

# **Developing a Procurement and Supplier Classification Model for Civil Aviation Engine Maintenance, Repair and Overhaul**

## **Case X**

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<p>The purpose of this research is to develop a procurement and supplier classification model for the case company, X.</p> <p>At the first phase of the thesis, primary research in the form of personnel interviews was planned and implemented to understand the situation at the case company. Simultaneously, secondary research was carried out to support the implementation of the interviews as well as to build the theoretical framework for this thesis. Secondary research was employed to discover the theoretical background related to procurement and supplier classification analyses. There are a number of methods for analyzing businesses. However, the methods used in this thesis were the spend analysis, Kraljic's portfolio analysis and the ABC analysis, which ranks a group of selected items, for example, spare parts according to the volume of purchasing in terms of money.</p> <p>At the second phase of the thesis, all discoveries from phase 1 were employed to analyze the purchasing statistics and develop a classification model suitable for the case company. Thus, the theoretical learnings and the interview results were integrated with the analyses of the purchasing statistics of direct procurement for 2017-2018 to develop a procurement and supplier classification model.</p> <p>At the third phase of the research, the key results from phases 1 and 2 of the thesis were emphasized. These results were further assessed to evaluate their validity and reliability. Finally, all findings from phases 1, 2 and 3 were combined to offer recommendations to the case company. The recommendations focus was on improving the procurement operation of the case company in terms of direct purchasing through the classification of procurement and supplier.</p>	
<b>Keywords:</b> Purchasing, Procurement, Procurement and Supplier Classification, Category Management, Spend Analysis, ABC Analysis, Kraljic's Purchasing Portfolio Analysis	

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# **1 Introduction**

Companies purchase different goods and services from a number of suppliers every day. The procurement and suppliers of different products and services are usually managed differently. Suppliers provide their best resources to the best business partner.

The introduction chapter contains eight subchapters. The first subchapter presents the background, which offers a rationale for conducting this research. The second subchapter contains the research question (RQ). The RQ is divided into investigative questions (IQs). RQ and IQs reveal the aim and outcome of this thesis. The third subchapter highlights the boundaries and limitations, that is, the demarcation of this study. The fourth subchapter emphasizes the international aspect of this thesis, which is one of the main requirements for international business studies. The fifth subchapter reveals the benefits and the benefiting parties of this research. The sixth subchapter introduces the key concepts of this study. The seventh subchapter analyzes the risks related to this thesis. Finally, the eighth subchapter presents the case company X.

## **1.1 Background**

Global air traffic grows more than 4.0% annually which means it will be more than doubled in twenty years (ICAO 2016, 10; Airbus 2018, 32). Thus, the aerospace industry grows rapidly. Therefore, aerospace suppliers are forced to keep up with industry growth. The aerospace industry is extremely regulated by governments. These regulations make the aerospace supply chain become complex (EASA 2003). Suppliers must support this complex supply chain with shorter lead times at a competitive cost.

Maintenance, Repair and Overhaul (MRO) expenses are a notable part of the airplane total cost of ownership (TCO). The MRO spending of an airplane is estimated to be 80% of the entire life time expenses. MRO activities depend on airplane type and may last more than 30 years. MRO usually covers 13% of total operating costs of an airline company. The MRO of the aircraft engine cover 27% of this 13%. (The UK Aerospace 2016, 20-21.)

Airliners search for opportunities to cut operation costs. With other costs being more demanding to control, they focus on their airplanes, especially on MRO. Civil aircraft engine MRO covered 40% of the total aircraft MRO market worldwide. For example, the total aircraft MRO market was USD 64.3 billion in 2015. (MacDonald 2017, 107-108.)

The bookkeeping of a company provides information only about the total cost of procurement. However, what and why a certain material is purchased from a number of suppliers are questions which procurement and supplier classification provide the answer to. (Iloranta & Pajunen-Muhonen 2018, 104.) For example, spend analysis partly provide answers to these questions. The spend analysis offer cost savings from 2% to 25% of the total spend (Pandit & Marmanis 2008, 5).

Increasing the sales by one euro will result in the profit of a few cents. However, savings in the spending by one euro will generate almost one euro profit. (Huuhka 2017, 28.) Thus, when the procurement costs decrease, the profitability will increase even though sales remain the same (Iloranta & Pajunen-Muhonen 2018, 25).

For example, management of the component service purchasing in terms of the lead time, the quality and price offers a number of cost saving opportunities. The classification offer cost saving through optimization of, for example, the reorder point, the order frequency, the delivery time and logistics (Mitchell & Lamoureux 2016, 1). Efficiency in lead times such as reorder time, logistic and delivery time offers added value for the customer as well. Thus, reducing the cost of the procurement increases profitability and enhances the competitiveness of the company (Nieminen 2016, 10-11).

The case company has numbers of engine MRO orders in the year 2019. The engine MRO has a planned lead time of approximately 55 to 65 days. The lead time starts from the moment the engine arrives in the workshop and is ready to be shipped to the customer. In order to keep up with the lead times, it is necessary that suppliers also keep up with these lead times. These kinds of issues encourage the case company to create a uniform and solid procurement and supplier classification system.

## **1.2 Research Question**

The aim of this research is to develop a procurement and supplier classification model for the case company X. The direct purchasing statistic of 2017-2018 is analyzed to develop this model. The model contains the procedure of the related analyses. Thus, the past purchasing and supplier behavior are analyzed to help predict the future procurement strategies. The head of the procurement department in the case company set some requirements for this model as follows:

1. This model is developed by taking in to account the accuracy of the model in its service.

2. The model is used practicality in day-to-day operative procurement.
3. The model should be adaptable for different application in civil aviation engine MRO operative procurement.

Therefore, the research question (RQ) can be written as:

**RQ:** What kind of model facilitates the direct procurement and supplier classification?

RQ is divided into four investigative questions (IQ) as follows:

**IQ1.** What are issues related to direct procurement and their supplier, which should be evaluated using classification?

**IQ2.** What kinds of theories are available to classify procurement and suppliers in order to solve issues in IQ1.?

**IQ3.** How to employ the theories found at IQ2. and the procurement statistics of 2017-2018 to develop and implement a procurement and supplier classification model?

**IQ4.** How the model at IQ3. is used to brings benefit?

Table 1 presents an overlay matrix which contains the knowledge base, research methods and results chapters for all investigative question.

Table 1. Overlay matrix

Investigative Question	Knowledge base	Research Methods	Results
<b>IQ 1.</b>	Secondary- and Primary Research such as Literature Reviews and Personnel Interview	Qualitative	Chapter 2 and 4.1
<b>IQ 2.</b>	Findings of IQ 1. Secondary Research Literature Reviews	Qualitative	Chapter 2
<b>IQ 3.</b>	Findings of IQ 1., IQ 2. Empirical data, Statistics	Qualitative Quantitative	Chapters 2 and 4.2 ... 4.4
<b>IQ 4.</b>	Findings of IQ 1., IQ 2. and IQ 3. Results	Comparations Validity Evaluations Reliability Tests	Chapter 5

### 1.3 Demarcation

The boundaries and limitations of this thesis are highlighted in this subchapter. The methods applied in the analyses are the spend analysis, the ABC analysis and Kraljic's portfolio analysis. Only the purchasing statistics of 2017-2018 are analyzed as a reference period. In addition to the spare part analysis (new and secondhand) the services subcontracting purchasing are analyzed.

### 1.4 International Aspect

International aspect is one of the main requirements for international business studies in Haaga-Helia University of Applied Sciences. The case company purchases almost entire direct purchasing from the international suppliers. Therefore, in this thesis international procurement and supplier are classified.

### 1.5 Benefit

The case company benefits from a procurement and supplier classification model, which is academically verified and validate. The classification model studies the purchasing statistics. The analyses identify and reveal potential improvement opportunities. These opportunities facilitate strategic decision making, for instance, in terms of improving the competitiveness, the cost-effectiveness and to add value to customers. The procurement and supplier classification help to make strategic decision about the long-term relationship with a preferable supplier. Therefore, it also benefits the business to business (B2B) relationship. The classification model developed in this thesis can also be used in other similar businesses in the industry. Method created for procurement and supplier classification in terms of the direct purchasing analyses can be used for the indirect purchasing as well (Nieminen 2016, 82).

### 1.6 Key Concepts

**Purchasing** is the process of controlling the external resources of business, in order to guarantee the availability of all the necessary goods and services under the best possible conditions (van Weele 2018, 2). Purchasing covers operational activities of procurement (Huuhka 2017, 13).

**Procurement** covers all purchasing tasks starting from external suppliers to end customers (Iloranta & Pajunen-Muhonen 2018, 50). Procurement also covers proactive actions. Therefore, procurement includes strategic activities (Huuhka 2017, 13).

**The direct purchasing** covers services and goods which become part of the end product to be sold, for example, raw materials, components and subcontracting services (van Weele 2018, 6).

**The indirect purchasing** covers materials and services which are necessary for business operation, for example, production facilities, supplies and Jigs. However, they do not become part of the final product to be sold. (Iloranta & Pajunen-Muhonen 2018, 58.)

**Procurement and Supplier Classification** arranges a wide variety of different goods and services purchased from very different suppliers. This arrangement guides managers to become aware of the best possible evaluation for further business strategy development. (Iloranta & Pajunen-Muhonen 2018, 104.)

**Spend analysis** is a method for examining the purchasing statistics to understand what and why materials have been purchased from whom and how much cost has accrued. (Nieminen 2016, 82-83.; Iloranta & Pajunen-Muhonen 2018, 104-105.)

**ABC analysis** ranks a group of selected items. For example, suppliers are ordered according to the volume of purchasing in terms of money. Similarly, items can be positioned in the terms of the cost or the consumption to discover the most important items. (Nieminen 2016, 83-84.; Iloranta & Pajunen-Muhonen 2018, 107-108.)

**Peter Kraljic's portfolio analysis** positions the purchased goods and services in a matrix with four cells. Products are located in the matrix cells based on their quality as follows: routine products, volume products, bottlenecks and strategic products. (Nieminen 2016, 85-86.; Iloranta & Pajunen-Muhonen 2018, 114-115.)

## **1.7 Risk Management**

A risk is a potential damage and the risk management helps control the risks (Wolke & Oldenbourg 2017, 1-4). A potential risk is, for example, the absence of the validity and reliability of the research method and the result of the thesis. To control this risk, secondary data can be used to assess the validity and reliability of the research method and the result of the thesis (Kananen 2015, 82-83).



Data distortion in the spend analysis is also a risk, which must be avoided during data processing (Pandit & Marmanis 2008, 6). Also, there are plenty of other issues which require attention to minimize potential risks such as the schedule management, the interview process, the primary and secondary research, the data analyses, the result presenting and the academic writing.

### **1.8 Case Company**

The commissioning company is X. For confidentiality reason this part is censored.

## **2 Procurement and Supplier Classification**

An old merchant saying suggests that the growth is obtained by selling, however, the profit is gained by buying (Iloranta & Pajunen-Muhonen 2018, 25). Therefore, it is important to understand the differences in the product and service which are purchased every day.

As an example, the case company needs the procurement and supplier classification to manage a huge number of products, which are purchased from different suppliers. Therefore, the case company aims to establish and implement a uniform model to collect information and to classify goods and services. This model makes it easier to systematically gather purchasing data, to continuously analyze purchasing and find potential cost saving opportunities.

This chapter contains the theory for procurement and supplier classification. The first subchapter explains the difference between procurement and purchasing by taking advantage of the linear procurement process. The second subchapter provides theories about procurement and supplier classification. The third subchapter introduces the category management. The fourth subchapter contains the theory of the analysis tools for classification.

### **2.1 Procurement versus Purchasing**

Acquiring activities has gradually developed as throughout the history. Therefore, vocabulary representing acquiring activities has also evolved. Procurement is used in the public sector. However, purchasing is preferred expression in the private sector particularly in the industrial and service companies. (van Weele 2018, 10.)

Figure 1 presents the linear procurement process. The purpose of this figure is to compare procurement with purchasing activities. The linear procurement process contains eight steps, starting from left: (1) make or buy assessment, (2) quality and quantity estimation, (3) supplier selection procedure, (4) discussing the terms of contract with the supplier, (5) issuing purchase order to a selected supplier, (6) checking the supplier performance, (7) supplier rating and ranking, and (8) improving supplier relationships (UK). (van Weele 2018, 7-8.)

Concerning the objectives of this thesis, steps from (5) to (8) are catching the attention the most. In this thesis, mainly the order function steps (5) to step (7) are analyzed for classification to find opportunities to make strategic decision in tactical purchasing.

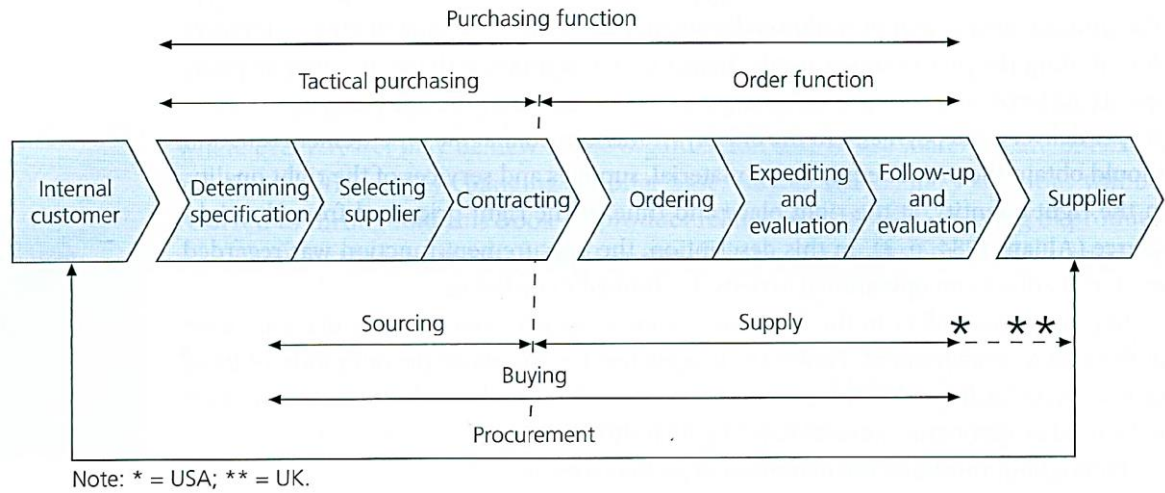


Figure 1. The linear procurement process. (van Weele 2018, 8)

Purchasing and procurement are usually known to have the same meanings in daily businesses. However, academically purchasing covers the operative part of the linear procurement process (Huuhka 2017, 13). Purchasing emphasizes the price and the functionality of goods and services (van Weele 2018, 10). Moreover, procurement is a strategic activity which covers proactive actions (Huuhka 2017, 13). Procurement focuses on product lifecycle cost, thus, the total cost of ownership (TOC) (van Weele 2018, 9). To avoid confusion, also in this thesis in some cases both terms procurement and purchasing are used as synonyms (Nieminen 2016, 11).

## 2.2 Procurement and Supplier Classification

Different terminologies are used in the field of procurement and supplier classification in recent years. For example, segmentation, grouping, categorization and their different derivatives are used in this field. Based on their importance for the business, all of the terminologies aim to systematically sort and organize the goods, the service and their suppliers. In fact, it is wise to manage the group of goods, services and their suppliers that behave in the same manner. (Iloranta & Pajunen-Muhonen 2018, 52.)

Table 2 contains direct, indirect spend and investment categories. These three categories are further organized in eight subcategories. The expenditures of a company are usually written in the financial statements in three locations: (1) direct procurement, (2) indirect procurement and (3) investment. Depending on the business case, procurement can be further categorized into subcategories to further characterize their supplier markets. (Iloranta & Pajunen-Muhonen 2018, 55-58.)

Table 2. Goods and services categorization. (Iloranta & Pajunen-Muhonen 2018, 55-58.)

Spend Category	Goods and Services Categories
(1) Direct Spend	Raw materials
	Semi-manufactured products
	Components
	Finished products
	Services
(2) Indirect Spend	Supplementary materials
	Maintenance, repair and operating materials (MRO items)
(3) Investment	Investment goods or capital equipment

The direct spending category has typically been purchased more carefully compared with the indirect category. This is due to the fact that direct materials cause unique problems depending on industry. Therefore, direct expenditures are categorized into more detail subcategories for further analyses to discover cost saving opportunities. (Pandit & Marmanis 2008, 85.) Procurement and their suppliers can also be classified according to their financial importance, for example by using ABC analysis (Iloranta & Pajunen-Muhonen 2018, 107).

### 2.3 Category Management

There are many criteria for categorizing procurement. The purchasing can be categorized, for example, based on the technical characteristics of the material. Categories help streamline the work of the operational purchasing. How exactly are procurement and suppliers classified and categorized? To answer this question a number of aspects should be considered. The classification depends on business operation and on what exactly is aimed by classification. Therefore, there is not one and correct answer to classification question. (Huuhka 2017, 66.)

The category management aims to divide the procurement into clear areas and thereby gain the synergy between the buyer and the supplier. The materials and services are categorized to help their management. In fact, it makes more sense to manage, for example, the service purchasing separately from spare part purchasing. Therefore, it is essential to organize different purchasing into different categories. (Nieminen 2016, 48.)

In category management, the purchasing strategies extent from purchaser to supplier organization. Category management can be applied to minimize unnecessary paperwork

during day-to-day routine purchasing process. To save time, for example, production employees may order directly online a categorized material from a certain vendor. Supplier starts the delivery process and sends payment electronically. (van Weele 2018, 179.) As an example, the XXX is an additional feature of the XXX-system which is the ERP-system in the case company. Purchase orders can directly be sent to suppliers using XXX instead of logging into the supplier web shop and re-enter the order.

Table 3 divides procurement into several different categories based on (1) the intended use of the procurement, (2) the nature of the procurement, (3) the financial significance, (4) the group and (5) the supplier market. (Huuhka 2017, 40.; The World of Logistics 2019.; Iloranta & Pajunen-Muhonen 2018, 55-63.) The materials and services are classified and categorized to provide procurement that is more manageable. Categories are formed based on, for example, the intended use of item and/or the supplier market (Huuhka 2017, 55).

Table 3. An edited procurement classification. (The World of Logistics 2019)

Classification Criterion	Category
(1) Use	Direct Spend
	Indirect Spend and Investment. Are also called non product related (NPR) spends (Iloranta & el. 2018, 58).
(2) Nature	Raw materials
	Components
	Maintenance, repair and operating materials (MRO items)
	Investments
(3) Financial	Amount in Volume
	Amount in Euros €
(4) Group	Goods
	Services
(5) Supplier Market	Supplier

Figure 2 shows an edited model of categorization. On top (1) the goods and the services are classified based on the use, that is, indirect procurement (see Table 3). (2) These classes are further categorized into the electronic devices, the office supplies and kitchen products, based on their nature. (3) The supplies categories are further categorized into goods and services, based on their application. (4) Procurement and suppliers are classified after analyses. (Huuhka 2017, 55.)

Suppliers are analyzed and classified, for example, based on their quality. Thus, supplier performance is monitored to measure the actual capabilities of each supplier in terms of quality and delivery record, competitiveness and innovativeness. These data are applied to accomplish procurement and supplier classification. (van Weele 2018, 45.)

It is meaningful to compare for example between Dell and Samsung instead of comparing between Dell and Sotka, since they are in different category (Figure 2). This is one of the reasons for the categorization when analysing the purchasing and/or the supplier performance. For the sake of clarity Figure 2 categorization system and terminologies are applied also in this thesis.

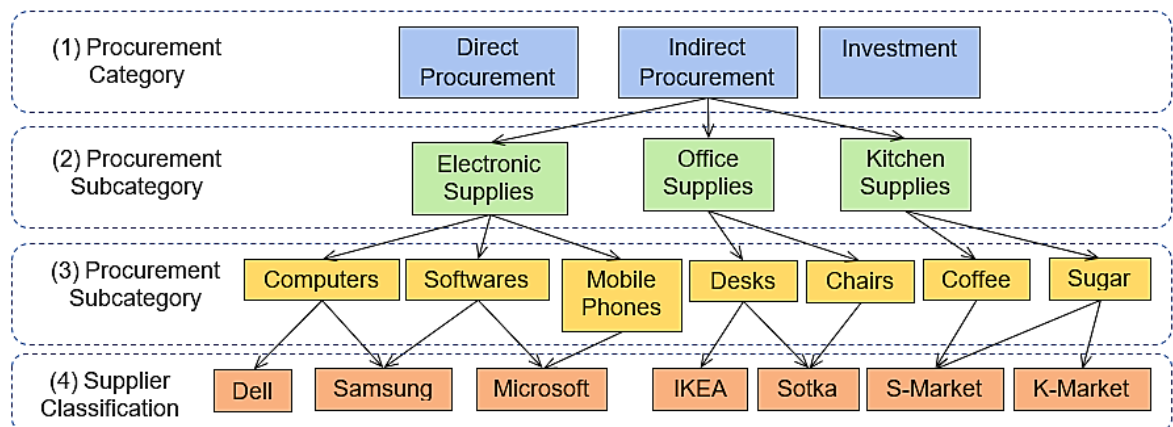


Figure 2. An edited model to classify Procurement and Suppliers. (Huuhka 2017, 55.)

## 2.4 Analysis Methods

Regular bookkeeping provides information only about the total invoicing of suppliers. However, it does not link this information to deliveries and/or to what is procured. In order to classify procurement and their supplier, it is important to have information about all purchasing, their content, propose and suppliers. (Iloranta & Pajunen-Muhonen 2018, 104.; Huuhka 2017, 49.) This information is collected using categorization with different methods of analysis.

There are a number of tools for analyzing businesses. These tools are, for instance, value analysis, value re-engineering, Porter's five forces analysis and/or Key Performance Indicators (KPI) for the measuring of efficiency and measurements of quality. However, according to academic literatures procurement and their suppliers are usually analyzed and classified using the spend analysis, the ABC analysis and Kraljic's portfolio analysis.

The spend analysis is an important starting point for understanding the entire procurement and their suppliers (Nieminen 2016, 81). The ABC analysis is a simple method for organizing procurement based on how important they are. Kraljic's portfolio analysis emphasizes that not all products and services are strategic. Therefore, they should be treated differently. (Huuhka 2017, 44-50.) Next subchapters provide further details for different methods of analysis.

### 2.4.1 Spend Analysis

Automotive firms in the USA such as Ford and GM used the expression spend analysis in the 1980s. Back then the spend analysis was a method to systematically analyse the purchasing history of the company to improve the supply base. (Pandit & Marmanis 2008, 10.) The spend analysis is an important starting point to develop procurement nowadays.

The spend analysis is employed for example to classify procurement, to manage different material categories, to monitor procurement, to control costs, to plan and to implement business operations and to rank suppliers. (Huuhka 2017, 47.) The spend analysis is simply a procedure to inspect the purchasing of the past time in order to report their condition (Pandit & Marmanis 2008, 5). Table 4 contains example questions which the spend analysis provides answers to. (Pandit & Marmanis 2008, 5; Nieminen 2016, 83)

Table 4. Spend-analysis questions. (Pandit & Marmanis 2008, 5; Nieminen 2016, 83)

Question	Explanation
1. What were overall costs of the procurement? How the spending was distributed between the suppliers?	To find possibility to reduce the number of suppliers?
2. What is the peak material spending? What are the main products and services, which are purchased? Have the prices been stable?	Do volumes allow closer cooperation with suppliers to lower the unit prices?
3. Which suppliers are the most important to the company?	To make comparisons between suppliers for decision making.
4. How many purchasing were made from approved suppliers?	Company should negotiate with more favorable suppliers.
5. How many bypass purchasing were made?	To make comparisons in spending.

Bypass procurements are rushed purchases done without purchasing order registered in ERP-system. Therefore, the information in ERP-system is not necessary 100% complete. However, routine direct procurements are normally performed via ERP-system. Therefore, direct purchasing data are usually reliable and easily available. (Huuhka 2017, 49.)

Rushed purchasing must be avoided. Non-purchasing order and off-contract spending are the example of bypass purchasing which may result in purchasing inefficiency in terms of prices, payment conditions and refund policies. (Pandit & Marmanis 2008, 69.)

Figure 3 shows a line of action called “The 7 Steps of the Spend Analysis”. There is plenty of alternative line of action which can be implemented to perform the spend analysis. However, depending on the case, there are different purposes to use a certain procedure for the spend analysis. (LOGY 2018.)

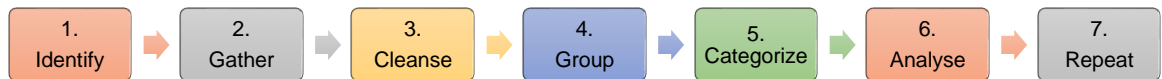


Figure 3. Spend analysis steps. (LOGY 2018.)

Each step includes the following functions (LOGY 2018, 1.; Pandit & Marmanis 2008, 12-14.):

1. Identify:
  - a. selecting the data from ERP system(s)
  - b. discover the exact place or position of the needed data, for instance, the department of procurement, financing and marketing and so on.
  - c. spend analysis is intended to provide an overall view of all purchases. Therefore, it is also important to consider indirect purchases such as equipment and supplies needed for business operation. However, this thesis is limited to classify direct procurement only, therefore, step number one identify is slightly different in this thesis.
2. Gather:
  - a. combine all the needed data into a single database in a uniform and comparable format
  - b. storing the data for example into a excel document or database
  - c. pivot tables in Excel are an easy method of forming smart and flexible summary tables. (Pandit & Marmanis 2008, 133-142.)
3. Cleanse:
  - a. free data from errors and duplicates, detect and correct inaccurate data, remove the corrupt data, convert, organize and enrich the data
  - b. concerning the step three, the data cleansing aims to improve the accuracy and quality of the spend analysis. However, data distortion is a risk, which must be avoided during data cleansing. Cleansed data makes data easier to compare, for example, between the same category of purchase and different supplier. (Pandit & Marmanis 2008, 6.)
4. Group:
  - a. merge purchasing in terms of volume from the single supplier



- b. the step 4. Group and the step 5. Categorize are of great importance steps concerning this thesis. There is a huge number of items and their supplier to be categorized for further analyses.
5. Categorise:
  - a. arrange in classes to see where the money is spent and what is purchased?
  - b. categorization is company-specific, categorized purchasing are easier to compare, for example, between the different supplier.
  - c. pivot tables are convenient to organize a wide range of spend data associated with transactions, suppliers and categories in many different ways. Data can be organized into groups to produce the aimed report which shows spend trends. (Pandit & Marmanis 2008, 133-142.)
6. Analyse:
  - a. examine and compare the data between a certain period of time in the purchasing history to see trends and potential improvement opportunities
  - b. data can be transferred to other Excel-sheet from pivot tables to produce reports and show a variety of graphs and charts. (Pandit & Marmanis 2008, 133-142.)
7. Repeat: update data continuously to keep up with the changes in the purchasing

(LOGY 2018, 1.; Pandit & Marmanis 2008, 12-14.)

Table 5 shows another example of spend analysis implementation steps. (Huuhka 2017, 47.) However, “The 7 Steps of the Spend Analysis” has a clear procedure, therefore, it is implemented in this thesis. Spend analysis provides a good basis for other analyses: the ABC and Kraljic’s portfolio analysis.

Table 5. Spend analysis steps. (Huuhka 2017, 47.)

Steps	Explanation
1. Define material and supplier groups	From ERP, direct purchasing, goods and services
2. Form tables using purchasing data	Data cleansing, Pivot tables for procurement and suppliers
3. Set purchased items in order of size	Amount in euros € spend on different goods and services, employ 20/80-rule
4. Rank suppliers in order of purchased volume	Find favorable-, less favorable suppliers
5. Set suppliers in order of financial importance	Amount in euros and quantity

## 2.4.2 ABC Analysis

The capital invested in procurements and warehouses became an important issue in the 1970s and 1980s. For that reason, many simple ABC analyses were performed to classify

and manage procurements and warehouses. The ABC analyses aim to separate economically significant procurement from less important procurement. (Iloranta & Pajunen-Muhonen 2018, 107.) The purpose of the ABC analysis is to find an important part of the information in the large mass of data of the procurements (Nieminen 2016, 83). ABC analysis can identify the suppliers, the products and the services that may behave in the similar way (Huuhka 2017, 44).

In the ABC analysis, items are positioned, for example, in order of importunateness in terms of money. The most important procurement is positioned at the top and the least important at bottom of the list. According to the Pareto principle, 20/80 rule applies to any phenomenon and to the analysis of procurements as well. According to it, 80% of the consequences are due to 20% of the causes. (Nieminen 2016, 84.)

Even though, in procurement the ratio is not always 20/80, however, the idea is without exception the same. For example, 20% of the suppliers account for 80% of the procurement volume is often rise or fall sharply, for example, 10% of the suppliers can account for 80% of volume or 20% of suppliers can account for 90% of volume. However, Pareto idea is applied in the ABC analysis regardless of the exact ratio. (Nieminen 2016, 84.)

The Tail Management reviews the purchasing that are least important. The ABC analysis arranges items in ascending order for example in terms of money. Therefore, a large number of items are positioned at bottom of the list. These items are the least important compared with the items on top of the list. The category at the bottom of the list is typically very long. This category contains products or services, which are less important in comparison with the category on top of the list. The category at the bottom of the list is typically the 80% of the total items. However, they cover less than 20% of the volume in terms of monetary value of the purchasing. These products may be purchased without significant attention. However, an old saying says millions are formed from these pennies. Therefore, these products or services need consideration in a systematic way. Significant cost savings in procurement process costs can be achieved by systematizing these purchasing with selected suppliers. (Nieminen 2016, 92.)

### **2.4.3 Kraljic's Portfolio Analysis**

Peter Kraljic introduced his purchasing portfolio analysis in the 1980s, which is still commonly used by organizations for analyzing procurement. The popularity of the analysis is based on its simplicity, usability and visuality. (Nieminen 2016, 85.)

The Kraljic's portfolio highlighted an important issue in procurement that all products and services do not have the same strategic value. Therefore, they should be treated and managed in different ways. Portfolio analysis enables the business to minimize its purchasing risks. In fact, it identifies organizational weaknesses related to the supplier market. (Huuhka 2017, 50.)

The previously described the spend analysis and the ABC analysis are based on quantitative analysis. They do not mention about qualitative variables such as what is the strategic value of the supplier and procurement. The purchasing portfolio analysis examines the supplier market in addition to the purchasing volume. (Nieminen 2016, 85.)

Figure 4 shows Kraljic's matrix. The balance of power between the buyer and the supplier is shown by the blue color in the matrix (van Weele 2018, 176). Kraljic categorized its product and service groups into four categories using two criteria. In Kraljic's original matrix, the dimensions were "the financial impact of the product or service to be procured" and "the controllability of the supplier market". (Huuhka 2017, 50.)

In the portfolio analysis, the horizontal axis describes the controllability of the supplier market, for example, the number of suppliers and/or availability of material. On the left it is easy, and the right harder to control. (Nieminen 2016, 86.)

The vertical axis in the portfolio analysis describes the financial importance of the purchasing of a certain product and service on an annual basis. The more important the procurement is for the financial performance of the company the higher it is positioned in the matrix. Certain products and services can be important in terms of value added and profitability. However, the monetary volume of purchasing is usually measured, because it is easy to measure. The more money is spent on a certain product and/or service on an annual basis, the more important the purchasing is for the business. (Huuhka 2017, 50.)

Routine products and services are placed in the left lower corner of the matrix. For these items, the overall cost of procurement is not very high and a number of competitor vendors supplies these items, therefore supplier market management is relatively easy. Routine products may contain, for example, simple and cheap raw materials. (Iloranta & Pajunen-Muhonen 2018, 119.)

For routine products, it is important to improve purchasing operational efficiency by developing the procurement process. Procurement operations can be developed together with the supplier. For example, purchasing fasteners can possibly be focused on one supplier.

(Nieminen 2016, 89.) Thus, purchasing the fasteners of the jet engine can possibly be focused on one supplier as well.

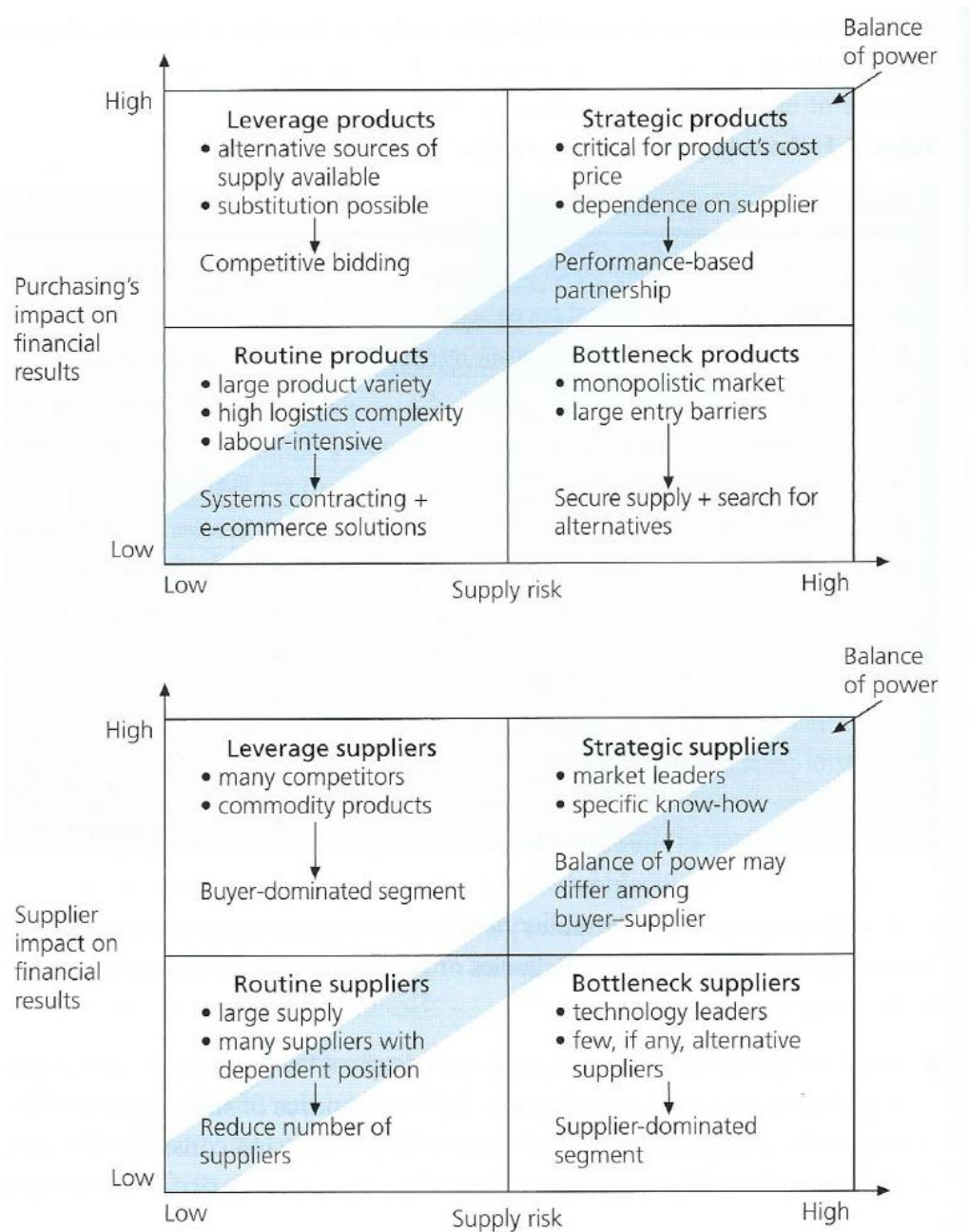


Figure 4. Peter Kraljic's portfolio analysis. (van Weele 2018, 176.)

Leverage items, also known as volume products and services are positioned in the upper left section of the matrix. These products have high impact on profitability. However, their supplier market management is relatively easy. Leverage products are purchased in high volume. They are easily available in the supplier market. Therefore, they offer plenty of opportunities in terms of contract negotiations and procurement efficiency. (Iloranta & Pajunen-Muhonen 2018, 119.)

The price is important in the leverage product and/or service category as there are potential suppliers in the market. Switching the supplier does not require any particular investment and/or does not involve significant risk. In this case, the recommended strategy is competitive tendering. (Nieminen 2016, 89.)

Bottleneck products and services are placed in the right lower section on the matrix. Their acquisition does not have a major impact on the financial result of the business. However, the challenging task is to control the supplier market of the bottleneck items. A bottleneck product can be a special component that is rarely needed such as electronic components. The primary strategy is to possibly eliminate the bottleneck products. (Nieminen 2016, 89.)

Strategic products and services are placed at the top right corner of the matrix. Purchasing these products are important for profitability, while at the same time the controlling of the supplier market is difficult. Strategic items are needed in large quantities and require specialized technology, for example, to support the maintenance line of aircraft engines. (Iloranta & Pajunen-Muhonen 2018, 122.) The basic strategy of sourcing in this category is the continuous development of a cooperative relationship with suppliers. The cooperative relationship may possibly result in the balance of power between the buyer and the supplier. (Nieminen 2016, 90.)

As a summary, observations from procurement and supplier classification generate added value for business. The management of the company take advantage of classification when preparing future contracts. Companies gain experience from the supplier classification process. For example, these experiences can help in optimizing the supplier base. In addition, these experiences can help companies to focus on suppliers with excellent qualifications. (van Weele 2018, 45.) Companies are dependent on their suppliers. However, strategies are not the same for every supplier. Also, suppliers normally offer tailored services to their customers. The best resources go to the best business partners. (van Weele 2018, 350-351.) Cost saving is the benefit, for example, the spend analyses provide. Typical cost saving options that companies discover are (Pandit & Marmanis 2008, 67):

- 1) Total spending level opportunities
- 2) Transaction level opportunities, for example

As an example of transaction level opportunities, companies can compare contract details with the transaction details. Contract violations such as unrealized discounts, missing specified quantity and delivery terms increase the procurement costs. (Pandit & Marmanis 2008, 72.) Total purchasing reports show how should the supply base be controlled. For

example, if the same item is purchased from different suppliers at different price and/or different agreement terms, the price optimization and contract management become too complex. The procurement cost decreases with volume, however, the cost increases in very high volumes. Therefore, the optimization of volumes and number of suppliers may help to achieve the lowest supplier cost. (Pandit & Marmanis 2008, 67.)

Figure 5 shows as a summary, the main analysis methods applied in procurement and supplier classification in this thesis. The spend analysis is the main tool for analyzing the procurement and suppliers. The Spend analysis can be derived according to the needed results. It gives the opportunity to find areas for improvement in procurement, both at the operational and strategic levels. Spend analysis is a good indicator of purchasing behaviour when it is repeated periodically for example for a particular unit or product group.

An ABC analysis provides a graph where the horizontal axis has a cumulative percentage of factors and the vertical axis has a cumulative percentage of consequences. As the curve changes its behaviour, the nature of the factors also changes. Based on the changes in the curve, the factors can be divided into groups according to their nature. This is a good method when a group-specific development is considered. Kraljic's portfolio analysis highlights that not all purchased products and services are strategically equivalent and should not be treated and managed in the same way.

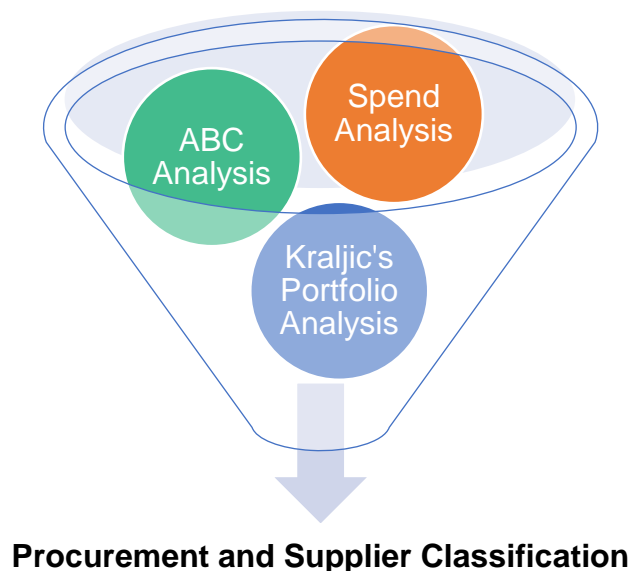


Figure 5. The analysis methods for procurement and supplier classification.

The linear procurement process clarifies the difference between procurement and purchasing. The procurement activities are separated into strategic, tactical and operational

functions. The procurement process should be proactive, so that the company does not continually react to problems only when they are discovered. The past operation provides hints for future procurement strategies. The category management is applied to divide the procurement into clear areas before analyses. Typical cost saving opportunities are recalled during analyses.

### 3 Research Methods

Research methods are used to solve research problems. Figure 6 visualizes divisions related to research methods starting from top: (1) research problem, (2) research questions, (3) research approach, (4) data collection methods, (5) research material, (6) data analysis methods, and (7) conclusion. At the very beginning of the research and depending on the nature of the research problem and research questions, the academic investigator makes a strategic decision about the selection of the research approach. (Kananen 2015, 63-65.)

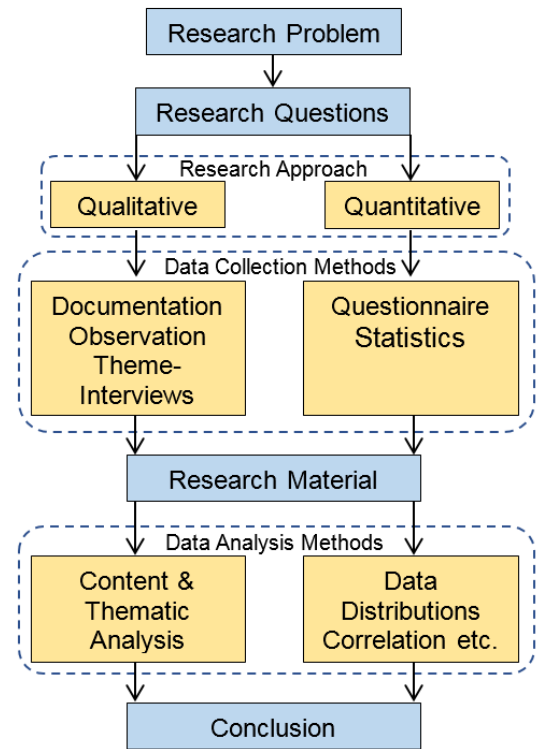


Figure 6. Research methods. (Kananen 2015, 65)

Data collection methods depend on the research approach. A qualitative research produces documented research material for example, the memos of meeting and/or interviews. Also, subject related observations such as interactions between people are documented as a qualitative research material. A quantitative research may ask questions in written text, however, produces answers in numerical form such as questionnaire numerical results and statistics calculations. Primary data is unique and is collected for the research in question from first-hand sources like interviews and/or statistics. Secondary data is the topic related theoretical material created by someone else. Secondary data are not considered as research material. However, secondary data may be applied to indicate the validity of the research. (Kananen 2015, 81-83.)

Moreover, the data analysis methods depend on the research approach. Before the analysis, qualitative research material must be transcribed for example interviews are written down in text. Several forms of information generated in qualitative research must be organized without distortion for further comparisons. Quantitative research materials are analyzed using accurately defined methods such as statistics formulas. These methods are selected depending on what is in question. (Kananen 2015, 83.) Further detail about the research method used in this thesis is provided in subchapters: 3.1 Research Approach and 3.4 Validity and Reliability.



### 3.1 Research Approach

Research approaches are proven procedures and standard rules applied to solve problems in an academic way. (Kananen 2015, 63-65.)

The spend analysis and the ABC analysis examine the spend statistics. The answers of these analyses are in numerical form, for example, procurement lead time. They are related to the quantitative research approach. However, the purchasing portfolio analysis assesses the market in addition to the financial impact of the purchasing volume. The outcome of the purchasing portfolio analysis is a categorization of the item, which is a qualitative research approach. However, it is hard to qualitatively analyze items in the purchasing portfolio without using quantitative results from the spend analysis and the ABC analysis. (Nieminen 2016, 85.)

Figure 7 visualizes the research design for this thesis. Research design is a proposal how to answer research questions. Some minor changes in research design are possible during the design implementation. Research methods explained earlier (Figure 6) are used as a reference to this thesis research design.

At the first phase of the research, in order to understand the situation, the case company personnel are interviewed. Simultaneously, a secondary research was performed to reinforce the quality of the interviews and to form the theoretical fundamentals for this thesis. Phase one interviews helps to understand and to verify the applicability of the theories, methods and criteria of purchasing and supplier classification.

At the research phase two, findings from phase 1 such as the theoretical background and interview analyses and results were combined with analyses of the purchasing statistics of 2017-2018 to develop a procurement and supplier classification model. The purchasing statistics are analyzed using the spend analysis, the ABC analysis and Kraljic's portfolio analyses.

At the third and the final phase of the research, outcomes from phase 1&2 were further analyzed to evaluate their validity and their reliability. All findings from phase 1, 2 and 3 were combined to offer recommendations to improve the case company procurement operation in terms of direct purchasing through the classification of purchasing and suppliers.

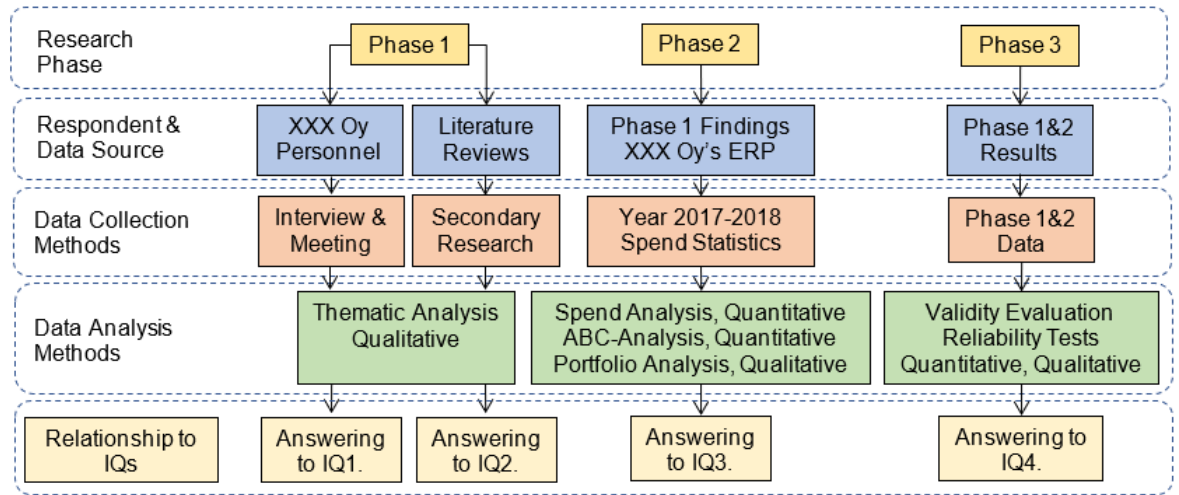


Figure 7. Visualization of the Research Design.

### 3.2 Data Collection Means

In this thesis, primary research in the form of personnel interviews were planned and implemented. A single question-frame is used in all interviews. However, interviews will be conducted openly on the topic of procurement and supplier classification. Therefore, interviewees can openly discuss the classification issues related to their position in the case company. Each interview starts with a short introduction on the topic of procurement and supplier classification. There are five pre-determined interview questions as follows:

1. Is it necessary to classify the procurement and supplier to make the daily work easier? Explain your answer.
2. How would it be the best to categorize, group and classify the purchasing of the parts and services as well as their suppliers to reduce operation costs?
3. What are the strengths in the procurement of spare parts and subcontracting repair services in the case company? Explain your answer.
4. What are the weaknesses in the procurement of spare parts and subcontracting repair services? Explain your answer.
5. Who should be interviewed in terms of procurement and supplier classification in the internal supply chain of the case company?

Secondary research is carried out to support interviews implementation as well as to build the theoretical framework for this thesis. The theoretical learnings and the interview results are combined with the purchasing statistics analyses of 2017-2018, which is provided by the case company.

### 3.3 Data Analyses Means

There are a number of tools for analysing businesses. However, according to academic literatures procurement and their suppliers are usually analysed and classified using the spend analysis, the ABC analysis and Kraljic's portfolio analysis. For these analyses pivot

tables in Excel are employed to organize and analyse a wide range data in this thesis (Pandit & Marmanis 2008, 133-142).

### **3.4 Validity and Reliability**

In this subchapter the validity and the reliability of the research methods are reviewed. However, the validity and reliability of the data collections, the analyses and their results are assessed at subchapter 5.2.

Secondary data may be used to confirm the validity of the research (Kananen 2015, 82-83). The external validity means the extent to which the thesis findings may be generalized. The content validity means questions and/or scales used in the thesis are accurate. Moreover, these questions are the correct tools for evaluating exactly what is planned to study. The reliability of the research method is related to the stability of results. In other word reliability of the research method means if the research is repeated the results are always the same. (Yin 2018, 40.)

The research method solves the research problem. Therefore, the correct method(s) must be chosen. Choosing a research method is comparable to a patient who goes to a doctor and complains about illness. The doctor first needs to understand the problem then he/she chooses the correct treatment to eliminate the problem. (Kananen 2015, 65.)

Therefore, at research phase one and in order to understand the situation related to IQ1., the case company personnel are interviewed. However, for the sake of the validity of interviews the very right personnel must be interviewed.

Interviews are often considered the best method of data collection. The history of interview goes back to Aristotle's time. Socrates used the interview to get his students to think. (Hirsjärvi & Hurme 2015, 11.)

In this thesis, the case company personnel were participated in face-to-face theme-interviews. Also known as a semi-structured interview, a theme-interview is an intermediate form of a structured and open interview. In semi-structured interviews, the pre-defined interview questions are the same for all interviewees. However, the question order may vary between the interviews. A semi-structured interview has both pre-structured questions and open-discussion. Therefore, depending on the interview and open-discussion flow the question order may vary during the ongoing interview. (Hirsjärvi & Hurme 2015, 41-48.)

The interviews aimed to answer investigative question: IQ1. What are issues related to direct procurement and their supplier which should be evaluated using classification?

Thus, interviews are carried out as a primary data collection to discover the problems related to procurement and supplier classification in the case company. However, simultaneously with interviews, a comprehensive secondary literature research is performed to mutually support interviews academic implementation and to choose the correct treatments for problems related to investigative question IQ1. Thus, to answer investigative question: IQ2. What kinds of theories are available to classify procurement and suppliers in order to solve issues in IQ1.?

The used language is also an important aspect of interviews. Both the interviewer and the interviewee should smoothly communicate and interact to correctly understand the questions and answers. (Hirsjärvi & Hurme 2015, 48-53.) Therefore, in this thesis both Finnish and English languages are used in different interviews and meetings. Moreover, minutes were prepared for all interviews and meeting to verify and validate the reliability of the primary data collection. Also, written minutes were double-checked using a voice recorder. Each interviewee confirmed the interview minute of own.

In the first research phase, the interviews show the direction for the second research phase. At the research phase two, the purchasing statistics of the case company are analysed to answer IQ3. However, to ensure the validity and the reliability of research phase two data cleansing is very essential (see Chapter 2.4.1).

At the third research phase, in order to evaluate the external validity of the research method, secondary data are used. For example, Hiekkataipale 2017 and Pääkkö 2011 bachelor theses analysed indirect purchasing. Even though, these theses concern indirect procurement, however, the spend analysis is intended to provide an overall view of all procurement. Therefore, spend analysis is applicable to both direct and indirect purchasing (Nieminen 2016, 82).

The tools and procedures in phase 1&2 (Figure 7) such as data collection and analyses are validated by comparing them with secondary data such as Pandit & Marmanis 2008, Iloranta & Pajunen-Muhonen 2018, Huuhka 2017 and Nieminen 2016. They all confirmed in their books that the results of the spend analysis provide a reliable data for other analysis such as the ABC analysis and the portfolio analysis. Also, data processing without a data distortion in the spend analysis improves the accuracy and the reliability of spend analysis.

## 4 Results

This chapter provides the outcomes of all analyses. These results are prepared based on these questions:

1. What data and result are available, that is, the description?
2. What can be achieved with these data and results, that is, interpretation?

The first subchapter contains interview outcomes as well as other primary data collection results such as meeting and e-mail discussions with the thesis advisor from the case company. The next subchapters apply the toolbox of classification, which is used to analyze the purchasing statistics of 2017-2018. The second subchapter displays the spend analysis outcomes. The third subchapter reveals the ABC analysis results. The fourth subchapter includes the portfolio analysis results.

### 4.1 Interviews

In this thesis, eight interviews were planned, however, two interviewees cancelled the appointments due to limitation in their time. Therefore, only six interviews were implemented. Managing director, chief operating officer, the head of procurement department, two purchasers and one data analyst were interviewed during May-August 2019. The interviews aimed to answer investigative question: IQ1. What are issues related to direct procurement and their suppliers, which should be evaluated using classification?

Despite the fact that in this thesis, a single question-frame was used in all interviews, nevertheless, interviews were conducted openly on the topic of procurement and supplier classification. Therefore, interviewees discussed about the variety of classification issues depending on their position in the case company. However, they also repeated a number of the same problems. Each interview started with a short introduction on the topic of procurement and supplier classification. There were five pre-determined interview questions. The interviewees answers to each question are as follows:

**1) *Is it necessary to classify the procurement and supplier to make the daily work easier? Explain your answer.***

According to interviews, the engine maintenance lead-time is approximately eight weeks. There is some maintenance information available in advance before the engine arrives at the case company. For example, where is the engine used and what are the engine owners and manufacturers maintenance requirements? However, the need for spare parts and/or repair orders are identified after the engine is disassembled. This means one week

after the engine has arrived in the case company. On the other hand, it takes about two weeks to assemble the engine and three days to test it. Therefore, there are only about four weeks available to purchase spare parts and/or repair services. Therefore, the procurements become a challenging task because there is too little time available. The procurement lead-time is an issue in terms of classification.

Moreover, according to interviews, a huge amount of material moves in the case company, which require classification every day. So far, the classification of procurement and suppliers rely on individuals gut feeling and experiences. Thus, only whenever there is a need for classification, some individual personnel do it based on their awareness of product and supplier market. Although this is possible, however, this is not a systematic way to classify huge amount of material procurement and suppliers. Thus, it is desired that the case company have some individuals who are capable of doing classification manually, however, the business continues to grow, and therefore, it is necessary to have a uniform and solid system to continuously classify the procurement and supplier.

Therefore, according to interviews, an academically fact-based study is needed to develop a solid and uniform classification model to get a better view of procurement operation. This classification model helps improve the procurement team purchasing understanding and helps enhance the production operations as well as the entire supply chain. Thus, in order to get the best out of such a complex supply chain, the procurement operations need to be directed in the right direction to streamline and support the production.

Therefore, according to interviews, the classification model can help in the daily job by providing information about:

- What has been procured, the volume?
- How much and where is the money spent, the euro?
- How has each supplier performed, delivery times and quality?
- What is the supplier and subcontractor market situation for each part-number?
- How fast do the materials arrive, the purchasing lead times?
- What should be the minimum and maximum stock levels, inventory management?

**2) *How would it be the best to categorize, group and classify the purchasing of the parts and services as well as their suppliers to reduce operation costs?***

According to interviews, the MRO business is highly capital-intensive. Thus, direct materials and services cover up to 80% of total turnover. Moreover, the biggest cost reduction strategy for every engine repair shop is to use the overhauled spare parts. However, maintaining a large overhauled spare part inventories for the case company, which is a relatively small operator in the industry, is too expensive. Thus, inventories must be well

optimized for a such capital-intensive industry. In this situation, close cooperation between the case company and their headquarters helps. Thus, the headquarters has capability to maintain a large spare part stock for the case company since they trade spare parts also to other companies. Spare parts trade is the area where the headquarters has started their business fifteen years ago. The headquarters is trusted and known worldwide who supplies spare parts to large airline companies. The case company procures secondhand spare parts mainly from their headquarters.

Moreover, according to interviews, there are even more cost saving opportunities in the component repair subcontracting and their supplier market compared with the spare part supplier market. The classification can help to have a better understanding about the supplier quality, delivery times, turnaround times, reliability, prices and supplier market of the component repair subcontracting.

Furthermore, extending the classification of the procurement, supplier and subcontractor into the part-number level helps to find out which part numbers have cost saving potential and which vendors provide the best service for a certain part number.

For instance, a spare part called bushing has 200-300 different part numbers. Only some certain qualified suppliers can supply those part numbers. Also, there are plenty of other evaluation criteria for vendors such as the price, the quality, the turnaround time. Thus, in order to have a fairly accurate model, it is necessary to break down the classification into part number level. It only takes one part-number for an engine to lay the entire engine on hold, which cost the case company operation unit USD 5000-10000 per day when the engine is delayed due to part is not arriving. Therefore, the purchasing classification should also consider the item level to support the procurement strategy. For this reason, the classification of the procurement, supplier and subcontractor into the part-number level is very important in terms of cost saving.

Furthermore, the tiered pricing and related discount contracts are based on discount optimization methods that usually depend on the monetary volume of procurement. Thus, procurement and suppliers are classified by the monetary volume in the spend analysis. Also, purchasers must know, what are the discount percentage limit threshold and what are the contracts term for a certain supplier. Then purchasers see from spend analysis how much in euro company has purchased from a certain supplier during a certain period of time. Therefore, the purchasers select the supplier who offers the highest discount. An example of tiered pricing and discounts:

- from USD 0.00 to USD 500 000 5% discounts

- from USD 500 000 to USD 1 000 000 10% discounts
- from USD 1 000 000 to USD 2 000 000 20% discounts
- more than USD 2 000 000 35% discounts
- however, all and all the maximum discount is 25% discounts

The discount contracts require information that can be provided by spend analysis and classification. However, the tiered pricing and related discount contract optimization methods require a relatively complex discount calculation. Therefore, the case company employs a fixed flat rebate discount percentage for the moment. Moreover, there are rebate discounts on some spare parts with suppliers. When the company purchase over USD 500 000, the limit threshold for rebate discounts starts. This is a relatively simple discount method if the purchasing volume is so high. The classification of the procurement, supplier and subcontractor is vital when considering the discount optimization.

**3) *What are the strengths in the procurement of spare parts and subcontracting repair services in the case company? Explain your answer.***

According to interviews, the case company has flexibility in its operation in terms of custom customer service. This is combined with personnel experiences and their comprehensive awareness about the products and about the supplier market. These are taken as the strength. In addition, the case company purchases overhauled spare parts mainly from their headquarters with rebate agreement. This is also considered as a strength due to having preferred pricing.

According to interviews, the XXX is a handy additional feature of the XXX-system which is the EPR-system in the case company. For further information see the end of Chapter 2.3. Thus, simply the orders can directly be sent to suppliers using XXX instead of logging into the suppliers' web shop and re-enter the order. The XXX connects the case company to its suppliers to make the purchase order. The advantage of the XXX is that buyer does not need to login to an unfamiliar internet portal and saves time and energy. However, for the moment there are only two suppliers which use the XXX.

Regarding the third interview question an interviewee highlighted concentrated procurement. This means purchasing higher volume from the same supplier in order to receive a lower price. However, this was rejected by another interviewee. Thus, the case company is a relatively small player in the industry. The procurement volumes are smaller in comparison with some other competitors. Therefore, concentrated procurement may not provide competitive advantages.



**4) What are the weaknesses in the procurement of spare parts and subcontracting repair services? Explain your answer.**

According to interviews, the IT-infrastructure for correct documentation and reporting is vital and is normally taken for granted. Combining different data from different locations and reporting is not straightforward in XXX-system. Therefore, it is not easy to have reports. Thus, the development of Business Intelligence tools, the BI-tools, should be considered in the case company. This is not the personnel issue. This is the management issue. This is a matter of investment on needed resources such as BI-tools and investment on the hands and the brains. This investment will be paid back by savings, which comes when the procurement is done correctly in the right time, the right price, the right quantity and the right quality. All BI- tools are data driven, which means they are not better than data entered into the system. The procurement personnel are intelligent. Every personnel does its job correctly based on his/her own experience. However, this is not necessarily the sustainable systematic way of working for a long period of time. Shortages of procurement personnel result in doing rush procurements. That is performing the task as quick as possible. However, not necessarily entering all the correct data. Therefore, ending up with data, which is incorrect. Shortages of procurement personnel in some cases have resulted in incorrect documentation and data corruption.

The case company purchases the secondhand overhauled spare parts mainly from its headquarters. This is in a way strength but also the weakness. This limits the case company view over the overhauled spare part global market as well as their supplier market. Thus, what is the actual price of used spare parts in the market? What is the used spare parts supplier market situation? These are the questions, which the case company cannot answer right now due to being too dependent on its headquarters. In addition, the spare part quality assurance was taken as the weakness.

According to interviews, the flexibility in the customer service is in a way strength but also the weakness of the case company. Thus, flexible operation for custom customer service means purchasers do not routinely order the same parts for every engine.

In the aviation industry, sometimes it is difficult to classify procurement and suppliers. In some cases, there is only one original equipment manufacturer (OEM) for a certain spare part. Thus, the case company buys from one supplier and just as a new spare part. Alternatively, this OEM part is purchased as an overhauled spare part from other supplier. However, this does not apply to all OEM spare parts.

**5) Who should be interviewed in terms of procurement and supplier classification in the internal supply chain of the case company?**

At the end of each interview, each interviewee gave their hints on who could be interviewed next.

Table 6 contains summary of the interview results.

Table 6. Summary of the interview results.

	1th Question	2th Question	3th Question	4th Question	5th Question
1th Interview	<b>Yes, to manage:</b> - Delivery Time - Quality Assurance - Costs Minimizing	<b>Categories:</b> - Used Spare Parts - New Spare Parts - Subcontracting - OEM - Disposable Parts	<b>Simple Process:</b> - Spare Part Purchase  <b>ERP-System:</b> - XXX: XXX	<b>Used Spare Parts:</b> - Quality Assurance  <b>- New Spare Parts:</b> - Delivery Time	<b>Subcontracting:</b> - Personnel
2th Interview	<b>Yes, to manage:</b> - Delivery Time - Quality Assurance - Costs Minimizing	<b>Categories:</b> - Direct Ordering - Inspector Checking - Internal Circle - Testing - Repair	<b>Procurement:</b> - Concentrated	<b>Delivery Time:</b> - Turnaround Time	<b>Inspector Checking</b> - Personnel <b>Production:</b> - Personnel
3th Interview	<b>Yes, to manage:</b> - Suppliers Data and Performance - Amount in Volume and Euros €	<b>Categories:</b> - Used Spare Parts - New Spare Parts - Subcontracting	<b>Headquarters:</b> - Stor and Supply of Used Spare Parts <b>The Case Company:</b> - Flexible Services	<b>ERP-System:</b> - Data Processing for Classification	<b>Inspector Checking</b> - Personnel <b>Production:</b> - Personnel
4th Interview	<b>Yes, to manage:</b> - Approved supplier entire supply chain - Supplier Selection - Discount Contracts	<b>Categories:</b> - Used Spare Parts - New Spare Parts - Subcontracting	<b>Headquarters:</b> - Stor and Supply of Used Spare Parts	<b>Headquarters:</b> - Quality Assurance of Used Spare Parts' Original Suppliers	<b>Operation Unit</b> - Personnel
5th Interview	<b>Yes, to manage:</b> - Purchase volumes and lead times - Performance of the vendors	<b>Categories:</b> - Used and New Parts - Subcontracting - Based on part number and or suppliers	<b>The personnel of procurement team:</b> - detailed technical knowledge about the product purchasing	<b>Shortage of procurement personnel:</b> - incorrect documentation	<b>Inspector Checking</b> - Personnel <b>Production:</b> - Personnel
6th Interview	<b>Yes, to manage:</b> - Procurement lead - Stock management - Cost efficiency - Quality management	<b>Categories:</b> - Used Spare Parts - New Spare Parts - Subcontracting	<b>Headquarters:</b> - relabel stock - cost efficient -lead time efficient	<b>- Information flow</b> - systematic information flow - Challenging situation for new employees	<b>Production:</b> - Personnel

## 4.2 Spend Analysis

The purchasing statistics of 2017-2018 are analyzed as a reference period in this thesis. The year 2017 has 8892 and the year 2018 has 10124 rows of purchasing data. This is a huge amount of purchasing data to be analyzed. Analyzing every single purchasing item requires more time and resources, for example, in form of sophisticated software. However, the main principles of procurement and supplier classification should be highlighted in the analyses. The analyses are aimed to show the basic idea in a way that is easily understood. Therefore, some simplifications are made to these analyses. For example, only the relevant parts of the data are analyzed in this thesis. For example, Table 10 compares top seven part suppliers of 2017 and 2018. However, in the real day to day work the case

company needs analyses which require more purchasing data to input into accurate software.

In this thesis, the spend analysis is implemented by using seven steps (Figure 3). However, in this thesis only direct spend is analyzed. Therefore, the spend analysis steps are tailored to be suitable for the case company and specifically for direct spend analysis. Each analysis begins with the description of the data. The data is described for example by showing the big picture with the aid of the bar chart. Then, the purchasing data are further analyzed using the relevant tables. Finally, the interpretation is completed by explaining what can be achieved with data and result in the tables.

The spend analysis started by identifying the necessary data from the enterprise resource planning (ERP) system. This system is called the XXX-system in the case company. The first version of the procurement data was received on 20<sup>th</sup> February 2019. The thesis adviser from the case company identified and gathered the data from XXX-system into one database. However, after cleansing the data in this thesis, it was clear that the first version of data not only did not include all relevant items but also contained errors and some useless items.

Therefore, the second version of the purchasing data was prepared by combining data from different locations in XXX-system on 25<sup>th</sup> June 2019. However, after cleansing and after the first round of analyses, it was perceived that the monetary volume of purchasing is too high in the analyses for 2017-2018.

Therefore, the second version of the purchasing data was further investigated. The investigation revealed errors in form of repeating of the same order number. Some of the lines of purchasing were doubled, tripled and multiplied in the second version of the purchasing data. This error was caused by the incorrect gathering method. In fact, the same data were in more than one location in the XXX-system. The program code combined repeatedly all the same data from different location into a single database. Therefore, the third version of the purchasing data was prepared and issued on 18<sup>th</sup> September. The third version of data was free of unwanted double, the triple, and other multiple lines of purchasing. However, some of the purchasing item arrival dates were missing from the third version of the data. Using Excel function called VLOOKUP some of this missing arrival date was gathered from the second version of data.

Table 7 contains the total quantity of order numbers, the quantity of the order numbers with zero euro value, the quantity of the order numbers which status are closed and the

quantity of the missing arrival date. The procurement status is closed after the purchase order is sent to the supplier, the supplier has delivered the material and the case company has received the material. In this thesis, only the procurement lines with closed status are analyzed. The percentage of the quantity of the order numbers which status are closed 92% for 2017 and 96% for 2018. The percentage of the quantity of the order numbers with zero euro value is 28% of total order numbers for both 2017 and 2018. Some of the close statuses have zero value and some others missing the arrival date. The table also contains the percentage of the quantity of missing arrival dates. The missing arrival date will affect only the accuracy of the calculation of the average purchasing lead time and their standard deviation. The accuracy of the calculations is affected by 9% for 2017 and 15% for 2018.

Table 7. Total purchasing rows and the amount of the missing arrival date of the items.

Year	2017		2018	
Total Quantity of Order Numbers	8892	100 %	10124	100 %
Quantity of Order Numbers with Zero Euro	2454	28 %	2797	28 %
Order Numbers, which Status is Closed	8217	92 %	9763	96 %
Quantity of Missing Arrival Date	784	9 %	1510	15 %

As it was mentioned in the interviews, data exporting from XXX-system is not straightforward. The data exporting is time consuming and it requires some programming knowledge. The programming codes gather and export the data from XXX-system into a single database in the form of an Excel table. The database exported from XXX-system was the starting point of spend analysis in this thesis. This data was further cleansed. First the data was processed by adding the supplier categories for the product and service purchasing. The direct procurement supplier category was added from a separate datasheet by using VLOOKUP function. In fact, adding the direct procurement supplier category helped removing the unwanted indirect procurement data. Then the purchasing arrival date was added from a separate datasheet. All analyses are implemented by using mainly the third version of procurement data in this thesis.

Table 8 contains the grouping of spare part suppliers. The grouping aimed to merge the monetary volume of purchasing from the very same supplier. Grouping is done separately for the purchasing of the spare parts and for the subcontracting services of 2017 and 2018. In the grouping, the suppliers are arranged in terms of monetary volume of the purchasing. Therefore, grouping answers to question: where the money is spent. How much is the monetary volume of purchasing from a certain supplier. The amount of purchasing can be compared between suppliers in 2017 and 2018. The monetary volume of the purchasing of 2018 is approximately two times greater in comparison with 2017. However,

the year 2017 has 19 part supplier which is higher compared with 2018 which has 18 part suppliers. This is in line with supplier management philosophy, reducing the number of the inefficient supplier to cut the procurement process cost.

Table 8. Grouping of part suppliers for 2017 and 2018.

Spare Part Suppliers 2017	Total of Closed Status [€]	Total of Closed Status [€] %
S1	468 760.47 €	40 %
S2	438 847.76 €	37 %
S3	179 920.83 €	15 %
S4	28 123.28 €	2 %
S5	20 476.04 €	2 %
S6	15 107.61 €	1 %
S7	12 171.93 €	1 %
S8	7 690.40 €	1 %
S9	2 601.80 €	0.2 %
S10	2 376.32 €	0.2 %
S11	2 079.29 €	0.2 %
S12	1 613.13 €	0.1 %
S13	1 438.27 €	0.1 %
S14	1 332.08 €	0.1 %
S15	909.37 €	0.1 %
S16	645.85 €	0.1 %
S17	474.11 €	0.04 %
S18	268.97 €	0.02 %
S19	268.03 €	0.02 %
<b>Total:</b>	<b>1 185 105.52 €</b>	<b>100 %</b>
Spare Part Suppliers 2018		
S1	1 606 926.18 €	68 %
S2	574 367.65 €	24 %
S3	60 270.29 €	3 %
S4	53 970.60 €	2 %
S5	22 263.41 €	1 %
S6	14 298.65 €	1 %
S7	9 246.33 €	0.4 %
S8	3 996.11 €	0.2 %
S9	3 421.89 €	0.1 %
S10	2 673.46 €	0.1 %
S11	2 179.60 €	0.1 %
S12	2 161.04 €	0.1 %
S13	1 817.36 €	0.1 %
S14	1 769.58 €	0.1 %
S15	887.05 €	0.04 %
S16	738.26 €	0.03 %
S17	141.67 €	0.01 %
S18	113.94 €	0.005 %
<b>Total:</b>	<b>2 361 243.06 €</b>	<b>100 %</b>

In order to see possible cost saving opportunities, combining these comparisons with information about coming and past engine MRO-orders helps in decisions making. In fact, it is worth to study grouping before planning to negotiate about discount contracts. In the grouping, the suppliers are arranged in terms of monetary volume. The purchasers should be aware of the threshold of the discount percentage limit and the terms of discount contracts for a certain supplier. Then, it is easy to select the supplier who offers the highest discount. This is an example of using spend analysis in the tiered pricing and discounts management. Table 8 information is also used in portfolio analyses.

Table 19 in Attachment 1. provides the grouping of service subcontracting suppliers for 2017 and 2018. The monetary volume of service purchasing is smaller in 2017 in comparison with 2018. The quantity of the service supplier is 40 in 2017 and 43 in 2018. All and all there are more service subcontracting suppliers compared with part supplier suppliers. Therefore, service purchasing suggests more potential cost saving in comparison with the part suppliers. Also, the service supplier base can be analysed to find possibility to reduce the number of suppliers. For some reason the monetary volume of purchasing is zero for the suppliers S40 and S43.

Figure 8 shows the categorization model developed for the case company in this thesis. Thus, the parent category is formed based on the use of the goods and services, that is, direct procurement. Then the parent category is divided into subcategories as follows:

1. New Spare Parts:
  - a. Original Equipment Manufacturer (OEM) Parts
  - b. The Non-OEM Parts
  - c. The Disposable Spare Parts
2. Overhauled Used Spare Parts:
  - a. Original Equipment Manufacturer (OEM) Parts
  - b. The Non-OEM Parts
3. Service Subcontracting:
  - a. The Functionality Tests
  - b. Component Overhaul

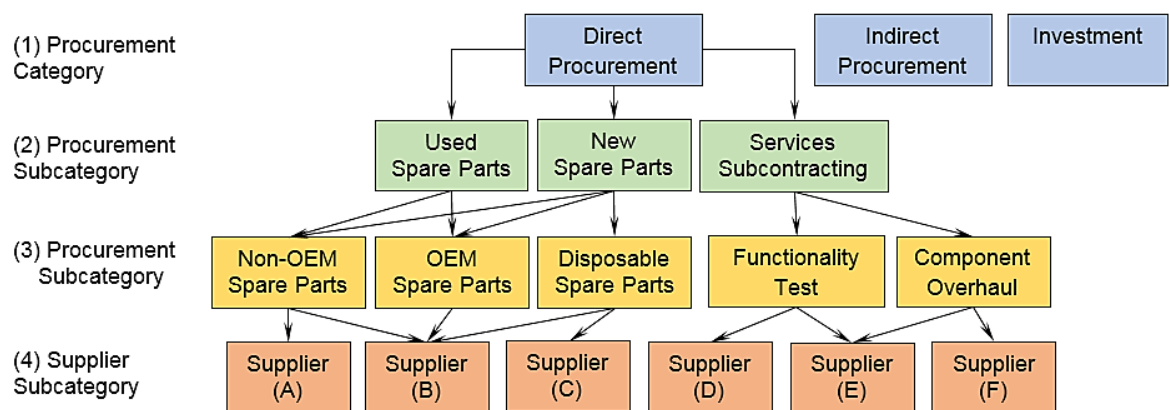


Figure 8. The categorization model specifically developed for the case company.

Once the purchase data was collected, cleansed, grouped and categorized, the differences were compared between the purchasing of 2017 and 2018. First, numerical analyses were implemented for categories. Then, the categories were further analysed at the deeper supplier and the part number level. The categories were analysed for both spare part and service purchasing. For example, when analysing supplier performance, it is meaningful to compare between suppliers (A) and (B) instead of comparing between (A)

and (C) since they are in the different purchasing category. These comparisons aim to find cost saving and waste reduction opportunities and/or to make new and relevant changes.

Figure 9 shows the purchasing breakdown in terms of monetary volume which statuses are closed. The figure answers to question how much money is spent on each subcategory. The figure shows the procurement breakdown of subcategories. On the left 2017 and on the right 2018. These charts also show the big picture how the direct purchasing has evolved in 2017-2018.

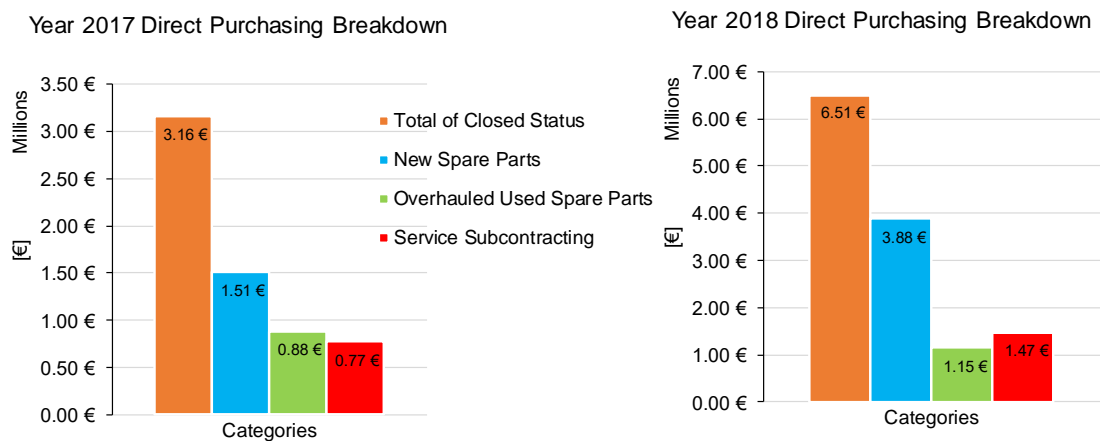


Figure 9. Purchasing breakdown on the left 2017 and on the right 2018.

Table 9 contains the analysis of subcategories of Figure 9. The table reveals the direction where the purchasing has evolved between the years 2017-2018. The percentage unit of the new spare part purchasing is grown by 12% in 2018 compared with 2017. The percentage unit of the overhauled used spare part purchasing is decreased by 10%. The percentage unit of the service purchasing is decreased by 2%. The purchasing of all categories has grown in the year 2018 compared 2017.

Combining these comparisons with information about past and coming engine MRO-orders helps to estimate what to expect of coming procurement and production operations to avoid monetary waste.

Table 9. Spend analysis of three subcategory.

Year		2017		2018		2017-2018 Comparison	
Category		Purchasing [€]	%-Portion	Purchasing [€]	%-Portion	%-Unit Change	%-Growth
	Total of Closed Status	3 163 172.91 €	100 %	6 507 609.77 €	100 %	-	206 %
	New Spare Parts	1 507 465.44 €	48 %	3 882 497.75 €	60 %	12 %	258 %
	Overhauled Used Spare Parts	883 322.49 €	28 %	1 150 286.40 €	18 %	-10 %	130 %
	Service Subcontracting	772 384.98 €	24 %	1 474 825.62 €	23 %	-2 %	191 %

Table 10 contains spare part suppliers sorted by the monetary volume of 2017-2018 (Table 8). The table compares the average of procurement lead times in days and the standard deviation of the lead time. A high standard deviation reveals the lead times of a certain supplier vary widely compared with the average lead time. A low standard deviation indicates the lead times of a certain supplier are close to the average lead time.

The procurement starts at the date named as "Order Date". The part arrives in the case company at the date named as "Arrival Date". The purchasing lead time is calculated from the difference between the order date and arrival date in days. The average lead time and the standard deviation is calculated using Excel functions. The order numbers without the arrival date are excluded from the analyses. The accuracy of the analyses is affected by the missing arrival dates 9% for 2017 and 15% for 2018.

In Table 10 the average lead time and standard deviation are decreased for the supplier S4 in 2018 compared with S7 the year 2017.

Table 10. Analysis of Spare Part Suppliers Performance of 2017-2018.

Spare Part Suppliers 2017	Average of Lead Time in Days	Standard Deviation of Lead Times
S1	7	5
S2	10	12
S3	9	16
S4	12	6
S5	5	3
S6	4	2
S7	10	14
S8	10	27
S9	13	14
S10	32	46
S11	7	15
S12	14	20
S13	8	9
S14	5	2
S15	7	5
S16	5	5
S17	58	49
S18	13	0
S19	8	4
Spare Part Suppliers 2018		
S1	9	9
S2	7	5
S3	9	7
S4	7	6
S5	11	5
S6	7	4
S7	15	18
S8	16	3
S9	15	33
S10	7	13
S11	6	7
S12	6	3
S13	8	10
S14	21	36
S15	7	2
S16	33	25
S17	12	12
S18	20	2



This is an example analysis, which reveal the performance of the supplier. The procurement performance of the case company can similarly be analysed. In order to find potential cost saving opportunities, the combination of these analyses with information about the past and coming engine MRO orders offer hints for inventory optimization and/or discount contracts negotiation. See Table 20, Table 21 and Table 22 in Attachment 2. for further performance analyses of spare part suppliers and subcontracting service suppliers of 2017 and 2018.

Table 11 compares top 10 service subcontracting part numbers of 2017 and 2018. The table compares the volume in terms of money and quantity, average of procurement lead time and standard deviation of lead time. The purchasing volume can be a part of the reason for the lead times and standard deviations are higher in 2018 in comparison with the 2017. The service subcontracting part numbers which missing the arrival date are excluded from the analyses.

The engine maintenance lead time is approximately 60 days and the procurement target lead time is approximately 30 days. The engine on hold due to long lead time costs the operation unit USD 5000-10000 per day when the engine is delayed. This is an issue, which the case company procurement team should decide, whether to purchase the overhauling service with longer lead-time, to cannibalize and/or purchase a more expensive spare part with shorter lead-time.

Table 11. Analysis of Top 10 Service subcontracting part numbers in 2017 and 2018.

Part Numbers 2017	Total of Closed Status [€]	Average Lead Time [Days]	Standard Deviation	Quantity
P1	22 398.69 €	4	0.0	1
P2	19 461.57 €	5	2.1	0
P3	17 028.72 €	4	1.2	9
P4	12 663.23 €	4	0.6	0
P5	12 213.85 €	6	3.1	0
P6	11 286.15 €	3	0.2	3
P7	10 975.80 €	5	0.8	11
P8	10 664.88 €	6	0.9	14
P9	10 541.26 €	5	0.5	0
P10	10 409.13 €	3	0.5	8
Part Numbers 2018				
P1	57 851.83 €	5	1.1	1
P2	57 785.68 €	4	1.0	11
P3	45 605.98 €	5	1.0	28
P4	42 047.94 €	4	0.6	11
P5	25 664.20 €	11	5.2	0
P6	23 372.28 €	5	0.5	12
P7	20 436.79 €	5	0.2	8
P8	15 774.44 €	4	0.0	9
P9	15 719.27 €	3	0.4	89
P10	15 272.40 €	5	0.4	9

Figure 10 shows further analysis at part number level. The figure compares the color-coded monetary volume of the overall top 10 spare part numbers between 2017 and 2018. According to figure the amount of purchasing on red color part number P1 is the highest for both 2017 and 2018. Also, for this particular part the monetary volume of purchasing has increased more than three times in 2018 compared with 2017. Therefore, deeper specific analyses of the purchasing data were started on for this particular part number. The monetary volume of purchasing has increased for some other part number colors as well.

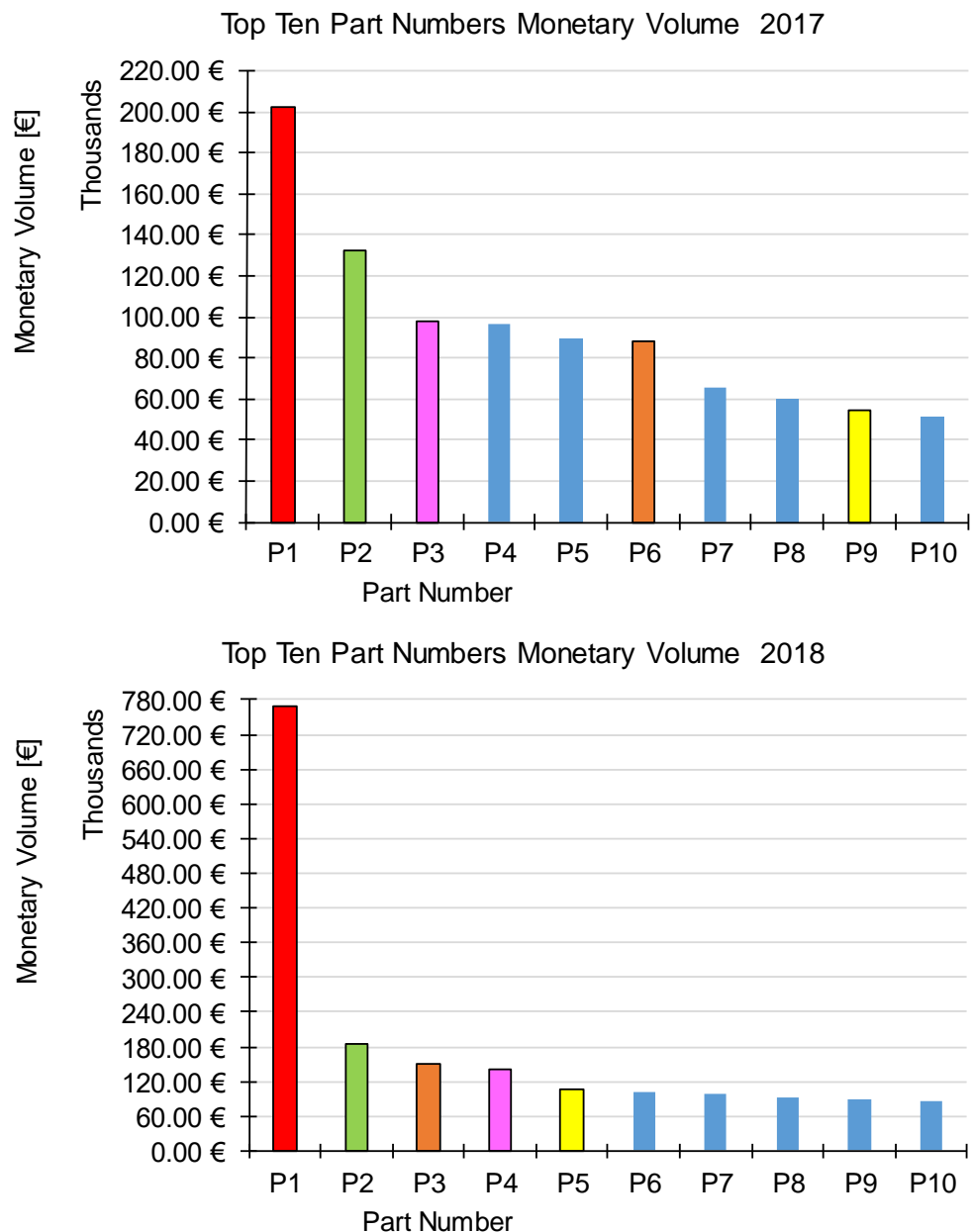


Figure 10. Top Ten Spare Part Monetary Volume, on top 2017 on the bottom 2018.

Table 12 contains the purchasing history analyses of the spare part number: P1. The analyses revealed that the part number P1 description is XXX and the only supplier is S1. Therefore, this is a new spare part. According to the table, the price of this part number is increased on 20<sup>th</sup> November 2018. The rising price has notable profit impact when taking into account the quantity of purchasing. Nevertheless, the increase in price is not unexpected as it was mentioned in interviews. Usually the prices increase after November every year. The table also shows the purchasing lead times. Thus, the demand forecast possibly based on the coming engine MRO helps to make purchasing decision in advance to manage the lead times before the price increases. The outcome is cost efficiency and price competitiveness. Moreover, S1 is the only supplier of the spare part number P1, unless another vendor is available, the supplier market is very challenging for this part number. Therefore, this part number not only has high profit impact but also has high supply risk. Identical analyses can be implemented for other part numbers. These results are used in portfolio analyses.

Table 12. Purchasing History of Spare Part No: P1, years: 2017 and 2018.

Order Number	Unit Price [€]	Order Date	Arrival Date	Lead Time	Quantity	Total [€]
O1	1 283.59 €	24.2.2017	3.3.2017	1	8	102 687.22 €
O2	1 242.12 €	18.5.2017	18.5.2017	0	8	99 369.79 €
O4	1 239.03 €	6.8.2018	10.10.2018	7	2	24 780.58 €
O5	1 242.49 €	14.8.2018	29.10.2018	8	16	198 797.87 €
O6	1 272.63 €	15.8.2018	29.9.2018	5	1	2 545.25 €
O7	1 354.91 €	20.11.2018	22.1.2019	6	40	541 962.64 €

Figure 11 compares the spare part purchasing volume of overall top 10 part numbers in terms of quantity between the 2017 and 2018. The amount of purchasing volume are the highest for part numbers:

- P1, supplier: S1 2017
- P1, supplier: S1 2018

These purchasing volumes can give the hint to inventory optimizations for coming MRO-orders. The amount of purchasing of these part numbers are the highest, therefore, it is important to have knowledge about the supplier market. Obviously, there is high risk in the supplier market of these part numbers since they have only one supplier. Identical analyses should be implemented for other spare part numbers, which are purchased in high volume. The case company purchases secondhand overhauled parts only from their headquarters. The supplier market for this category is unknown for the case company. It is also important to have knowledge about the overhauled spare parts supplier market.

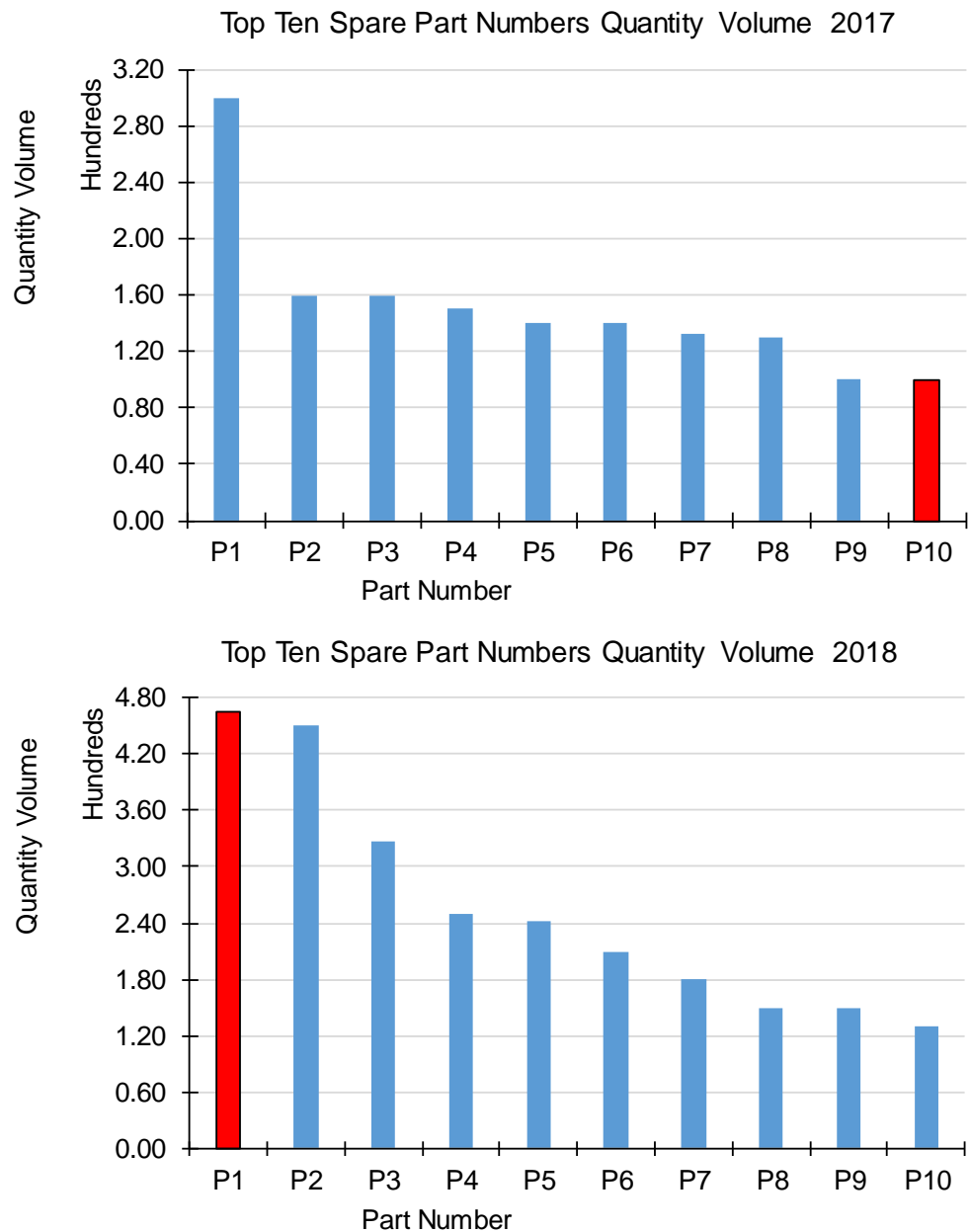


Figure 11. Top 10 spare part purchasing volume in terms of quantity years: 2017-2018.

In order to analyse the purchasing in part number level, let us recall Table 8 where the monetary volume of purchasing was the highest from suppliers:

- S1: new parts
- S1: overhauled parts

Figure 12 compares top 10 part numbers purchased from S1 in terms of monetary volume in 2017 and 2018. The highest amount of purchasing is on part numbers P1 in the year 2017 and P1 in the year 2018.

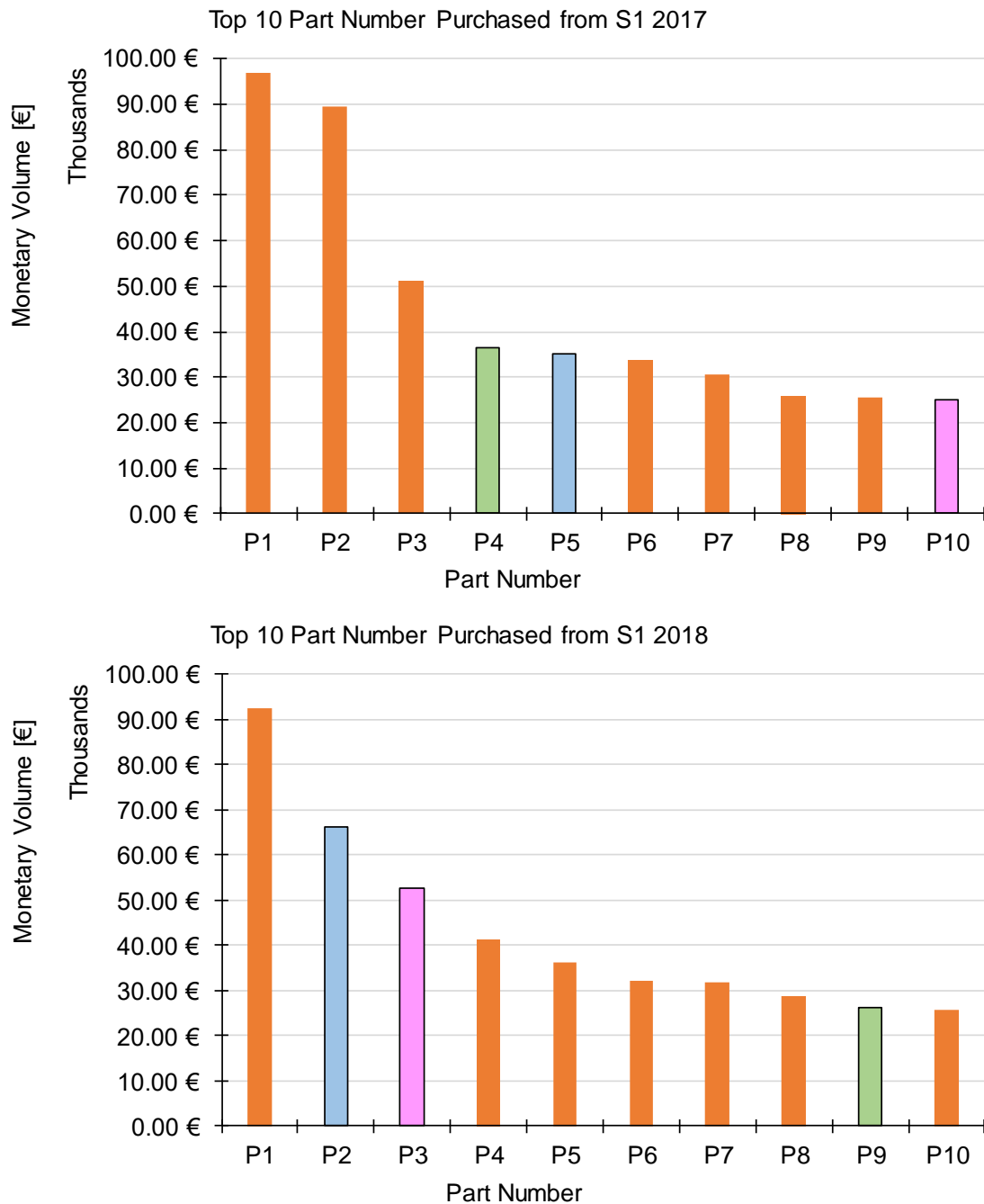


Figure 12. Top 10 secondhand spare parts monetary volume years 2017-2018.

Table 13 contains further information about top 10 overhauled spare part in Figure 12, on top 2017 on the bottom 2018. The table contains the count of order, average lead time and the volume in terms of quantity. For example, the part numbers P1 and P2 have high profit impact. They are purchased in high volume in terms of quantity. They have high supply risk since the headquarters is the only supplier of the overhauled used spare parts. Unless these part numbers are purchased at higher price as a new spare part.

Table 13. Top 10 secondhand overhauled spare parts, on top 2017 on the bottom 2018.

S1 2017	Total of Closed Status [€]	Count of Order	Average Lead Time [Days]	Quantity
P1	96 867.48 €	2	16	108
P2	89 442.62 €	2	12	97
P3	51 238.02 €	6	7	23
P4	36 470.35 €	2	12	39
P5	35 109.14 €	1	7	18
P6	33 622.28 €	2	16	71
P7	30 523.87 €	4	7	13
P8	25 845.91 €	4	7	11
P9	25 395.26 €	1	7	27
P10	25 126.53 €	1	7	51
S1 2018				
P1	92 510.93 €	2	13	103
P2	66 154.77 €	2	7	29
P3	52 625.12 €	2	12	99
P4	41 194.40 €	4	5	26
P5	36 081.23 €	1	4	14
P6	32 195.87 €	2	8	2
P7	31 882.12 €	3	8	60
P8	28 693.25 €	2	9	54
P9	26 082.83 €	2	13	29
P10	25 766.56 €	1	5	12

Table 14 contains deeper information about the purchasing history of the part number: P1 2017 and P1 2018 which description is BLADE STG 1-HPT. The lead time and the price are slightly changed. The lead times are in the range of planned procurement lead time of four weeks. The price and the quality of overhauled spare parts are lower compared with purchasing new spare parts. Identical analyses should be done for new parts which the highest volume of purchasing comes from S1.

Table 14. Analyses of purchase history of part number: P1 2017 and P1 2018.

Order Nr.	Price [€]	Status	Ordered	Arrival	Lead Time	Part Number	Quantity	Total [€]
O1	902.38 €	Closed	31.10.17	15.11.17	15	P1	68	61 361.82 €
O2	887.64 €	Closed	30.10.17	15.11.17	16	P2	40	35 505.66 €
O1	899.58 €	Closed	28.2.18	12.3.18	12	P1	43	38 681.71 €
O2	897.15 €	Closed	16.1.18	29.1.18	13	P2	60	53 829.22 €

### 4.3 ABC Analysis

In this thesis, the ABC analysis shows the basic idea by using the relevant part of the data. In order to have comparable results, it is necessary to perform the ABC analyses separately for each category:

1. New Spare Parts
2. Overhauled Used Spare Parts
3. Service Subcontracting.

Many suppliers sell new spare parts and service subcontracting. Therefore, it is relevant to implement the ABC analysis for their suppliers as well. The ABC analyses were carried out based on the monetary volume of the purchasing.

Table 15 contains Class-A of the ABC analysis for overhauled spare parts where part numbers are classified in terms of monetary volume. Figure 15 in Attachment 3. presents the entire ABC analysis diagram of overhauled spare parts purchasing of 2017 as follows:

- Class-(A) contains 81 part numbers, which is approximately 12.0% of the total part numbers 675 where 80% of the money is spent
- Class-(B) contains 171 part numbers, which is approximately 25.2 % of the total part numbers 675, where 15% of the money is spent
- Class-(C) contains 423 part numbers, which is approximately 62.8 % of the total part numbers 675, where 5% of the money is spent

Reducing the number of suppliers is not an option for secondhand overhauled spare parts since there is only one supplier who provides them. However, the upcoming production activities can be forecasted by the ABC classification of past statistics in the case company. These production activities can be facilitated, for example, by optimizing the inventory of various raw materials, semi-finished products or finished products.

Based on the ABC-analysis, it is easy to conclude that Class-A part numbers are the priority to focus on. Information provided by the ABC analysis, help to enhance the response and to make the right decisions of developing operation.

It is important to distribute the information achieved from the ABC analysis results at the organizational level according to job responsibilities. The information should be distributed to the buyers, the production planners and the sales people. However, it is important to note that the ABC analysis result perform nothing by itself. The people who work for the case company do the main work. These people should understand the potential and benefits of ABC analysis results. There are questions, which the results of the ABC analysis provide the answer to.

Table 15. Class-A of ABC analysis of overhauled spare parts of 2017.

Cumulative Factors %	Overhauled Parts 2017	Closed Status [€]	Cumulative Consequences %	Class
0.1 %	P1	61 361.82 €	7 %	A
0.3 %	P2	57 374.48 €	13 %	
0.4 %	P3	35 505.66 €	17 %	
0.6 %	P4	35 109.14 €	21 %	
0.7 %	P5	32 919.78 €	25 %	
0.9 %	P6	32 676.93 €	29 %	
1.0 %	P7	32 068.14 €	32 %	
1.2 %	P8	25 395.26 €	35 %	
1.3 %	P9	25 126.53 €	38 %	
1.5 %	P10	18 961.52 €	40 %	
1.6 %	P11	16 876.62 €	42 %	
1.8 %	P12	16 070.95 €	44 %	
1.9 %	P13	12 762.27 €	46 %	
2.1 %	P14	12 171.96 €	47 %	
2.2 %	P15	11 939.85 €	48 %	
2.4 %	P16	11 885.16 €	50 %	
2.5 %	P17	10 597.56 €	51 %	
2.7 %	P18	9 643.78 €	52 %	
2.8 %	P19	9 508.53 €	53 %	
3.0 %	P20	8 670.15 €	54 %	
3.1 %	P21	7 780.86 €	55 %	
3.3 %	P22	7 637.08 €	56 %	
3.4 %	P23	7 291.42 €	57 %	
3.6 %	P24	7 131.09 €	57 %	
3.7 %	P25	6 873.50 €	58 %	
3.9 %	P26	5 950.86 €	59 %	
4.0 %	P27	5 782.42 €	59 %	
4.1 %	P28	5 592.73 €	60 %	
4.3 %	P29	5 525.10 €	61 %	
4.4 %	P30	5 156.55 €	61 %	
4.6 %	P31	5 144.92 €	62 %	
4.7 %	P32	5 001.69 €	62 %	
4.9 %	P33	4 955.30 €	63 %	
5.0 %	P34	4 938.63 €	64 %	
5.2 %	P35	4 747.71 €	64 %	
5.3 %	P36	4 740.38 €	65 %	
5.5 %	P37	4 740.38 €	65 %	
5.6 %	P38	4 250.07 €	66 %	
5.8 %	P39	4 136.12 €	66 %	
5.9 %	P40	4 129.63 €	67 %	
6.1 %	P41	4 086.03 €	67 %	
6.2 %	P42	4 032.46 €	68 %	
6.4 %	P43	3 982.98 €	68 %	
6.5 %	P44	3 906.43 €	68 %	
6.7 %	P45	3 825.07 €	69 %	
6.8 %	P46	3 825.07 €	69 %	
7.0 %	P47	3 817.84 €	70 %	
7.1 %	P48	3 747.91 €	70 %	
7.3 %	P49	3 661.22 €	71 %	
7.4 %	P50	3 550.57 €	71 %	
7.6 %	P51	3 400.06 €	71 %	
7.7 %	P52	3 316.19 €	72 %	
7.9 %	P53	3 164.83 €	72 %	
8.0 %	P54	3 157.36 €	72 %	
8.1 %	P55	3 018.05 €	73 %	
8.3 %	P56	2 753.53 €	73 %	
8.4 %	P57	2 698.04 €	73 %	
8.6 %	P58	2 669.26 €	74 %	
8.7 %	P59	2 637.35 €	74 %	
8.9 %	P60	2 591.71 €	74 %	
9.0 %	P61	2 584.73 €	75 %	
9.2 %	P62	2 550.05 €	75 %	
9.3 %	P63	2 542.06 €	75 %	
9.5 %	P64	2 490.35 €	75 %	
9.6 %	P65	2 423.63 €	76 %	
9.8 %	P66	2 410.95 €	76 %	
9.9 %	P67	2 380.04 €	76 %	
10.1 %	P68	2 367.89 €	76 %	
10.2 %	P69	2 295.69 €	77 %	
10.4 %	P70	2 274.26 €	77 %	
10.5 %	P71	2 229.59 €	77 %	
10.7 %	P72	2 133.17 €	78 %	
10.8 %	P73	2 068.06 €	78 %	
11.0 %	P74	2 065.59 €	78 %	
11.1 %	P75	2 065.30 €	78 %	
11.3 %	P76	2 058.57 €	78 %	
11.4 %	P77	2 041.21 €	79 %	
11.6 %	P78	2 022.41 €	79 %	
11.7 %	P79	2 019.26 €	79 %	
11.9 %	P80	1 970.71 €	79 %	
12.0 %	P81	1 955.20 €	80 %	



Table 16 contains the ABC analysis of part suppliers of 2018. In class-A, 69% of the purchasing is made from one supplier. In class-B, 15% of the purchasing is made from two suppliers. In class-C, 6% of the purchasing is made from 15 suppliers.

Table 16. ABC analysis of suppliers of 2018.

Cumulative Factors %	Part Suppliers 2018	Volume [€]	Cumulative Consequences %	Class
6 %	S1	3 568 208.71 €	69 %	A
11 %	S2	1 171 072.98 €	92 %	B
17 %	S3	129 708.31 €	95 %	
22 %	S4	127 215.71 €	97 %	C
28 %	S5	44 813.18 €	98 %	
33 %	S6	28 668.22 €	99 %	
39 %	S7	18 507.81 €	99 %	
44 %	S8	16 715.72 €	99 %	
50 %	S9	8 108.50 €	99 %	
56 %	S10	6 166.53 €	99.6 %	
61 %	S11	5 973.31 €	99.7 %	
67 %	S12	4 524.96 €	99.8 %	
72 %	S13	4 322.09 €	99.8 %	
78 %	S14	3 539.74 €	99.9 %	
83 %	S15	1 790.33 €	99.9 %	
89 %	S16	1 774.09 €	99.98 %	
94 %	S17	693.36 €	99.996 %	
100 %	S18	227.87 €	100 %	

Figure 16 in Attachment 3. presents the entire ABC analysis of subcontract purchasing in terms of monetary volume purchased 2017. Class-A contains 528 part numbers, which is approximately 20.69% of the total part numbers: 2552, where 80% of the money is spent. Class-B contains 674 part numbers, which is approximately 26.41% of the total part numbers, where 15% of the money is spent. Class-C contains 1350 part numbers, which is approximately 52.9 % of the total part numbers, where only 5% of the money is spent.

The ABC analysis in Figure 16 reveals 1350 of part numbers are listed at bottom of the list where only 5% of the money is spent. These products or services can also be worthy of systematic consideration. Therefore, case company can consider the Tail Management possibly to reduce the number of the supplier. This means possibly purchasing the Class-C and/or the Class-B services from Class-A suppliers. Significant cost savings can be achieved by reducing the number of the supplier. Identical ABC analyses can be implemented for the subcontracting service category.

#### 4.4 Kraljic's Portfolio Analysis

Kraljic's portfolio analysis was performed after the ABC analysis and the spend analysis. Two portfolio analyses are separately executed for the service suppliers and overhauled

engine component part numbers. These analyses are aimed to show the basic idea of the portfolio analysis in a way that is easily understood. Therefore, some simplifications are made to these portfolio analyses. Only the most important part of the data is analyzed. In order to have an accurate analysis, the case company needs portfolio analyses, which require more purchasing data to input into accurate software.

Table 17 contains top five service suppliers of 2017-2018. The table shows the monetary purchasing volume of service, their percentage, the count of the part number and the quantity of parts. This information is used in portfolio analysis in Figure 13.

Table 17. Service supplier portfolio analysis of 2017-2018.

Service Suppliers 2017		Total [€]	Total [€] %	Count of Parts	Quantity
1	S1	123 824.41 €	16.0 %	2063	2063
2	S2	83 374.51 €	10.8 %	140	3560
3	S3	78 095.22 €	10.1 %	218	347
4	S4	71 356.92 €	9.2 %	54	91
5	S5	46 643.85 €	6.0 %	34	39
Service Suppliers 2018					
1	S1	481 411.24 €	32.6 %	2162	8968
2	S2	173 688.04 €	11.8 %	234	2010
3	S3	107 976.52 €	7.3 %	214	240
4	S4	95 236.44 €	6.5 %	444	9724
5	S5	66 416.24 €	4.5 %	297	401

Figure 13 presents Kraljic's portfolio analysis of top five service suppliers in Table 17. The figure shows on top the portfolio analyses of 2017 and on the bottom 2018. The horizontal axis shows the quantity of part numbers which are purchased from a certain supplier. The quantity of part measures the supply risk in this case. The higher is the quantity of the parts the higher is the supply risk. The vertical axis shows the monetary volume of the purchasing percentage. The overall monetary volume of service purchasing in 2018 is approximately doubled compared with 2017 (Figure 9). Therefore, the scale is doubled in the horizontal and in the vertical axis of 2018 portfolio. This thesis, it is assumed that the higher is the monetary volume of purchasing the higher is impact on profit. The suppliers are equipped with color codes to facilitate the analyses.

Figure 13 shows that three out of five suppliers are located at the routine item section, one is placed at the leverage item section and one is placed at the bottleneck item section in 2017 and 2018. For routine products, it is important to develop the purchasing process. Purchasing operations can be developed in cooperation with the supplier. The price is relevant in the leverage items, the author proposal is competitive tendering. The bottleneck

items are normally eliminated. This will cause challenging situations in the aviation engine maintenance since the entire industry is highly regulated by governments.

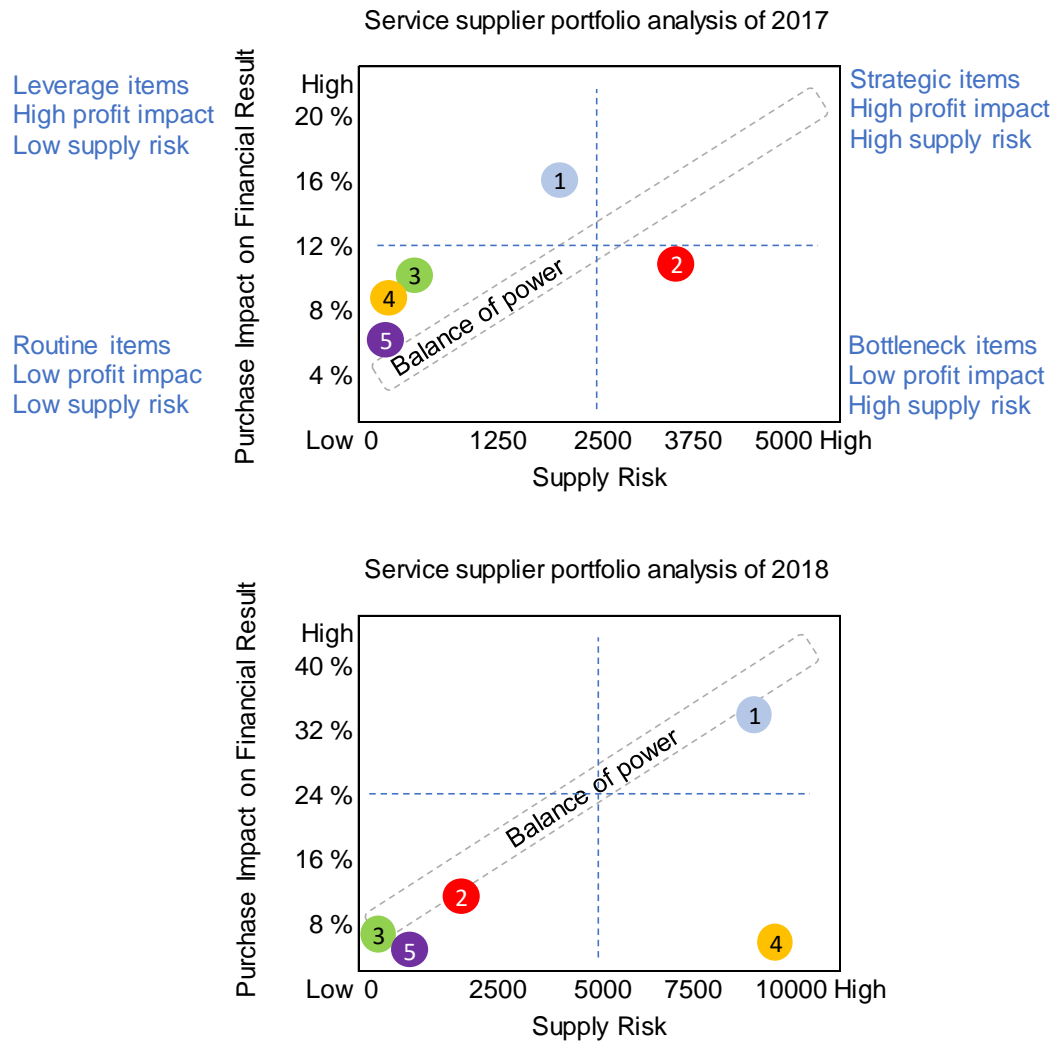


Figure 13. Service supplier portfolio analysis of 2017- 2018.

Table 18 contains top five part numbers of overhaul service. The table is sorted based on the monetary volume of the purchasing. The table contains the percentage and the quantity of purchasing and the number of suppliers which provide these services.

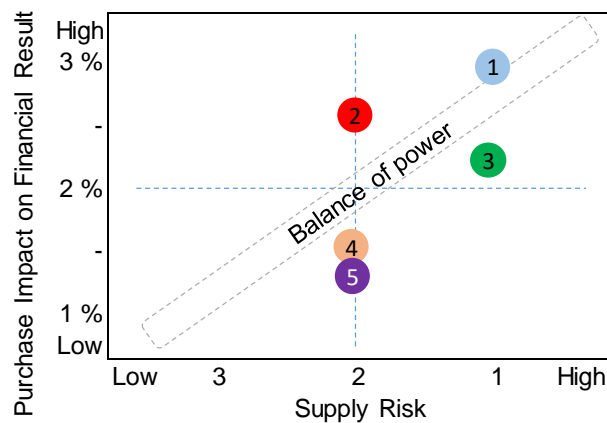
Figure 14 displays Kraljic's portfolio analysis of top five service subcontracting part numbers (Table 18). The figure shows the portfolio analyses for the year 2017 on top and for the year 2018 on the bottom. The horizontal axis indicates the number of the supplier available in the market to provide an overhaul service for a certain part number. The vertical axis shows the purchasing percentage which measures the financial impact of a certain service on an annual basis. In this thesis, it is assumed that the higher is the purchasing percentage the higher is the impact on profit. The part numbers are equipped with

color codes to facilitate the visualization of the analyses. Items: 1, 2 and 3 with blue, red and green color, are positioned in the strategic sector in the right upper corner of the matrix, which has high profit impact and high supply risk. Items: 4 and 5 are positioned between the routine and bottleneck sector with low profit impact and high supply risk.

Table 18. Top five service subcontracting part numbers portfolio analysis of 2017-2018.

Subcontract Purchasing 2017		Total [€]	Total [€] %	Quantity	Suppliers
1	P1	22 398.69 €	0.3 %	13	1
2	P2	20 459.03 €	0.3 %	5	2
3	P3	17 028.72 €	0.2 %	94	1
4	P4	12 663.23 €	0.2 %	2	2
5	P5	12 277.85 €	0.2 %	135	2
Subcontract Purchasing 2018					
1	P1	85 584.48 €	5.8 %	145	1
2	P2	77 793.56 €	5.3 %	460	1
3	P3	65 656.28 €	4.5 %	8	1
4	P4	54 981.72 €	3.7 %	143	1
5	P5	43 960.76 €	3.0 %	218	1

Top 5 Service Subcontracting Part Numbers 2017 Portfolio



Top 5 Service Subcontracting Part Numbers 2018 Portfolio

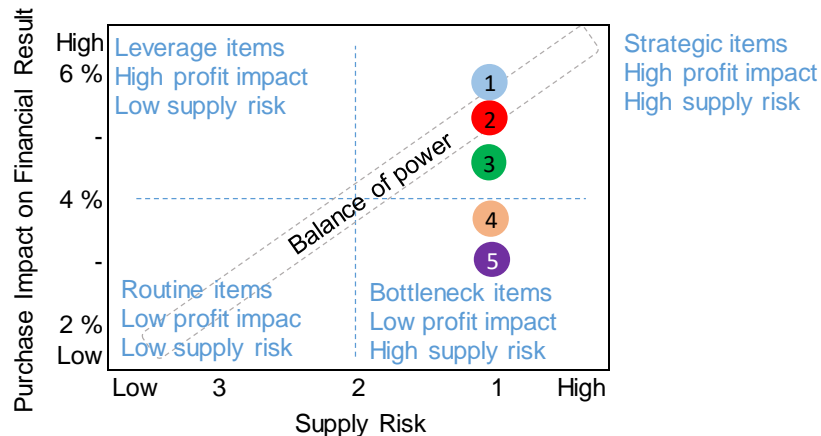


Figure 14. Part number portfolio analysis of 2017- 2018.

As an example, and according to interviews, engine fastener maintenance can be categorized as a routine service. The purchasing process of this category can be developed together with the service provider. Routine service can possibly be focused on one supplier.

The price is a relevant factor for the leverage items, therefore, if there are service providers in the market and if changing the vendor does not require investment, the recommended strategy is the competitive tendering of the potential engine component.

The lead time of overhauling a small engine component such as a fastener can be considered as a bottleneck issue. The primary strategy is to eliminate the bottleneck service provider. For example, by possibly cannibalizing the component with overhauled spare parts available in stock.

For the strategic services provider category, the aim is to improve the relationship with the vendor. Providing the services in-house is also an alternative for outsourcing.

## 5 Discussion

Developing a procurement and supplier classification model for civil aviation engine maintenance, repair and overhaul was a very interesting topic to write a thesis. The direct procurement is not breakdown in the income statement. This thesis clarified why the case company should classify its procurement and suppliers.

The discussion chapter contains five subchapters. The first subchapter reveals the key results related to investigative questions (IQ). The second subchapter justifies the validity and reliability of the analysis methods and their results. The third subchapter offers recommendation on how to benefit from results. The fourth subchapter contains proposal for future research. The fifth subchapter reveals what have the author learned from this thesis.

### 5.1 Key Results

Recalling the research question (RQ) of this thesis, the objective was to find out what kind of model facilitates the direct procurement and supplier classification. The RQ was divided into four investigative questions (IQ). This subchapter reveals the key results associated with all IQs.

The IQ1 focused on finding issues related to direct procurement and their supplier, which should be evaluated using classification in the case company. Primary research in the form of personnel interviews were implemented to answer IQ1. The interviews revealed that classification depends on business operation and on what exactly is aimed by classification. According to interviews, the procurement lead time is an issue particularly when considering service subcontracting procurement lead times (Table 11).

The absence of a uniform and solid method and related user friendly Business Intelligence (BI) tools for the classification of procurement and supplier maybe one of the reasons why:

- the management of the lead times is a challenging task
- the number of suppliers is high, which complicates the supplier relationship management, procurement management and cost monitoring.

The IQ2 concentrated on building the theoretical background to this thesis and to support the interviews implementation in IQ1. The theories supported the interviews finding that the procurement and supplier classification depend on the number of aspects (Table 3). The theory of categorization showed how to divide the procurement and suppliers into

clear areas and thereby help to classify procurement and suppliers (Figure 2). The procurement and supplier classification are usually analysed using the spend analysis, the ABC analysis and Kraljic's portfolio analysis (Figure 5).

The IQ3 focused on developing a model to classify procurement and suppliers. Theories and information found at IQ1, IQ2 and the purchasing statistics of 2017-2018 were applied to implement the procurement and supplier classification model.

The past academic publications revealed that the spend analysis is the main tool for procurement and supplier classification. Seven steps turn out to be suitable for applying in the spend analysis in this thesis. The data cleansing revealed why it is important to improve the quality of the data before starting the actual analyses. The grouping proved to be a simple method of seeing where the money is spent and how much is the monetary volume of purchasing from a certain supplier, which was shown in Table 8. The categorization helped to see where the purchasing has evolved during a certain period of time in Figure 8 and Table 9. A simple lead time analysis model was shown in Table 10. How fast does a certain part number arrives was analyzed in Table 11. Obviously, this analysis helps to provide answer to question: what should be the minimum and maximum stock levels. Table 12 and Table 14 provide a simple model to analyse purchasing history of a certain part number. The spend analysis showed how to find potential development targets and thereby cost saving opportunities.

The ABC analysis revealed part numbers that are the priority to focus on and, therefore, help to enhance the response and to make the right decisions regarding the procurement development. Table 16 is an example where the tail management application possibility should be considered. Kraljic's portfolio analysis highlighted the basic idea of portfolio analysis. Table 18 is a simple analysis model that helps to provide answer to question: what is the supplier and subcontractor market situation for each part number. The complete answer to IQ3. Is available in Chapter 2 and in Chapter 4.

The IQ4. was answered by taking advantage from results achieved in IQ1, IQ2 and IQ3. The model developed in this thesis contains plenty of spend analysis related items, these are, grouping (Table 8 and Table 19), categorization (Figure 8), the purchasing category breakdown (Figure 9), category analysis (Table 1), supplier performance analysis (Table 10), purchasing volume analysis (Figure 10) and purchasing history analysis (Table 12). The practical knowledge and the results provided by the spend analysis will obviously help the case company purchasing personnel to make the right decisions in their daily purchasing operation. Also, they help the case company management to plan future procurement

strategies. For example, combining the spend analysis results with information about coming and past engine MRO-orders helps the company management in decisions making and negotiation with suppliers.

The classification model developed in this thesis also contains the ABC analysis. The results achieved by the ABC analysis (Table 15 and Figure 15), help to prioritize the response and to make the right decisions not only in daily operation but also in future supply chain management related strategies. For example, by optimizing the inventory of various raw materials, semi-finished products or finished products.

The classification model developed in this thesis also contains Kraljic's portfolio analysis. Based on results: the purchasing operations of a routine service can possibly be focused on one supplier. The price is an important factor in leverage products and services, therefore, if there are suppliers available in the market and if changing the vendor does not require investment, the recommended strategy is the competitive tendering. The primary strategy is to eliminate the bottleneck products and services. For example, by possibly cannibalizing the product with the product available in stock. For the strategic products and services, the aim is to improve the relationship with the suppliers. Providing the services in-house is also an alternative.

## **5.2 Validity and Reliability**

In this subchapter the validity and reliability of the analysis results are justified. In this thesis, the analyses are performed on the purchasing statistics of 2017 and 2018. Three version of data were issued during the thesis implementation. The first version of the data was received on 20<sup>th</sup> February 2019. Cleansing operation revealed that the first version of data not only did not include all relevant items but also contained errors and some useless items. The second version of the purchasing data was issued on 25<sup>th</sup> June 2019. The analyses revealed that the monetary volume of purchasing is too high for 2017-2018. The investigation on second version of data revealed errors in form of repeating of the same order number. Thus, lines of purchasing were doubled, tripled and multiplied. The third version of data was issued on 18<sup>th</sup> September 2019, which was free of unwanted repeated errors. Overall three rounds of data investigation, processing, cleansings and analyses were performed on three version of the purchasing statistics of 2017-2018.

The analyses are aimed to show the basic idea in a way that is easily understood, therefore, some simplifications were made in analyses. For example, due to time and resource



limitation, only the relevant parts of the data were analyzed in this thesis. The procurement status is closed after the suppliers deliver and the material arrive in the case company. In this thesis, the order numbers which status are closed are analyzed.

Human factor may be one of the reasons for the order numbers with zero euro value, which is 28% of total order numbers (Table 7) for 2017 and 2018. The missing arrival date affected only the accuracy of the calculation of the average purchasing lead time and their standard deviation. The percentage of the missing arrival date are 9% for 2017 and 15% for 2018.

Three rounds of data investigations, processing, cleansing and analyses is adequate to confirm the reliability of the purchasing data, their analyses and thereby the analysis results. The reference time period of analyses is two years. The purchasing statistics of the case company should be continuously analyzed for a longer period of time, in order to improve the analyses and their results. In the real day to day work the case company needs real time reports which require purchasing history form a longer period of time to input into accurate software.

The content of the analyses is valid since the academic publications confirm the validity of the analysis methods. Therefore, methods used in this thesis are the correct tools for evaluating exactly what is planned to study. Three rounds of analyses were performed in this thesis on three version of data. There was not radical difference between three rounds of analyses except the numerical magnitude. Therefore, the numerical stability of the results is also confirmed.

As a summary, over all the validity of the methods and tools applied is quite high. The reliability of analyses and their results are good, due to the fact that there are some marginal errors and missing items in the data.

### **5.3 Recommendations**

This subchapter provides recommendation. The interviews and analyses results recommend user the friendly Business Intelligence (BI) tools for the case company. These tools are vital for combining huge amount of different purchasing data from different locations to produce the real time reporting. The case company should invest in necessary BI-tools, its personnel and their training to see the potential and benefits of the procurement and sup-

plier classification results. This investment will be paid back by savings from the procurement cost, which comes when the procurement is done correctly in the right time, in the right price, in the right quantity and in the right quality.

BI-tools are derived by data. BI-tools are not better than data entered into them. It is highly recommended to have a uniform data in the system, therefore, avoid entering incorrect data into the system.

The procurement personnel are very intelligent and experienced in the case company. It is recommended that their experiences are used to continuously update the uniform and solid procurement and supplier classification model developed in this thesis. This model should be applied by every junior and senior personnel in the case company every day. It is highly recommended that the procurement and supplier classification results be distributed at the organizational level according to job responsibilities. Obviously, the tasks are efficiently performed when are done according to a uniform model of procurement and supplier classification. The people in the case company should be trained to recognize the potential and benefits of the procurement and supplier classification results.

#### **5.4 Suggestions for Future Research**

This subchapter contains proposal for future research. There is a huge amount of purchasing data which should be continuously analyzed in the case company year after year. The author would suggest a research on the application of automated Business Intelligence (BI) tools. This research can particularly focus on procurement and supplier classification related analysis methods, data analyses and real time reporting issues. For example, the future research can be stated with a new thesis. This thesis can be planned and implemented by the Haaga Helia University students of Information Technology (IT) and Business Expertise.

#### **5.5 Reflection on Learning**

This subchapter reveals information about what have the author learned from this thesis. For the first time the author conducted a primary research in the form of personnel interviews in this thesis. Not only the information provided by interviews helped to understand the situation in the case company but also, they improved the author in business interaction skills.

While constructing the theoretical framework, the author studied the procurement history. Purchasing activities has gradually developed throughout the history. Terminology representing these activities has also evolved. Different terminologies are used in the field of procurement and supplier classification, for example, segmentation, grouping, categorization and their different derivatives. However, all of these terminologies aim to systematically sort and organize the goods, the service and their suppliers.

The category management aims to divide the procurement into clear areas and thereby gain the synergy between the buyer and the supplier.

There are a number of tools for analysing businesses. However, according to academic literatures procurement and their suppliers are usually analysed and classified using the spend analysis, the ABC analysis and Kraljic's portfolio analysis.

While doing the analysis, the author used Excel functions to work on huge amount of data. The spend analysis is simply a procedure to inspect the purchasing of the past time in order to report their condition. The purpose of the ABC analysis is to find an important part of the information in the large mass of data of the procurements. The Tail Management reviews the full range of purchasing that are least important. The Kraljic's portfolio analyses highlighted an important issue in procurement that all products and services do not have the same strategic value.

The case company is noticeably smaller in comparison with some other competitors in the industry. This thesis showed that case company has huge amount of purchasing data to be analysed. Obviously, big players in the industry have even more purchasing data to be analysed.

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## Attachment 1. Grouping of Service Suppliers

Table 19. Grouping of service subcontracting suppliers for the years 2017 and 2018.

Service Suppliers 2017	Total of Closed Status [€]	Total of Closed Status [€] %	Service Suppliers 2018	Total of Closed Status [€]	Total of Closed Status [€] %
S1	119 608.76 €	17 %	S1	356 141.44 €	33 %
S2	75 358.19 €	11 %	S2	109 413.40 €	10 %
S3	70 359.45 €	10 %	S3	88 277.93 €	8 %
S4	59 849.47 €	8 %	S4	72 838.13 €	7 %
S5	46 643.85 €	7 %	S5	53 546.87 €	5 %
S6	41 679.63 €	6 %	S6	50 812.07 €	5 %
S7	37 530.62 €	5 %	S7	46 186.68 €	4 %
S8	30 279.01 €	4 %	S8	36 488.62 €	3 %
S9	29 739.91 €	4 %	S9	27 532.41 €	3 %
S10	27 120.97 €	4 %	S10	23 090.97 €	2 %
S11	23 222.87 €	3 %	S11	19 735.73 €	2 %
S12	21 377.98 €	3 %	S12	18 660.39 €	2 %
S13	20 714.22 €	3 %	S13	17 016.89 €	2 %
S14	15 961.22 €	2 %	S14	16 416.76 €	2 %
S15	15 939.33 €	2 %	S15	14 578.77 €	1 %
S16	14 409.41 €	2 %	S16	13 855.33 €	1 %
S17	12 599.63 €	2 %	S17	12 722.30 €	1 %
S18	8 817.10 €	1 %	S18	10 461.22 €	1 %
S19	7 104.71 €	1 %	S19	9 300.50 €	1 %
S20	4 609.58 €	1 %	S20	7 884.26 €	1 %
S21	4 522.11 €	1 %	S21	7 756.33 €	1 %
S22	4 075.26 €	1 %	S22	7 368.86 €	1 %
S23	3 474.56 €	0.5 %	S23	7 080.55 €	1 %
S24	3 122.00 €	0.4 %	S24	7 019.15 €	1 %
S25	2 620.87 €	0.4 %	S25	5 221.70 €	0.5 %
S26	2 393.65 €	0.3 %	S26	5 049.86 €	0.5 %
S27	2 333.45 €	0.3 %	S27	4 920.08 €	0.5 %
S28	1 968.76 €	0.3 %	S28	4 414.05 €	0.4 %
S29	1 728.91 €	0.2 %	S29	4 208.66 €	0.4 %
S30	1 389.80 €	0.2 %	S30	3 445.69 €	0.3 %
S31	1 260.98 €	0.2 %	S31	3 344.60 €	0.3 %
S32	1 147.50 €	0.2 %	S32	3 299.02 €	0.3 %
S33	981.84 €	0.1 %	S33	3 295.58 €	0.3 %
S34	896.49 €	0.1 %	S34	2 826.90 €	0.3 %
S35	750.00 €	0.1 %	S35	2 790.05 €	0.3 %
S36	748.97 €	0.1 %	S36	2 329.00 €	0.2 %
S37	375.56 €	0.1 %	S37	1 998.15 €	0.2 %
S38	210.17 €	0.03 %	S38	1 255.35 €	0.1 %
S39	184.06 €	0.03 %	S39	894.88 €	0.1 %
S40	0.00 €	0 %	S40	323.47 €	0.03 %
<b>Total:</b>	<b>717 110.84 €</b>	<b>100 %</b>	S41	123.58 €	0.01 %
			S42	76.94 €	0.01 %
			S43	0.00 €	0 %
			<b>Total:</b>	<b>1 084 003.10 €</b>	<b>100 %</b>

## Attachment 2. Analysis of Suppliers Performance

Table 20. Analysis of Spare Part Suppliers Performance in 2017-2018.

Spare Part Suppliers 2017	Total of Closed Status [€]	Total of Closed Status [€] %	Count of Order Number	Average of Lead Time in Days	Standard Deviation of Lead Times
S1	937 520.94 €	40 %	69	1	1
S2	877 695.52 €	37 %	67	1	1
S3	359 841.66 €	15 %	106	1	2
S4	56 246.56 €	2 %	39	1	1
S5	40 952.08 €	2 %	1	1	0
S6	30 215.22 €	1 %	1	0	0
S7	24 343.86 €	1 %	8	1	1
S8	15 380.79 €	1 %	22	1	3
S9	5 203.60 €	0.2 %	3	1	1
S10	4 752.64 €	0.2 %	0	3	5
S11	4 158.58 €	0.2 %	5	1	1
S12	3 226.26 €	0.1 %	2	1	2
S13	2 876.55 €	0.1 %	22	1	1
S14	2 664.15 €	0.1 %	1	0	0
S15	1 818.73 €	0.1 %	3	1	1
S16	1 291.70 €	0.1 %	2	1	0
S17	948.22 €	0.04 %	2	6	5
S18	537.94 €	0.02 %	0	1	0
S19	536.06 €	0.02 %	1	1	0
<b>Total:</b>	<b>2 370 211.04 €</b>	<b>100 %</b>			
Spare Part Suppliers 2018					
S1	3 213 852.35 €	68 %	134	1	1
S2	1 148 735.30 €	24 %	63	1	1
S3	120 540.57 €	3 %	60	1	1
S4	107 941.21 €	2 %	20	1	1
S5	44 526.83 €	1 %	25	1	0
S6	28 597.29 €	1 %	1	1	0
S7	18 492.65 €	0.4 %	2	1	2
S8	7 992.22 €	0.2 %	1	2	0
S9	6 843.78 €	0.1 %	9	1	3
S10	5 346.91 €	0.1 %	3	1	1
S11	4 359.21 €	0.1 %	17	1	1
S12	4 322.09 €	0.1 %	3	1	0
S13	3 634.72 €	0.1 %	5	1	1
S14	3 539.16 €	0.1 %	5	2	4
S15	1 774.09 €	0.04 %	0	1	0
S16	1 476.53 €	0.03 %	2	3	3
S17	283.34 €	0.01 %	0	1	1
S18	227.87 €	0.005 %	0	2	0
<b>Total:</b>	<b>4 722 486.12 €</b>	<b>100 %</b>			

Table 21. Analysis of Service Subcontracting Suppliers Performance in 2017.

Service Suppliers 2017	Total of Closed Status [€]	Total of Closed Status [€] %	Count of Order Number	Average of Lead Time in Days	Standard Deviation of Lead Times
S1	119 608.76 €	17 %	194	4	1
S2	75 358.19 €	11 %	13	4	2
S3	70 359.45 €	10 %	5	4	2
S4	59 849.47 €	8 %	20	3	2
S5	46 643.85 €	7 %	3	4	3
S6	41 679.63 €	6 %	3	4	1
S7	37 530.62 €	5 %	21	3	1
S8	30 279.01 €	4 %	2	4	1
S9	29 739.91 €	4 %	20	4	1
S10	27 120.97 €	4 %	42	3	1
S11	23 222.87 €	3 %	6	3	1
S12	21 377.98 €	3 %	25	5	3
S13	20 714.22 €	3 %	30	6	1
S14	15 961.22 €	2 %	5	3	2
S15	15 939.33 €	2 %	5	2	1
S16	14 409.41 €	2 %	5	3	1
S17	12 599.63 €	2 %	11	3	0
S18	8 817.10 €	1 %	1	2	1
S19	7 104.71 €	1 %	1	5	2
S20	4 609.58 €	1 %	1	5	4
S21	4 522.11 €	1 %	2	3	1
S22	4 075.26 €	1 %	1	2	2
S23	3 474.56 €	0.5 %	18	6	1
S24	3 122.00 €	0.4 %	0	3	1
S25	2 620.87 €	0.4 %	0	3	0
S26	2 393.65 €	0.3 %	1	3	3
S27	2 333.45 €	0.3 %	2	2	0
S28	1 968.76 €	0.3 %	1	7	2
S29	1 728.91 €	0.2 %	1	4	2
S30	1 389.80 €	0.2 %	0	2	0
S31	1 260.98 €	0.2 %	0	1	1
S32	1 147.50 €	0.2 %	1	2	1
S33	981.84 €	0.1 %	2	2	0
S34	896.49 €	0.1 %	0	5	0
S35	750.00 €	0.1 %	0	2	1
S36	748.97 €	0.1 %	1	5	3
S37	375.56 €	0.1 %	1	0	0
S38	210.17 €	0.03 %	0	3	2
S39	184.06 €	0.03 %	0	5	0
S40	0.00 €	0.00 %	0	0	0
<b>Total:</b>	<b>717 110.84 €</b>	<b>100 %</b>			



Table 22. Analysis of Service Subcontracting Suppliers Performance in 2018.

Service Suppliers 2018	Total of Closed Status [€]	Total of Closed Status [€] %	Count of Order Number	Average of Lead Time in Days	Standard Deviation of Lead Times
S1	356 141.44 €	33 %	187	5	1
S2	109 413.40 €	10 %	16	4	1
S3	88 277.93 €	8 %	37	4	1
S4	72 838.13 €	7 %	16	4	1
S5	53 546.87 €	5 %	4	5	4
S6	50 812.07 €	5 %	4	4	2
S7	46 186.68 €	4 %	33	6	2
S8	36 488.62 €	3 %	20	3	2
S9	27 532.41 €	3 %	17	3	2
S10	23 090.97 €	2 %	3	5	3
S11	19 735.73 €	2 %	33	6	1
S12	18 660.39 €	2 %	1	9	5
S13	17 016.89 €	2 %	3	9	3
S14	16 416.76 €	2 %	1	2	1
S15	14 578.77 €	1 %	2	7	7
S16	13 855.33 €	1 %	1	3	2
S17	12 722.30 €	1 %	9	3	0
S18	10 461.22 €	1 %	5	2	1
S19	9 300.50 €	1 %	18	2	0
S20	7 884.26 €	1 %	1	3	1
S21	7 756.33 €	1 %	6	3	2
S22	7 368.86 €	1 %	2	5	4
S23	7 080.55 €	1 %	2	3	1
S24	7 019.15 €	1 %	3	3	3
S25	5 221.70 €	0.5 %	1	4	2
S26	5 049.86 €	0.5 %	0	4	0
S27	4 920.08 €	0.5 %	1	2	1
S28	4 414.05 €	0.4 %	4	3	1
S29	4 208.66 €	0.4 %	1	4	2
S30	3 445.69 €	0.3 %	2	3	3
S31	3 344.60 €	0.3 %	11	8	3
S32	3 299.02 €	0.3 %	1	2	1
S33	3 295.58 €	0.3 %	1	6	2
S34	2 826.90 €	0.3 %	2	3	1
S35	2 790.05 €	0.3 %	1	3	2
S36	2 329.00 €	0.2 %	0	6	5
S37	1 998.15 €	0.2 %	7	8	1
S38	1 255.35 €	0.1 %	1	3	1
S39	894.88 €	0.1 %	1	1	0
S40	323.47 €	0.03 %	1	1	1
S41	123.58 €	0.01 %	0	4	1
S42	76.94 €	0.01 %	0	2	0
S43	0.00 €	0 %	44	5	0
<b>Total:</b>	<b>1 084 003.10 €</b>	<b>100 %</b>			

### Attachment 3. ABC Analysis

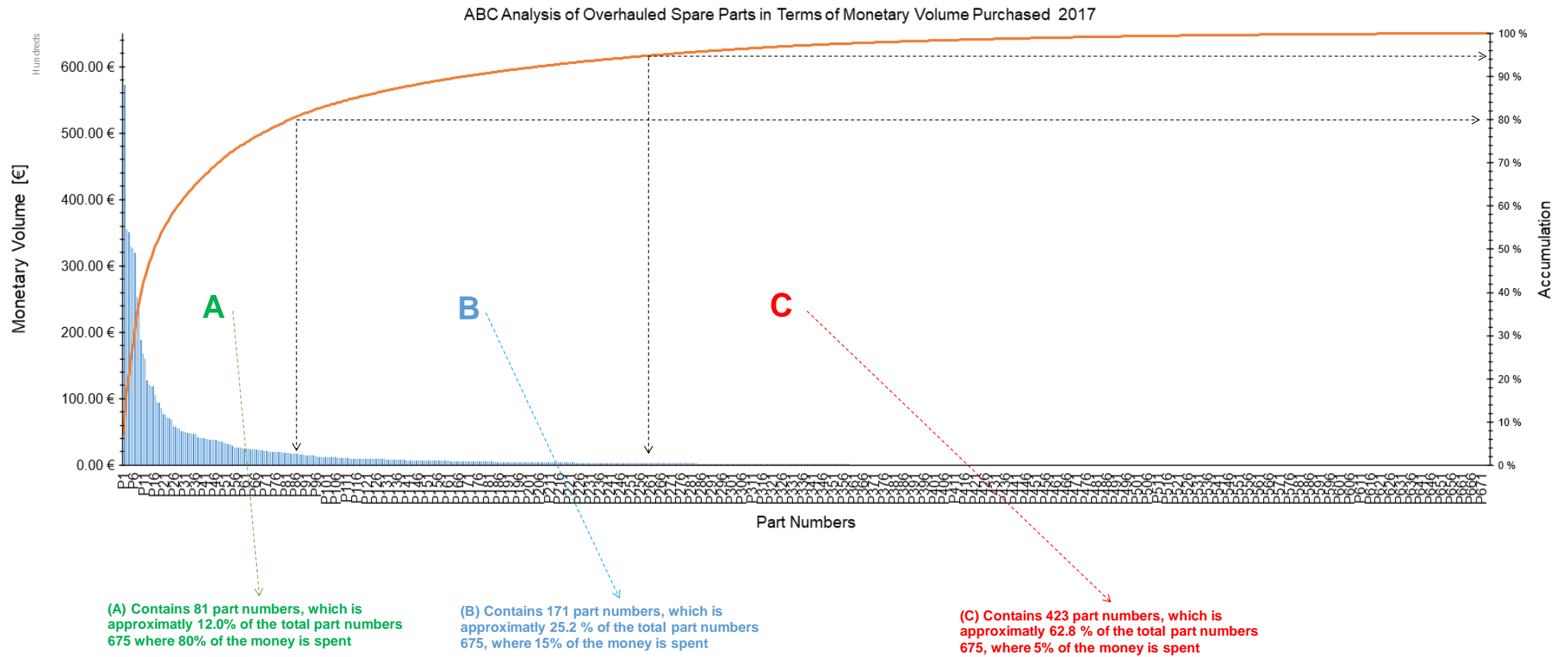


Figure 15. ABC analysis of overhauled spare parts in terms of monetary volume.

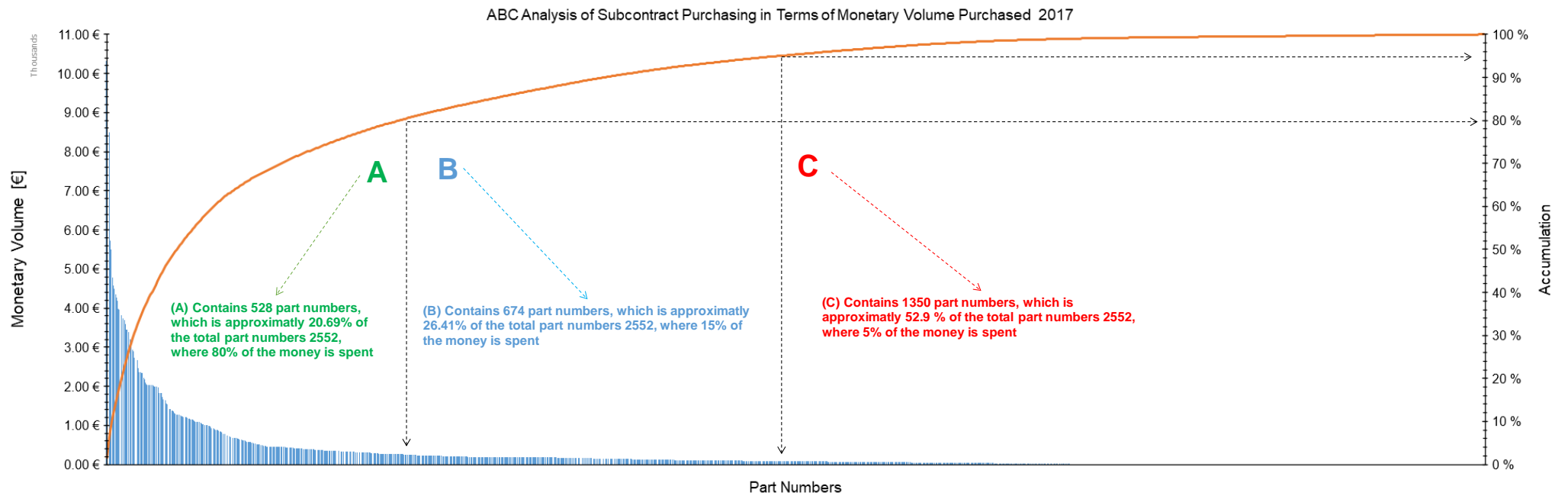


Figure 16. ABC analysis of subcontract purchasing in terms of monetary volume purchased 2017.