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APPLYING SIX SIGMA METHODOLOGY TO PURCHASING PROCESS IMPROVEMENT

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Liiketoiminnan jatkuva kehittäminen luo pohjan yleiselle kannattavuudelle ja kilpailuedun saavuttamiselle. Toimintaa pyritään usein parantamaan keskittymällä liiketoimintaprosessien kehittämiseen. Tämän pro gradu -tutkielman tarkoituksena onkin paneutua liiketoimintaprosessien kehittämiseen case-yrityksen näkökulmasta. Tutkimuksen tavoitteena on selvittää, kuinka yrityksen ostoprosessia on mahdollista parantaa keskittymällä siihen liitännäisiin hankinnan aliprosesseihin. Tutkimus toteutetaan osana Six Sigma prosessikehitysprojektia, jonka tarkoituksena on tunnistaa kehittämispotentiaali, tarjota konkreettiset toimenpiteet prosessin parantamiseksi, sekä varmistaa parannusten ylläpitäminen myös tulevaisuudessa.

Empiirinen tutkimus osoittaa, että ostoprosessia on mahdollista parantaa kehittämällä toimittajan suorituskyvyn mittaamiseen keskittyvä prosessi. Toimittajien operatiivisella suorituskyvyllä on keskeinen merkitys ostoprosessin sujuvuudessa, sekä ostofunktion tuloksellisuudessa. Toimivan mittausprosessin puute johtaa heikentyneeseen toimittajakentän läpinäkyvyyteen, toimittajien heikentyneeseen suorituskykyyn, sekä varotoimenpiteistä aiheutuneisiin lisäkustannuksiin. Vastaavasti toimivan mittausprosessin kehittäminen ja implementointi lisäävät tietoutta toimittajakentästä ja mahdollistavat suorituskyvyn kehittämisen, mikä osaltaan vaikuttaa alentavasti myös liiketoiminnan kustannuksiin. Keskeistä suorituskyvyn mittaamisessa on sen tarkoituksenmukainen ja ennen kaikkea säännöllinen toteuttaminen.

ABSTRACT

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Continuous improvement of business operations creates the foundation for overall profitability and the achievement of competitive edge. Business operations can be improved by focusing on the improvement of business processes. This master's thesis concentrates on examining business process improvement from the perspective of a case company. The study aims to find out, how the purchasing process can be improved by focusing on purchasing sub-processes. The research is being conducted as a part of Six Sigma process improvement project, that aims to identify improvement potential, provide practical ideas for improvement and to ensure that the improvements are being maintained also in the future.

The empirical study shows that the purchasing process can be improved by developing a process for supplier performance measurement. Supplier performance has significant impact on the operational excellence of both, the purchasing process and the purchasing function itself. Lack of operational system for performance measurement may lead to reduced transparency of the supplier base, decreased supplier performance and additional costs. On the other way around, developing and implementing a performance measurement process has potential to increase knowledge of the supplier base, enable supplier development which may also lead to decreased costs. The key factors in the performance measurement are, that the measurement is being conducted appropriately and first and foremost regularly.

ACKNOWLEDGEMENTS

Writing this thesis was a long but first and foremost educating project. Conducting a research driven by personal interest towards process improvement and purchasing management provided a well motivating premise for applying theoretical knowledge in practical business environment. Hence, project proceeded as scheduled without any remarkable challenges or setbacks. Conducting the research deepened my personal knowledge of process improvement and purchasing management, but also improved my skills as a researcher. I am highly confident that these skills are going to be an asset also in the practical working environment.

Completing the thesis and receiving master's degree, acts as an ending point for a period in life as a student in Lappeenranta-Lahti University of Technology. The past year and a half have been demanding, but also extremely rewarding. LUT has provided a well motivating and supporting environment for learning and personal growth. Studying the field of personal interest, getting taught by inspiring lecturers and receiving support from the student community made it easy to stay well motivated. Even though the studies are now over, and the degree is about to be achieved the learning is never going to end but continues throughout the life.

It is also important to point out, that writing this thesis would not have been possible without all the support I got. First, I would like to thank my friends, fellow students, work colleagues and family for all the support I received during both, the studies and the thesis project. Second, I would like to thank professor Jukka Hallikas for guidance, advice and support during the research process. Last, I would also like to express my gratitude to the case company representatives for providing me with the opportunity to conduct the research, but also for the insights and ideas during the process improvement project.

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Table of Contents

1 INTRODUCTION 9

1.1 RESEARCH QUESTIONS AND OBJECTIVES 11

1.2 OUTLINE OF THE STUDY 12

1.3 KEY CONCEPTS OF THE STUDY 13

1.4 THEORETICAL FRAMEWORK 15

1.5 LIMITATIONS 16

2 BUSINESS PROCESS IMPROVEMENT (BPI) 18

2.1 PROCESS THINKING 19

2.1.1 Process as a concept 20

2.1.2 Process identification and classification 23

2.1.3 Process modeling 24

2.2 SIX SIGMA 26

2.2.1 SIPOC 30

2.2.2 FMEA 32

3 PURCHASING MANAGEMENT 35

3.1 PURCHASING PROCESS 37

3.1.1 Determining specification 39

3.1.2 Selecting supplier 41

3.1.3 Contracting 44

3.1.4 Ordering and expediting 47

3.1.5 Follow-up and evaluation 49

3.2 SUPPLIER PERFORMANCE 52

3.2.1 Supplier performance measurement 53

3.2.2 Measurement areas and techniques 55

3.2.3 KPI based supplier scorecard 59

4 PROCESS IMPROVEMENT PROJECT 62

4.1 CASE BACKGROUND 62

4.1.1 Selecting process for improvement 62

4.2 RESEARCH METHODOLOGY 64

4.2.1 Data collection 65

4.2.2 Conducting the interviews 67

4.2.3 Data analysis 68

4.3 DEFINITION 69

4.3.1 Describing the process with SIPOC diagram 72

4.4 MEASUREMENT 74
4.4.1 FMEA based process risk analysis 75
4.5 ANALYSIS 78
4.6 IMPROVEMENT 82
4.6.1 Workshop 1: Updating the product matrix 83
4.6.2 Workshop 2: Modelling the process with improvements 85
4.7 CONTROL 87
5 DISCUSSION AND CONCLUSIONS 89
5.1 COMPARISON OF THEORETICAL AND EMPIRICAL FINDINGS 89
5.2 ANSWERING THE RESEARCH QUESTIONS 95
5.3 VALIDITY, RELIABILITY AND CONFIDENTIALITY 97
5.4 LIMITATIONS AND FUTURE RESEARCH 99
5.5 CONCLUSIONS 101
LIST OF REFERENCES 103
APPENDICES 115
APPENDIX 1. INTERVIEW TEMPLATES 115
APPENDIX 2. SIPOC DIAGRAM 116
APPENDIX 3. FMEA (1/2) 117
APPENDIX 3. FMEA (2/2) 118
APPENDIX 4. INSTRUCTIONS FOR UPDATING PRODUCT CATEGORIZATION MATRIX 119
APPENDIX 5. SUPPLIER PERFORMANCE MEASUREMENT PROCESS DESCRIPTION 120
APPENDIX 6. SUPPLIER SCORECARD 121

LIST OF FIGURES

Figure 1. Research process
Figure 2. Thesis Framework
Figure 3. Research limitations
Figure 4. Simplified representation of a process
Figure 5. Process hierarchy
Figure 6. Six Sigma Performance Improvement Model
Figure 7. SIPOC-diagram
Figure 8. The generic value chain
Figure 9. Purchasing management: Balancing cost-risk-value
Figure 10. Purchasing process model and related concepts
Figure 11. Purchasing process approach
Figure 12. Detailed and functional specifications
Figure 13. The supplier selection process
Figure 14. Kraljic based portfolio analysis and negotiation approach
Figure 15. Five-Phase Negotiation process by
Figure 16. Factors related to prioritization in expediting
Figure 17. Formal performance control processes
Figure 18. Key metrics for supplier performance measurement
Figure 19. Steps for Supplier Scorecard Development
Figure 20. Supplier scorecard
Figure 21. Sub-process selected for improvement
Figure 22. Interview agendas
Figure 23. Severity of the failure modes
Figure 24. Probability of occurrence of the failure modes
Figure 25. RPN values by each failure mode
Figure 26. Process step RPN averages
Figure 27. Constructed product categorization matrix
Figure 28. Purchasing process in comparison to supplier performance measurement process of the case company.

LIST OF TABLES

Table 1. FMEA document general format
Table 2. Comparison of supplier measurement and evaluation systems
Table 3. Selected research method and justification
Table 4. Selected data collection method and justification
Table 5. Used data analyzing method and justification
Table 6. Background questions and answers on definition phase
Table 7. Questions for generating the SIPOC diagram
Table 8. Questions for generating FMEA

1 INTRODUCTION

In the modern business world companies are continuously looking for possibilities to improve their performance. Toughening competition and rapidly evolving business environment create challenges that require companies to constantly develop their operations. Pilachowski (1996, 1). Improvement is required in all areas of business including supply chain and purchasing. From both economical and operational perspectives, the purchasing management has significant impact on the supply chain performance and further on, the overall profitability of the company. (Branch, 2006, 7).

Purchasing management focuses on the management of company's external resources so that the goods, services, capabilities and information required are being acquired effectively and with the most favorable terms (van Weele 2005, 10-14). In practice, this requires purchasing function to ensure the efficiency of both the actual purchasing process and the performance of the suppliers. Suppliers can also be perceived as extensions of the actual enterprise and hence, well performing purchasing process has potential to provide increased value for both, the buying company and its suppliers (Baily et al. 2008, 423). From this perspective the importance of well performing purchasing process can be argued to be evident.

Business process management (BPM) considers business operations as a network of various processes that are also often extended over functional and even organizational boundaries. Management of these processes creates the foundation for operative business outcomes. (Laamanen and Tinnilä, 2009, 10). Further on, overall performance improvements are being pursued through the methods of business process improvement (BPI). (Dumas et al., 2013, 15). This process-oriented improvement approach challenges the traditional function-focused management by primarily organizing and improving business processes instead of different functions (Dumas et al., 2013, 15). The benefits of BPI have been generally acknowledged and therefore, different BPI related management philosophies have also been extensively utilized.

This thesis aims to examine how the purchasing performance can be improved through the methods of business process improvement. In general, process improvement philosophies such as Lean and Six Sigma have been extensively studied and applied in various business environments. Theoretical background of the purchasing performance could be defined extensive as well. However, each organization operates differently and could therefore, be defined as unique itself. From this perspective, a research gap can be found in the application possibilities of process improvement methodologies in new specific business environment.

This research aims to provide an example of how the business process improvement can be conducted within the purchasing function of selected case company. In practice, this thesis aims to improve the overall purchasing process performance by first, identifying and selecting a purchasing sub-process with highest improvement potential. Second, the selected purchasing sub-process will be systematically improved by applying BPI related Six Sigma methodology on the process. Research related to purchasing sub-processes could also be defined as comparatively limited and hence, novelty value can also be seen from this perspective.

Case company's requirement for systematic process improvement acts as a primary premise for the thesis. Therefore, increased emphasis is being placed on managerial implications and proposals for practical improvements. Considering this perspective, the conduction of the research is also highly pragmatic and follows closely the conduction Six Sigma process improvement project. The project is being initiated by first considering the existing literature and second, conducting and reporting different phases of the improvement project. As a result, the research should provide suggestions on how the case company's purchasing process performance can be practically improved.

1.1 Research questions and objectives

The objective of the study is to improve purchasing process overall performance by selecting, analyzing and improving a purchasing sub-process with highest improvement potential. This objective will be approached through the existing literature and theories about business process improvement and purchasing management. This theoretical framework will then be mirrored towards actual business operations of the case company´s purchasing function.

The main objective of the study is being supported with three additional sub-objectives. The first sub-objective is to identify and select the most potential sub-process for improvement. The second sub-objective is to identify defects and errors related to this process through systematic examination and analysis. Lastly, the third sub-objective is to provide suggestions for process improvement. Based on these objectives, the main research question is being formulated as follows:

How the purchasing process performance can be improved by developing a purchasing sub-process?

The main research question will be approached through four sub-research questions which are closely linked on the sub-objectives of the research. The sub-research questions are being formulated as follows:

- Which purchasing sub-process should be selected for improvement and why?
- What kind of defects can be found in the process?
- How the selected process can be improved?
- What benefits can be achieved by improving the process?

1.2 Outline of the study

The research process consists of five different phases as figure 1 below demonstrates. First, the research background, research gap, research questions, and limitations are being briefly discussed on the introduction chapter. Theoretical perspective is then considered by conducting a literature review, that constructs the theoretical basis of the study based on theories of business process improvement and purchasing management. Further on, this theoretical framework acts as a guideline for the empirical section of the study.

Following to the theoretical part of the study, thesis demonstrates empirical data collection and the conduction of the process improvement project. This section first represents case background information and research- and data collection methodology. Followed by the brief introduction to the case study, section represents different phases of the improvement project in accordance to the Six Sigma DMAIC framework.

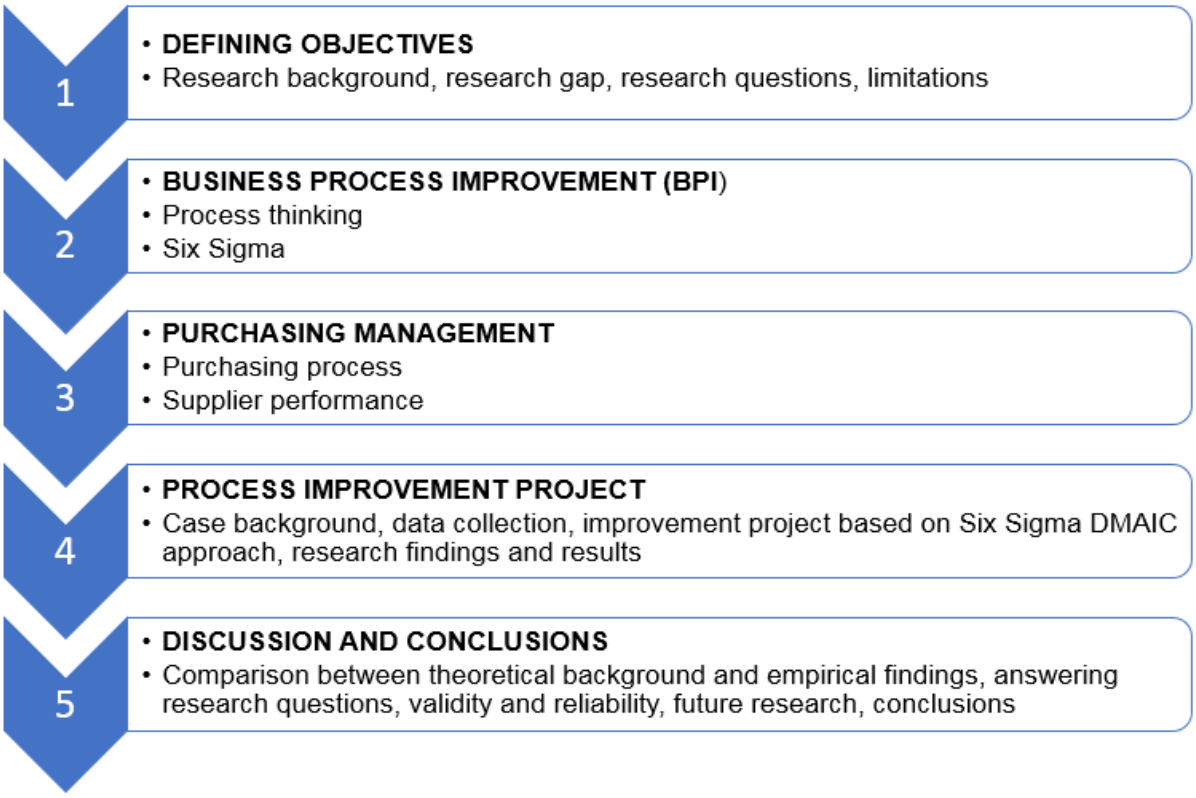

Figure 1. Research process

Last, the research aims to create connection between theoretical background and empirical findings. Empirical findings are being analyzed and mirrored towards theoretical background through discussion, evaluation and critics. This section concludes the whole research project by providing answers on the research questions, assessing the validity and reliability of the research and by providing insights about future research possibilities.

1.3 Key concepts of the study

The definition of the relevant concepts enables appropriate approach towards research objectives. The main concepts of this study are process thinking, Six Sigma, purchasing process, supplier performance and supplier performance measurement. This section aims to provide a concise definition for these concepts, yet they will be discussed more thoroughly in theoretical section of the study.

Process thinking refers to a mindset where a set of activities is being perceived as a chain that creates value for the customers (Laamanen and Tinnilä, 2009, 10). Processes consists of different activities that may include various tasks. The completion of the previous activity initiates the next and value is being created and transferred through these transactions within and between the processes. (Kirchmer, 2011, 3). Process begins with an input to a specific functional area, proceeds through a set of activities and results as an output of the process. This output can then be interpreted as an input for the following process. (Damij and Damij, 2014, 16).

Six Sigma is quality management philosophy that aims to improve processes through systematic and logical approaches. This method improves operational competence by decreasing defects and variation in the process (Wang et al., 2004, 1-2). Six Sigma is a flexible and adaptive tool for business process improvement, based on clearly defined operations model within the organization (Ihalainen and Hölttä, 2001, 39). It is a philosophy that strives to achieve and maintain commercial success by considering customer requirements and needs (Santana, Marzagão and Carvalho, 2016).

Purchasing process is a process conducted by the purchasing function, designed to acquire goods and services for the organization (Erridge, 1995,11). Purchasing process consists of multiple stages and is partially extended over organizational boundaries (Johnsen, Howard and Miemczyk, 2014, 34-35). International purchasing processes are often complex and may require expertise in multiple disciplines such as logistics, marketing, design and finance. (Branch, 2006, 7). Purchasing process aims to gain benefits of the company's external resources so that the goods, services, capabilities and information required for the management and maintenance of the company's primary and support functions are acquired with the most favorable terms (van Weele, 2005, 10-14).

Supplier performance refers to the supplier's overall capability to deliver requested business results. It has significant impact on the overall purchasing performance through cost reductions, quality-, delivery-, innovation- and service performance. (Johnsen et. al., 2014, 4). Supplier performance refers to the supplier's ability to supply required products in accordance to the terms of quality, delivery, responsiveness, cost, and technical support (Wu, Choi and Rungtusanatham, 2010). Supplier performance has significant impact on the overall purchasing performance and should therefore, be continuously measured and further on improved (van Weele, 2005, 278).

Supplier performance measurement is part of the follow-up actions related to the last phase of the purchasing process. It concludes the purchasing process cycle and provides a point of reference for the upcoming supplier selections. (van Weele, 2005, 64). Supplier performance measurement consists of various systems and methods to collect, analyze, measure and rank suppliers on a continuous basis (Monczka, Trent and Handfield, 2005, 269). It does not only integrate supply chain stakeholders, but also improves the overall performance of the supply chain (Dey et al., 2015). Supplier performance is being measured to discover the areas where the performance is below the standards (Johnsen et. al., 2014, 115).

1.4 Theoretical framework

Theoretical framework of the study relies strongly on the process perspective. This approach aims to provide conceptual background about the processes in general, but to also act as a guideline for the empirical part of the study. Theoretical framework is being constructed methodically in accordance to the research objectives. Data collection was conducted systematically, based on the selected keywords and relevant authors related to theories, through various databases (LUT Finna, Springer, Lutpub). As the figure 2 below represents, the main theories of the study are business process improvement (BPI) and purchasing management.

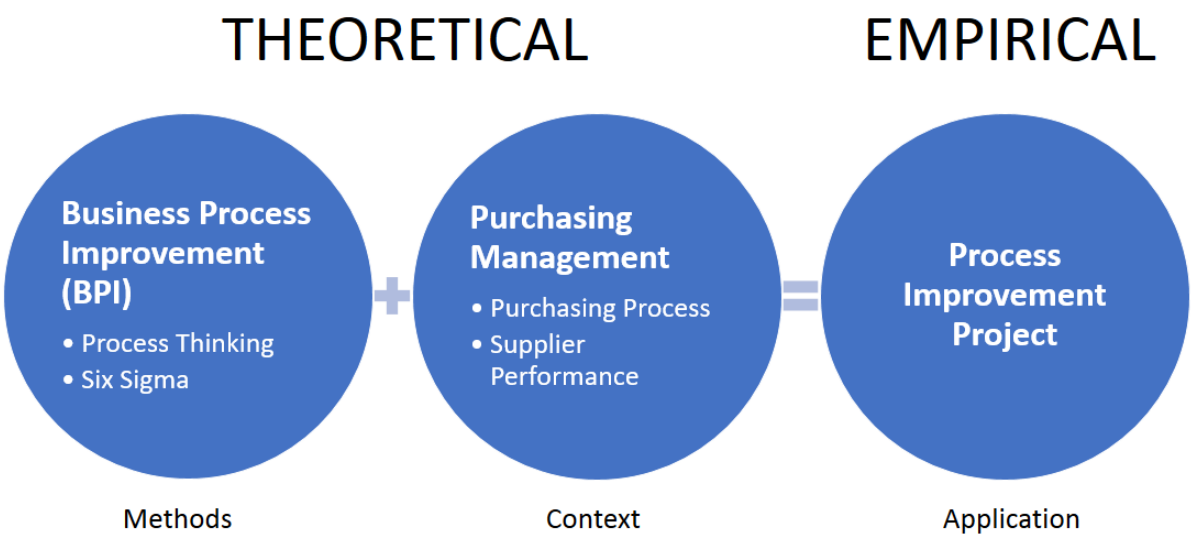

Figure 2. Thesis Framework

As can be seen from the figure 2 above, business process improvement acts as a first part of theoretical framework with subsections, process thinking and Six Sigma. Process thinking forms the foundation for the whole business process improvement and is therefore, being discussed below this theory. Six Sigma methodology is being utilized on the process improvement project on the empirical section of the study and therefore, considering theoretical perspective of this improvement methodology plays a major part in the success of the research.

Purchasing management as main theory and subsections purchasing process and supplier performance are acting as a second part of the theoretical framework as can be seen presented on figure 2. Considering purchasing management and especially purchasing process diverts the focus from general process management closer to the actual purchasing function and operative purchasing. The main objective of this study is to provide improvements on the purchasing process and therefore, this process is being thoroughly discussed in theoretical part of the study. In addition to the actual purchasing process, supplier performance also has significant impact on the overall performance of the purchasing function. Supplier performance measurement process is also being examined on the empirical part of the study and therefore, this topic is being considered as a subsection below the purchasing management theory.

Theoretical framework was mainly constructed prior to conduction of empirical part of the study. However, the last part (supplier performance) was included on the framework only after process for the empirical improvement project was selected. This decision enabled more appropriate and specific theoretical approach towards the research objectives. It also provided more thorough understanding of the supplier performance measurement process and hence, enabled more specified theoretical perspective for the empirical data collection.

1.5 Limitations

The research is being conducted as a qualitative single case study within a specific case organization. This approach limits the generalizability of the research findings due to the high context dependency of the researched phenomenon (Tuomi and Sarajärvi, 2009, 28-30). The research is being carried out as a one-time project within a specific period of time. Processes and working practices are constantly evolving in a highly dynamic business environment. Therefore, the research results are also limited on the present situation of the company and some of the findings may not be valid after some time.

The case company operates internationally on multiple continents. Purchasing functions and purchasing processes differ in different business units. This thesis is

being conducted as a single-case study and therefore, research is being limited on specific business unit located in Finland. This approach enables a more specific and local expertise of the purchasing process in the business unit, but also decreases the requirement of resources needed for the execution of the research from the perspective of the case company. Thesis also aims to provide proposals for improving the purchasing process, and these proposals are often more easily implemented within a specific business unit instead of the whole company.

The case company operates in the manufacturing industry, but also provides customers with external products. It is sourcing both, finished goods and raw materials for production. Material purchasing is being executed by the supply chain function and finished goods are being sourced by the purchasing function which operates as a separate unit within the supply chain organization. Material purchasing is closely linked to the production planning and manufacturing processes which can be defined as partly technical. Therefore, this thesis focuses on the sourcing of finished goods by the purchasing function and excludes the material purchasing from the research.

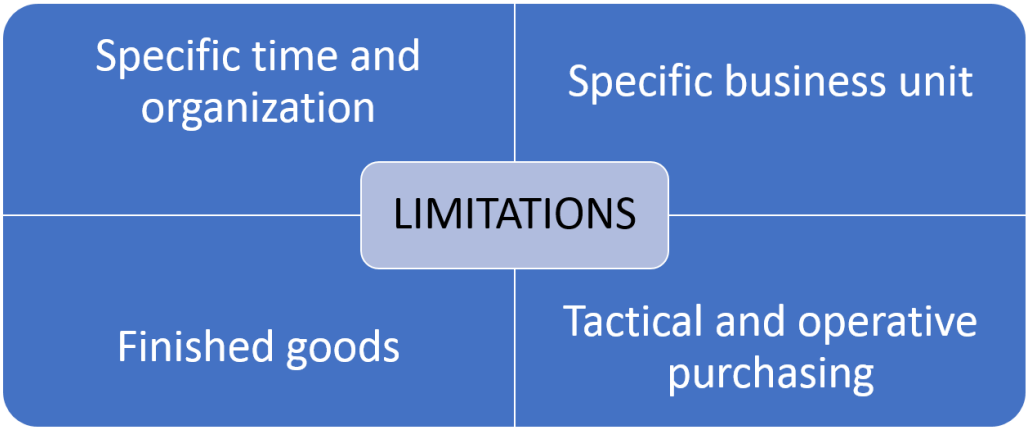

Figure 3. Research limitations

Purchasing can be classified as strategic, tactical or operative. This thesis, however, focuses on tactical and operative purchasing. Both, tactical and operative purchasing are being executed by the purchasing function of the case company in a regular basis and hence, can be thoroughly examined. Strategic purchasing, however, is often extended over the boundaries of the specific business unit and therefore, it won´t be discussed further in this research.

2 BUSINESS PROCESS IMPROVEMENT (BPI)

Traditionally, the management of different organizations has relied strongly on function focused hierarchies. Different internal organizations specialized on specific functional areas of business have been conducting different sets of activities related to their own areas of expertise. (Damij and Damij, 2014, 10-11). This leadership method has enabled function specific control of resources through budgeting, specified objectives and rewarding systems. (Laamanen and Tinnilä, 2009, 6).

However, the business environment has changed significantly during the past decades through globalization, IT-related innovations, digitalization, consumer awareness and improved quality requirements. (Laamanen and Tinnilä, 2009, 6). This has led to the situation where function-focused organizations have begun to evolve towards more horizontally oriented process organizations. This change has also led companies towards more process-oriented management method generally known as business process management (BPM). (Lehnert, Linhart and Roeglinger, 2017). This management method focuses on the management of core business processes, where function related responsibilities are being replaced with process ownerships. (Hannus, 1994, 31-32).

BPM focuses on improving the operational performance through business process improvement (BPI). This method concentrates primarily on organizing and improving the performance of the processes instead of different functions (Islam and Daud Ahmed, 2012). The key idea of this management method is to enable flexibility and increased value creation based on the requirements of the end customer. (Dumas et al., 2013, 15). However, main business processes are often extended over organizational boundaries and may therefore, be challenging to improve. (Hannus, 1993, 32).

The quantitative objectives of the BPI are comparatively similar to functional oriented performance improvement. Profitability, customer satisfaction, productivity and employee competency are desired outcomes in both improvement methods. However, the set of tools to achieve these objectives differ between the methods. When

functional management relies strongly on cost-effectiveness, function related objectives and tendering suppliers, the BPI relies on the benefits of speed, flexibility, cooperation, operational excellence and partnerships. (Laamanen and Tinnilä, 2009, 7).

It can be argued that business process management acts as one of the core drivers for business improvement and innovation. Considering end-to-end business processes from the perspective of end customer enables organizations to achieve improved business outcomes through increased customer satisfaction and process dynamicity. (Hantry et al., 2010). However, to be able to implement this management philosophy effectively, process-oriented mindset and understanding of the processes from network perspective can be argued to be crucial.

2.1 Process thinking

Function-focused management philosophies have been criticized for dividing organizational functions on separate silos. This can be perceived extremely harmful especially from the perspective of cross-functional processes. (Bolstorff and Rosenbaum, 2003, 21-22). As (Laamanen, 2001, 18) pointed out, modern organizations have started to realize the limitations and disadvantages of functional management philosophies and therefore, begun to concentrate on identifying and improving specific business processes.

As Bolstorff and Rosenbaum (2003, 21-22) describe, process-oriented managers are considering performance as a result of interaction between different phases of the process. This kind of perspective enables wider and more comprehensive approach towards business operations as inputs, process steps and outputs are being perceived as interactive entity of value creating activities. This kind of viewpoint is also being defined as process thinking. It forms the foundation of the BPI but what are the basic principles behind the process thinking philosophy?

Based on the definition of Laamanen (2001, 21-22), the core idea of the process thinking is simple: Customers and their needs are being considered first. From there,

the focus is being turned on the products and services (outputs) that fulfill these customer needs. Next the process (activities and resources) is being designed to deliver required products or services to the customer. Lastly required information and resources (inputs) to execute the process, and the channel to acquire them (suppliers) are being considered.

According to Hannus (1993, 41) process thinking follows three main principles: The process always has a customer that receives the output, it can be extended over functional or organizational boundaries, and it should always be evaluated from the perspective of internal or external customer. Conclusively, process thinking begins from the customer need and ends on fulfilling it. In the modern markets, this kind of customer centered approach can be argued to be conducive factor for overall business excellence. Laamanen (2001, 22) agrees and argues that process thinking may lead to the achievement of the following benefits:

1) Cooperation with the customer is fluent and the customer is happy with the quality of service
2) Employees are understanding the big picture and their roles in value creation as a part of the organization entity.
3) Improvements in business operations are being executed in accordance to the customer needs and the overall objectives of the organization.

Hence, the benefits of the customer-oriented process orientation can be argued to be evident. The core of the process thinking philosophy is to create increased value to the customers through business process improvements (Laamanen and Tinnilä, 2009, 10). However, to be able to execute process improvements effectively, the process must be understood also from the conceptual perspective.

2.1.1 Process as a concept

Harrington (1991, 9) defines process as “any activity or group of activities that receive an input, adds value to it, and produces output to internal or external customer”. According to Laamanen and Tinnilä (2009, 121) process can be defined as a

“combination of logically related activities and resources needed to transform inputs to outputs. Fleischmann, Raß and Singer (2013, 1) in turn define process as a “structure consisting of logically connected tasks, operators, material expenses, and information”. Each of the presented definitions describe process from different perspective and can therefore, be argued to be correct. In addition, figure 4 below represents the elements of a process based on the definition of Laamanen (2001, 20), adapted from Hannus (1994, 48).

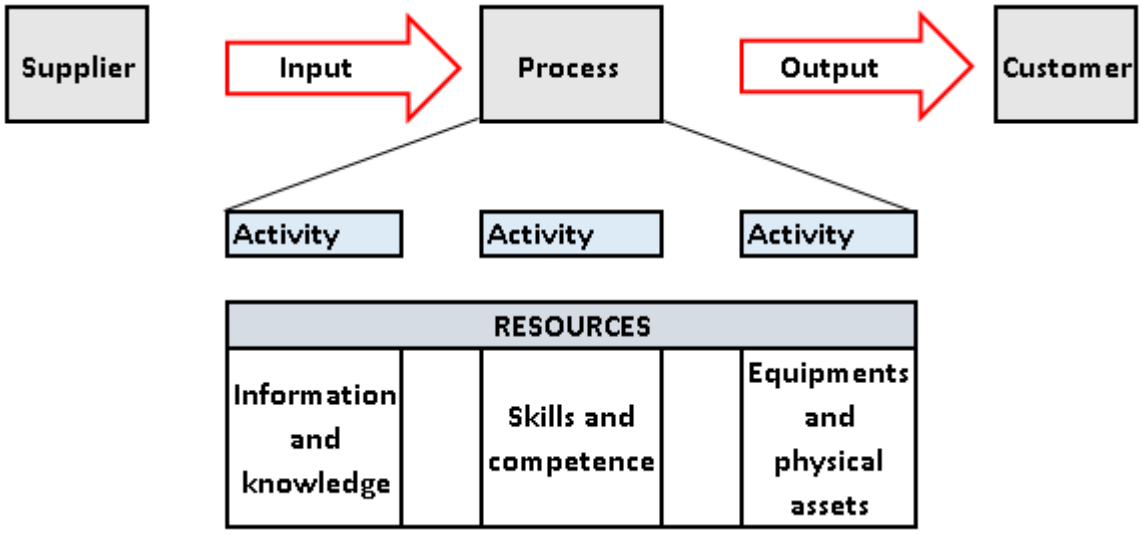

Figure 4. Simplified representation of a process (Laamanen, 2001, 20)

As the Figure 4 demonstrates the basic principle of the process is simple: It receives and input, performs a set of activities and as a result, delivers output to a customer. As Laamanen and Tinnilä (2009, 108-116) described input may refer to information, material or any other kind of impulse that initiates the process and the other way around, output refers to any kind of information, material or product that has been produced as a result of the process. Both Laamanen (2001, 20) and Hannus (1994, 48) are pointing out the importance of the resources required to execute the set of activities. These resources are highly process specific and are often crucial for the effective execution of the process. Generally, in the context of business processes information, skills, and physical assets are often being identified as process resources.

From the organizational perspective, business operations do not consist of isolated processes, but act as an interactive process network. Different processes are closely

connected to each other and often extended over functional boundaries. According to Esseling, Harrington and Nimwegen, (1997,2) different processes require different kind of resources but also differ in their level of importance. This creates requirement for process prioritization and further on, the definition of process hierarchy. From this perspective, processes can be determined to different levels as can be seen from the figure 5 below.

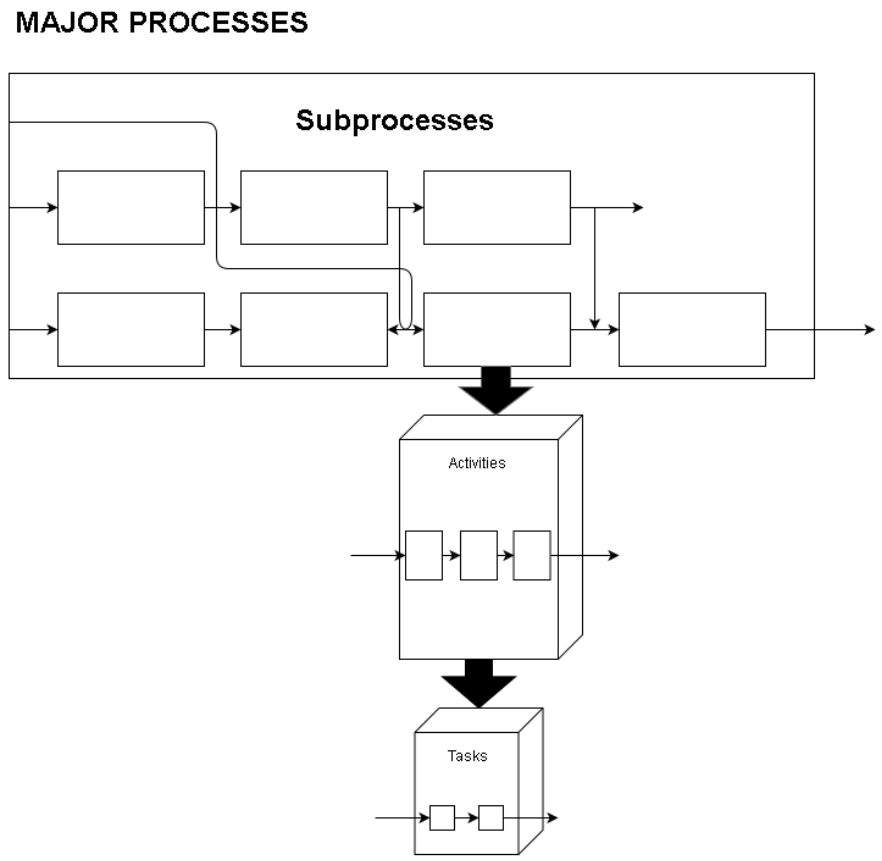

Figure 5. Process hierarchy (Esseling, Harrington and Nimwegen, 1997,2)

As the figure 5 represents, the highest level of the process hierarchy are major processes. These major processes consist of various sub-processes that may include various sets of activities. These activities can then further on be divided into different tasks required to perform individual activities. (Esseling, Harrington and Nimwegen, 1997,2). A perspective by Harrington, (1991, 30) concludes the process hierarchy from the macro view perspective, as different activities related to upper level processes can also be defined as sub-processes themselves.

The practical implementation of the business process management relies on the idea of process ownerships. In practice this means that each major process has appointed process owner who takes the responsibility of the overall performance of the process (Hannus, 1994, 363). This responsibility may include various tasks and activities such as supervision, planning and development of working methods and information systems. It may also contain measurement, evaluation, reporting and process improvement activities. (Laamanen and Tinnilä, 2009, 127). According to Hannus (1994, 40) process ownerships are usually appointed to individual supervisors but in practice, processes are being executed in teams.

2.1.2 Process identification and classification

In order to effectively analyze the process, it has to be first identified accordingly. According to Laamanen (2001, 52) process boundaries should be defined based on where the process begins and where it ends. In addition to the actual process steps, identification should also consider the main inputs, outputs and customers. As Pesonen (2007, 133) argues, identification of the organizations main business processes leads to the construction of organizational process map, that also promotes the overall understanding of business operations of the company.

According to Westcott (2003) process identification plays a major role especially in quality management. Quality standardizations such as ISO 9001 are underlining the importance of the systematic process models. To be able to construct these models accordingly process networks need to be identified and documented. As Laamanen (2001, 52) describes the process identification should follow three basic principles:

1) The identification of the process should be based on the idea that the process always begins and ends on the customer
2) Process map should be constructed with precision as it acts as a basis for improvement throughout the whole organization
3) The processes should be identified and mapped as an interactive network that also considers customers

As soon as the processes have been identified, they can also be classified. According to Laamanen (2001, 53) processes can be classified with various criteria's that may lead to definitions such as product-, service-, customer- main-, core-, support-, key-, or control processes. However, as Dijkman, Dumas and Ouyang (2008) point out most commonly used method for classifying processes is to divide them in core- and sub-processes. Based on this definition, core-processes have direct impact on the value creation and are often extended to external customers. In turn, sub-processes are acting as supportive element, and their existence is often vital for the effective execution of the core-processes (Laamanen, 2001, 53).

2.1.3 Process modeling

As previously described, the identification of organizations processes leads to the construction of organizational process map that represents all relevant business processes and their mutual relations. (Heinrich et al., 2007). Even though process map provides a valuable overview on organizations operations, the development of individual processes requires a more detailed description produced by process modeling. This method has commonly been used in business process improvement. It provides knowledge about different steps and activities in the process and can therefore be used as instructions, base of communication, tool for analysis or guide for process (re-)designing. (Hewing, 2014, 77-78).

According to Laamanen (2001, 75) process modelling is a method for demonstrating the actions of the organization in a way that promotes understanding, analysis and improvement. As Anastassiu et al. (2016) argue this technique provides an appropriate visualization of business process that is in most cases, easier to apprehend than written descriptions. Krogstie (2016, 18) agrees as process modeling techniques provide conceptual process models that can also be used and interpreted extensively regardless lingual and interpretative limitations.

Processes can be modelled in various ways and the most appropriate method is highly dependent on the organization and business environment. Regardless of the selected

modeling method Laamanen (2001, 76) argues that the generated process description should fulfill the following criteria:

- The process description includes all the critical aspects related to process
- It demonstrates relevant connections and relationships within the process
- It helps to understand both, the overall process and the importance of individual performance in relation to the achievement of business objectives
- It promotes cooperation between different stakeholders related to process
- It enables flexibility in process within defined boundaries

The main feature of the process description is that it can be easily interpreted and understood (Laamanen 2001, 76). According to Trent (2008, 147) process flowchart is generally used technique for graphical process illustration. In practice, flowchart represents the existing or proposed process by using simplified symbols, shapes, lines and words to display different activities and their connections in the different phases of the process. Harrington (1991, 87) however, underlines the achieved benefits of the flowchart method. Flowchart represents logical order of different tasks and their relations which should further on be used as a guideline for practical execution. This approach enables the identification of defects and errors, especially when the process is not being executed in accordance to the description.

Hence, flowchart can be perceived as a valuable tool for both, process modeling and process improvement. However, description should always be generated based on the expertise of the process owner. (Harrington 1991, 87). As Laamanen (2001, 86) points out modeling the process may serve various purposes and the process description can be generated to illustrate process from following perspectives:

- Existing process
- Existing process with minor improvements
- Radically improved process
- Ideal process

According to Laamanen (2001, 87) radically improved or ideal processes are usually expensive and resource consuming to implement and therefore, the most preferable option is to model existing process with minor improvements. This kind of approach has potential to deliver performance improvements without significant and resource consuming modifications on the business operations. According to Trent (2008, 148) it may also be beneficial to model both currently existing and lightly improved processes, as it enables a clear visualization of the achieved benefits.

However, as Karjalainen and Karjalainen (2002, 104) argue the generated process description should also be continuously fulfilled and updated. Business operations are constantly evolving and therefore, process descriptions should also be modified. Hence, frequent analysis and evaluation enables processes to perform in accordance to changing requirements also in the future.

2.2 Six Sigma

Six Sigma management philosophy has its roots in 1980 in Motorola's high-volume manufacturing environment. It was originally developed by an engineer Bill Smith and generally acknowledged through the operations of Jack Welch in General Electric. (Pepper & Spedding, 2010, 139). The name "Six Sigma" refers to a statistical measurement method of the defect rate within a system, which basically concludes the Six Sigma philosophy. The management method aims to decrease the number of defects and variation in the process and hence, improve the operational competence through systematic and logical approaches. (Wang et al., 2004, 1-2).

Ihalainen and Hölttä, (2001, 39) are defining Six Sigma as flexible and adaptive tool for business process improvement, that relies on clearly defined operations and responsibilities within the organization. It enables efficiency improvements through organized approach that considers also the economical perspective. Muralidharan, (2015, 5) agrees with the definition, but underlines the importance of customer orientation of the management method. Six Sigma is a business process improvement tool that aims to achieve increased customer satisfaction through problem solving.

Unlike some other quality management methods, Six Sigma considers customer needs as a premise for operational excellence. (Muralidharan, 2015, 6).

Six Sigma management has been effectively utilized in both manufacturing and service industries and Six Sigma methodology has been applied on various types of processes. However, the extensive utilization requires thorough understanding of the management method and management commitment to the philosophy. To be able to achieve the full benefits of Six Sigma philosophy, it should be implemented as a part of the organizational culture. (Ihalainen and Hölttä, 2001, 43).

Six Sigma management promotes continuous improvement through process streamlining and supplier development. It aims to recognize the root causes of the defects, and hence, provide permanent solutions instead of just managing with the current symptoms of the problems. (Muralidharan, 2015, 6). Six Sigma also provides quality level indicator for the process efficiency: The higher the sigma-level of the process is, the smaller the number of defects exist (Wang et al., 2004, 2). According to Pepper & Spedding (2010) the execution of Six Sigma process improvement project proceeds through DMAIC framework that consists of five different phases: Define, measure, analyze, improve and control. Karout and Awasthi, (2017) & Mishra and Kumar Sharma (2014) describe these DMAIC steps as follows:

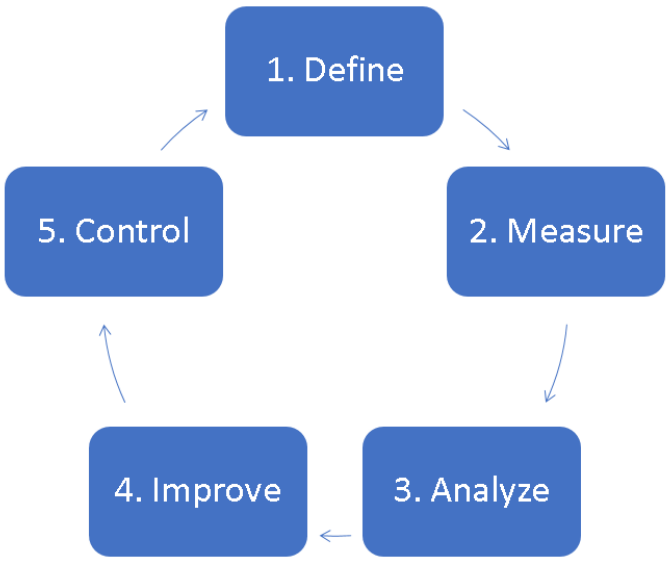

Figure 6. Six Sigma Performance Improvement Model (Monczka, Trent and Handfield, 2005, 255).

- Define: The Six Sigma project begins with a clear definition the problem with specific and operational terms. This definition acts as a guideline and goal for the further improvement. Answers to the questions: What is the problem? What type of defects exist? What are the desired outcomes of the project?

- Measure: The measurement techniques and used metrics are being considered from the perspective of process performance and customer value generation. Answers to the questions: How the process is being measured? How well it performs?

- Analyze: This phase aims to discover the root causes behind defects, errors and excessive variation during the process. Answers to the question: What are the main causes behind defects?

- Improve: Once the root cause has been exposed and understood, the analyst team generates ideas to remove or resolve the problem. Answers to the question: How the causes of defects can be removed?

- Control: The control phase concentrates on maintaining the improvements. This is often being executed through continuous measurement and quality control. Answers to the question: How the improvements can be maintained?

Each of these stages are being carried out by utilizing different Six Sigma tools and techniques. This enables effective execution of process improvement, but also increases the overall control over the system in the long term. (Sharma et al., 2018). According to Ihalainen and Hölttä (2001, 57), improved process is usually selected in the beginning of the project as a result of thorough cost-quality analysis. This enables justified selection of the process with highest improvement potential. Laamanen (2001, 87) however suggests that the process for improvement should primary be selected based on the discussions with process owners and company management.

As Pepper & Spedding (2010) argued, Six Sigma methodology benefits from in-house expertise and employee competence. Training Six Sigma experts in-house combines the benefits of business specific expertise and process improvement philosophy in general. The practical deployment of the Six Sigma philosophy relies on hierarchical belt ranking system, where practitioners are being determined on different belt levels based on their skills and experience (Swink and Jacobs, 2012). As Antony and Karaminas (2016), Ihalainen and Hölttä (2001, 6-11) and Karjalainen and Karjalainen (2002, 73-79) describe the Six Sigma belt hierarchy consists of five main belt levels. Belts, required skills and responsibilities are being presented below:

- Yellow Belts are familiar with the basics of Six Sigma methodology, concepts and tools. They may attend and support on the projects, yet they don't contain required competence to run Six Sigma improvement projects themselves.

- Green Belts are participating on Six Sigma project as project workers under the supervision of Black Belt, normally alongside of their main occupation. Green Belts have extensive Six Sigma knowledge and are also trained in project management, teamwork, problem solving and statistical analysis.

- Black Belts are professionals of the Six Sigma philosophy and usually work full-time as Six Sigma project managers. Black Belts have high expertise of Six Sigma tools and methods and can be defined as professionals of advanced problem solving.

- Master Black Belts are experienced Six Sigma professionals who possess a strong expertise in problem solving. Master Black Belts are also known of their knowledge and skills related to statistical methods, technical skills and change management. Master Black Belts are usually operating as teachers, mentors and trainers for Black- and Green Belts.

- Six Sigma Champions are the managers of Six Sigma within the companies. Champions are responsible of selection and supervision of the Six Sigma projects and are also responsible of removing obstacles related to the projects.

Champions are promoting the Six Sigma philosophy as a part of organizational culture.

Hence, Six Sigma Belt hierarchy provides a clear responsibility allocation based on skills and expertise of the individuals. Different belt levels have their own importance in different areas of the Six Sigma projects. As previously described, Six Sigma combines the individual problem-solving expertise with systematic DMAIC approach and Six Sigma tool set. SIPOC and FMEA are one of the most commonly used tools of Six Sigma and will be more thoroughly discussed in the following chapters.

2.2.1 SIPOC

Six Sigma DMAIC framework begins with defining phase that focuses on recognizing the problem and further on limiting the project to a specific process. This is often executed by describing and mapping the processes. SIPOC diagram is one of the most generally used Six Sigma tool for describing the process. (Muralidharan, 2015, 104). This tool considers extended supplier-customer relationship in addition to simplified input, process, output and can therefore, be described as high-level process map. The name SIPOC acts as an acronym for suppliers, input, process, outputs and customers (John et al., 2008, 34).

SIPOC diagram defines clear start and ending points for the Six Sigma project, but also simplifies and makes otherwise complex process easier to understand. It provides intelligible information about the actual tasks, process steps and responsibilities. (Bhalla, 2010). As Muralidharan, (2015, 105) argues, SIPOC diagram has an ability to expose bottlenecks, missing links, unnecessary steps and redundancies in the process. SIPOC can also be seen beneficial in the cross-functional context, as it demonstrates the sets of activities over functional boundaries.

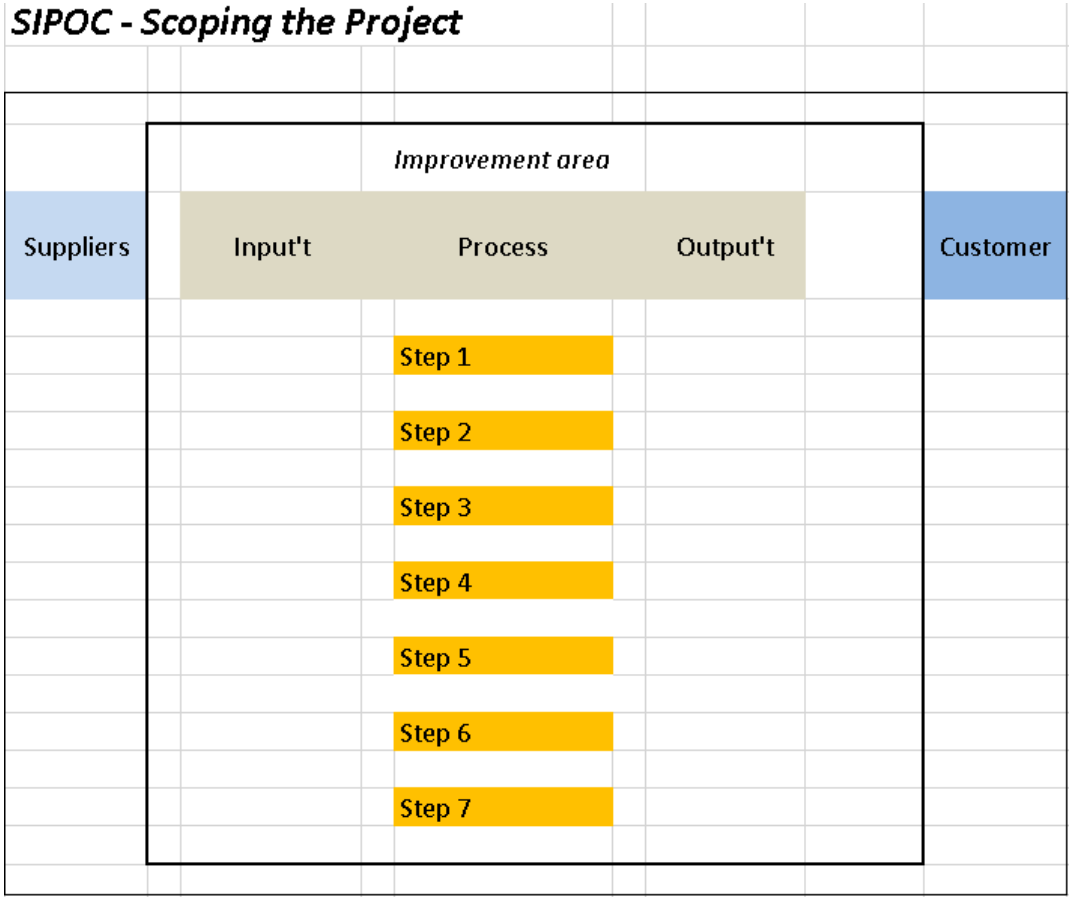

Figure 7. SIPOC-diagram (Karjalainen and Karjalainen 2002, 102

Figure 7 above demonstrates an example of SIPOC diagram. According to Muralidharan, (2015, 105), the formal visualization of the SIPOC may vary depending on the organization. For example, in highly customer-driven organizations the diagram can be applied inversely as COPIS, which considers customers as a key factor in the process. Bhalla (2010) however, argues that the construction of SIPOC should be executed specifically and in accordance to the given guidelines. This ensures that the relevant flows of both, information and materials are being considered as key variables of the overall process. Johnsen et al. (2008, 34) propose a following approach for the SIPOC construction:

1. Identify the process and define the process boundaries.
2. Draw a diagram of the process divided in 5-7 process steps.
3. Define the correct sequence for the process steps
4. Identify key inputs, suppliers and outputs
5. Define key customers as receivers of the final output.

As a result, the generated SIPOC diagram provides apprehensible demonstration of the selected process, beginning from the suppliers and ending to the customers. According to Karjalainen and Karjalainen (2002, 102) SIPOC diagram increases the overall understanding of the process and should therefore, be generated as early as possible. Further on, the diagram can be used as a tool for process analysis that aims to improve output quality by examining inputs and process variables.

2.2.2 FMEA

Failure mode and effect analysis (FMEA) is a method for identifying and eliminating potential problems, errors and failures from the process. Originally, it was developed by reliability engineers to examine malfunctions in military systems in the 1950. (Kubiak, 2014). Later on, it has been extensively utilized in various industries such as the aerospace industry in the 1960s (Liu, 2016, 3) and by the automotive industry in the 1980s (Guinot et al., 2017). FMEA has been acknowledged as a valuable tool for detecting and assessing possible failures and errors, but also for preventing them from occurring (Liu, 2016, 3).

The main goal of the FMEA is to reveal and prevent potential failures and problems in different stages of the process (Sharma, Kumar and Kumar, 2005). This tool analyzes every step in the process and identifies possible errors, failures, effects and possible causes that could lead to the failed conditions (Guinot et al., 2017). Liu (2016, 4) argues that effective usage of FMEA enables the correction of discovered failure modes before their escalation. Hence, the deployment of this tool enables improved process performance by decreasing the density and probability of defects in the process.

According to Guinot et al. (2017) and Liu (2016, 4) the process specific expertise plays a major part in the success of the analysis. Therefore, FMEA should primarily be conducted by the process owners and workers. Process specific expertise enables attendees to comprehensively identify all potential failure modes in different phases of the process. The analysis will then be continued by considering the occurrence (O),

severity (S) and detection possibility (D) of the discovered failure modes. This leads to the calculation of the risk priority numbers (RPN) with the following formula:

$$\mathbf{RPN} = O \times S \times D,$$

where *O* is the probability of the failure, *S* represents the seriousness of the failure and *D* is the ability to detect the cause of the failure before the actual effect occurs. Each of these risk factors are usually being rated on a numerical scale from 1 to 10, which leads to the formation of comparative RPN numbers (Liu, 2016, 4).

Table 1. FMEA document general format (Kubiak, 2014)

Initial development of the FMEA									Improvement activities		Post-improvement activities				
Process step / input	Potential failure mode	Potential failure effects	SEV	Potential causes	OCC	Current controls	DET	RPN	Actions recommended	Resp.	Actions taken	SEV	OCC	DET	RPN
1	2	3	4	5	6	7	8	9	10	11	12	13			

DET = Detection
FMEA= Failure mode and effects analysis
OCC = Occurrence
Resp= Responsible
RPN = Risk priority number
SEV = Severity

Table 1 above represents a practical example of the FMEA document. As Sharma et. al. (2005) and Kubiak (2014) propose, the following approach is recommended in order to provide reliable results of the potential failure modes:

1. Identify and map the process steps for further examination
2. Identify all the potential failure modes that can possibly occur during the examined process
3. Identify potential effects for each of the failure modes
4. Evaluate the severity of the of previously identified failure effects (Scale 1-10)
5. Evaluate the frequency of occurrence of the failure modes (Scale 1-10)
6. Evaluate the probability to discover failure modes and effects (Scale 1-10)

7. Calculate risk priority number (RPN) according to the formula (RPN = *O* X *S* X *D*)
8. Prioritize the most potential failure modes based on their RPN rankings
9. Generate procedures and corrective actions to overcome the problems with major risks
10. Calculate updated RPN values following to the conduction of corrective actions

Karjalainen and Karjalainen (2002, 102) are proposing that similarly to SIPOC, also FMEA should be conducted as early in the process improvement project as possible. It can also be conducted repeatedly, which enables continuous process improvement through updated and repeatable analysis.

3 PURCHASING MANAGEMENT

Traditionally, purchasing has been perceived as support activity for the primary business activities such as marketing, sales, logistics and service. In general, support activities have been designed to enable and promote efficient execution of the primary activities. (van Weele, 2005, 9-10). Porter's value chain model is one of the most commonly used tools for demonstrating relationships between primary and support activities. The value chain model has been argued to be useful tool in both, the analysis and the improvement of individual activities. Even though the value is generated throughout the value chain, the practical improvements are usually being achieved by focusing on the performance of individual functions. (Martek and Chen, 2016). The value chain model is being presented on the figure 8 below.

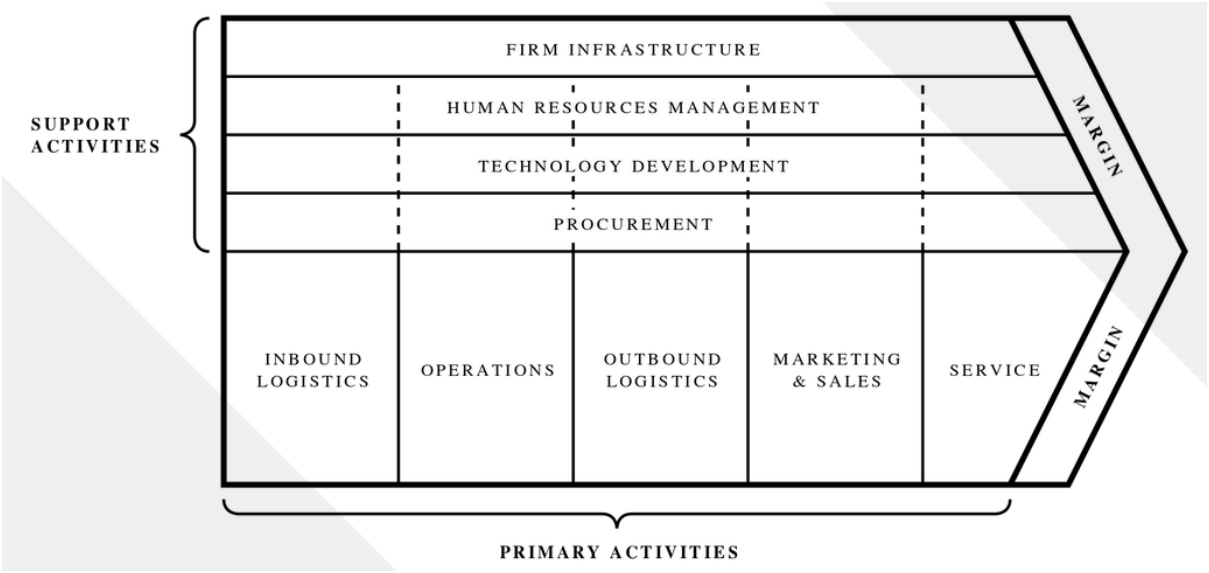

Figure 8. The generic value chain (Barnes, 2001, 52)

As the figure 8 above represents, purchasing is perceived as one of the support activities. According to Presutti (2003), this conception is nonetheless changing due to the changes in business environment. Competition has increased substantially, which has led companies to seek increased profitability through cost reductions. From this perspective, purchasing management has significant impact on the economic efficiency of supply chain and hence, the role of purchasing can be seen to have changed closer to the major activities. (Saranga and Moser, 2010).

Chen (2012) agrees but points out the importance of procurement in the context of business relations. Competitive advantage is often achieved through innovation and new product development (NPD), which often involves also the suppliers. Supplier relationships are usually being managed by the purchasing function and hence, connection between new innovations and purchasing activities is evident. Tikka (2017, 20) agrees and underlines the changed role of the purchasing function. Purchasing function has increased significance in the succession of extended order-delivery process and should therefore, be perceived as one of the primary functions.

Previous perspectives underlined the importance of the purchasing as part of the company value chain. However, the effects of different activities conducted by the purchasing function are also often extended over functional and even organizational boundaries. van Weele (2014, 55) presents a standpoint that considers the role of the purchasing management from the perspective of value improvement, cost reductions and risk management. This three-dimensional model by van Weele (2014,55) is being demonstrated on the figure 9 below.

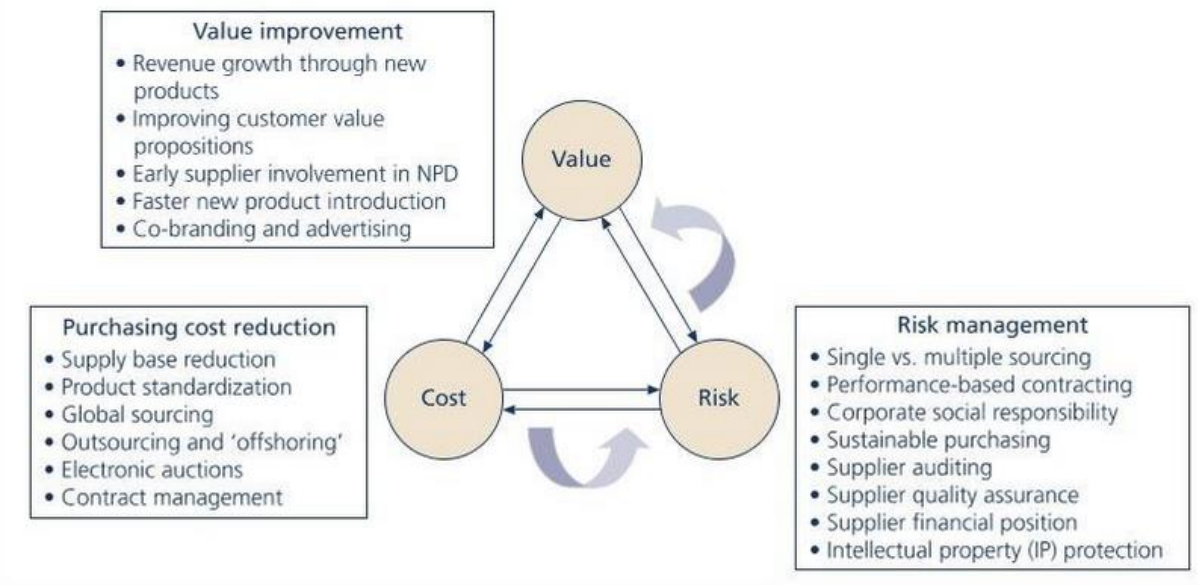

Figure 9. Purchasing management: Balancing cost-risk-value (van Weele, 2014, 55)

According to van Weele (2014, 55) one of the main responsibilities of the purchasing function has traditionally been the achievement of cost reductions through cost

effective purchasing. As can be seen from the figure 9 above, buyers have pursued this agenda by reducing supplier base, sourcing globally, tendering suppliers, standardizing products et cetera. Unfortunately, this approach has also had negative effects especially on supplier relationships as suppliers have been constantly required to deliver product and services with higher quality and with lower prices. (Pereira et al., 2011).

As the figure 9 demonstrates, purchasing management plays a major role also in the organizational risk management. As van Weele (2005, 10-14) described, one of the main responsibilities of the purchasing function is the management of the company's external resources so that the goods, services, capabilities and information required for the management and maintenance of the company's primary and support activities are ensured in the most favorable terms. To execute this goal effectively, purchasing function is required to proactively asses and eliminate risks in the supply chain. (Johnsen et. al., 2014, 386). In practice, this can be executed through outsourcing, supplier management, quality control and audits for example. As Radzinski (2017) pointed out, modern purchasing risk management also considers risks from the sustainability perspective.

As the figure 9 represents, the purchasing management also aims to deliver increased value for the organization. Aitken and Paton (2016) argued that the understanding of value and value creation has significantly increased in the modern purchasing organizations. Value is being created throughout the supply chain in both, inter-organizational cooperation (Johnsen et. al., 2014, 386) and through the cooperation with external stakeholders (Matthyssens et al., 2016). Value is also being generated in co-operative relationships with other internal departments through information sharing, communication and training of the personnel (Baily et al., 2008, 4).

3.1 Purchasing process

Purchasing function manages costs, risks and value through the purchasing process. According to van Weele (2014, 8) purchasing process consists of six different stages that could also be perceived as purchasing sub-processes. The stages are:

Determining specification, selecting supplier, contracting, ordering, expediting- and follow-up evaluations. According to Johnsen et. al., (2014, 35) these stages can also be divided in tactical (“source to contract”) and operational (“procure-to-pay”) purchasing. As the figure 10 below demonstrates, this whole continuity between internal customer and external supplier can be defined as the entity of procurement.

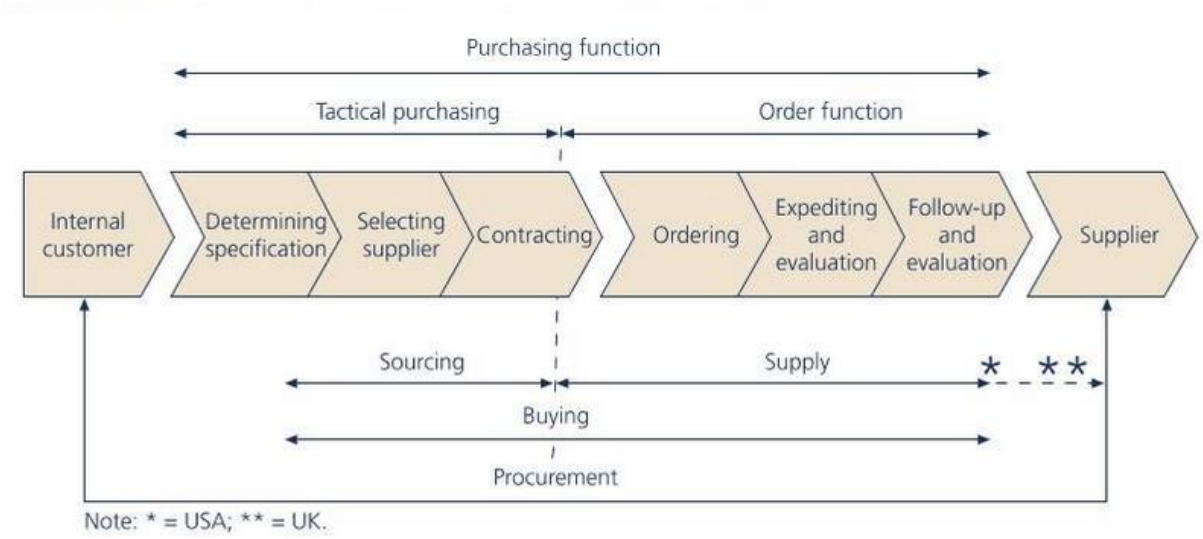

Figure 10. Purchasing process model and related concepts (van Weele, 2014, 8)

However, according to Johnsen et. al., (2014, 35), this six-staged purchasing process model applies only in new-purchase situations, when the experience about the supply market is relatively low. In the long-term contracts, the purchasing process mainly consists of the last three stages as continuous operative purchasing does not require amendments on specification, suppliers or contracts. van Weele (2005, 13-14) however, points out that these six activities are not solely the responsibility of the purchasing function and are often executed in close cross-functional cooperation with other internal departments.

Each of the six stages include various tasks, information, documents and responsibilities. According to van Weele (2014, 28), different stages are highly interrelated and success of one step highly affects another. From the process perspective, each of the stages can be perceived as sub-processes that receive inputs from the previous and deliver outputs to the subsequent stages. Hence, the quality of the first inputs of the process cycle strongly define the performance of the upcoming

process stages. These process stages are presented in detail on the Figure 11 below and will be more thoroughly discussed in the upcoming chapters.

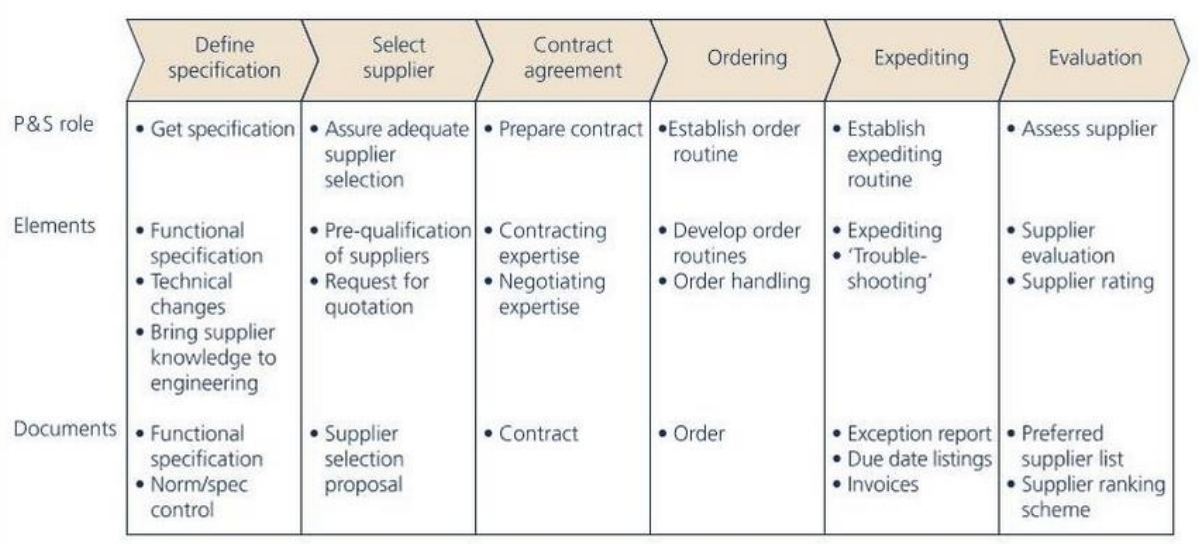

Figure 11. Purchasing process approach (van Weele, 2014, 28)

3.1.1 Determining specification

The purchasing process begins with the purchasing requisition for a product or service. Provider of this requisition may vary depending of the organization, but usually the purchasing requisition is being sent by the user or the person in need of the product. To be able to provide correct product or service, the requirement has to be specified. As van Weele (2005, 47) argued, this first stage, defining specification has significant impact on the overall excellence of the purchasing process.

This first stage of the purchasing process focuses on defining specific requirements for the upcoming purchase which in many cases, acts as a basis for make-or-buy decision. Hence, specification often determines if the product is more profitable to buy from external supplier, or to manufacture in-house. (van Weele, 2005, 47). Purchasing specification captures the purchasing needs in a documented form, that can be used as a referencing point throughout the purchasing process. The supplier's ability to correspond with the provided specification, hence, determines the overall success of the purchasing process. (Johnsen et. al., 2014, 35). Branch (2006, 17) agrees as the specification directly defines requirements for the purchased product or service.

The specification document(s) can be generated with two alternative methods; functionally- or in detail. As the figure 12 below demonstrates, these two methods differentiate in the allowed level of supplier innovation and possibility of misunderstanding (Johnsen et. al., 2014, 36). According to van Weele (2005, 47) functional specification defines the functional requirements that the product must provide for the user. The benefits of this kind of specification are the given possibility for potential supplier to contribute with highest expertise, latest technologies and innovation in product development. However, leaving details to supplier can be seen risky as it increases the possibility of miss interpretation.

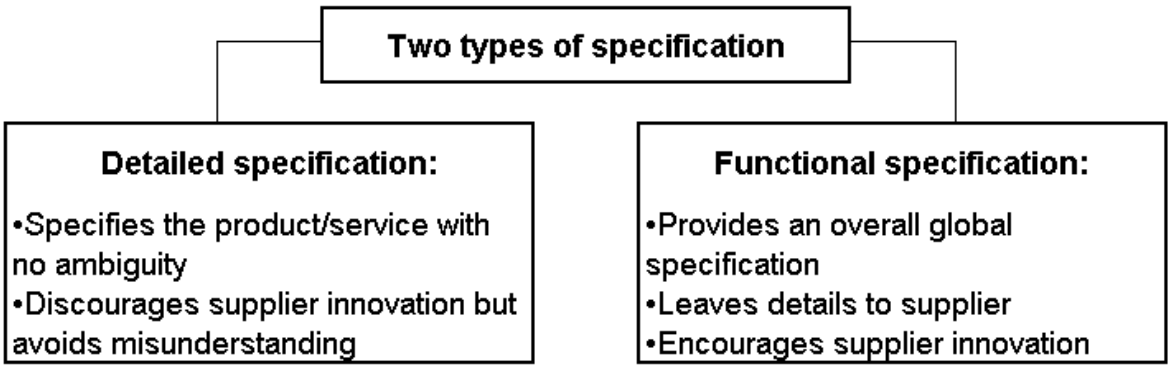

Figure 12. Detailed and functional specifications (Johnsen et. al., 2014, 36)

On the other way around, detailed specification precisely defines technical characteristics as well as the activities to be performed by the supplier. This kind of specification reduces the possibility of error and the change of misunderstandings, which can be perceived as extremely beneficial. (Johnsen et. al., 2014, 36). However, this approach contains a risk of over specification which limits the number of potential suppliers and may lead to higher production costs without increased functionality. According to van Weele, (2005, 48) regardless to the type of selected specification the purchase specification document sent to supplier should comprise at least following information:

- Quality specification to define method of delivery, required certificates, technical norms and standards.

- Logistical specification to define requested quantities, destination and lead-time for the delivery
- Maintenance specification to define instructions on how the product should be maintained or serviced
- Legal and environmental specification to define compliance of both product and production from the perspective of health, safety and environment
- Financial specification to indicate within what financial constraints the product or service should be delivered.

In addition to the presented requirements by van Weele (2005, 48), Johnsen et. al. (2014, 37) point out the importance of customer orientation and sustainability issues. The specification given to supplier should correspond with expectations of the company's end customer, but to also consider requirements related to sustainability and corporate social responsibility (CSR). In practice, this may require combined expertise, knowledge and cross-functional cooperation from various stakeholders within and outside of the company. (Johnsen et. al. 2014, 37).

3.1.2 Selecting supplier

As soon as the purchasing specification has been determined, purchasing function begins the search for potential suppliers. Traditionally, this has been one of the main responsibilities of the purchasing function. Successful supplier selection plays a similar importance in the purchasing process excellence as the previously described determination of specification; Even perfectly determined specification may lead to disaster in the hands of incompetent supplier. (Monczka, Trent and Handfield, 2005, 33). In short, the basic idea of the supplier selection process is to identify a large number of suppliers and to gradually narrow down the options until the last supplier(s) remains. The simplified supplier selection process is being demonstrated on the figure 13 below.

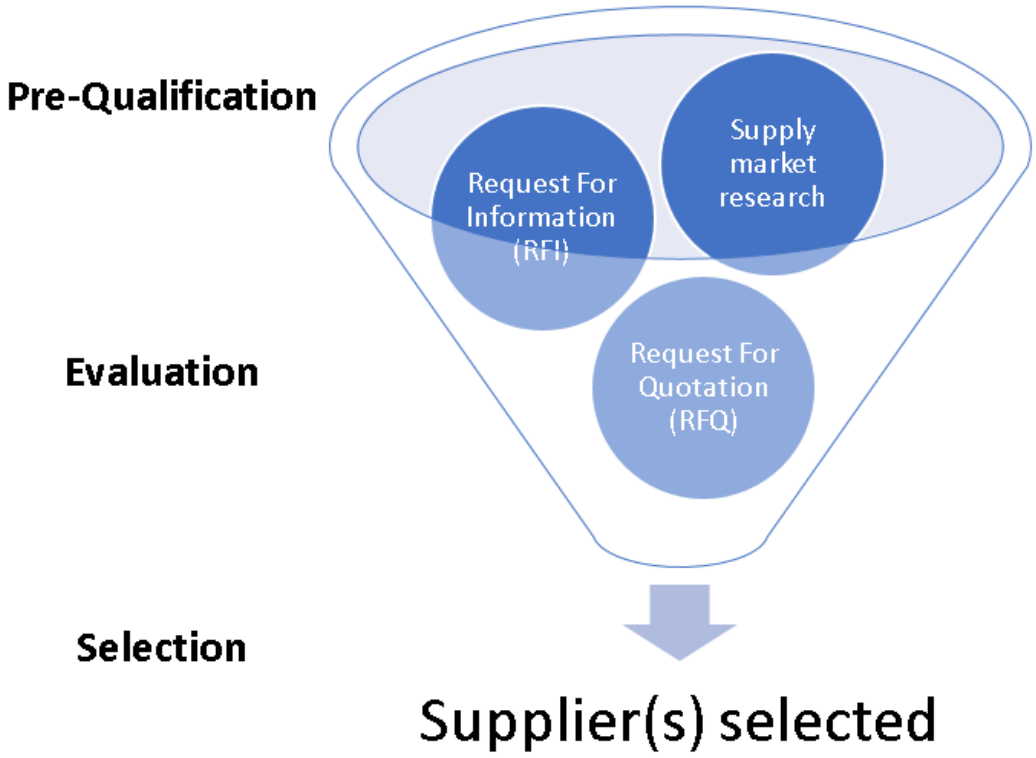

Figure 13. The supplier selection process (Johnsen et. al., 2014, 40, adapted by Huuhka, 2016, 134).

As the figure 13 represents, the supplier selection process begins with a supply market research that focuses on scouting for potential suppliers, usually in global basis. Supply market research is generally being conducted in new-task situations where existing supplier contracts cannot be utilized, or the company wants to extend the selection of alternative suppliers. (van Weele, 2005, 52). In the past, the research was often done by attending exhibitions, conferences and seminars or by directly visiting potential suppliers.

In the modern business environment however, the research is usually being conducted through the utilization of internet, e-commerce and various databases. (Branch, 2006, 29). Supply market research compares the given specification towards the capabilities of potential suppliers. This comparison produces so-called “bidders’ long list” that represents alternate suppliers with capability to fulfill the pre-qualification requirements. Suppliers on this list will then be further on investigated and assessed and evaluated. (Johnsen et. al., 2014, 40).

As the figure 13 demonstrates, following to the supply market research the list of pre-qualified suppliers is being narrowed down by sending potential suppliers a request for information (RFI), which aims to gather more detailed information about the capabilities of alternative suppliers. (van Weele, 2005, 52). This information can be gathered by visiting potential suppliers or by conducting audits to existing vendors. Especially in bigger companies, purchasing function often has a list of approved and preferred suppliers. The company is comparatively familiar with the capabilities of these vendors and hence, approved- and preferred suppliers have an advantage on the bidders' long list in comparison to new alternate suppliers. (Johnsen et. al., 2014, 40).

As the figure 13 represents, following to the RFI the long list is being narrowed down to the supplier short list which only includes final alternative suppliers with the highest potential. These suppliers are then issued with the request for quotation (RFQ). van Weele, 2005, 52). In comparison to the RFI, RFQ is more detailed document that also contains specified information about the product features, price, quantities and delivery schedule. RFQ can also be perceived as invitation to tender. Johnsen et. al. (2014, 40) however, are pointing out that RFQ is legally binding document and should therefore, contain all the relevant information presented in unambiguous language to decrease the possibility of misunderstandings.

The final bidding can be conducted in both, closed or open environment depending on the level of desired transparency and collaboration. Various internet-based solutions such as e-auctions and electronic reverse auctions are being commonly used in the bidding process. (Baily et al., 2008, 407). Buyers will then begin to evaluate the bids, which may include technical, logistical, financial, legal, quality and risk related assessments. Ultimately, evaluation leads to the selection of the most potential supplier(s) and the suppliers who are not selected, are being informed about the result of the tender. (van Weele, 2005, 52-53).

3.1.3 Contracting

As soon as the bidding has finished the purchasing process advances to the contracting phase. According to Tikka (2017, 88), contract can be defined as a "verbal or written agreement, that obliges both of the parties to comply with the terms agreed. Foremost, it refers on the mutual understanding between buyer and seller". As Johnsen et. al. (2014, 42) argue, contracts are essential in pursuit of avoiding risks of non-compliance. The level of formality and terms in the contracts may significantly vary in different kind of situations. However, written and highly specified contracts are generally recommended, especially when operating globally and in cross-cultural business environment.

Erridge (1995,171) argues that the company should utilize specific negotiation strategies for different kind of suppliers in order to achieve beneficial agreements. According to Caniëls and Gelderman (2007), Kraljic's matrix is one of the most commonly used tools for product- and supplier categorization. It provides proposal of the purchasing strategy based on the supply risk and profit impact of the purchased product. It has also been commonly used as a guideline for the selection of different kind of negotiation strategies. Kraljic's matrix is being presented on the figure 14 below.

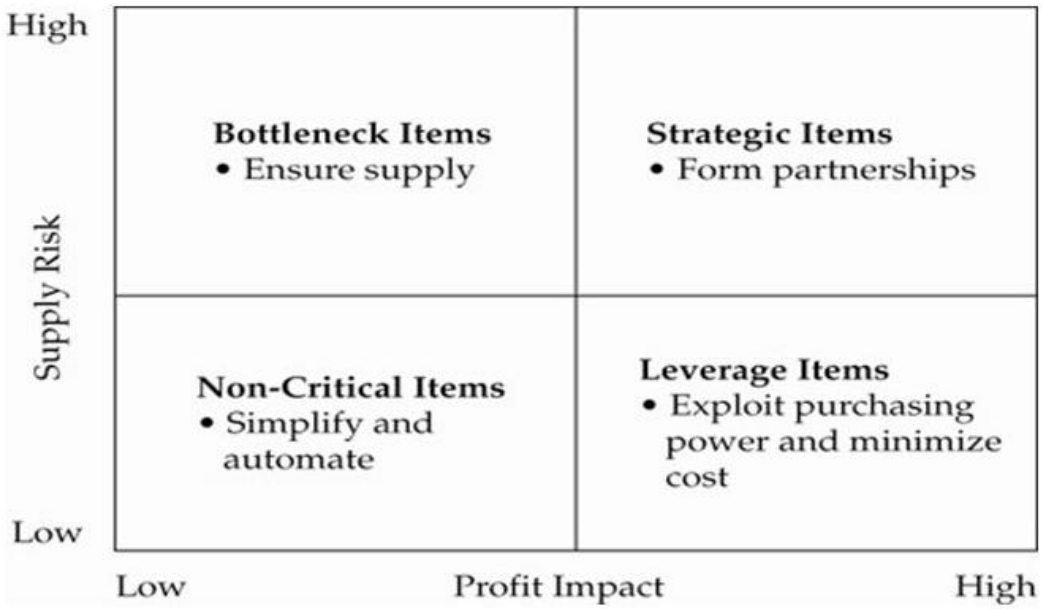

Figure 14. Kraljic based portfolio analysis and negotiation approach (Huuhka, 2016, 138)

As the figure above 14 represents, purchased products can be determined into four different categories based on their supply risk and profit impact. Further on, a different types of supplier strategies and negotiation approaches are being applied for different product categories. (Montgomery et. al. 2018). For example, negotiations for strategic- and bottleneck items should pursue collaborative partnerships and securing supply, when non-critical- and leverage items can be sourced through aggressive negotiations and tendering. (Huuhka, 2016, 138).

However, according to Branch (2006, 111) the characteristics and negotiation skills of the negotiator have equivalent importance on the succession of the negotiations as the selected negotiation strategy. Different negotiation strategies benefit from different kind of negotiation styles. These styles can be learned and improved through training and experience but in some cases, the situation might require the change of the negotiator in order to pursue the correct negotiation agenda. The negotiation process presented by Monczka et. al. (2005, 414) is being demonstrated on the figure 15 below.

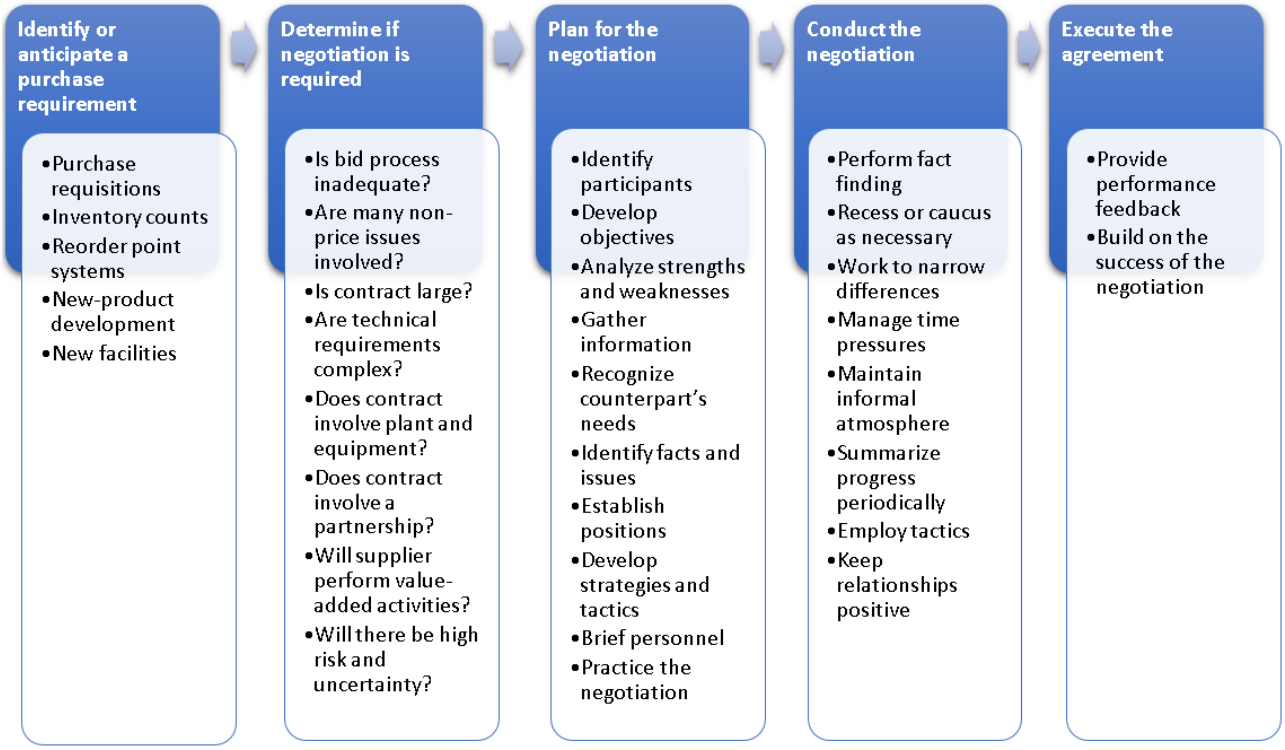

Figure 15. Five-Phase Negotiation process by (Monczka et. al. 2005, 414)

As can be seen from the figure 15 above the purchasing process consists of different phases with various elements. Contracting through this negotiation process is one of the major responsibilities of the purchasing function, which also challenges and determines the expertise of the purchasing personnel. (van Weele 2005, 57). Monczka et. al. (2005, 414) agree and point out the fact that negotiation process does not occur only between different organizations but involves people with personal objectives and relationships. According to van Weele (2005, 57) the main responsibilities of the buyer during the contracting phase can be summarized as follows:

- To provide purchasing expertise in a form of purchasing contracts and terms, that consider all aspects of the purchasing agreement
- Determination of prices and other commercial conditions
- Minimizing risks and liabilities related to purchasing through contractual arrangements
- Preparing and conducting negotiations with the supplier
- Editing the purchasing agreement

According to Huuhka (2016, 137) companies should emphasize the importance of the negotiations, as substantial part of the purchasing related cost-reductions is being achieved through the terms of the contracts. Tikka (2017, 89) agrees and points out that negotiating requires thorough preparation in order to achieve beneficial terms with the supplier. The negotiator should possess thorough knowledge and understanding about the requirements, resources, expectations and constraints of the contract.

The negotiation process defines the terms of the final agreement. Johnsen et. al. (2014, 42) are underlining the variety of benefits that can be achieved with successful contracting. Terms related to price, payment, delivery and risks directly affect the company profitability, cash-flow, working capital and risk profile. As van Weele (2005, 55-56) argue the contract can also be used as a tool to ensure compliance through penalty clauses and warranty conditions. Especially, in international purchasing the contract should consider country specific laws and regulations, which may differ significantly between the countries.

3.1.4 Ordering and expediting

As soon as the negotiations have finished and parties have signed the contract, purchasing process advances to ordering phase. Normally the contract acts as defining framework for routine purchase transactions and the actual purchase orders are being sent afterwards. However, especially in the new-buy situations the contract itself may also be considered as order document and the purchasing process proceeds based on the details defined on the contract. (Johnsen et. al., 2014, 46).

Purchase orders are usually being sent electronically through ERP system, based on the material purchase requisitions. Some of the advanced systems are also able to generate purchase orders automatically, which decrease the requirement of human contribution and hence, substantially increase the process efficiency. (van Weele 2005, 57). According to Erridge (1995,177), the purchasing order document should include at least following information:

- Purchase order number and issue date
- Customer requisition number
- Supplier name and address
- Customer delivery location, time and address
- Customer name, invoicing address and account number
- Quantity, detailed description and the price of goods
- Required codes such as for products, suppliers or users
- Names and contact details of the customers and purchasing contacts

Suppliers are normally required to provide order confirmation which then can be compared to the original purchase order document. Theoretically speaking, this should be all that the ordering phase requires, yet problems tend to always occur. (Johnsen et. al., 2014, 47). Problems related to the delivery are acting as a basis for expediting activities. Expediting refers to the process of directly contacting suppliers to investigate the status of past-due or near-due deliveries. Expediting itself does not create value to the purchasing process but is still often perceived as necessary action for securing

the flow of goods. (Monczka et. al., 2005, 142). According to van Weele (2005, 60), expediting activities can be classified in three different categories:

- **Exception expediting** refers to reactive behavior, when buyer begins to investigate situation when the deliveries are already past-due. The usage of this method usually leads to disruptions in production and is not therefore, recommended.
- **Routine status check** is a method used to prevent upcoming disruptions and problems on the material flow, by proactively requesting re-confirmations on the delivery dates from the supplier.
- **Advanced status check** is commonly used expediting method for securing deliveries of critical items from critical suppliers. This method involves buyer in the manufacturing process through regularly conducted situation checks and field expeditions and is therefore, perceived as highly resource consuming.

The selected method of expediting is highly dependent on the prevailing circumstances and business environment. Some products and suppliers may require more intensive expediting and monitoring than others. As Baily et al. (2008, 194) argued, the expediting resource prioritization should be approached from three different perspectives as presented on the figure 16 below.

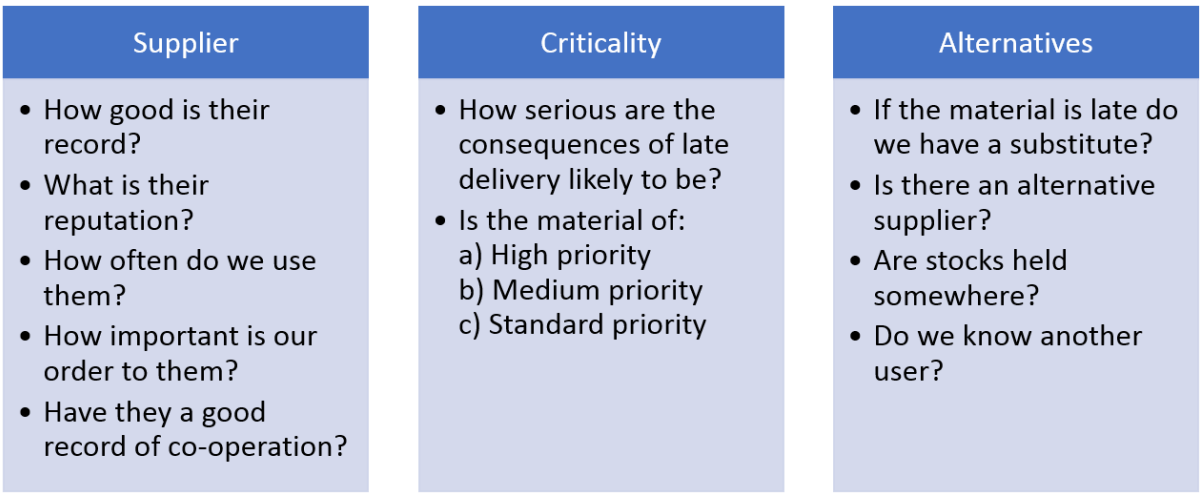

Figure 16. Factors related to prioritization in expediting (adapted from Baily et al., 2008, 194)

As can be seen from the figure 16, required level of expediting is highly dependent on the performance of the supplier, criticality of the product and the availability of alternative substitutes. Hence, supplying critical items from bad performing supplier without substitute items available, significantly increases the requirement for expediting in comparison to low-importance items bought from a well performing supplier. (Baily et al., 2008, 194). Therefore, buyers are advised to consider the questions presented on the figure 16 when planning the prioritization for expediting activities.

Monczka et. al. (2005, 142) however, are pointing out that insufficient delivery performance is not always an outcome of the incapable supplier. It is possible that the buyer has made challenging last-minute schedule changes, or requirements for the delivery has not been indicated clearly in the first place. According to Baily et al. (2008, 194) the flow of materials can be secured, and the requirement of expediting can be decreased with stronger buyer-supplier relationships. This approach also enables increased transparency, communication, information sharing, proactivity and mutual trust between the business partners.

3.1.5 Follow-up and evaluation

Even the purchase has been received and the products have already been put to use, the purchasing process continues through follow-up activities. As Tikka (2017, 122) points out, buyers may be required to contact suppliers and solve issues related to claims, warranties, penalties, reports or maintenance instructions. Johnsen et. al. (2014, 47) however, point out that as follow-up actions buyers are also required to evaluate both, the purchasing process and suppliers. If the process- or supplier performance does not meet the requirements the buyers should focus on identifying problems and inefficiencies and eliminating them from the process.

Monczka et. al. (2005, 143) argue that in addition to the actual purchasing process, the purchasing function may be partly responsible of numerous side activities. These activities may include inventory management, forecasting, production planning or invoice processing for example. van Weele (2005, 85) agrees and points out that

purchasing function is also acting as a part of cross-functional network within the organization. In addition to the processes performed mainly by the buyers, purchasing is often included in various cross-functional processes such as marketing or new product development.

Follow-up actions may also include reporting, maintenance and update of supplier master data. In practice this can be done by frequently assessing and categorizing suppliers. Supplier assessment is mainly perceived as a part of supplier selection sub-process as previously presented. However, the existing supplier base requires frequent assessment to execute supplier selections effectively. Therefore, supplier evaluations are also being perceived as follow-up actions. According to van Weele (2005, 278) suppliers can be assessed in four different levels as presented below:

- Product level focuses on supplier's product range and quality. Regular inspections are being conducted to ensure conformance in both finished goods and raw materials.

- Process level concentrates on the production process instead of the finished product. This approach is based on the idea that the quality of the product directly correlates with the excellence of the production process. Supplier´s machinery and quality control process can be seen in the centrum of this assessment.

- Quality assurance system level focuses on the supplier´s quality control system in overall. Assessment considers followed guidelines, procedures, maintenance and refining frequency of the quality control system.

- Company level is the highest level of assessment. It considers suppliers from company perspective and hence, evaluates capabilities from financial, managerial and strategical perspectives. This inspection aims to evaluate suppliers' capabilities to deliver requested results in the present but also in the future.

To be able to effectively assess suppliers, required data must be first collected and analyzed. As van Weele (2005, 278) argues, data collection can be conducted with various methods such as supplier audits, personal assessments or KPI based supplier ratings. Some of these methods are also commonly being used simultaneously.

Supplier audits are generally used tools to ensure suppliers capability and compliance. In practice it refers to visitation on suppliers' premises to evaluate their quality system and production process. (Baily et al. 2008, 150). This procedure includes various methods to inspect, measure and asses suppliers' operations and organization. Exposed defects and risks are being reported and discussed with the supplier and further on, improvement ideas are being generated and established. (van Weele, 2005, 279). This method can be defined as thorough and effective, but on the other hand expensive and resource consuming for both organizations (Branch, 2006, 102).

Personal assessments rely on strong relationships between the buying organization and suppliers. Suppliers are being evaluated and rated by selected specialists in the buying company who are already familiar with supplier's organization. (Baily et al. 2008, 150-151). This method requires extensive knowledge of the supplier's capability and operations from various areas of business such as quality control, engineering, manufacturing and production planning. (van Weele, 2005, 279). Personal assessment can be argued to be cost- and resource effective method for evaluating suppliers. However, this assessment method relies on silent knowledge of the individual specialists and can therefore, be vulnerable for assessment bias. (Monczka, Trent and Handfield, 2005, 222).

KPI based supplier ranking is closely connected on the supplier performance measurement which also acts as one of the main follow-up actions of the purchasing process. This specific purchasing sub-process was also selected for the process improvement project in the empirical part of this study. Therefore, supplier performance, performance measurement and KPI based supplier ratings are being more thoroughly discussed in the following chapters of the thesis.

3.2 Supplier performance

In addition to the actual purchasing process, the overall performance of the purchasing function is highly dependent on suppliers and their excellence. Even if the operative purchasing was executed perfectly, the company may still encounter challenges if the suppliers fail to deliver expected results. According to Johnsen et. al. (2014, 4), supplier performance refers to the supplier's overall capability to deliver requested business outcomes. It has significant impact on the overall purchasing excellence through quality-, delivery-, innovation- and service performance. Supplier performance is also directly connected to purchasing process related cost reductions.

As van Weele (2014, 348-349) argues the importance of suppliers is continuously growing and companies are required to consider both, the current performance and suppliers' ability to provide required services also in the future. Burt and Pinkerton (1996, 221-222) agree and point out that suppliers should be encouraged to pursue constant performance improvements. In practice, improvements can be achieved through continuous assessment, feedback and supplier development practices. Erridge (1995, 104) however, suggest that the requirements for the performance may significantly vary depending on the purchased products and organization as the emphasis can be placed on different areas of performance.

According to Baily et al. (2008, 423) required performance should be connected directly on company's business objectives. Supplier competence should act as conducive factor for the achievement of desired business results and hence, suppliers should be perceived as extensions for the actual enterprise. Monczka et. al. (2005, 19) are arguing that the most effective way to improve supplier's performance is through continuous measurement and evaluation. This procedure also provides ideal method for communicating requirements between different supply chain stakeholders and hence, encourages increased information sharing and organizational knowledge.

3.2.1 Supplier performance measurement

Supplier performance measurement can be perceived as a part of extended supplier assessment. According to Monczka, Trent and Handfield (2005, 269) “supplier performance measurement includes the methods and systems to collect and provide information to measure, rate, or rank supplier performance on a continuous basis”. Based on this definition, a clear line can be drawn between supplier assessment and performance measurement. Supplier assessment is mainly being conducted as a one-time event prior to the supplier selection. Supplier’s performance measurement, however, is an ongoing process that focuses on frequently collecting updated information about the supplier’s past and current performance.

Sundtoft Hald and Ellegaard (2011) are defining supplier performance measurement as “the process of quantifying the efficiency and effectiveness of supplier action”. This definition can be argued to be appropriate as quantified measurement enables logical and specified approach on long term evaluation and supplier development. According to Osiro, Lima-Junior and Carpinetti (2014) in manufacturing companies approximately 50-70% of production costs are spent on purchased goods. Therefore, supplier performance should be continuously measured and further on developed. Pilachowski (1996, 3) however, points out that the ultimate goal behind measurement practices should be the pursuit towards better customer satisfaction. Therefore, used performance measurement metrics should also correlate with customer requirements.

According to van Weele (2005, 62) appropriate documentation of the supplier performance acts as a basis for upcoming repeats of the purchasing process. Performance monitoring enables supplier base ratings and further on, facilitates supplier selections in the future. Johnsen et. al. (2014, 47) agree and underline the benefits of continuous performance measurement. Giving scores to the suppliers enables motivational behavior when suppliers are being rewarded for their exemplary behavior. On the other way around, poor performance and breaches of contract can be compensated and penalized. Similarly, Huuhka (2016, 146) agrees and argues that performance measurement should be used as a tool for encouraging improved performance through supplier development and supplier relationship management.

Winter and Lasch (2016) however, point out the importance of evaluation and development from the sustainability perspective. In the modern business environment companies are not held accountable only for their own actions but also for the activities performed by their suppliers. Especially environmental or social violations may have extended negative effects across the supply chain. Johnsen et. al. (2014, 115) agree as in some cases suppliers have been exposed for not complying with the agreed sustainability standards. This kind of behavior has often caused significant backslash in lost profits and unwanted publicity to various stakeholders throughout the supply chain.

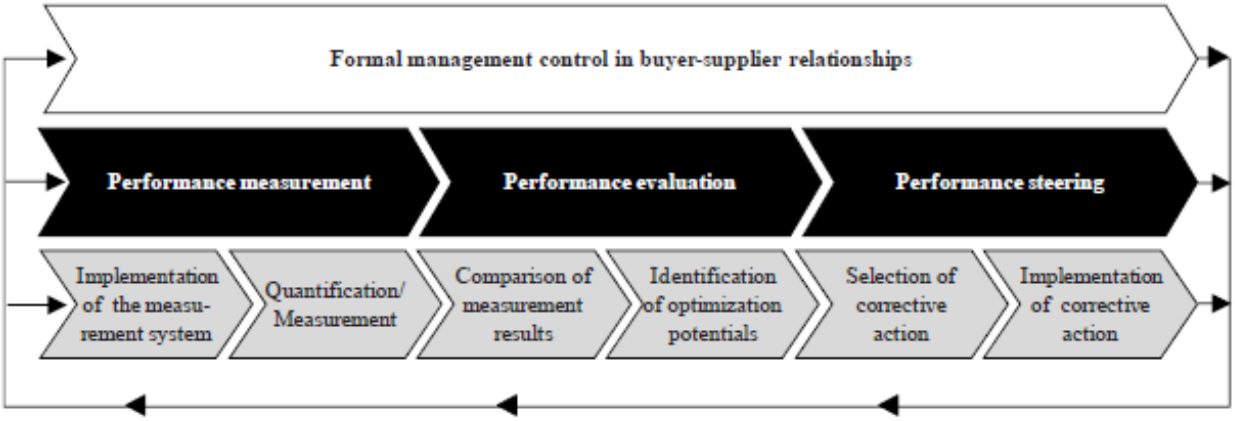

Figure 17. Formal performance control processes (Gebert, 2014, 4)

As Figure 17 above demonstrates, performance measurement, evaluation and steering are forming the continuity of the supplier performance improvement. First, performance measurement provides measurable data about supplier performance. Second, the data being evaluated and areas for improvement are being discovered. Last, corrective actions can be selected and implemented in practice. (Gebert, 2014, 4). However, as Baily et al. (2008, 422-423) point out, the measurement system does not run by itself but requires commitment, update, maintenance and resources to operate effectively. Hence, commitment on the implemented performance measurement system highly defines the overall succession of the measurement practices.

According to Monczka, Trent and Handfield (2005, 642) supplier performance should be measured based on the metrics that support both, overall corporate and function related strategy and objectives. This perspective highly defines the guidelines for the construction of the measurement and evaluation system. To be able to evaluate suppliers effectively, Sundtoft Hald and Ellegaard (2011) are proposing a following three phased approach:

1) Designing supplier performance evaluation system, based on the defined key objectives, in a measurable way.
2) Implementation of the evaluation system. Systematic data collection and processing in measurable format.
3) The usage of the supplier evaluation system. Taking actions based on the collected and reviewed data about the supplier performance.

Baily et al. (2008, 422) share a similar perspective and argue that performance measurement system should be constructed by defining the objectives (1), designing the performance measures (2), and managing through the measurement (3). Trent and Handfield (2005, 644) however, point out that construction of supplier performance and evaluation system requires leadership, support and commitment of the management. Without the support of the executive management, the system is challenging to implement as a part of the purchasing function operations.

3.2.2 Measurement areas and techniques

According to Monczka, Trent and Handfield (2005, 269) the whole measurement system should be based on the question “what to measure and how to weigh the performance categories”. This question challenges management to decide which quantitative and qualitative measures should be chosen to measure different areas of supplier’s performance. Literature provides a wide selection of different kind of performance categories that have successfully been measured in the past. According to Monczka, Trent and Handfield (2005, 269), Pilachowski (1996, 33) and Gordon (2008, 92-93) four commonly measured performance categories can be identified: Delivery, quality, cost and cooperation.

Delivery performance refers to supplier's ability to deliver required quantities within requested schedule (Monczka, Trent and Handfield, 2005, 269). This category considers the performance from the perspective of cycle time, lead time, and suppliers' responsiveness in situations of urgency (Gordon, 2008, 93). Improvements in this performance category may then lead to reductions in lead times, decreased supply risk and improved supply fulfillment in case of market shortages (Pilachowski, 1996, 36).

Quality performance, however, concentrates on the quality of purchased products and services (Gordon, 2008, 92). Emphasis is being placed on the ratio between received total quantity and the number of rejected units. Pilachowski (1996, 35). This performance category is being considered in most of the performance measurement systems and used metrics are often designed to measure quality escapes, in-process quality and incoming quality (Gordon, 2008, 92). The goal of measuring the quality performance is to make sure that received products or services meet agreed quality requirements (Monczka, Trent and Handfield, 2005, 269).

Cost performance category refers to the supplier's ability to provide products or services with affordable pricing (Monczka, Trent and Handfield, 2005, 269). This category usually concentrates on comparing the product pricing between different suppliers. (Pilachowski, 1996, 37). However, as Gordon (2008, 93) points out, this category may also consider the cost effectiveness from the perspective of purchasing business process. Reductions of costs can, hence, be achieved through process streamlining and elimination of inefficiencies.

Cooperation performance category measures supplier's ability to provide additional value to the buyer-supplier relationship. Hence, this category can rate suppliers based on their ability to provide commercial, technical, forwarding or service-related expertise and competence. (Pilachowski, 1996, 38). As Gordon (2008, 93) points out, many companies are highly dependent on their supplier's ability to develop and produce new products and innovations. Different kind of aftersales services may also be required in addition to the supply of the actual product. Hence, the measurement of this performance category can also be seen as beneficial. (Johnsen et. al. 2014, 117).

As Monczka, Trent and Handfield (2005, 269) presented, delivery, quality and cost related performance can usually be measured with quantitative measures. Cooperation performance, however, often requires qualitative evaluations. Different performance categories may contain various metrics and the final ratings are often based on multiple drivers. Gordon (2008, 94) argues that the key metrics for presented performance categories can be defined as figure 18 demonstrates:

Figure 18. Key metrics for supplier performance measurement (Gordon 2008, 94).

As the figure 18 above represents, in the model presented by Gordon (2008, 94) previously discussed delivery and service categories are being replaced with “Time” and “Technology”. The presented metrics, however, can be seen appropriate regardless the perspective as the metrics presented on the time category are similar to delivery, and technology acts as a part of the service performance.

Monczka, Trent and Handfield (2005, 270) are underlining the importance of measurement and reporting frequency. The required frequency is highly dependent on the measured suppliers and should be based on the supply base segmentation. Key suppliers should be monitored more frequently as their performance is more crucial to the organization. (Gordon 2008, 42). Performance measurement is continuous process and therefore, performance should be monitored in daily, weekly and monthly basis. The suppliers should also be required to deliver requested reports on monthly or quarterly basis which can then be assessed in meetings annually. Monczka, Trent and Handfield (2005, 270)

According Monczka, Trent and Handfield (2005, 271) most of the companies are using one of the three performance evaluation techniques: Categorical, weighted-point or cost-based evaluation. Different techniques have different advantages and disadvantages and are therefore, being utilized in different kind of companies. The differences between different measurement and evaluation techniques can be seen presented on the table 2 below:

Table 2. Comparison of supplier measurement and evaluation systems (Monczka, Trent and Handfield 2005, 272).

System	*Advantages*	*Disadvantages*	*Users*
Categorical	Easy to implement Requires minimal data Different personnel contribute Good for firms with limited resources Low-cost system	Least reliable Less frequent generation of evaluations Most subjective Usually manual	Smaller firms Firms in the process of developing an evaluation system
Weighted-Point	Flexible system Supplier ranking allowed Moderate implementation costs Quantitative and qualitative factors combined into a single system	Tends to focus on unit price Requires some computer support	Most firms can use this approach
Cost-Based	Total cost approach Specific areas of supplier nonperformance identified Objective supplier ranking Greatest potential for long-range improvement	Cost accounting system required Most complex so implementation costs high Computer resouces required	Larger firms Firms with a large supply base

As the table 2 above demonstrates, categorial evaluation system is the most basic method for measuring suppliers' performance. This evaluation system is easy and comparatively inexpensive to implement and is therefore, commonly used especially in smaller companies. The basic idea of this measurement method is to rate different

categories with simplified scale and hence provide structure for the measurement process. (Monczka, Trent and Handfield 2005, 271).

Weighted-Point system, similarly, quantifies scores in different categories but also calculates weights for the categories themselves. This method increases the reliability of the measurement system but is also often more expensive to implement. Weighted-Point system provides a flexible tool for performance measurement, as weights between different categories can be amended or the measured categories can be changed entirely. (Thompson, 1991)

Cost-based measurement can be argued to be the most thorough evaluation technique. This system quantifies the total cost of doing business with specific supplier. Hence, this method considers the overall costs instead of focusing on specific products or services. (Monczka and Trecha, 1988). However, the implementation of this system is relatively expensive and requires advanced IT-systems to be maintained effectively. Therefore, this evaluation method is mostly being utilized by larger companies with more resources and larger supply base. (Monczka, Trent and Handfield 2005, 271).

3.2.3 KPI based supplier scorecard

KPI cased scorecards are commonly used tools for quantifying and representing supplier's performance. According to Gordon (2008, 113) scorecards are an effective way for displaying and organizing the performance data. Scorecards are comparatively easy to use and understand and are therefore, commonly used in various organizations. However, as Desai (1996) points out, effective usage of the scorecard system requires regular review process based on reliable data collected from both, in-house systems and suppliers' reports. Therefore, the effectiveness of the scorecard-based measurement system is highly dependent on the commitment of both company management and external suppliers.

As Johnsen et. al. (2014, 116) argue, the measurement system should be based on different key performance indicators (KPIs) aligned with the purchasing strategy. These KPIs will then be used to measure selected areas of supplier performance.

Gordon (2008, 113) agrees and underlines the context dependency of the KPI based scorecard systems. The measured categories and KPIs should always be selected based on the company business objectives. Scorecard used by another company is rarely based on the same requirements and therefore, should not be borrowed. Also, Doolen et. al. (2006) agree and propose a five-step approach for designing and implementing supplier scorecard system as can be seen presented on figure 19 below.

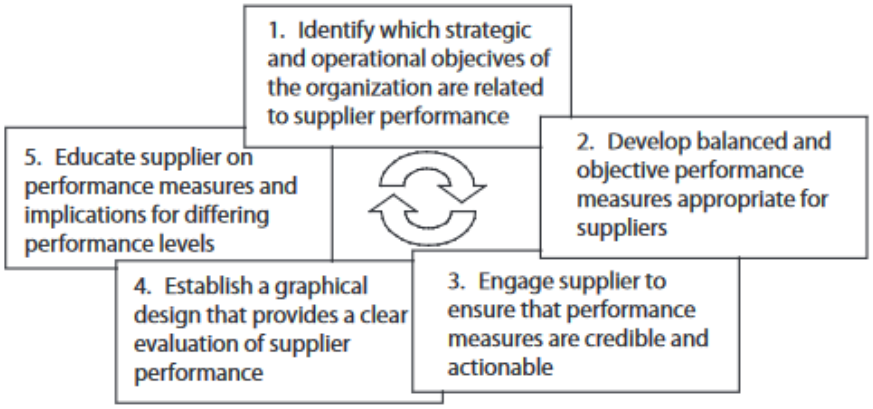

Figure 19. Steps for Supplier Scorecard Development (Doolen et. al. 2006).

As the figure 19 above demonstrates, the construction process of the scorecard system is highly similar to the construction of the total evaluation system. Doolen et. al. (2006) however, underline the importance of cooperation with suppliers. Suppliers should be engaged to ensure credibility and commitment to the generated measures and KPIs. The graphical design should also be designed to demonstrate performance understandably. On the last phase of the process, suppliers should be educated about the used measures and implications of different performance levels. As a result, the scorecard should provide reliable and understandable data about different areas of supplier performance. Doolen et. al. (2006) are presenting an example of practical scorecard as can be seen from the figure 20 below.

Supplier	ABC
Commodity	Precision Machining
Report Period	1st QTR FY 05 (JAN-MAR)
Rating	Preferred

Overall Score						94%
Quality	Category Weight =		25		97.5	98%
PPM	0	5000	400	40	39.0	98%
Factory Disruption	0	2	0	20	20.0	100%
Fault Analysis	99	95	98	20	18.5	93%
Root Cause/ Corrective Action	99	95	99	20	20.0	100%
Cost	Category Weight =		25		100.0	100%
Cost Reductions (%)	2	0	2	60	60.0	100%
Cost Reduction Proposals	2	1	2	20	20.0	100%
Cost Reduction Implementations	1	0	1	20	20.0	100%
Delivery	Category Weight =		25		78.7	79%
On-time Delivery (%)	99	97	97	25	17.5	70%
Lead-time (%)	99	97	99	25	25.0	100%
Lead-time Reduction (%)	2	0	0	25	17.5	70%
Flexibility (%)	99	50	58	25	18.7	75%
Customer Support	Category Weight =		25		100.0	100%
RFQ Response Time	2	4	2	30	30.0	100%
PO Confirmation Time	1	2	1	30	30.0	100%
Financial Statements	1	1	1	20	20.0	100%
EOL Certification Data	1	1	1	20	20.0	100%

Current QTR Spending	> 90	Meets or exceeds 90% of target level of performance
$4,786,542.00	70-89%	Performs within threshold and 90% of target level of performance
Projected Next QTR spending	< 69%	Fails to meet the threshold level of performance
$5,686,542.00		

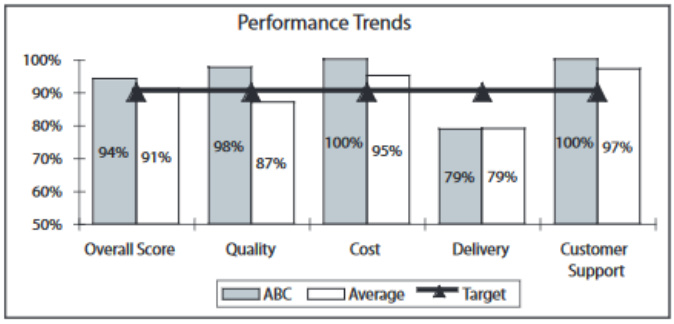

Figure 20. Supplier scorecard (Doolen et. al. 2006).

As the figure 20 represents, the practical scorecard demonstrates supplier performance understandably from various perspectives. Both, different performance categories and individual metrics are being weighted in order measure the performance in accordance to the business objectives. Weighing individual measures also enables changes on the performance measurement priority in case of changes in the business environment. The scorecard may also provide demonstration of performance trends in different performance categories. This enables clear visualization of supplier performance, which can further on be used as a tool for encouraging improved supplier performance (Doolen et. al. 2006).

4 PROCESS IMPROVEMENT PROJECT

This chapter focuses on presenting empirical data collection process and research findings. First, the chapter presents background information for the actual case study. Second, research methodology and data collection methods are being discussed. Third, chapter presents the empirical data collection process from the perspective of process improvement project through Six Sigma DMAIC framework. As the previous literature review presented, the Six Sigma project should be conducted systematically through five different phases; Definition, measurement, analysis, improvement and control. Hence, different phases of the project are also being reported in this chapter based on the same logical order.

4.1 Case Background

The case company of this research is large listed company operating in the manufacturing industry. The company employs nearly 18 thousand employees internationally and operates globally in more than 30 countries on multiple continents. The company produces consumer goods that are being supplied to end customers through B2B sales and distributors. However, as presented in the introduction chapter this research is limited on the Nordic region and further on to the business unit located in Finland. The selected business unit has its own purchasing function that provides external products for its customers in Nordic, and European markets. Business unit also supplies materials for its own production, yet this research focuses on the purchasing of finished goods from external suppliers.

4.1.1 Selecting process for improvement

The process improvement project began by selecting the process for improvement. The aim of the selection was to identify the process with highest improvement potential in accordance to the research objectives. The whole purchasing process was thoroughly evaluated and discussed with the case company representatives in order to identify the most suitable purchasing sub-process. Based on these discussions,

supplier performance measurement was selected to be the process for the improvement project. As the figure 21 below demonstrates from theoretical perspective, this purchasing sub-process is being included on the follow-up actions during the last phase of the purchasing process.

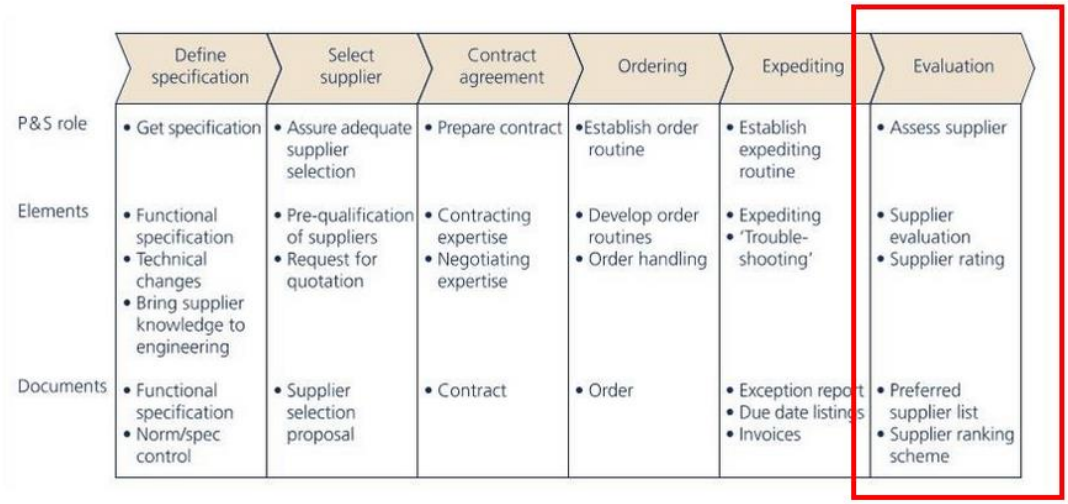

Figure 21. Sub-process selected for improvement

Different alternatives, desired project outcomes and required resources were discussed during the evaluation of alternative sub-processes. The research limitations were also considered prior to the selection. Eventually, supplier performance measurement process can be argued to be a reasonable choice based on the following perspectives:

- The case company did not have operational procedure for supplier performance measurement and evaluation
- Previously conducted audits have exposed deficiencies in the supplier performance measurement and control process
- As the literature review earlier presented, supplier performance has significant impact on the overall excellence of the purchasing process. Therefore, improving this specific sub-process had potential to provide considerable improvements on the purchasing process performance in general.

4.2 Research methodology

This chapter represents and justifies the used research- data collection- and analyzing methods. As Saunders et al. (2006, 156-157) argued the credibility of the research findings is highly dependent on the reliability (consistency of the research findings) and validity (expediency of the used methods) of the research methodology. Credibility can be increased with precise and thorough documentation and justification of the used research methods. Therefore, selected research methodologies with arguments for justification are being represented in tables 3, 4, and 5.

Table 3. Selected research method and justification

Research method	Justification
Qualitative	• Qualitative research enables the consideration of the context over extensive generalization (Roller and Lavrakas, 2015, 4). • Qualitative research method relies on non-numerical data and hence, enables deeper understanding of the studied phenomenon (Remler and Van Ryzin, 2011, 56-57).
Single-case study	• Case study can be argued to be appropriate option when the research aims to find answers on posed questions such as "what", "how" and "why" (Saunders et al., 2006, 145-147). • Case study approach can be seen beneficial when the focus is being placed on contemporary phenomenon within a real-life context (Yin, 2003). • Single-case study is an valuable option when research results are ment to be applied within a single organization instead of extensive generalization (Thomas and Myers, 2015, 29-30).

As the table 3 above demonstrates, the research was conducted as a qualitative single-case study. According to Saunders et al. (2006, 145-147), case study strategy aims to create understanding about the existing phenomenon in a specific context. This scientific approach can be considered appropriate as the study does not aim to provide highly generalizable results, but to create deeper understanding of the examined phenomenon (Tuomi and Sarajärvi, 2009, 28-30). This research was conducted, and the results were applied within a single organization and therefore, selected research method can be argued to be well justified.

4.2.1 Data collection

As the table 4 below demonstrates, the actual empirical data collection was carried out as focus group interviews through face-to-face and online meetings. The used research instrument was non-standardized group discussion template that enabled flexible approach towards research objectives through selected themes. As Saunders et al. (2006, 320) argue, selected research method enables a more flexible approach in comparison to highly standardized queries and interviews. Tuomi and Sarajärvi (2009, 73) are also underlining the benefits of this approach: The researcher is able to repeat and ask additional questions from the interviewees and hence, discover relevant information that might have remained undiscovered in highly structured interviews.

Saunders et al. (2006, 344) are also arguing that group interviews have high potential of discovering new information and insights about the topic as the participants might gain new ideas about the comments of other attendees. In addition to this, the interactivity of the interview situation and careful limitation of the researched topic supported the achievement of reliable data during multiple interviews. Stewart, Shamdasani and Rook (2007, 157-158) agree with Saunders et. al. as many of the improvement ideas are often discovered through brainstorming which could be defined as beneficial especially in process development.

The sample for data collection was selected through non-probability, purposive sampling. This approach enabled appropriate selection of the interviewed individuals with highest expertise and knowledge about examined process (Remler and Van Ryzin, 2011, 156). The sample size (4) consisted of supply chain manager, purchasing manager and two purchasers. The sample size was comparatively small, yet it covered all the relevant experts within the purchasing- and supply chain functions. As Tuomi and Sarajärvi (2009,85) point out, the expertise of interviewees and the quality of received answers has higher importance than the number of interviewed individuals. Remler and Van Ryzin (2011, 67) are also underlining that the number of attendees should be enough to make discussion lively, but not too high to prevent all from participating.

Table 4. Selected data collection method and justification

Research method	Justification
Non-standardized (qualitative) interviews	• Non-standardized interviews are suitable in situations where the research includes exploratory aspect (Saunders et al., 2006, 324). • Qualitative interviews are ecouraging detailed and in-depth answers that may provide new perspectives on the research objectives (Remler and Van Ryzin, 2011, 63).
Focus groups	• The unique advantage of the focus group discussion is the interaction between participants which often encourages new ideas and perspectives (Roller and Lavrakas, 2015, 111). • Conducting interviews in a group requires less resources and time in comparison to individually conducted interviews (Remler and Van Ryzin, 2011, 70). • Focus group interviews are capturing the benefits of interaction between highly proficient individuals (Saunders et al., 2006, 347).
Non-probability / purposive sampling	• Purposive sampling can be seen extremely beneficial in situations where research objectives require spefic knowledge and expertise from limited number of professionals (Roller and Lavrakas, 2015, 361). • Purposive sampling enables the exploitation of the expertise and competense of relatively small sample size (Remler and Van Ryzin, 2011, 156). • Purposive sampling is often used in case studies where sample size is comparatively small and the case is highly informative (Saunders et al., 2006, 237).
Sample size (4): **• Supply Chain Manager** **• Purchasing Manager** **• 2 Purchasers**	• In qualitative research the expediency of the sample plays a more significant role than sample size as the research results are not ment to be extensively generalized (Tuomi and Sarajärvi, 2009, 85) • Focus group interviews are mostly being conducted in groups of two (dyads), three (triads), four to six (mini-groups) or seven to ten (full-groups) (Roller and Lavrakas, 2015, 105). •In qualitative research the sample size is often limited due to the more intensive and time-consuming character of the data collection and analysis (Remler and Van Ryzin, 2011, 58).
Secondary data: **• Case Company purchasing process description** **• Internal audit reports**	• The usage of secondary data enables the contextual interpretation of the primary data (Saunders et al. 2006, 269). • Secondary data enables researcher to combine and benefit from the previously collected and documented data related to research topic (Remler and Van Ryzin, 2011, 9).

The research also utilized secondary data. The organizations documentary related purchasing process and internal audits were used as a backup for process improvement on the empirical phase of the study. As Saunders et al. (2006, 269) argue, the usage of secondary data enables contextual interpretation of the primary data. In practice this refers on the usage of the current process maps and audit reports as a point of reference during the selection of the improved process, analysis and further on brainstorming ideas for improvement.

4.2.2 Conducting the interviews

Four interviews were conducted in total and each of the meetings followed a pre-selected agenda based on the different phases of DMAIC approach. The author of the study acted as moderator for the focus group discussions. Each meeting had its own interview template which acted as a moderator's guide for steering the discussion in accordance to the project objectives. Predefined themes increased the objectivity of the moderator and further on, decreased the risk of moderator bias. The usage of the template also acted as a tool for interview time management.

As Hirsjärvi et. al. (2009, 204) argue, interview questions and research instrument should always be pre-tested. In accordance to this, the interview templates were carefully formulated and pre-tested with demand manager of the case company prior to the actual interviews. This procedure guaranteed the validity of the question formulations. The interviews were conducted in Finnish and received answers were later translated in English. The interviews were arranged with the agendas presented on the figure 22 below.

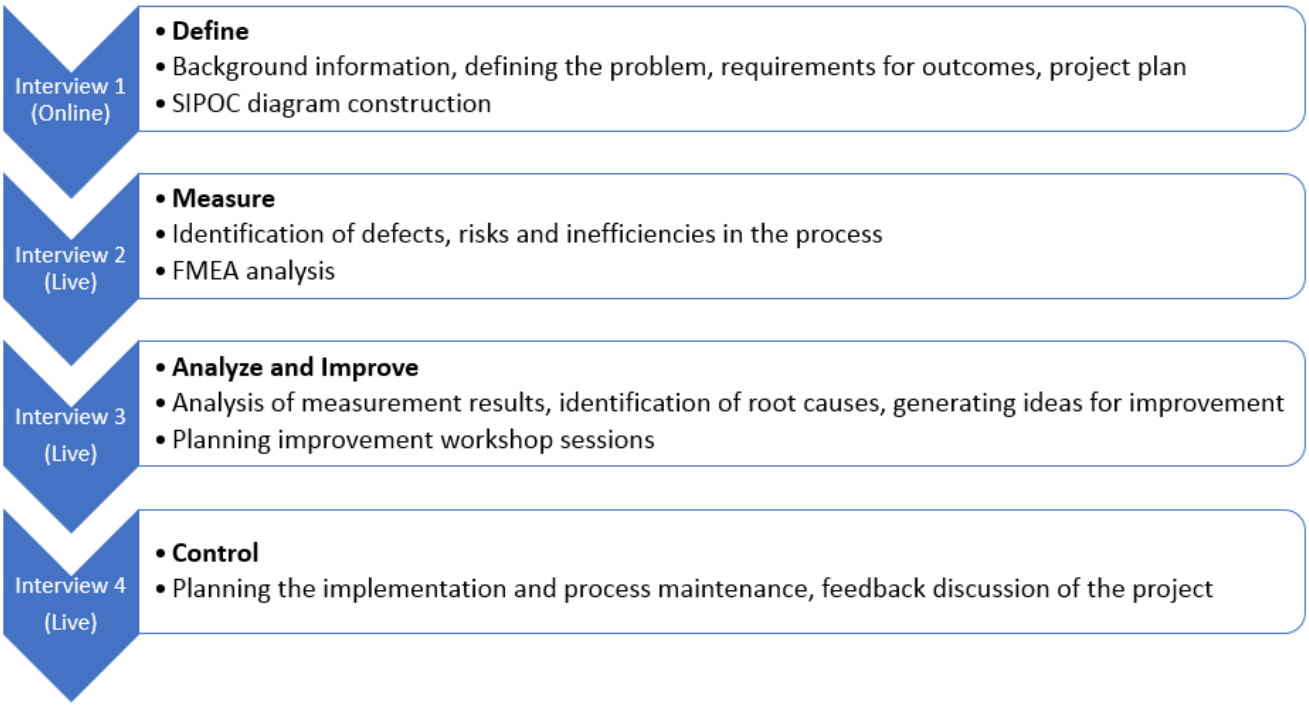

Figure 22. Interview agendas

4.2.3 Data analysis

As table 5 below demonstrates, the empirically collected data was analyzed deductively. This approach strengthened the connection between theoretical background related to the supplier performance measurement process and the specific business context within the case organization. Following to the interviews, collected data and notes were organized and transcribed. Transcribing was conducted with comparatively low accuracy as the research did not place emphasis on interaction during the interview situations but primarily focused on the contents of the discussions.

Table 5. Used data analyzing method and justification

Research method	Justification
Deductive	• Commencing research from the theoretical perspective creates a link between the existing knowledge and empirical findings (Saunders et al., 2006, 490). • Assumptions based on theoretical background are acting as a supportive aspect for empirical predictions (Remler and Van Ryzin, 2011, 18). • Deductive approach is often applied in situations where existing information is being tested in new context (Tuomi and Sarajärvi, 2009, 97).
Data preparation: **• Transcribing recordings** **• Organizing interview notes**	• To be able to generate consistent conclusions, the raw data has to be carefully organized (Remler and Van Ryzin, 2011, 75). • Qualitative data analysis requires that collected data and recordings are being subsequently transcribed (Saunders et al., 2006, 485). • The required level of transcribing is highly dependent on the research objectives. If the focus is placed on the interviewed topic, such as how specific process works, the transcribing can be conducted with lower accuracy (Ruusuvuori et. al. 2010, 425).
Summarising data	• Summarising data transforms large amount of words into briefer statements. This enables researcher to highlight principal themes from the overall data (Remler and Van Ryzin, 2011, 75). • The researcher becomes conversant with the data through summarising. This enables researcher to understand connection between the principal themes (Saunders et al., 2006, 491).
Content analysis	• Content analysis can be conducted based on verbal, numerical, conceptual or categorical formats (Tuomi and Sarajärvi, 2009, 105). • Content analysis enables the usage of quantitative based analyzing methods and hence, acts as a way fo facilitate interpretation of qualitative data (Remler and Van Ryzin, 2011, 76).

Following to the transcribing, the data was summarized. The summarizing procedure focused on underlining the main points of the given answers based on the interview topic and themes. These summarized answers were then further on analyzed through

specific Six Sigma tools such as SIPOC and FMEA in different phases of the project. These Six Sigma tools were also used as supportive visual demonstrations during the interviews, which enabled interviewees to understand the overall picture of the interview topics. Summarized interview answers and visual representations of the used Six Sigma tools are being discussed in the following chapters.

4.3 Definition

The process improvement project began with the definition phase in accordance to the DMAIC framework. This interview was conducted through online meeting in Skype. The intention was to collect background information for the business case but to also define goals and objectives, project scope and preliminary project plan for the upcoming research project. The definition phase was also conducted to achieve deeper understanding of the improved business process.

In practice, this was done by first getting answers on the background questions as presented on the table 6 below and by second, generating a top-level process description with SIPOC diagram as demonstrated on the appendix 2. Table 6 demonstrates the numbered main questions, additional questions marked with bullet points (used to gain additional information related to main questions) and summarized interview answers.

As the table 6 represents, the definition phase provided a clear insight about the problems, defects and improvement potential of selected purchasing sub-process. Question one focused on exposing the main problems related to supplier performance measurement process. According to the case company representatives, the company relies strongly on single-sourcing strategies in multiple product categories due to the limited number of potential suppliers. This has led to increased dependency on few of the main suppliers and hence, the importance of supplier performance was evident. To be able to ensure required performance, supplier performance should therefore, be carefully measured and monitored.

Table 6. Background questions and answers on definition phase

Question	Answer
1. Define the main problem(s) we are aiming to fix? • Why this specific problem(s)?	1: Most of the traded items rely strongly on single-sourcing strategy due to the limited number of potential suppliers. This has led to reduced supply reliability and dependency on few main suppliers: • Supplier performance should be continuously monitored to ensure that supplier performance meets required level 1: Transparency and knowledge of the supplier base and capabilities do not meet requirements: • We currently have limited knowledge of our suppliers financial situations, strategies, long-term objectives and ability to operate also in the future. • Insufficient knowledge related to suppliers capabilities and performance e.g. (2nd. tier suppliers and supplier network, product range and potential for expanded cooperation).
2. What kind of defects exist? • What negative effects these defects have caused?	2: Late deliveries and extended lead-times, lack of knowledge and transparency, general uncertainty, increased supply risk, decisions are often being made based on the "gut feeling". • Insufficient supply performance has been compensated with higher inventory levels and extensive buffer stock. • NPD process is slow and inefficient as we don't know our suppliers and their capabilities well enough.
3. How improving this specific process helps to overcome the main problem? • What is expected to be achieved as a result of the project? • What are the expected business improvements or outcomes?	3. Effective supplier performance measurement enables supplier rating, development and further on, improved supplier performance. • Standardized supplier performance monitoring system • Supplier performance scorecard based on appropriate KPIs. • Reduced inventory levels and requirement for buffer stock
4. Has this process been previously modeled?	4: The process has not been previously modeled and therefore, up to date process description does not exist.

The interviewees also pointed out that the company lacks knowledge and transparency of their supplier base. This has direct connection to the supply risk as the company is unaware of their suppliers' abilities to perform at present but also in the future. Lack of knowledge may also result in wasted supplier potential as the company is currently unaware of their supplier's product ranges, subcontractor network, production methods and expanded cooperation potential.

Second question focused on identifying defects in the process and how they effect in practice. As can be seen from the table 6, the company has faced late or postponed deliveries and extended lead-times. Poor delivery performance has led to the requirement of increased inventory and extensive buffer stock, which also directly increases business expenses. The company also suffers from general uncertainty and lack of knowledge and therefore, decisions are often made based on the “gut-feeling” without reliable or confirmed information. In practice this can be seen in general slowness especially during the NPD process.

Third question examined how improving the selected process helps to overcome presented problems and what are the expected outcomes of the improvement project. According to the interviewees, ability to accordingly measure and monitor supplier performance enables supplier rating, development and further on performance improvement. Improved supplier performance directly reduces the supply risk. Effective supplier performance measurement also promotes increased knowledge and transparency of the supplier base.

As a result, the project is expected to provide practical system for supplier performance measurement and monitoring. The system should consist of appropriate process description and KPI based supplier performance scorecard that also enables continuous evaluation of the performance. The implementation of this system should lead to decreased supply risk, increased knowledge about the supplier base and further on, decrease the requirement for extensive inventory and buffer stock.

Question four revealed that the supplier performance measurement process has not been previously modeled. Internal audit reports also indicated that up to date process description did not exist. Therefore, the problem was approached through upper-level process description of the process. In practice this was done through the utilization of SIPOC diagram. This approach focused on increasing the understanding of how the process operates in practice

4.3.1 Describing the process with SIPOC diagram

SIPOC diagram is generally being used to visualize existing processes. However, the case company did not have operational supplier performance measurement system in place and nor did the process for it existed. This directly affected the premise for the SIPOC construction. Instead of describing existing process, interviewees focused on thinking how the process should work in practice. The generated SIPOC diagram was then further on analyzed and used as guideline for the construction of the new supplier performance measurement process. Upper-level process description was generated by presenting questions on the table 7 below.

Table 7. Questions for generating the SIPOC diagram

5. Modeling the process: •Identify the process and define process boundaries •Draw a diagram of the process divided in 5-7 process steps •Define the correct sequence for the process steps •Identify key inputs, suppliers and outputs •Define key customers as receivers of the outputs •Identify input and output requirements	5. Generated SIPOC diagram with suppliers, inputs, process steps, outputs and customers. •Requirements for inputs and outputs

The attendants were first asked to define process boundaries by identifying where the process starts and where it ends. Next, interviewees were asked to identify process steps and their correct sequence. Following to the process steps, inputs, suppliers, outputs and customers were defined. Lastly, the interviewees were requested to define requirements for inputs and outputs of the process. The generated SIPOC diagram is being presented on appendix 2.

The process begins when sales or other in-house department sends purchasing requisition and product specification to the purchasing. These inputs are initiating the first process step, Kraljic matrix-based product categorization which provides supply

strategy proposal as an output. According to interviewees, convenience was perceived as the most important output requirement in this phase of the process.

The process continues when alternate suppliers send their capability reports and references as inputs. These inputs are initiating the next process step, supplier assessment. This process step focuses on analyzing and comparing the inputs and as a result, provides supplier ranking and supplier selection proposal as outputs. The correspondence between supplier ranking and product categorization was perceived as the most important output requirement.

The process then proceeds to step three, supplier selection and categorization. Sales- or other in-house departments were defined as process suppliers and overall assessment of the product (criticality, demand, cost and ABC-analysis) was identified as input for this process step. The process step then generates supplier category (scope, frequency, metrics and criteria of the assessment) as an output. In this process step, coverage of the classification and the correspondence between supplier categorization and category were defined as major requirements.

Assessment, evaluation and feedback of the first delivery were defined as fourth step of the process. This step is initiated, when suppliers and in-house departments provide delivery and quality reports, OTIF-report and cooperation evaluations as inputs to the process step. This process step then concentrates on analyzing these inputs and provides comparative report of expectations and reality as an output. Definition of corrective measures when required was defined as secondary output. According to the interviewees, OTIF reliability and quality of the reports were the main requirements for outputs.

The attendees defined follow-up of corrective actions and continuous performance measurement as the fifth and the last actual step of the process. This step is initiated when supplier provides reports of implementation of corrective measures and performance as inputs. Process step generates the assessment of the effectivity of corrective actions and performance measurement report as outputs. Reliability and verifiability were defined as key requirements for outputs.

The interviewees also proposed that the process could be extended with two additional process steps if required: Finding alternate suppliers as a step six and terminating supplier relationship as a step seven. However, these steps are not always included in the process and were therefore, defined as additional extension. All the inputs in different phases of the process had the same requirements; Comparability, coverage, convenience, reliability and verifiability. The supplier performance measurement process is primarily conducted by the purchasing function, which was also defined as a customer for all the process steps. Hence, the output requirements corresponded with process customer requirements and therefore, additional QFD analysis was not seen essential for the process improvement project.

4.4 Measurement

In accordance to DMAIC approach the second phase of the project focused on measuring the process. As chapter 2.2 described, the process measurement is often conducted through statistical analysis based on frequency data. This research however, focused on business process that did not yet practically exist. Therefore, process measurement was done by applying failure modes and effects analysis (FMEA) on the process. As the chapter 2.2.3 suggested, this tool focuses on identifying potential failure modes in different phases of the process. The analysis was conducted on excel FMEA template by ASQ which was also displayed to the attendees during the interview. This approach enabled attendees to perceive and visualize the process. It also increased flexibility during the interview, as the interviewees were able to return on the previous questions in case, they required changes, update or fulfillment.

At the beginning of the interview, participants were also given printed demonstrations of the previously generated SIPOC diagram. These prints were used as supportive tools that helped attendees to consider inputs, process steps and outputs and their connection to the FMEA matrix. Increased emphasis was placed on activities in different steps of the process, and their connection to process outputs. The analysis was conducted systematically based on predefined interview questions that can also be seen presented on table 8 below.

Table 8. Questions for generating FMEA

Question	Answer
1. Identify and map the process steps for further examination 2. Identify all the potential failure modes that can possibly occur during the process 3. What is the impact on the customer if the failure mode is not prevented or corrected? 4. Evaluate the severity of the of previously identified failure effects (Scale 1-10) 5. Evaluate the frequency of occurrence of the failure modes (Scale 1-10) • What causes the step go wrong? 6. Evaluate the probability to discover failure modes and effects (Scale 1-10)	Generated FMEA Matrix

As the table 8 above represents, the attendees were first requested to identify and map the process steps. Second, the attendees were asked to identify all potential failure modes in different stages of the process. Third, interviewees were asked to evaluate effects of the failure mode in case it escalates. Last, questions four, five and six requested interviewees to evaluate the severity, frequency of occurrence and probability to discover failure modes and effects in scale 1-10. As the process did not yet exist, neither it had existing process controls for avoiding failure modes. Therefore, current process controls were not considered during the analysis.

4.4.1 FMEA based process risk analysis

The interview provided fulfilled FMEA template which is also demonstrated on appendix 3. This chapter focuses on discussing the template and received interview answers. Therefore, it is recommended that FMEA in appendix 3 was observed alongside with the written discussion. The analysis began with definition of different process steps. Defined process steps were mainly in accordance with the previously generated SIPOC analysis with a few exceptions. Attendees defined the process steps as follows:

- Product categorization
- Supplier assessment, selection and categorization
- Assessment and evaluation of the first delivery
- Feedback discussion with the supplier
- Follow-up of the corrective actions

As the appendix 3 demonstrates, product categorization contained two possible failure modes. The first failure mode was that the product matrix is not up to date or updated regularly. The effect of this failure mode is that decisions are being made based on obsolete information which further on leads to faulty categorization. Reasons that cause this step to go wrong were resource prioritization, underestimation of necessity and lack of introductions and guidance. The interviewees defined the severity of this failure mode as six, and probability of occurrence as two.

As can be seen from the appendix 3, the second failure mode in product categorization was faulty categorization. Potential failure effect was incorrect sourcing strategy which may further on lead to additional costs, availability problems, supply interruptions and loss of sales and customers. Potential causes of this failure mode were lack of resources, assessment of necessity, lack of supply market knowledge and previously described obsolete product categorization. The severity of this failure mode was ranked as eight and probability of occurrence as three.

As the appendix 3 represents, the second process step, “supplier assessment, selection and categorization” contained three possible failure modes; Faulty assessment of supplier’s financial status, performance and strategic suitability. Potential failure effects for these failure modes were delivery and quality related problems, increased supply risk, underperformance of the supplier, waste of resources and unfavorable supplier selections. Potential causes for these failure modes were availability and reliability of information, lack of monitoring and challenges of evaluation. The interviewees ranked the severities of these failure modes as seven, five and two. The probabilities of occurrence were ranked as one, four and three.

As can be seen from the appendix 3, third process step, “assessment and evaluation of the first delivery” contained two possible failure modes; Assessment is not done, and assessment is made based on incorrect or missing data. The effects of these failure modes were that problems are being detected too late, number of problems increases and the problem solving is based on reactive actions instead of proactivity, which directly leads to the wasted resources. Potential causes for these failure effects were resource prioritization, faulty supplier categorization, lack of regularization and faulty or inadequate data. The severities of these failure modes were ranked as six and three and the probabilities of occurrence were ranked as two and three.

As the appendix 3 demonstrates, the fourth step of the process, “feedback discussion with the supplier” contained only one possible failure mode; Feedback discussion is not conducted. The effects of the escalation of this failure mode were that the supplier performance is not improved, performance measurement is wasted, problems cannot be fixed, and supplier may take wrong actions. The cause for this failure mode was a simple forgetting of the feedback discussion. Interviewees ranked the severity of this failure mode as five, and probability of occurrence as one.

As the appendix 3 represents, the fifth and the last step of the process, “Follow-up of the corrective actions” also contained only one possible failure mode; Monitoring of the implementation of the corrective measures is inadequate or not done at all. The effects of this failure mode were same with the previous failure mode. The possible causes for this failure mode were also forgetting and resource prioritization. Attendees ranked the severity of this failure mode as seven and probability of occurrence as six.

The ability to detect of all the failure modes was ranked as 10 based on to the fact that the supplier performance process did not currently exists and therefore, failure mode causes are extremely hard to notice. Based on the given severity-, probability of occurrence- and ability to detect ratings, each of the potential failure modes were given a risk priority number (RPN) based on the formula presented on the chapter 2.2.3. These RPN values varied between 50 and 420. Based on their RPN values, potential failure modes were then further on examined and analyzed.

4.5 Analysis

Following to the process measurement and failure modes and effect analysis, the improvement project proceeded to the analysis of the received results in accordance to the DMAIC framework. The aim of this phase of the project was to identify core- and root causes of the discovered failure modes, but also to provide insight about areas for improvement. The analysis was conducted in two different phases; First, the measurement results were pre-analyzed by the author of the study and second, discussed with the project team. This approach increased both, resource efficiency of the project and understanding of the received results.

The analysis was conducted based on the FMEA template, previously used in the process measurement. The primary focus of the analysis was placed on the risk prioritization based on the calculated RPN values. The goal was to identify the most important failure modes in different phases of the process. The FMEA template used for the analysis is being presented on the appendix 3.

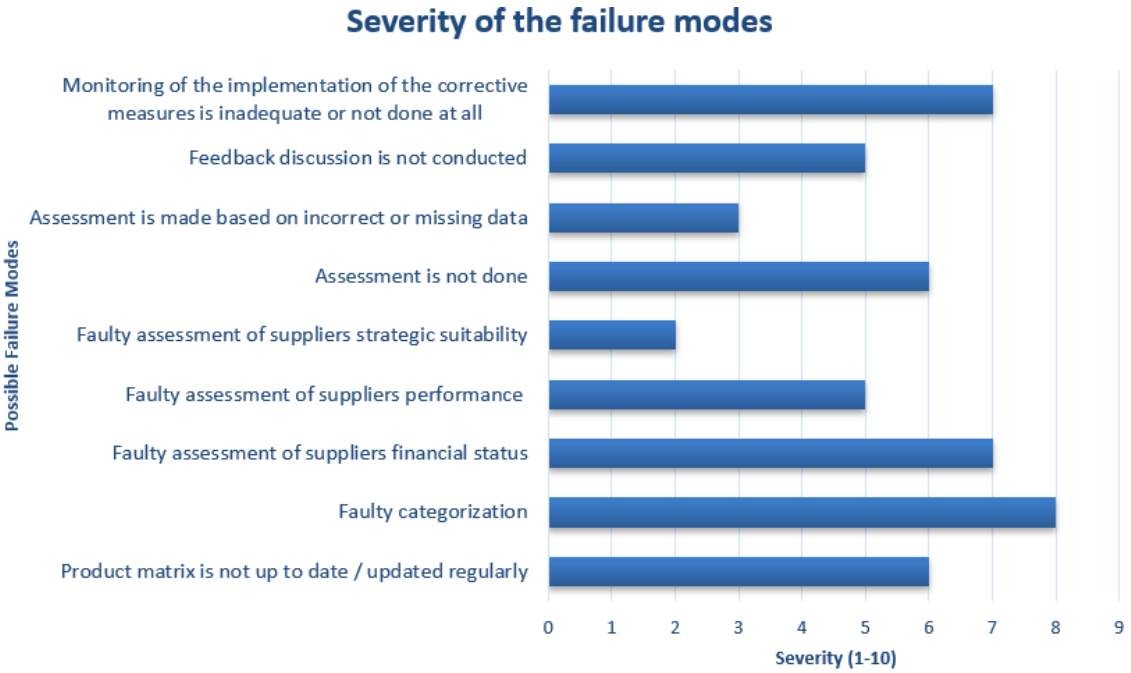

Figure 23. Severity of the failure modes

The analysis began by focusing on the severity of different failure modes. As the figure 23 above demonstrates, faulty categorization, faulty assessment of supplier financial

status, and monitoring of the implementation of the corrective measures is inadequate or not done at all, had the highest ratings of severity (7-8). Possible impacts of these failure modes presented on the appendix 3 also supported this argument as escalation of these failure modes would have significant negative effects. Faulty assessment of supplier's strategic suitability had the lowest severity rating (2), and the rest of the potential failure modes were rated in the middle (3-6). None of the failure modes were rated as 9-10 in severity, which can be seen extremely positive.

The analysis continued by considering the probability of occurrence of the possible failure modes. As the Figure 24 below demonstrates, the ratings were comparatively lower than previously discussed severity ratings. However, the premise for the analyze was that the process did not yet exist and therefore, the probability of occurrence was to some extent challenging to evaluate. Monitoring of the implementation of the corrective measures is inadequate or not done at all, had the highest rating of probability (6) similarly to the rating of severity. Faulty assessment of supplier's performance was the second highest (4) and the remaining failure modes were rated between 1 and 3.

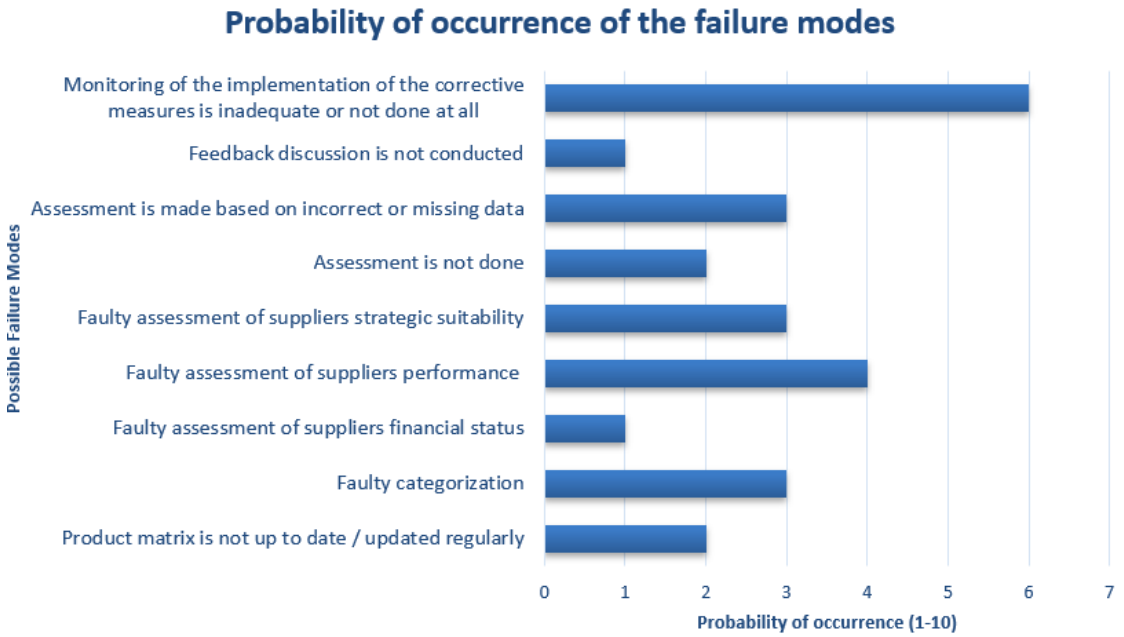

Figure 24. Probability of occurrence of the failure modes

As can be seen from the appendix 3, ability to detect was rated as 10 for all the failure modes. This was done based on the fact that the process did not yet exist and therefore, potential causes were extremely challenging to detect and evaluate. This practically removed one variable of the RPN formula and hence, decreased the reliability of the achieved results. If the ability to detect could have been reliably evaluated, the priority of the failure modes might have been different.

However, based on the received ratings of severity, probability of occurrence, and ability to detect, failure modes were given RPN numbers that can also be seen demonstrated on the figure 25 below. In accordance to the previous ratings, same three failure modes had clearly the highest RPN ratings; “Monitoring of the implementation of the corrective measures is inadequate or not done at all” (RPN 420), “Faulty product categorization” (240) and “Faulty assessment of suppliers performance” (200). It was evident that these failure modes should be emphasized in the improvement phase of the project, as they had the highest significance in the risk profile of the process.

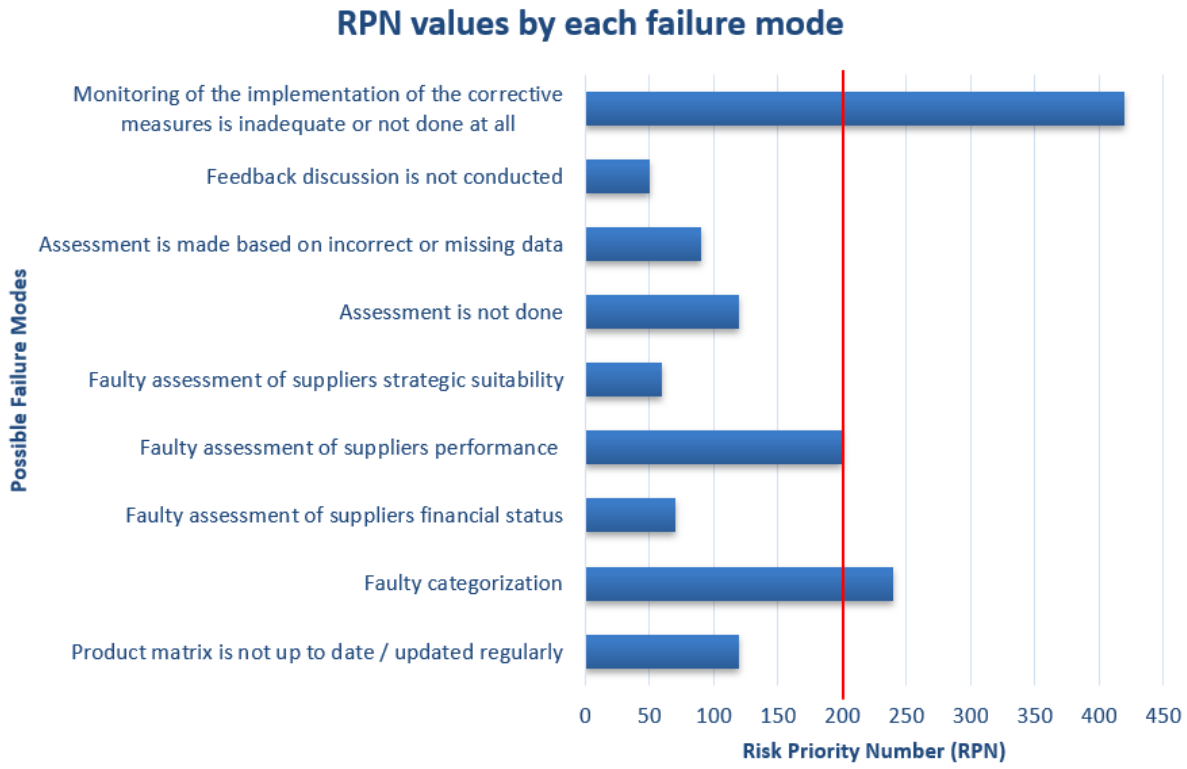

Figure 25. RPN values by each failure mode

The last part of the analysis focused on RPN averages between different steps of the process. This analysis was conducted to support the improvement phase of the project by underlining the most challenging steps of the process. As the figure 26 below demonstrates, the first step “Product categorization” and the last step “Follow-up of the corrective actions” had the highest RPN averages. Based on these results, the beginning and ending were perceived as the most challenging phases of the process. This observation, however, can be seen logical as the success of the first process step often defines the success of the following process steps. If the product categorization fails, the premise for the following steps is faulty and may likely lead to failure also in the subsequent process steps. The last step of the process delivers the final output to the customer and can therefore, also be defined as crucial.

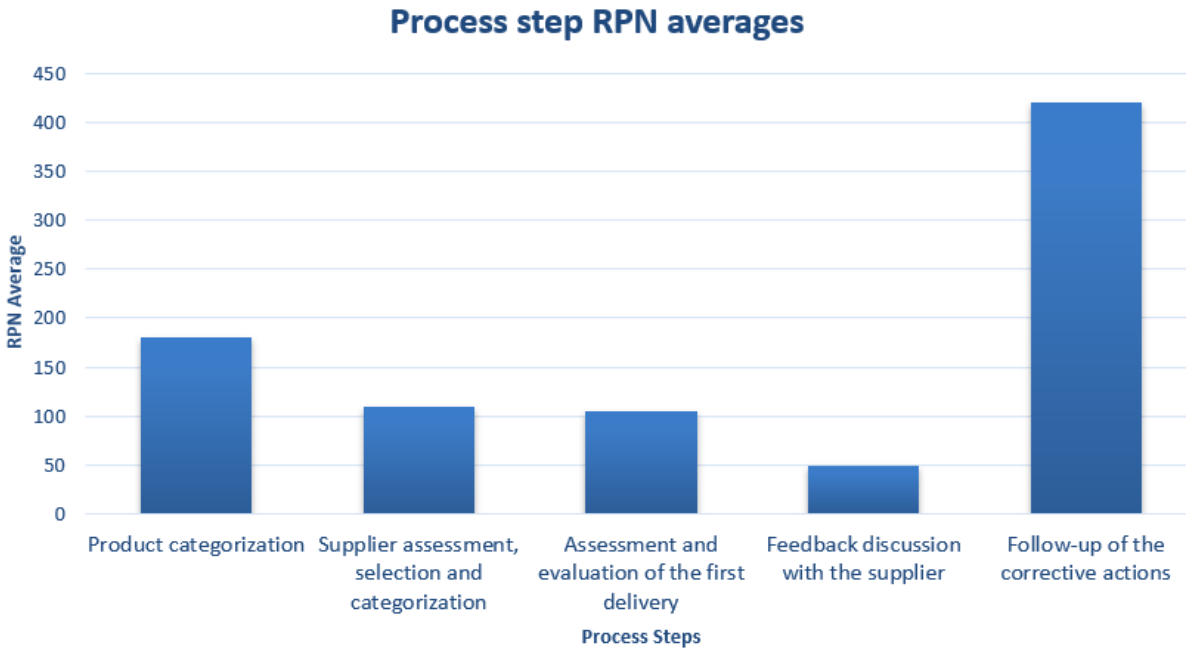

Figure 26. Process step RPN averages

Based on the previous analysis, the risk priority of the failure modes was clear. However, the analysis also focused on identifying the root causes behind the failure modes. It was evident, that the main problem was the same as the premise for the whole process improvement project: The process did not yet exist, and therefore the performance measurement was not conducted regularly. This lack of regularity was defined as root cause for all the main failure modes:

- Implementation of corrective actions by the supplier is not regularly monitored and therefore, supplier performance is not improved, and resources are being wasted.
- Product category matrix is not updated regularly which may lead to faulty categorization and further on to incorrect sourcing strategy.
- Supplier performance assessment is not regularly conducted and is therefore, often faulty and based on false information

4.6 Improvement

Following to the process analysis, project continued to the improvement phase. In this part of the project, the goal was to generate ideas for improvement and further on implement the ones with the highest potential. This was done by first, discussing the identified failure modes, their effects and causes. Previously used FMEA template was used as primary tool also in this phase of the project. Based on the discussion, improvement ideas were generated and suggested in the FMEA matrix which is also represented in the appendix 3.

Improvement ideas were generated for all the discovered failure modes. However, due to the prioritization of limited resources of the project, the emphasis was placed on the failure modes with the highest RPN values. As the appendix 3 demonstrates, these failure modes were “faulty product categorization”, “faulty assessment of suppliers performance” and “monitoring of the implementation of the corrective measures is inadequate or not done at all”. To be able to reduce the occurrence or improve the ability to detect the cause of the failure modes, following improvement ideas were suggested:

- The product categorization matrix must be updated and reviewed regularly.
- Suppliers and their performance must be measured more thoroughly, and feedback meetings must be arranged regularly.
- Implementation of the corrective actions by the supplier must be regularly monitored and evaluated.

The project team came to conclusion that preparing implementation of the improvement ideas required two practical actions. First, the product categorization matrix had to be updated to correspond with the current situation. Second, the whole supplier performance measurement process must be modelled in detail. This detailed process description should also include supplier scorecard and practical instructions for conducting the performance measurement and follow-up of corrective actions.

4.6.1 Workshop 1: Updating the product matrix

The practical implementation of the improvements began by generating Kraljic-based product category matrix in three separate workshop sessions. These sessions were conducted by the author of this study and the operative purchaser of the case company. This approach aimed to utilize the theoretical experience of the researcher and the practical industry- and company specific knowledge of the purchaser. The generated product category matrix was then reviewed and approved by the purchasing- and supply chain managers of the case company.

The categorization was conducted based on theoretical background about the Kaljic's matrix which was also briefly discussed in the chapter 3.1.3 of the thesis. As the product categorization matrix did not yet exist, the categorization began by limiting the scope of the categorization to 15 largest product categories based on the total spend of purchasing. Second, the profit impact of each of the product categories was evaluated in rating 1-10 based on the share of the total sales of external products and the average profit margins. This evaluation also considered the strategic importance of the products from the perspectives of main customers, private label designs and generic items.

Next, the supply risk of the product categories was evaluated in a similar scale of 1-10. This evaluation focused on analyzing the challenges of the supply markets by considering the number of potential alternate suppliers, geographical locations of suppliers, costs of changing suppliers and other risks related to supply chain. Lastly, main suppliers for different product categories were defined. In order to increase the validity, reliability and understandability of the matrix, the evaluation criteria were also

reported and commented on the evaluation sheet. Based on these evaluations, 15 largest product categories were placed on the product categorization matrix as presented on the figure 27 below.

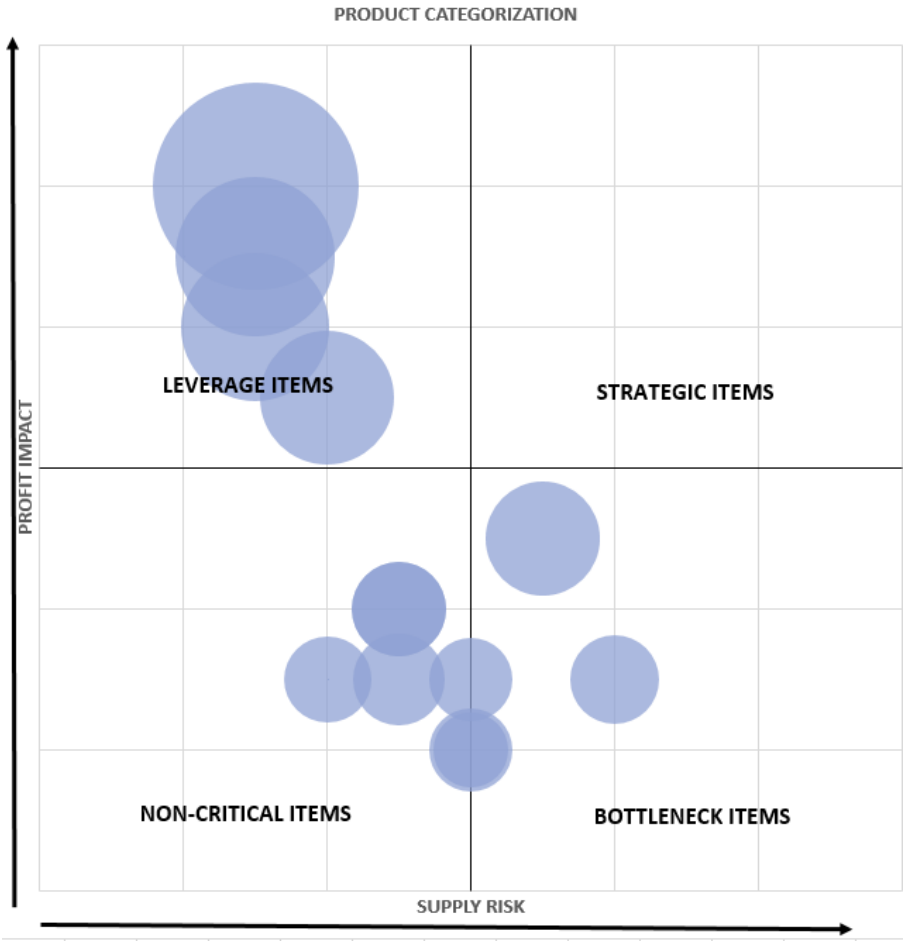

Figure 27. Constructed product categorization matrix

As the figure 27 above demonstrates, the generated product category matrix provided a new insight on the current product categories and further on, supply strategies. The matrix was reviewed and approved to be used as a tool for planning the supply strategy. Due to the confidentiality reasons, the names of the product categories are not being displayed in this thesis.

In addition to the actual product category matrix, updating instructions for the matrix were also provided. As the appendix 4 demonstrates, instructions provided clear and easily understandable guidelines for updating the matrix. Instructions for collecting the data from ERP will also be included on the template in the future. The update

frequency was also considered in the instructions as the main root cause of the problems in the process was the lack of regularity. Hence, compliance to the instructions partly acts as a controlling measure for maintaining the improvement.

4.6.2 Workshop 2: Modelling the process with improvements

The second improvement workshop consisted of two separate brainstorming sessions that focused on designing a process that also considers proposed improvements. First, the process was modelled by generating a flowchart-based process description. Previously generated SIPOC diagram and FMEA template were used as supportive tools during the process. The goal was to generate clear and easily understandable description of the process that could further on be used as a guideline for measuring the supplier performance. The generated process description is being presented on appendix 5.

As the appendix 5 demonstrates, the process steps were highly similar to previously generated FMEA template. The continuous performance measurement and follow-up of corrective actions, however, were defined as individual process steps. These specific process steps were also prioritized for the improvements and hence, process description enabled more focused approach towards the most challenging areas of the process. Inputs and outputs were mainly in accordance to previously generated SIPOC diagram.

It is also important to point out that even though the last two process steps were described individually, the continuous performance measurement and follow-up of corrective actions were perceived as repeating continuum: Supplier scorecard and defined corrective actions are acting as input for the follow-up of corrective actions. This step, however, generates corrective actions report as output which also acts as an input for the previous performance measurement process step. Hence, the process measures supplier performance and monitors implemented corrective actions on an ongoing basis.

The second session of this improvement workshop focused on designing the actual system for performance measurement. As the case company representatives pointed out, the main purpose of the performance measurement system should be to provide reliable information about the performance of individual suppliers. Hence, the system should be able to present trends and changes in different areas of performance. Using the system for conducting comparison between different suppliers, was not seen highly important at this point.

In practice, the system was designed in accordance to the theoretical background of the supplier performance measurement presented in chapter 3.2.1. First, the areas for measurement were defined based on the purchasing strategy and objectives. Second, categorial measurement system was selected as it was easiest to implement and therefore, recommended for companies in progress of developing a performance measurement system. Last, supplier scorecard was constructed by the author of the study and further on approved by the case company representatives.

The designed supplier scorecard can be seen presented on appendix 6. Based on the suggestions of case company representatives, quality and delivery were chosen to be the main areas of performance measurement. Cost and cooperation were also considered, yet they were perceived to be more important in supplier assessment and selection and were therefore, excluded from the scorecard. Both, quality and delivery contained several sub-categories of performance. As appendix 6 demonstrates, most of the categories are being evaluated based on the numerical data (N) and some of the categories through qualitative assessment (A). The data used for measurement is being collected from ERP system and supplier reports.

As the appendix 6 demonstrates, the scorecard included instructions for the measurement frequency of different supplier categories. In accordance to the literature, the most important A category suppliers are being measured most frequently once in a quarter, B category suppliers yearly and C category suppliers once in every three years. The same scorecard template is being used for all the supplier categories. As can be seen from appendix 6, the scorecard template contained following sections:

- Main performance categories and their sub-categories
- Criteria for conducting the evaluation for each of the categories
- Parameters for defining the rating values based on the received scores
- Scores, ratings and comments

Defined performance categories are being evaluated based on the criteria presented on the scorecard. The criteria were predetermined, yet it will be discussed and confirmed by the suppliers before the practical implementation of the measurement system. Similarly, the parameters for rating performance scores were not yet defined or confirmed by the suppliers. The whole performance measurement system is new, and therefore, assessable data has not yet been collected or analyzed. As soon as the process has been implemented and first measurement has been conducted, parameters will be defined for different levels of performance.

As the previously conducted FMEA suggested, the follow-up of corrective actions must also be considered. In practice this was done by including guidelines for the follow-up on the scorecard. Following to the performance measurement, identified problems are being reported on the template. Corrective actions are being recommended and fully or partly agreed by the supplier. Next, the schedule for conducting the corrective actions and for evaluating the results are being agreed together with the supplier. Hence, conducting the follow-up in accordance to the measurement frequency enables buyers to effectively evaluate the results of given recommendations.

4.7 Control

In accordance to the DMAIC approach, the last phase of the process improvement project was the control. The aim of this phase was to ensure, that the achieved improvements can be maintained also in the future. As the process was completely new, successful implementation of the performance measurement system played a major role in the success of maintaining the improvements. Therefore, implementation was carefully planned, and it will be executed by piloting it with the main suppliers through following phases:

- 3 main suppliers will be informed about the new measurement system
- Measurement criteria will be discussed and confirmed by the suppliers
- Data will be collected, assessed and the first measurement will be conducted
- Follow-up procedure will be tested and parameters for scoring the performance will be defined
- Effectivity of the system will be evaluated and required changes will be made
- The measurement system will be implemented for all the A, B and C category suppliers

In addition to the successful implementation, linking supplier performance measurement process to the ERP system acts as important controlling measure for maintaining the improvements. The ERP system will notify the buyers about the requirement for performance measurement in accordance to the measurement frequency of different supplier categories. Similarly, notifications for the follow-up of corrective actions by the supplier will be linked to the ERP system in accordance to agreed schedule of evaluation.

It is evident, that the developed performance measurement system will be further on improved and the changes will be made over time. Nevertheless, developed process provides a potential premise for effective performance measurement and further on, supplier development. Even though, the process has not yet been implemented and achieved benefits are mostly speculative, the company is still one step closer fully operational supplier performance measurement and evaluation system.

The last step of the control phase and the whole process improvement project was the feedback discussion with case company representatives. Predetermined requirements, expectations and achieved results were discussed. The case company representatives were highly satisfied with both, achieved results and the conduction of the project itself. The project succeeded to meet the expectations within the given schedule. In overall, the project was seen beneficial, and the generated practical improvements as useful.

5 DISCUSSION AND CONCLUSIONS

This chapter focuses on discussing and concluding the research findings. First, the discussion considers the connection between theoretical background and empirical research findings through comparison. Second, research questions are being answered and reliability, validity and limitations of the research are being discussed. Lastly, discussion provides insights about future research possibilities and ends to conclusions.

5.1 Comparison of theoretical and empirical findings

The empirical part of the study was conducted as process improvement project, based on Six Sigma DMAIC framework. This approach enabled logical perspective towards process improvement and created a strong connection between theoretical background and the actual business context. Even though the project relied on theoretical guidelines of Six Sigma philosophy, the practical conduction of the project had notable differences in comparison to theoretical Six Sigma project:

- As the literature on chapter 2.2 suggests, Six Sigma project should be initiated by the company management. This project, however, was conducted as a part of master's thesis research and hence, incentive was provided from outside of the case company.
- According to literature, Six Sigma project should be run by certified Six Sigma blackbelt with experience and understanding of Six Sigma methodology. This project, however, was executed as a part of master's thesis research and therefore, author´s experience about the Six Sigma methodology was comparatively limited.
- According to literature, the improvement philosophy should be applied across the organization and the improved process should be selected among the main business processes, preferably based on cost analysis. This project, however, was pre-limited on the purchasing sub-processes and extensive cost analysis was not conducted prior to the selection of the improved process.

Following to the selection of the improved process, the project proceeded to the definition phase. As Karout and Awasthi, (2017) & Mishra and Kumar Sharma (2014) suggested, the define phase should provide clear insight about the background and objectives of the project. Hence, define phase should be able to provide answers on the questions: What is the problem, what type of defects exist and what are the desired outcomes of the project? Muralidharan (2015, 104) also suggested that Six Sigma SIPOC diagram should be utilized in the definition phase of the project to provide increased understanding of the process through high-level process description.

The interview template for the definition phase was constructed based on the questions suggested by Karout and Awasthi, (2017) & Mishra and Kumar Sharma (2014). Hence, the definition phase succeeded to provide a clear understanding about the requirements and objectives of the project. As presented in chapter 4.1.1 the company did not have process for supplier performance measurement and therefore, it had to be designed. This was done by constructing a SIPOC diagram in accordance to the instructions provided by Johnsen et al. (2008, 34). The generated process description was mainly able to fulfill the description criteria presented by Laamanen (2001, 76) in chapter 2.1.3.

In chapter 3.1, van Weele (2014, 8) proposed overall description of the purchasing process, divided in six purchasing sub-processes. Supplier performance measurement was included as one of the follow-up actions in the last phase of the main purchasing process. However, when the supplier performance measurement process of the case company was modelled during the empirical part of the study, the generated description significantly differed from the model provided by van Weele (2001, 76). As the figure 28 below demonstrates, the performance measurement process of the case company was perceived as parallel to the main purchasing process. The construction of the process description, however, is generally highly company specific and therefore, the differences were not significantly surprising.

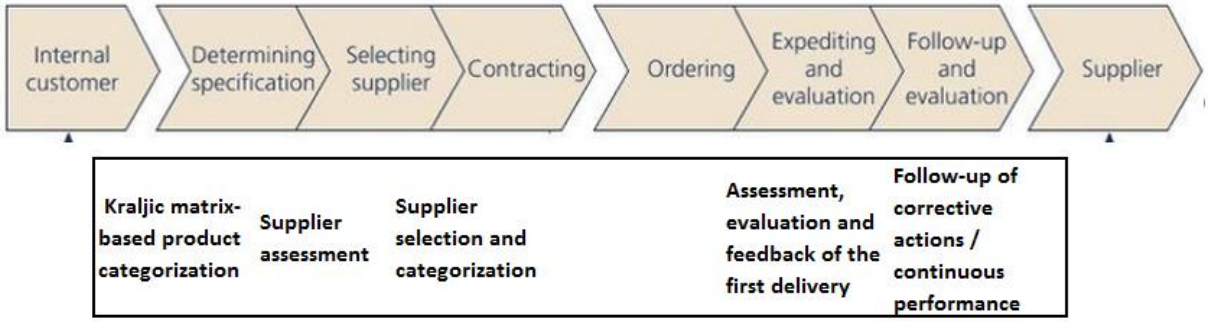

Figure 28. Purchasing process by (van Weele, 2014, 8) in comparison to supplier performance measurement process of the case company.

Following to the process description, the project proceeded to the measurement phase. According to Karout and Awasthi, (2017) & Mishra and Kumar Sharma (2014) the measurement should provide information on how well the process performs and how it can be measured. The practical measurement was conducted by utilizing FMEA on the process in accordance to the instructions provided by Sharma et. al. (2005) and Kubiak (2014) in chapter 2.2.3. Possible failure modes were identified and further on analyzed on the FMEA template. Guinot et al. (2017) and Liu (2016, 4) suggest that FMEA is most effective when conducted together with process owners and workers. The sample of this research included all the relevant personnel related to the process and hence, the selected Six Sigma tool could be utilized effectively.

The process lacked regularity and contained multiple risk factors in different process steps. As van Weele (2014, 28) argued, the succession of the first process steps strongly defines the performance of the upcoming stages. This was also seen in the FMEA analysis, as the importance of first and the last process steps were underlined. Guinot et al. (2017) and Liu (2016, 4) proposed that the occurrence, severity and detection possibility of the failure modes should be evaluated. Kubiak (2014) also proposed that the FMEA should consider current process controls.

The evaluation of occurrence, severity and detection possibility was conducted in accordance to the FMEA instructions. However, as the process did not yet exist, the detection possibility was ranked as 10 for all the failure modes. Based on the same reason, current process controls were not considered during the analysis. This could be perceived to have negative impact on the credibility of the measurement results.

Nevertheless, FMEA was able to provide comparatively valid information about the performance of the process and hence, was able to meet the requirements presented by Karout and Awasthi, (2017) & Mishra and Kumar Sharma (2014). Calculated RPN values also enabled prioritization of the failure modes which further on acted as a guideline for improvement practices.

After RPN based failure mode prioritization, project proceeded to analyzing phase. Identified failure modes were more thoroughly examined and the root causes behind the defects were exposed. Hence, this phase of the project succeeded to provide answers on the question “what are the main causes behind defects” as presented by Karout and Awasthi, (2017) & Mishra and Kumar Sharma (2014). Pepper & Spedding (2010, 139) argued that this phase of the Six Sigma project is often conducted by utilizing statistical methods and quantitative analysis. This project however, mainly focused on analyzing the selected business process through qualitative research methods, excluding statistical comparisons of severity, occurrence, probability to detect and RPN values. Hence, the analyze phase of the project partly differed from the guidelines presented in the literature.

The practical improvements were highly emphasized in accordance to the case company requirements and research objectives. The improvement phase consisted of workshop sessions that focused on first, generating up to date product categorization matrix and second, modeling improved process for supplier performance measurement. The improved process description also included supplier scorecard system and follow-up of corrective actions. The development of the improved process was mainly executed in accordance to the viewpoints presented in the literature.

Kraljic’s matrix was briefly discussed in chapter 3.1.3 in relation to different negotiation approaches. The product categorization matrix was constructed during the first improvement workshop in accordance to theoretical background as presented by (Montgomery et. al. 2018). Supply risk and profit impact of different product categories were discussed and evaluated. Hence, the generated product categorization matrix can be used as a guideline for selecting appropriate negotiation strategy as Huuhka (2016, 138) suggested.

The second workshop began by generating a process description of the improved process. As Laamanen (2001, 75) argued in chapter 2.1.3 the modelling should aim to provide a clear and easily understandable process description. To be able model the process successfully, a flowchart-based method was selected. As Harrington (1991, 87) argues, flowchart provides a logical guideline for practical execution of the process. According to case company representatives, the generated description was easily understandable and demonstrated all the relevant features of the process.

As Baily et al. (2008, 422), Monczka, Trent and Handfield (2005, 642) and Sundtoft Hald and Ellegaard (2011) proposed, the performance measurement system should be based on the purchasing strategy and objectives. This perspective acted as a premise also in the empirical part of the study. Measured areas of performance were selected based on the purchasing strategy. As Monczka, Trent and Handfield (2005, 270) argued, the required measurement frequency also differs between different suppliers. This perspective was also considered and therefore, different measurement frequencies were defined for different supplier categories.

In chapter 3.2.2 Monczka, Trent and Handfield (2005, 271) provided an overview of different supplier performance measurement and evaluation systems and their differences. As this overview suggested, categorial system was recommended for firms in the process of developing an evaluation system. This definition acted as an argument for justifying the usage of categorial measurement system. At this point, weighted-point or cost-based systems would have been too demanding to be implement effectively.

In chapter 3.2.3 Doolen et. al. (2006) proposed a five-step approach for implementing the scorecard system. This approach was partly followed by defining the measured areas of performance and by developing criteria for evaluation. However, as Doolen et. al. (2006) suggested, suppliers should be engaged before establishing a graphical design for the scorecard. In this project, the scorecard was constructed in advance and will be presented to suppliers later. According to Karout and Awasthi, (2017) & Mishra and Kumar Sharma (2014) the improvement phase should also include the practical implementation of the improvements. This project however, provided ideas

for improvement, yet they were not practically implemented. In order to include the implementation on the thesis report, the whole research schedule would have extended significantly. Therefore, the implementation phase was not included on the report and effects of the improvements remain speculative.

As Karout and Awasthi, (2017) & Mishra and Kumar Sharma (2014) argued, the improvement phase should be able to answer to the question: How the causes of defects can be removed? The empirical part succeeded to provide answers on this question by designing improved process for measuring supplier performance. However, the achieved benefits cannot be fully confirmed before the practical implementation of the process. Despite the missing implementation, the process was perceived as highly potential and expectations of the achieved results are optimistic.

The last phase of the DMAIC framework was the control. As Karout and Awasthi, (2017) & Mishra and Kumar Sharma (2014) argued, this phase should provide answers on the question: How the improvements can be maintained? As the chapter 4.7 presented, the improvements can be maintained by successfully implementing the developed process, linking it to the ERP system and by evaluating and improving the system also in the future. According to Pepper & Spedding (2010) the control phase is normally being conducted after the improvements have been implemented. This research however, presented controlling measures in advance before the actual implementation.

Feedback discussion with case company representatives acted as an ending point for the process improvement project. Project objectives, expectations and achieved results were discussed and evaluated. The case company representatives were satisfied with achieved results and the project was perceived as a successful in general. However, as Muralidharan (2015, 6) pointed out, Six Sigma management promotes continuous improvement which does not end on a specific project. Even though this project was carried out as a part of master's thesis research and the report is about to be published, the work with the developed process continues. The author of this study continues to work with the project team until the system is practically implemented.

5.2 Answering the research questions

The whole research project was conducted to provide answers on research questions formulated at the beginning of the project. These research questions were first approached through existing literature about business process improvement and purchasing management. Second, the themes were examined in a real business context by conducting empirical data collection in a case company. Collected data was then further on analyzed and as a result, the research questions can finally be answered. The main research question set for this research was:

How the purchasing process performance can be improved by developing a purchasing sub-process?

Four sub-questions were asked to support the formulation of the main research question. These sub-questions are being addressed first, and the main research question which basically summarizes the main points of the sub-questions, is being answered at the end of this chapter. Sub-questions and their answers are being separately presented as follows:

Which purchasing sub-process should be selected for improvement and why?

The sub-process selected for improvement should be the one with the highest improvement potential. In this case study, supplier performance measurement process held the highest potential and was therefore, selected to be improved. The decision was supported from various perspectives: This specific process was defined significantly important, as the supplier performance directly affects the overall excellence of the purchasing process. The case company did not yet have systematic procedure for supplier performance measurement, which was also previously addressed in internal audit reports. Hence, the requirement for operational supplier performance measurement process was evident and the process was chosen for the improvement project.

What kind of defects can be found in the process?

The main defect in the process was the lack of regularity. Supplier performance measurement was not systematically conducted which was also defined as a root cause for other defects in the process. The first process step product categorization was not done regularly either and therefore, product matrix was not up to date. Supplier assessment was done faulty, based on unreliable, insufficient or missing data. The process also lacked procedure for systematic follow-up of the implementation of corrective actions by the supplier.

How the selected process can be improved?

The process can be improved by focusing on the identified main defects. In practice this can be done by designing a systematic supplier performance measurement process and by implementing it as a part of the daily operations of the purchasing function. Improved process description includes proper instructions for updating product categorization matrix, measuring supplier performance and following-up the implementation of corrective actions. These procedures are also being linked to the ERP system, which guarantees that the activities are being conducted regularly.

What benefits can be achieved by improving the process?

By Implementing improved supplier performance process as a part of the operations of the purchasing function, the whole purchasing process can be executed more effectively. Effective supplier performance measurement leads to increased knowledge of the supplier base, more accurate supplier assessment, supplier selection and further on supplier development. Supplier development in turn, enables improved supplier performance which may lead to better resource allocation, decreased supply risk and inventory related cost reductions.

The answer for the main research question can then be provided by summarizing the main points of previously presented answers of sub-questions: The purchasing process performance can be improved by developing supplier performance

measurement process. In practice this can be done by designing systematic procedure for measuring supplier performance and implementing it as a part of the purchasing function operations and ERP. The process description should include detailed instructions for effective execution of previously low performing process steps. As a result, the whole purchasing process can be executed more effectively which further on leads to improved supplier- and purchasing performance.

5.3 Validity, reliability and confidentiality

The credibility of the research can be evaluated by assessing the validity and reliability of the research. This evaluation is a key part of the research process and aims to decrease the possibility of mistakes and misinterpretations (Tuomi and Sarajärvi 2009, 134). Validation of the research findings happens throughout the research process. Proper discussion, however, has been perceived as important characteristic of credible research. (Creswell, 2003,195). Qualitative research has also been criticized for ambiguous reliability criteria in general. Therefore, proper assessment of the used research methods plays a high importance. (Eskola and Suoranta, 1998, 208).

Validity refers to the ability of the used research methods to accurately measure what they were supposed to. (Saunders et al. 2006, 603). In this research, all the research steps were carefully documented throughout the research process. The interviews were properly planned, recorded and permission for the recording was also requested. The interviewees were selected through purposive sampling and prior to the interviews, were familiarized with the topics to mitigate the risk of misperceptions.

The used research instrument was carefully constructed based on the research objectives and relevant literature about the topics. Research instrument was also pre-tested with case company representative before conducting the actual interviews. Secondary data sources such as internal audit reports and process descriptions were also used as supportive elements for the data collection. According to Stuart et al. (2002) the usage of several data sources and careful documentation of the process steps are acting as improving factor for the research validity.

Stuart et al. (2002) are claiming that research validity can be evaluated based on the generalizability of the research findings. This research was conducted as a single-case study within a single organization. According to Thomas and Myers (2015, 29-30) the case study research does not pursue to provide generalizable results, but to examine phenomenon within a specific context. Hence, this research emphasized managerial implications instead of extended generalization.

The research findings are highly time and organizational dependent which can be defined as decreasing factor for the research validity. However, the conduction of the research was based on well documented Six Sigma DMAIC framework which is comparatively easy to deploy in different business context. Therefore, detailed documentation of the project can also be seen to some extent as improving factor for the research validity.

According to Saunders et al. (2006, 600) the research reliability refers to the transparency and repeatability of the research findings. According to Eskola and Suoranta, (1998, 212-215) the evaluation of the research reliability should focus on the justification and documentation of the used research- and data collection methods. In this thesis, increased emphasis was placed on presenting, documenting and justifying selected research methods (chapter 4.2). Different phases of the research were also reported from Six Sigma project perspective (chapters 4.4-4.8).

The data was collected from comparatively small sample which can be perceived as decreasing factor for the research reliability in general. However, the sample was selected through purposive sampling and included all the relevant experts from the perspective of research objectives. From this premise, the expertise of the interviewees played higher significance than the size of the sample and hence, acted as improving factor for the research reliability.

Four interviews were conducted in total for the same research sample. Similar topics and Six Sigma tools were discussed and used throughout the interviews. This promoted the achievement of data saturation, as the last interviews did not provide new information or major changes on previously discovered results. The interviews

were conducted in Finnish and results were then translated in English. Translation may contain a risk of misinterpretation and therefore, negatively affects the reliability of research.

Six Sigma methodology and tools played a major role throughout the research process. Tools such as SIPOC diagram and FMEA template were used as supportive elements for data collection and analysis. This can be perceived as improving factor for both validity and reliability, as the same tools have been successfully deployed numerous times in different research environments in the past. The researcher itself did not contain organization specific expertise about the researched phenomenon and hence was able to act objectively with minimized researcher bias. This can also be seen positively affecting both, validity and reliability of the research.

The research also considered confidentiality perspective. As Saunders et al. (2006, 194) point out, the researcher is responsible of securing that the data collection and received results remain confidential. Interview data was analyzed confidentially, and the recordings and notes were later disposed. Anonymity of the case company and its representatives acted as a premise for the conduction of the research. Therefore, company name, the names of the interviewees and other identifiable factors are not presented on the thesis.

5.4 Limitations and future research

As previously described in the beginning of the thesis, the research was limited to specific time and organization, specific business unit, purchasing of finished goods and tactical and operative purchasing. The research was conducted as qualitative single-case study which according to Thomas and Myers (2018, 29-30) does not pursue extensive generalization but emphasizes organization specific managerial implications. Even though the research was conducted within defined limitations, the achieved results can at least to some extent be applied in different business environments.

The process improvement project provided a systematic procedure for supplier performance measurement. The process was developed for the purchasing function of the case company and especially for the purchase of finished goods from external suppliers. Even though extensive generalizations of the research findings cannot be made, the same process could be applied within the same organization on raw material purchasing. However, it should be remembered that the findings are also limited on specific time and may not be actual after some time.

Generally, Six Sigma management has been extensively utilized and examined in different business environments. This research acted as practical example of the utilization of Six Sigma tools and methods on the actual business process. The research selected a specific purchasing sub-process which was further on measured, analyzed and improved. Existing literature regarding purchasing related business process improvement is comparatively limited. Therefore, future research proposals could be targeted on this area of the process improvement.

First, future research could be conducted to examine the achieved benefits and business outcomes of this study; How systematic supplier performance measurement affected on the overall excellence of the purchasing process and did it lead to increased delivery performance and inventory related cost reductions? Second, the utilization possibilities of Six Sigma methodology on different purchasing sub-processes could also be further on studied. Comparative study about achieved benefits of the improvement practices could provide new information about both, the sub-process criticality and application potential of the Six Sigma methodology. Different Six Sigma tools and their application on the similar processes could also be further on examined.

Another interesting future research proposal could be to apply Six Sigma methodology on the purchasing of services instead of actual products. Service purchasing differs significantly from the product purchasing and hence, this kind of research could provide new insights about the purchasing process itself. It would also be interesting to examine, how supplier performance measurement criteria and practices differ

between product- and service-oriented industries and how it affects the overall excellence of the purchasing performance.

5.5 Conclusions

In the modern business environment, the requirement for systematic business process improvement is evident. This requirement can also be identified in the context of purchasing management. Both, the purchasing process excellence and the performance of the suppliers are strictly connected to the operational efficiency and the overall profitability of the company. Therefore, implementing business process improvement in the field of procurement and purchasing can be perceived as highly important.

This case study focused on examining business process improvement from the perspective of the purchasing function of selected case company. The research was conducted as a part of Six Sigma process improvement project in accordance to the DMAIC framework. This framework enabled a systematic and logical approach towards practical improvements by first, identifying improvement potential, measuring and analyzing the process and last, providing practical improvements and tools for maintaining achieved results.

In the context of the case company, supplier performance measurement process held the highest improvement potential. In general, appropriate supplier performance measurement enables supplier development and further on, improved supplier performance. The process did not yet exist in the case company, and therefore, it had to be designed. The process improvement project was systematically conducted and reported alongside with the research findings. As a result, a systematic supplier performance measurement process was developed. Nevertheless, the work continues, as the developed process is about to be implemented also in practice.

In relation to the existing literature, the academic novelty value of the research was comparatively limited. As previously described, Six Sigma projects have been extensively conducted and the methodology has been applied in various business

environments. This project was conducted in accordance to the Six Sigma guidelines and hence, it acted more as a supportive element for the existing theory. In general, Six Sigma projects mainly concentrate on the improvement of existing processes. In this research however, the developed process was entirely new and therefore, methodology had to be applied from different premises. Hence, some significance can be seen in the research findings, as the results act as an argument for varied application possibilities of the deployed improvement methodology.

From this perspective, the research provided an example of practical business process improvement within a specific business environment. However, due to the methodological nature of the single case-study the results cannot be extensively generalized. Considering this limitation, it is also important to point out that the premise for the whole research project was that managerial implications and practical improvements are being emphasized. Case company representatives were highly satisfied with the results and therefore, the research project can be argued to be successful.

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APPENDICES

Appendix 1. Interview templates

Define

1. Define the main problem(s) we are aiming to fix?
- Why this specific problem(s)?

2. What kind of defects exist?
- What negative effects these defects have caused?

3. How improving this specific process helps to overcome the main problem?
- What is expected to be achieved as a result of the project?
- What are the expected business improvements or outcomes?

4. Has this process been previously modeled?

5. Modeling the process:
- Identify the process and define process boundaries
- Draw a diagram of the process divided in 5-7 process steps
- Define the correct sequence for the process steps
- Identify key inputs, suppliers and outputs
- Define key customers as receivers of the outputs
- Identify input and output requirements

Measure

1. Identify and map process steps for further examination
2. Identify all the potential failure modes that can possibly occur during the process
3. What is the impact on the customer if the failure mode is note prevented or corrected
4. Evaluate the severity of the previously identified failure effects (Scale 1-10)
5. Evaluate the frequencey of occurrence of the failure modes (Scale 1-10)
   - What causes the step to go wrong?
6. Evaluate the probability to discover failure modes and effects (Scale 1-10)

Analyze / Improve

What are the root causes behind the failure modes?
Which failure modes should be prioritized for the improvement?
Provide ideas for improving the ability to detect or to reduce the occurrence of the failure modes

Control

How the improvements can be maintained?
How the process will be implemented?
Feedback of the project: Has the project succeeded to achieve required results?

Appendix 2. SIPOC diagram

SIPOC - Scoping the Project

Source: Quality Karjalainen

Project name

			Improvement area			
Suppliers	Input requirements	Input't	Process	Output't	Output requirements	Customer
Sales / other in-house departments	Comparability Coverage Expediency Reliability Verifiability	Purchasing requisition Product specification	1 Kraljic matrix-based product categorization	Supply strategy proposal	Convenience	Purchasing
Alternate Suppliers	Comparability Coverage Expediency Reliability Verifiability	Capability reports and references	2 Supplier assessment	Supplier ranking Supplier selection proposal	Correspondence with product categorization	Purchasing
Sales / other in-house departments	Comparability Coverage Expediency Reliability Verifiability	Overall assessment of the product: • Assessment of criticality • Demand and cost analysis • ABC-analysis	3 Supplier selection and categorization	Supplier category: • Scope and frequency of the assessment • Assessment metrics and criteria	Correspondence with supplier categorization Coverage of the classification	Purchasing
Supplier / In-house departments	Comparability Coverage Expediency Reliability Verifiability	Delivery and quality reports OTIF report Cooperation evaluation	4 Assessment, evaluation and feedback of the first delivery	Comparative report of the expectations and reality Definition of corrective measures if required	OTIF reliability Quality	Purchasing
Supplier	Comparability Coverage Expediency Reliability Verifiability	Report on the implementation of corrective measures Performance reports	5 Follow-up of corrective actions / continuous performance measurement	Assessment of the efectivity of corrective actions Performance measurement report	Reliability Verifiability	Purchasing
			6 Finding alternate suppliers			
			7 Terminating supplier relationship			

Appendix 3. FMEA (1/2)

Failure modes and effects analysis (FMEA)

Project:	**Supplier Performance Measurement and Evaluation**	**29.1.2019**
FMEA Team:	Supply Chain Manager, Purchasing Manager, Purchasers	Juho Hänninen

SEV = How severe is effect on the customer?
OCC = How frequent is the cause likely to occur?
DET = How probable is detection of cause?
RPN = Risk priority number in order to rank concerns; calculated as SEV x OCC x DET

Process step	Potential failure mode	Potential failure effects	SEV	Potential causes	OCC	DET	RPN	Actions recommended
Product categorization	Product matrix is not up to date / updated regularly	Decisions are being made based on obsolete information -> Faulty categorization	6	Resource prioritization, underestimation of necessity, lack of introductions and guidance	2	10	**120**	Updating the product matrix regularly
	Faulty product categorization	Incorrect sourcing strategy -> Additional costs, availability problems, supply interruptions, lost sales, lost of customers	8	Product categorization is not up-to-date, lack of resources, assessment of necessity, lack of supply market knowledge	3	10	**240**	Regular review and updating of the product category matrix
Supplier assessment, selection and categorization	Faulty assessment of suppliers financial status	Possibility that the supplier fails to meet requirements -> Delivery and quality related problems, increased supply risk	7	Information availability / reliability due to the geographical location or industry of the supplier	1	10	**70**	Regular analysis of the financial status of the supplier base
	Faulty assessment of suppliers performance	Underperformance of the supplier (capacity related problems, delivery problems, quality problems)	5	Supplier provides faulty information of its operations, lack of monitoring, the challenge of evaluation (due to the geographical location of the supplier)	4	10	**200**	More thorough pre-reviews, regular meetings with supplier
	Faulty assessment of suppliers strategic suitability	Distorted perception of suppliers capability / willingness of broader cooperation -> Waste of resources, unfavorable supplier selection	2	Lack of reliable information	3	10	**60**	Underlining the importance of background investigation

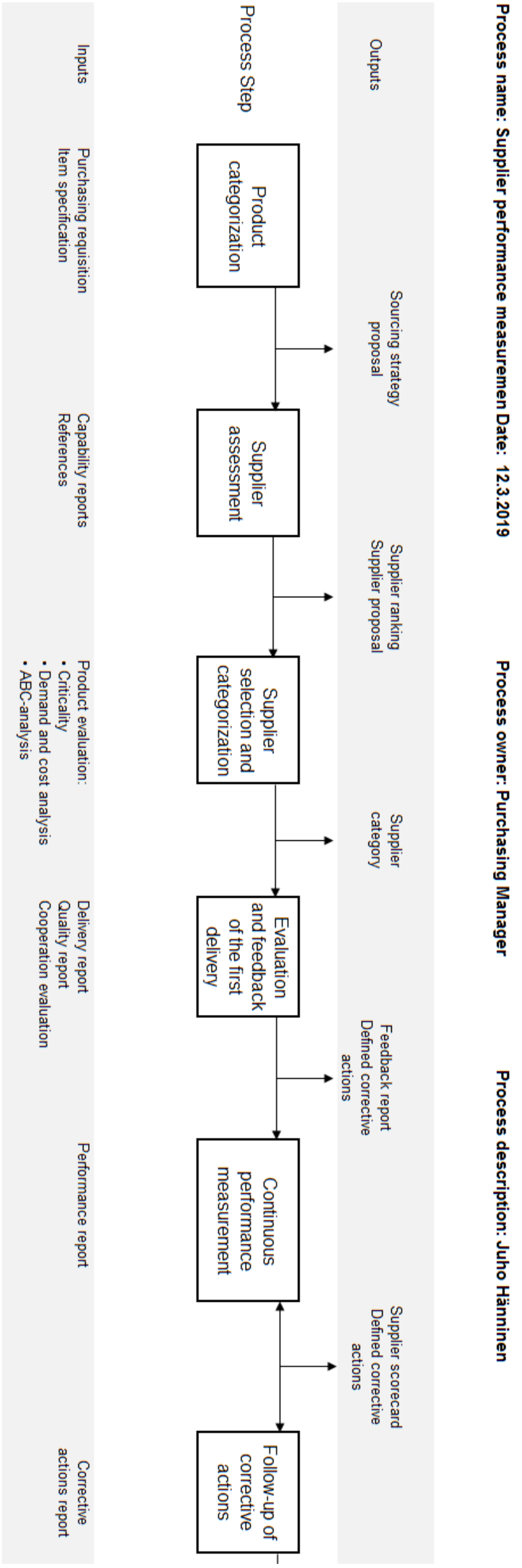
Appendix 3. FMEA (2/2)

Assessment and evaluation of the first delivery	Assessment is not done	Problems are detected too late, number of problems increases, problem solving is based on reactive actions instead of proactivity	6	Resource prioritization, faulty supplier categorization, lack of regularization	2	10	**120**	Regularization of the assessment, linkage to the ERP system
	Assessment is made based on incorrect or missing data	Problems are detected too late, number of problems increases, problem solving is based on reactive actions instead of proactivity -> Waste of resources	3	Faulty or inadequate data	3	10	**90**	Linkage to the ERP system, data verification
Feedback discussion with the supplier	Feedback discussion is not conducted	Supplier performance is not improved, performance measurement is wasted, problems cannot be fixed, supplier takes wrong actions	5	Forgetting	1	10	**50**	ERP linked reminders
Follow-up of the corrective actions	Monitoring of the implementation of the corrective measures is inadequate or not done at all	Supplier performance is not improved, performance measurement is wasted, problems cannot be fixed, supplier takes wrong actions	7	Forgetting, resource prioritization	6	10	**420**	Increased regularity in monitoring, linkage to the ERP system

Appendix 4. Instructions for updating product categorization matrix

Update frequency:	**Once in a year**	
Last updated:		
Updated by:		
Activity	**Detailed description**	**ERP instructions**
1. Define scope for categorization	Limit the ammount of evaluated product categories: • Based on the total spend (15 largest)	
2. Evaluate profit impact in a scale of 1-10 (1=small, 10=high)	Evaluate profit impact of the product category based on: • Category % of the total external product sales • Average profit margin of the product category Also consider: • MTO or generic items • To which customers the items are being sold	
3. Evaluate supply risk in a scale of 1-10 (1=small, 10=high)	Evaluate how challenging the supplier markets are for the product category: • How many potential suppliers available • Geographical location of the suppliers • Costs to change the supplier • Risks and challenges	
4. Define main supplier(s)	Define main supplier(s) for each of the evaluated product categories	
5. Comment	Provide comments and remarks about the evaluation criteria and selections	

Appendix 5. Supplier performance measurement process description



Appendix 6. Supplier scorecard

Supplier Scorecard **Date:**

Supplier category	Measurement frequency
A	Quarterly
B	Yearly
C	Every 3 years

Supplier Name:	
Supplier Category:	
Responsible Buyer:	

Identified problem(s)	
Actions recommended	
Actions agreed	
Schedule for corrective actions	
Evaluation of corrective actions	

Performance Category	Criteria	Parameters	Score	Rating	Comments
Measured area of performance: N = Numerical A = Assesment	Criteria for evaluation	Parameters for defining the rating values based on the scores		1 = Does not meet 3 = Partly meets 5 = Fully meets	
Quality	**The compliance to quality requirements and certification**				
Product defects (N)	Number of faulty or broken products				
Packing defects (N)	Number of faulty or incorrect packaging				
Customer complaints (N)	Number of received complaints from distributors or end customers				
Complaint responsivenes (A)	Lead time in response, claim handling times, lead time of credit notes				
Certification (A)	How well supplier success to fulfill the minimum requirements for certification				
Documentation (A)	Clearness and understandability of product related documents				
Delivery	**Ability to meet delivery requirements**				
On-time delivery (N)	Number of postponed or late deliveries				
Lead-time (N)	Lead time in days from a placed order				
Correct quantity (N)	Number of errors in quantities				
Delivery defects (N)	Number of delivery damages excld. Delivery company				
Documentation (A)	Clearness and understandability of delivery documents				
Communication (A)	How well supplier communicates, responsiveness, reachability				