used in sales. In addition, the traveling and accommodation expenses were added on top of the workhours cost. The roles were divided into quality, procurement, and logistics. The logistics part would only be limited to the inbound logistics as the procurement responsibility ends after the purchased item had been received to our warehouse.

The standard information for the tables were linked together and raw information are based on a table chart by category from where it can be changed over time.

Supply air unit		Product complexity level 0,5-1,5 (easy-difficult)	
Number of units	20	New supplier is usually 1-1,5 and old is 0-0,5.	
		Supplier A	Supplier B
Purchase	Complexity	1,5	0,5
Acquisition costs			
	Evaluation	0	0
	Inspection	0	0
	Management	0	0
	Planning	0	0
	Training	0	0
	Traveling		
	Accommodation	0	0
Ownership costs			
	Good/Services offer	xxxx	xxxx
	Packaging	0	0
	Inventory	0	0
	Quality control	0	0
	Transportation	0	0
	Order preparation	0	0
	transportation labor	0	0
Post Ownership costs			
	Warranty	0	0
	Cost of Quality	0	0
	Rework	0	0
Total Cost of Ownership		xxxx	xxxx

Figure 16 TCO analysis

The two potential suppliers for the product were different to begin with. The Supplier A was a new supplier which will require more work in the beginning. In the other hand we have the Supplier B with a long-term relationship which means they are already familiar with the commissioner methods of working. For this difference a complexity factor was used to determine the inhouse labor impact. It can be used either on the product complexity or the complexity of getting the work done to a satisfied quality from the supplier. This is rated with factors from 0,5 to

1,5. 0,5 being an easy complexity level it is calculated using 100% times the complexity level which would go with ease and adding the 125% which is determined as normal difficulty. It would give an overall of 175% increase on the costs if it is rated as level 1,5 complexity. For the Supplier A the complexity level was 1,5 as it is a new supplier for this product and the commissioner overall. This means it would require more labor to get it working smoothly. For Supplier B the complexity level was 0,5. From the procurement quality engineer it requires quality training as they are mostly focused on heavy construction and the product requires light metal working (P.Tuomola, personal communication, November 11, 2021).

Figure 17 TCO summary and percentage

	Total A	Total B	Supplier A	Supplier B
Acquisition Costs			20 %	15 %
Ownership costs			73 %	80 %
Post Ownership costs			6 %	5 %
	XXXX	XXXX		

Overall summary of each phase is presented as a percentage of the TCO. As the ownership costs include the offer price and transportation €/kg, it gathers the highest percentage of the whole TCO. It illustrates easily where the costs are mostly impact. And by making a sensitivity analysis, the results give logic values after testing the variable changes to the parts seen as yellow which are number of units, Complexity and Goods/Services offer. This was calculated by comparing the increase or decrease value with combined the labor hours cost and other costs depending on the phase.

The goods offer from the potential suppliers were still ongoing and would be continued after the thesis is published. Still estimates could be done when considering the potential suppliers required workload on commissioner part. The price for the Supplier A would need to be lower than Supplier B in order to obtain a lower TCO than Supplier B. The actual numbers used in this part are classified. The Excel data can be seen is presented in attachment called "Information gathering-Evaluation.xlsx".

1.4 SWOT

Instead of categorizing each supplier with their own SWOT, the subjects were selected regarding the product and commissioner important factors. Depending on the suppliers they would be categorized using the first letters from the words of SWOT. For example, if the supplier is having strength in that subject, it would be categorized with the S -letter. Some subjects were selected by interviewing procurement department with quality included. Others were selected on along the way of doing this paper as there were clear subjects.

Strenghts	1,5
Opportunities	1
Weaknesses	-1
Threats	-0,5

Figure 18 Rating system for SWOT

Theme	Subject	S, W, O, T Supplier	
		A	B
Quality Control	Quality control management	S	S
	Human resource management	S	S
	ISO 9001	S	S
	ISO 10004	S	S
	Experienced workers	O	S
Cost	Labor price	O	S
	Pricing	O	S
	Credit	T	S
	Order volume	W	S
	Inventory volume	S	S
	Financial stability	W	S
Capabilities	Turnkey solution	W	O
	Design capabilities	W	O
	Installation capabilities	S	O
	Heavy metal	S	S
	Light metal	W	W
	Engineering to order	S	S
	Manufacturing capabilities	O	S
	Delivery	O	S
Willingness	Relationship development	O	S
	Continues improvement	S	S
	Increase capacity	O	S

Service for procurement	S	S
IRP security	S	S

Figure 19 SWOT analysis for supplier evaluation

With this method the suppliers could be compared and rated. Strengths and opportunities give positive points. As for weaknesses and threats give a negativity point. Each positive and negative point didn't give an equal value. As a weakness not necessary cancel a strength and same with the opportunity and threats. This means that there is a 0,5-value difference between each negative value and the same between the positive values. This makes the analysis more sensitive and focuses more on the positive side of the supplier, while leaving still room to consider if the negative values accumulate. By dividing each SWOT rating, we can observe and give conclusions with more flexibility instead of the summary rating.

	A	B
S	16,5	30
W	-5	-1
O	7	3
T	-0,5	0
Rating	18	32

Figure 20 SWOT overall rating

2 Analyzing the results

The analysis of the results consists of each supplier assessment methods results. Firstly, with the supplier evaluation rating with the characteristics on the results and some background information that may affect the results.

Following up with the TCO with information about the results. It didn't have the price offers in place. That said the results gives a direction on the costs needed for each supplier on each phase of the purchase.

Lastly the risk and potential analysis is done with the use SWOT analysis. Mainly taken the overall rating of the SWOT analysis that also shows the opportunities of the potential suppliers. The rating is divided on each SWOT category.

On the supplier evaluation the revenue was noticed for the first time in this paper. Supplier A had a considerably lower revenue. The average revenue before the covid-19 pandemic the revenue kept steady for years at over 1M€ revenue. PPS was 18% lower in Czechia compared to the commissioner country. Which means the good/services purchase would be cheaper. The mean nominal hourly labor cost per employee by manufacturing activity was 62% lower than the commissioner country. Which is a significant amount in difference as labor cost tend to be a larger sum from the product price. The overall rate was 3,49 which is high on Supplier A, even if there were some lower ratings included.

Supplier evaluation

	Supplier	
Supplier A	B	
Czechia	Latvia	
0,6M€	6,43M€	
3,49	4,06	

Figure 21 Supplier evaluation results

Supplier B had instead a well-established revenue and it was situated in one of the cheapest labor countries in the European Area. The mean nominal hourly labor cost per employee by manufacturing activity was 73% lower than the

commissioner country. The PPS was 37% cheaper than the commissioner. This makes it an excellent option as a producer. The overall rate was 4,06 which is extremely high as it gets over 4. This supplier had well known experience in many categories. Comparing the two options, the supplier evaluation shows that the Supplier B has the most potential in this supplier evaluation.

Figure 22 TCO overall analysis

	Total A	Total B	Supplier A	Supplier B
Acquisition Costs			17 %	12 %
Ownership costs			78%	85 %
Post Ownership costs			5 %	4 %
	XXXX	XXXX		

Even though the price was still in negotiation stage there could be suggestions made with TCO. The complexity was higher with Supplier A than Supplier B, as they are a new supplier to commissioner. This means that the Supplier A would need to achieve an offering that is 12,3% cheaper to be in the same price range with Supplier B on one unit. If the same offer number is increased on both suppliers, the percentage difference will decrease. As the percentages on each phase represent it would cost more to the commissioner to manage the Supplier A before and after the purchase. The detail design is included on the offer which increases the overall price from the commissioner history price. It hasn't been considered that with years of relationship with a supplier which produce the same product, it would decrease the labor needed in the commissioner, which results in lower TCO. This would mean that the complexity level would decrease over time.

Supplier B had weak processing knowledge in manufacturing light metals, which required resources from quality staff to achieve the necessary requirements. This is demonstrated on the complexity level as it is slightly increased to calculate the necessary costs.

TCO would point at this stage of the research Supplier B would be the best chose even if it requires some management cost from commissioner to begin with. The offer should show indications that the product parts that were produced in the commissioner country, would be cheaper than in the previous offers if produced by Supplier B.

Figure 23 SWOT overall analysis

	A	B
S	16,5	30
W	-5	-1
O	7	3
T	-0,5	0
Rating	18	32

SWOT gives a more flexible result. There was clearly Weaknesses on Supplier A, but as earlier describes it doesn't directly cancel the Strengths or Opportunities it has. In the Opportunities of Supplier A were a potential even though Strengths were almost half comparing to Supplier B. The Weaknesses and Threats were mainly financial related, but as previously described they had a steady and higher revenue in the past.

Supplier B had Strengths in most of the subjects of SWOT. In addition of the Willingness being the strengths, it already had a strong foothold on the commissioner and a good relationship. The supplier is used to work with major clients in general.

3 Conclusion of company X

The current situation for the commissioner is that they use multisourcing strategy on the supply air units. As described previously the commissioner's preferred outcome is to find a single supplier with a turnkey solution. On the strategic point of view this means it has a single sourcing strategy. This can become a risk that presents itself as price increase over time. At the same time, it presents with possible capacity restrictions when using a single sourcing strategy. For the single sourcing point of view the previous results show that Supplier B would be the preferred option. It has design and installation capabilities with previous knowledge of the product. With that said the processing and manufacturing with light metals were shown to have problems in the past. There is a good relationship already meaning the communication and willingness will give value to the learning process and strengthen the supplier.

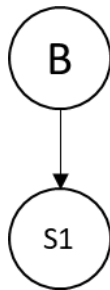


Figure 25 Single sourcing illustration (Cousins Paul, 2008, p. 53)

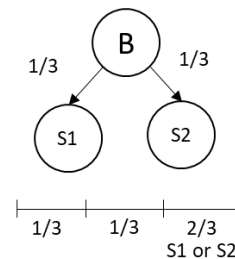


Figure 24 Network sourcing illustration (Nojan Najafi, 2014, p. 4)

As previously described the single sourcing strategy could increase the price over time. This risk could be lowered by selecting Supplier A or another supplier as an alternative supplier. Would be beneficial to increase the Supplier A or another supplier with small volume of purchases to develop the relationship with a lower risk and produce a secondary supplier for the same product. This can be managed using a network sourcing method, where the Supplier B has the larger volume for production and Supplier A or other supplier is managing a lower volume.

The results at written stage may have external global affecters. One is the financial status in the world. The PPS used in this thesis uses GDP which will be affected by the global market in general. After the EU record high GDP in 2020 of 6,8%, its forecasts to halve into near 3,6% in 2022. There is still uncertainty how the pandemic recovery will be affected. (European Commision, 2021)

The TCO doesn't have offers in the moment it was written. This means the result may change if either of the Suppliers would decline the offer request. If Supplier A decides that it can't produce the product as a turnkey solution, it would mean that an alternative turnkey supplier is recommended to be found in the market to compete with Supplier B. The prices would rise usually when the supplier realizes that they have leverage as a single source. Meaning that there would be time to find a second supplier that provides a turnkey solution to compete.

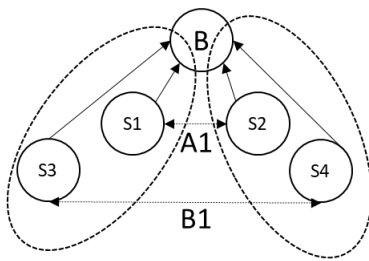


Figure 27 Parallel sourcing illustration (Cousins Paul, 2008, p. 56)

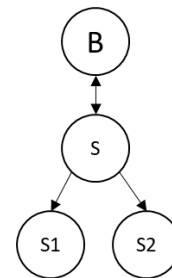


Figure 26 Delegated sourcing illustration (Cousins Paul, 2008, p. 54)

If the Supplier B decides to make only the parts of the product which would be heavy metal parts, the commissioner would need to find a supplier with the capability to produce light metal parts for the product. In addition, the variables of Supplier A would mean that either the commissioner would need to follow a parallel sourcing strategy to ensure the capacity and the price is kept low in their supply chain. This would be combined with a delegated sourcing strategy. Delegated sourcing would ensure the turnkey solution would be possible and make the Supplier B a key supplier with authorities to use sub suppliers from the commissioner to produce the product.

This results with the variable selections would be directed towards a turnkey solution for this product instead that would be developed over time. This requires relationship development and focus the necessity on supplier management instead of the network sourcing that had been used towards this product.

As a follow-up the measurements should be updated as it's connected to the GDP, which vary over time. TCO can be developed further towards a comparison or detail level with the support of the financial and procurement departments. The turnkey solution required the design phase which should be separated from the costs in the future to ease the offering comparison. The methods used can be modified for proactive supplier evaluation for the potential supplier even before adding them to the SRM system. This method would be categorized as a part of procurement market research or pre-evaluation phase.

In addition, the TCO offer can be simulated as a country-based product price estimation. With the structure of the labor by NACE percentage, the mean labor cost in manufacturing industry and the historical purchase information, the labor cost difference can be calculated from the order. The remaining amount which is an average of 30% that other than labor cost can be calculated with the PPS value percentage. This gives possibility to compare the prices between the Europe countries in a basic level connected with each product price.

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