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Purchasing Process Improvement

A case study of company X's New Product Development (NPD) Process

Mikhail Rezende da Silva e Oliveira

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Jyväskylän ammattikorkeakoulu
JAMK University of Applied Sciences

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Abstract

The New Product Development (NPD) purchasing process has been extensively studied and improved nowadays. It can give greater competitive advantage over competitors when properly performed. Therefore, company X assigned the task of defining the current bottlenecks of its current NPD purchasing process and proposing the most appropriate improvements and developments. Hence, three research questions for limiting the research scope were created:

- What is it required for achieving a world-class purchasing process in business?

- How is the current NPD purchasing process executed inside company X?

- How could the current NPD purchasing process be improved towards a world-class purchasing process?

The topics pertinent to the NPD purchasing process as well as to purchasing and business areas and the future of purchasing processes were studied in depth. The data needed for describing the process in question and finding its flaws was retrieved from semi-structured interviews conducted with the employees of different and pertinent departments.

The findings were qualitative and quantitatively assessed as well as analyzed by using the PFMEA technique. The results were quite aligned, and four main categories of issues emerged. They were time constraints, communication, team alignment and systems. In addition, three process maps were constructed for each of the three different types of components. They were complex parts, complex parts with supplier drawings and simple parts. The recommended actions were divided in terms of more general and specific ones, and they were based on employee expertise and a literature review.

Keywords/tags (subjects)
Purchasing, NPD, Strategic Sourcing, Process, Improvement, Development

Miscellaneous (Confidential information)
Appendices 2, 3 and 4 are confidential and they have been removed from the public thesis. Grounds for secrecy: Act on the Openness of Government Activities 621/1999, Section 24, 17: business or professional secret. Period of secrecy is five years and it ends 18.5.2025.

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1 Why continuously develop Purchasing processes?

1.1 Positive reasons for developing Purchasing processes

Handfield, Monczka, Giunipero and Patterson (2011, 8-10) give seven good reasons for companies to pay attention to in order to strive for thriving at their purchasing departments. Starting from increasing value and thrift due to the potential savings that come from the usual big purchasing share of a firm's revenue. Next, enhancing customer value by managing the supplier base properly and by using their capabilities in the company's favor. The third one is creating strategic partnerships with key suppliers to pull overall costs down together while jointly driving innovation for products, improving processes and developing cycle times. The fourth reason includes improving finished product quality by ensuring the best supplier quality as well as a solid New Product Development (NPD) process, and consequently, enhancing the company's reputation. The fifth justification is reducing the cycle time of time-to-market by, for instance, involving suppliers at early stages of product or process designs. The sixth one is significantly impacting the ISM (Institute for Supply Management) report on business which is an important economic index followed by the financial experts. Lastly, contributing to company's competitive advantage proven by the recognition and wages of purchasing experts.

In addition, a company's survival and prosperity in its business heavily depend on adapting and a constant searching for fulfilling customer's requirements and needs which might suffer very fast changes on current days. In other words, the New Product Development (NPD) process which includes, for instance, the time-to-market cycles, the superiority of a company's product as well as the competitive advantage delivered by the process itself, plays an indispensable role to growth, survival and profitability of an enterprise. In order to deliver successful products in the market, a solid and seamless NPD process must be in place. Briefly explaining the enablers for its success, a company should, firstly, focus on developments aligned with the company's strategies. The second enabler is proper acquisition and allocation of resources such as human resources and budget. Lastly, as mentioned above, the process for developing new products should be robust and structured without margin for major flaws. (Owens & Davis 2000.)

In summary, the extension of purchasing as well as NPD importance for the success of a company can clearly be seen. Currently, both areas have a big impact on companies' financial, logistics and overall results. For example, making sure that the firm is sourcing the needed material or services for the best total cost, considering not only short-term goals but also the long-term ones. Purchasing employees have to secure the proper supply of materials, deal with supplier relationship management and be involved into cross-functional teams for the development of new products/services and for coping with the early supplier involvement process.

1.2   Introduction to the research scope

Going slightly deeper into the purchasing process during the New Product Development (NPD), the purchasing department has a crucial and fundamental role in delivering great results. A great deal can be achieved when the strategic activities are properly performed as well as when the operational ones are efficiently executed during the process in question. Companies are always striving for developing and improving those processes so as to enhance throughput and, consequently, their overall results. In light of that, company X decided to assign this thesis because the topic was pertinent to its current objectives. In summary, the thesis focused on finding the best description and definition of the current sourcing process for New Product Development (NPD) and, logically, analyze and study feasible suggestions for improvements.

The practical implementation of the thesis was divided into six main steps in order to ensure clarity and a systematic way of research. The first step was to conduct a literature review on pertinent topics. The second step included the collection of data and information in order to provide a clear and coherent process structure. The third step included defining and mapping the current purchasing process of NPD by applying adequate research methods. The fourth step consisted of a qualitative analysis of the positive sides of the process as well as current bottlenecks and challenges. The fifth step was to apply a quantitative method of analysis on the collected data and information as well as to apply the PFMEA technique. The sixth step, based on academic research, field expertise and achievable goals, focused on

suggesting short- and long-term improvements in order to increase efficiency and effectiveness of the process. A summary of the steps can be seen in Figure 1.

Overall View of Research implementation					
1. Literature Review	2. Information and Data collection	3. Process Mapping and description	4. Analysis of positive and negative aspects	5. Quantitative and PFMEA methods on collected data	6. Suggestions of improvements and developments

Figure 1. Overall view of main steps of the research in question.

The thesis was divided in eleven chapters. The first one discusses the research scope, and introductions to the company and to the purchasing topic. Chapters from two to five are related to the extensive research on literature review and research methodologies. The sixth chapter includes a deeper description of subjects connected to the company and factors involved during the specific NPD purchasing process. The seventh chapter is composed by a summary of the research implementation and its stages. Chapters eight and nine present the research results and their analyses. Chapter ten collates all the results and present the final resolutions for process bottlenecks. Lastly, the eleventh chapter discusses the author's opinions and perspectives regarding the topic, the research process and the results.

In order to limit and clarify the scope of the study, the following research questions were created.

- What is it required for achieving a world-class purchasing process in business?

- How is the current NPD purchasing process executed inside company X?

- How could the current NPD purchasing process be improved towards a world-class purchasing process?

The first research question was answered by reviewing pertinent literature review. The topics covered in the research scope were extensive, therefore, an in-depth study of subjects was needed. The second question was answered by investigating the current NPD purchasing process inside the company. The study strived for exhausting all types of analyses conducted with the collected data, and thus, it presents a vast scrutiny of matters identified from the research methodologies. Finally, the third question was answered during the last steps of the study by suggesting reasonable developments based on internal priorities and academic and/or professional expertise. The comparison of the results from different methodologies as well as the literature review were essential for delivering a robust group of recommendations.

1.3   Introduction to company X

Company X operates in the manufacturing industry and plays a big role in the global business. It has several different departments, and purchasing is one of them. The purchasing team is composed of purchasers (direct and indirect purchasing), managers and a director. The purchaser roles can be divided into mainly two, the traditional purchasing function and the involvement into NPD. Due to the company's size and limited time for the completion of the research, the study was limited to only consider the NPD process inside the purchasing department.

In order to understand where the company is inserted in the market, it is smart to determine which kind of manufacturing it belongs to. Weele (2018, 5) divides the manufacturing processes in three main categories. The first is the Make to Stock (MTS) category which is the manufacturing of standard goods and creation of a finished goods inventory with goals of high production efficiency. The second is the Make to Order (MTO) category which is the manufacturing of products after a customer has placed an order with possible customization, and sometimes this is related to high inventory costs. The Engineer to Order (ETO) category is the manufacturing of goods that covers the whole process from design to the finished product according to a customer's order. Company X has its business inserted into

the MTO manufacturing process since it produces industrial machinery according to customer orders. Moreover, depending on the customer's needs, there are several options for customizing the appearance and functionalities of the product.

2 Purchasing

2.1 Purchasing Overview

In academic literature and the professional field, many synonymous for purchasing are commonly seen. For example, procurement, sourcing, buying and supplying are usually interchanged despite the fact that each of them has a different meaning. In this study, the distinctions between the terms were recognized but only purchasing, procurement and sourcing were used according to their definitions and scopes. All the other concepts were studied and revised even though they were not added to the study.

Thus, it is wise to define the main term of the whole study. Weele (2018, 2) states purchasing as

> *The management of the company's external resources in such a way that the supply of all goods, services, capabilities and knowledge which are necessary for running, maintaining, and managing the company's primary and support activities is secured under the most favorable conditions.*

Lysons and Farrington (2006, 8-9) similarly define purchasing as

> *The process undertaken by the organizational unit that, either as function or as part of an integrated supply chain, is responsible for procuring or assisting users to procure, in the most efficient manner, required supplies at the right time, quality, quantity and price and the management of suppliers, thereby, contributing to the competitive advantage of the enterprise and achievement of its corporate strategy.*

As a traditional division of purchased goods, there are two major areas. Direct purchasing, which deals with all the needed material for producing the company's finished product. Secondly, there is indirect purchasing, which handles all the other goods necessary for running the business and manufacturing the finished goods. This includes, for example, Maintenance, Repair and Operations (MRO), machines, office material, physical assets and facilities. Most of the time, companies manage direct

purchasing very tightly because it usually accounts for the biggest share of their spending percentage depending on the business activity. (Weele 2018, 6.).

The scope of NPD encompasses innovation, supplier collaboration and strategic sourcing. Therefore, it is straightly related to the direct purchasing since one of its central aims is to source the necessary parts for manufacturing the finished product as well as possible in matters of costs, technology and provided service level. (Luzzini, Amann, Caniato, Essig & Ronchi 2015.)

A summary of the concepts and the included scopes for each term can be seen in Figure 2.
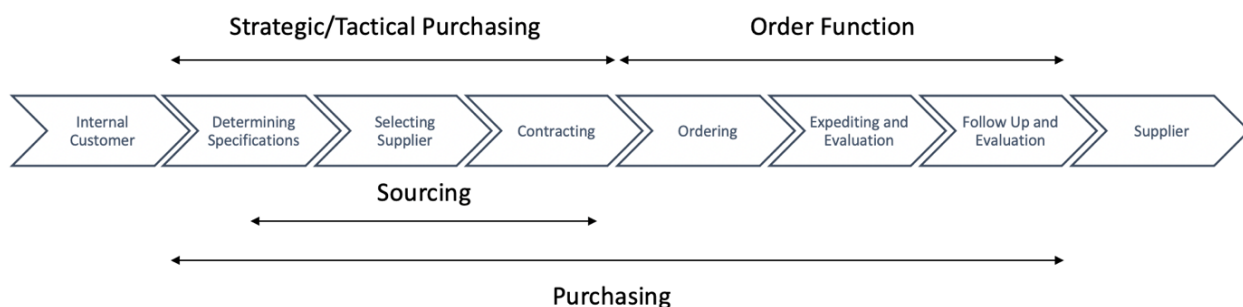
Figure 2. Purchasing and Sourcing basic processes. Adapted from Weele (2018, 8).

In Figure 2, we have four terms. The overview of the purchasing term has already been discussed. Sourcing is discussed in more detailed in the next chapter. Strategic purchasing, sometimes also called the tactical level in purchasing, is involved in the processes and decisions which have medium- or long-term impact on a company's results. These processes and decisions include, for example, decisions on long-term agreements and types of partnerships with suppliers, choosing sourcing strategies for commodities and conducting procedures and approaches for supplier audits, technical revisions and product standardization. On the other hand, order function is involved in the more operational work of the purchasing function, for instance, placing orders for already existing contracts with suppliers, expediting orders and handling daily tasks such as invoicing and payments. (Weele 2018, 283-284.)

As clearly seen above, the purchasing function has a primary goal to make all sorts of matters and operations run smoothly through the company in order to achieve growth and profits. However, for the scope of this study, only a few concepts and processes inside the purchasing field were studied. They are described and explained more in depth in the following chapters.

2.2 Sourcing

Going deeper into the sourcing concept, Giunipero, Bittner, Shanks and Cho (2019) state that sourcing can be defined as all the needed activities for the supply management of required materials for a manufacturing company's goods, taking into consideration pertinent goals and strategies towards the firm's overall targets. These include, for example, identifying the best potential suppliers and selecting the most suitable one as well as arranging an agreement between the parties.

Giunipero and coworkers (2019) have categorized seven different areas in the sourcing process. The first area is the strategic and relational aspect which includes the power balance between the supplier and customer and mutual collaboration. The second area covers the transactional/tactical aspect which deals with the criteria for the chosen sourcing process, such as single or multiple sourcing. The third area includes the sourcing tools which are the supportive practices and tools for executing buyer tasks, for example, utilization of e-procurement and standards for bidding policies and processes. The fourth area is global sourcing which encompasses all the matters related to sourcing materials worldwide, for instance, pros, cons and risk management. Fifth, sustainable sourcing which involves all the ethical, social and green issues related to the sourcing activities and business. Sixth, services which is linked to the procurement of technology, know-how and expertise for developing a better sourcing process. Lastly, new product development, covering the sourcing activities for new required parts/material for new products, which can strongly affect the overall costs and performance depending on how well and proper its early stages is executed. (ibid.)

Regarding this thesis, three out of those seven categories had been heavily researched, namely, new product development, strategic and relational aspect, and sourcing tools. The importance and relevance of all of the seven categories was

evident, but it was not possible to embrace every single aspect of purchasing and sourcing. Therefore, regarding the scope of the thesis, three were the chosen ones.

2.3 Strategic Sourcing and Sourcing Tools

To start off, it is wise to make a clear distinction between operational and strategic sourcing. Operational sourcing deals with the low-level decisions which do not have big effects on a company's long-term matters. Low-risk, high-profit, non-critical items are handled by operational sourcing procedures as well as making slight changes on strategic decisions in order to facilitate meeting specific supplier requirements. (Lysons & Farrington 2006, 367.)

According to Lysons and Farrington (2006, 367)

> *Strategic sourcing is concerned with top-level, longer-term decisions relating to high-profit, high supply risk strategic items and low-profit, high supply risk bottleneck products and services. It is also concerned with the formulation of long-term purchasing policies, the supplier base, partnership sourcing, reciprocal and intra-company trading, globalization and countertrade, the purchase of capital equipment and ethical issues.*

A traditional model for defining steps in strategic sourcing is presented in Figure 3.
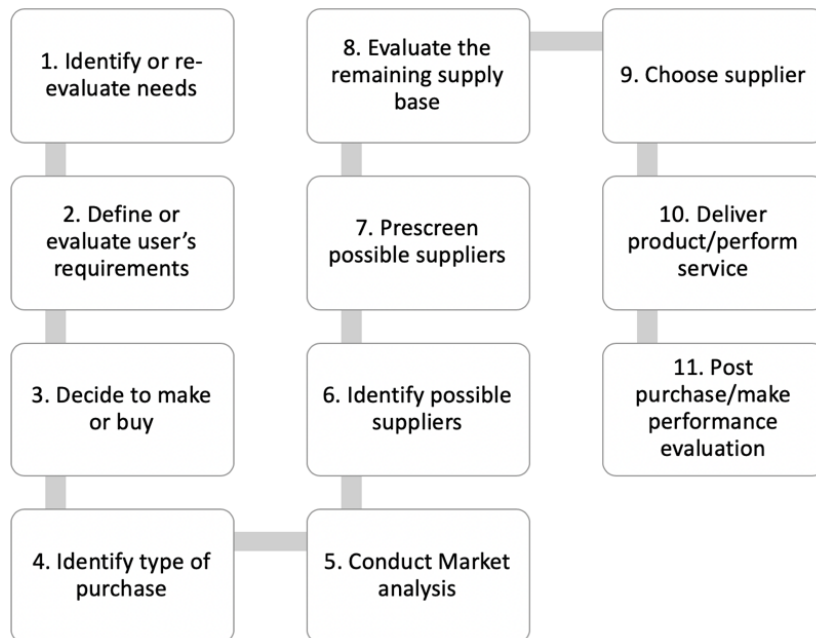
Figure 3. Strategic Sourcing steps. Adapted from Lysons & Farrington (2006, 368).

During step four in Figure 3, three different types of purchases are identified. The first one is a straight rebuy or routine purchase of goods and parts which are currently bought from known suppliers and with specific arrangements. The second type, a modified rebuy, means, for instance, a slight change that has been made in the current products or a necessity to pursue cost savings, improved quality or change of supplier. The third type, a new buy, considers the totally new products and specifications that may possibly contain high spending issues for manufacturing and tooling. (Lysons & Farrington 2006, 368,423-424.)

Step five in Figure 3 investigates the supply risk regarding the current supplier market, in other words, whether there are several supplier choices, a few large ones or only one supplier capable of delivering the desired product. Step seven shortens the list of suppliers made in step six. The other steps have very clear instructions, and therefore, they should not require further explanation. (ibid.)

The required information for sourcing can be retrieved from six areas according to Lysons and Farrington (2006, 368-391). First, there is the analysis of market conditions, i.e., all the data and information that is provided by, for example, the current situation of potential suppliers, local and wider economic matters and the

commodity supply issues. Secondly, there are directives which are the regulations, laws, guidelines and legislations from external (government and international organizations) and internal (the firm itself) sources. Thirdly, E-sourcing, together with e-procurement, e-catalogues and e-auctions are part of the sourcing tools which are further discussed in this chapter. The fourth are covers locating supplier sources in every possible source, such as databases retrieved from the internet, fairs, salespeople or exhibitions. Fifth, there are supplier appraisal assessments for ensuring that the required demands can be met by the supplier. The following aspects should be appraised, financial health, manufacturing capabilities, human resources, overall quality, performance, sustainable and corporate social responsibility (CSR) matters, information systems and the firm's structure. Lastly, there is the area for evaluating supplier performance, in other words, closely tracking supplier performance after establishing a working relationship between parties and ascertaining the achievement of the requirements.

In light of those, strategic sourcing should be based on not only on metrics and performance measurements of direct costs, quality index and on time delivery numbers, but also on extending the decision parameters to more wide and strategic aspects regarding supplier capabilities. A supplier's quality management procedures, manufacturing and innovation capabilities, technological opportunities and long-term productivity goals are topics which should be taken into account for strategic sourcing. (Talluri & Narasimhan, 2004.). Therefore, it makes sense to define the value chain for which strategic sourcing decisions are made and where it can add value to the company. The most common steps and processes can be seen below in Figure 4, according to Anderson and Katz (1998) although each purchase should be addressed in line with its own specifications and demands.
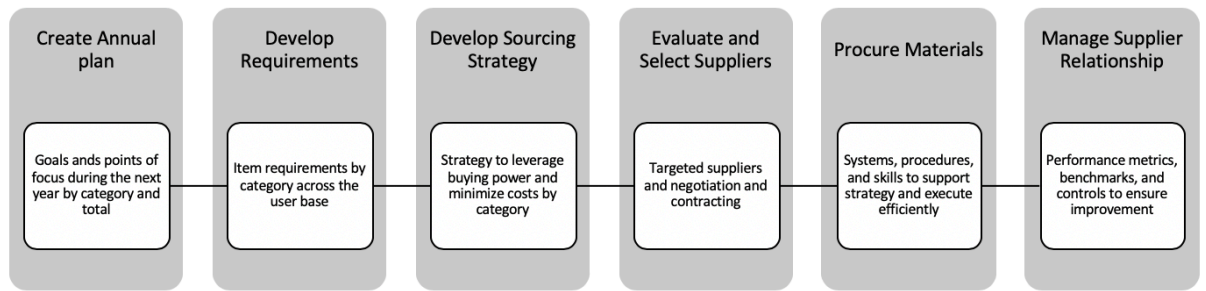
Figure 4. Value Chain for Strategic Sourcing. Adapted from Anderson and Katz (1998).

The last aspect for strategic sourcing which was discussed is the development of a sourcing strategy, in other words, deciding on the supplier base management, the desired relationship with suppliers and which type of agreements the company wants to have with them. As part of the sourcing strategy, one important aspect which companies have been engaging in the recent years, is the supplier base reduction. It should not be seen as a final objective itself but as a driver for decreasing part and service expenses and easing supply chain management. Moreover, the sourcing strategy is supposed to tackle the following aspects: the first one is deciding on single or multiple sourcing meaning having only one or more than one supplier for the same product. Secondly, local or global sourcing, in other words, choosing either local and national or global suppliers. The third aspect includes deciding which type of relationship to pursue, either a more strategic partnership or a competitive relationship (arm's length). The next factor is placing a contract for the item/supplier in question or buying it on a spot basis. Lastly, founding the agreement on price or performance basis and on how detailed the agreement must be. (Weele 2018, 214-216.)

The second topic of sourcing is sourcing tools. They are the support part for developing an outstanding sourcing strategy and execution. In the research conducted at the end of the last century and beginning of the current one, as well as in the ensuring applications and implementations, e-sourcing was undoubtedly stated as a driver for an effective and efficient execution of sourcing tasks. There are several different tools which lay under the scope in question, for instance, reverse auctions, e-procurement as well as the usage of the internet for sourcing activities. Currently, companies and researchers are looking deeper into how the sourcing tools

can be better utilized for improving performance and throughput once they have been clearly accepted as essential mechanisms in the business environment. (Giunipero et al. 2019.)

For example, Hannon (2003) affirms the positive connection between e-sourcing and enhanced supplier involvement in a company's business. To reinforce that idea, Gutman (2002) also confirms the potential added-value results through e-sourcing for materials' price and quality as well as an enhanced long-term supplier partnership. Practical results from Gutman's study shows, respectively, a reduction of 25% and 15% in sourcing and time-to-market cycle times in addition to an improved overall product quality and better supplier awareness in innovation and market responsive areas. However, Gattiker, Huang and Schwarz (2007) have found that aspects, such as trust and information richness, in the supplier-customer relationships are strengthened by face-to-face negotiations. Therefore, it is vital to emphasize the importance of the utilization of best practices for both activities taking the most valuable for sourcing out of their processes and methods.

2.4   Purchasing and NPD

New Product Development is directly related to innovation, and therefore, it is advisable to start with its definition. According to Lysons and Farrington (2006, 243) innovation is "the process of turning ideas and knowledge into products and services that create a consumer demand within the marketplace". There are four types of innovation. Product and process innovation which should be self-explanatory by their names. Breakthrough innovation that will have a major impact on the whole industry and sometimes on different fields of life (for instance, the creation of aircraft). Last, incremental innovations which are improvements made for an existing product or service. (Lysons & Farrington 2006, 244.)

Weele (2018, 228) defines two forms of innovation. There is the closed innovation process where the company by itself develops new ideas and products and does not share information and knowledge to outside parties. The second option is the open innovation process. In this case, the company gathers its strategic and close partners to develop and design new products as well as shares information, knowledge and

market awareness. Consequently, it opens room for early supplier involvement during the NPD process. In Figure 5 the basic steps for NPD are shown.
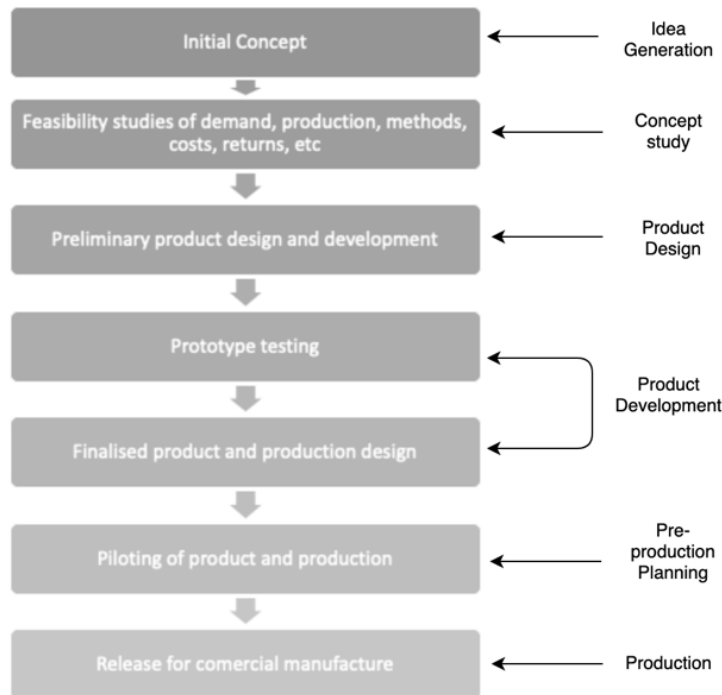
Figure 5. NPD basic steps. Adapted from Lysons & Farrington (2006, 246) and Weele (2018, 234-235).

The steps for the NPD process follow a very logical course. The ideas and feasibility studies must be analyzed in the first place. Prototypes are built once the ideas, specifications and designs are finalized. Next, those prototypes are validated in practical means, for example, with real field tests. The following step is a rehearsal for serial production in order to check whether all the aspects are running smoothly, such as the delivery of parts, needed trainings and batch quality assurance. After this, the real manufacturing will take place in the factory. In light of those steps, the later the stage of a project is, the more rigid the specifications are, and thus, it is more difficult to make changes. When analyzing the basic timeline for the NPD process regarding costs of the technical changes and possibilities for purchasing and engineering changes, the increase in costs is clearly seen if changes are made at the late stages. Besides, changes in the course of action for purchasing and engineering

are stricter over time. The summary of it can be seen in Figure 6. (Lysons & Farrington 2006, 246-248; Weele 2018, 234-235).
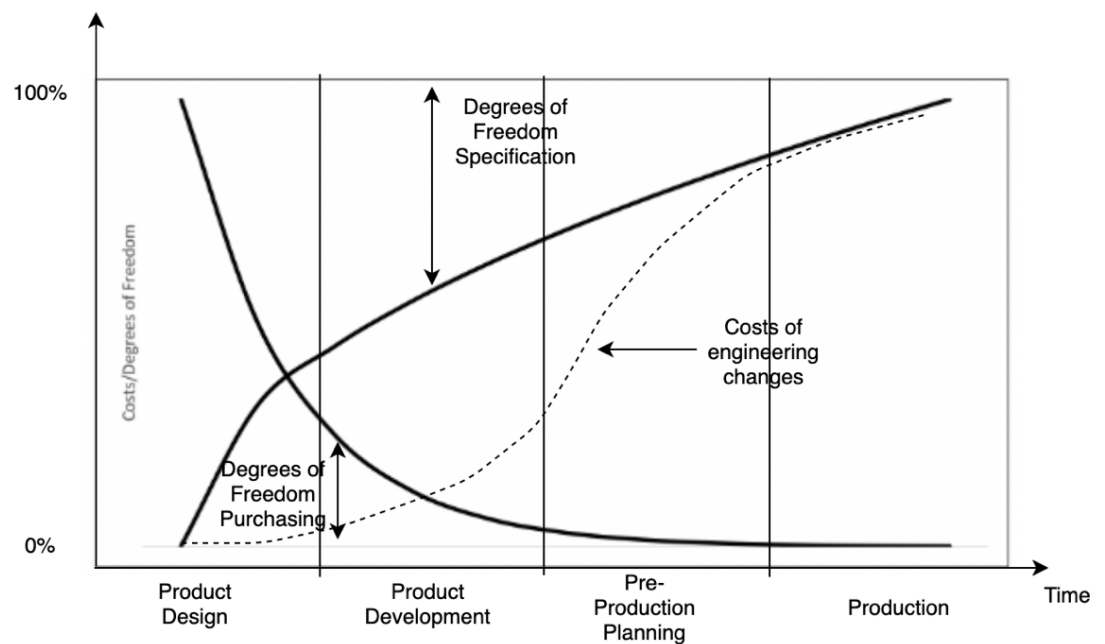
Figure 6. Costs and possible change of course for purchasing and engineering in NPD. Adapted from Weele (2018, 235).

Every company that wants to stay in the business as well as be profitable and grow needs to be aware of technological and market changes as well as a shift in customer demands and expectations. Thus, new product development plays an important role for keeping the company running in its current business. Early supplier and purchasing involvement (ESI and EPI respectively) are the key activities for innovation and new product development. Enhancing collaboration with the strategic suppliers for knowledge, expertise and innovation, increased added value for internal customers and potential savings for sourcing projects are examples of matters inside NPD which can be achieved. (Giunipero et al. 2019; Weele 2018, 18.)

For example, Giunipero and others (2019) and Weele (2018, 18) stated that the conversion of design options into targets for the components' costs can lead to many benefits, such as better cost control, performance and decreased uncertainty. In

addition, the ability to create seamlessly cross-functional teams working towards the company's goals is decisive for great results because this acquires the best out of each function. Therefore, the interaction and alignment between functions and departments is vital for an optimal outcome from NPD. All those described above, when properly done, will improve the new product development sourcing process.

One crucial aspect during the NPD for delivering a great result is the early supplier involvement. It is described as an approach to bring strategic suppliers to the early phases of product design during the product development process. Due to resource and knowledge constraints, a company is not able to develop an entirely new product by itself without a cooperative and joint innovation network. Hence, during the NPD, the supplier's capabilities and know-how are applied to improving the product's design, efficiency, functionality and manufacturability. (Lysons & Farrington 2006, 253.). Weele (2018, 238) gives one example of average cost reduction in percentage. The example can be seen in Table 1 below.

Table 1. Possible cost reductions according to design phase in ESI. Adapted from Weele (2018, 238).

	Degree of design complexity		
Product Design Stage	Low (%)	Average (%)	High (%)
Initial Design	2 -5	10 - 25	30 - 50
Changing existing design	1 - 3	3 - 15	15 - 25
Redesign to improve quality	10	15 - 30	40 - 60

Indeed, Luzzini and others (2015) found by their empirical research that companies when focusing on innovation strategies, might enhance the engagement and commitment to strategic sourcing and supplier collaboration. Moreover, the study also emphasized the connection between purchasing expertise and both aspects mentioned above. The type of cooperation between company and suppliers varies according to product complexity, technological uncertainty and performance targets. The bigger the technological uncertainty is, the more companies strive for thriving in their sourcing strategy and supplier collaboration. In turn, better strategic sourcing

and supplier collaboration positively impact on the innovation performance. The summary can be seen in Figure 7.
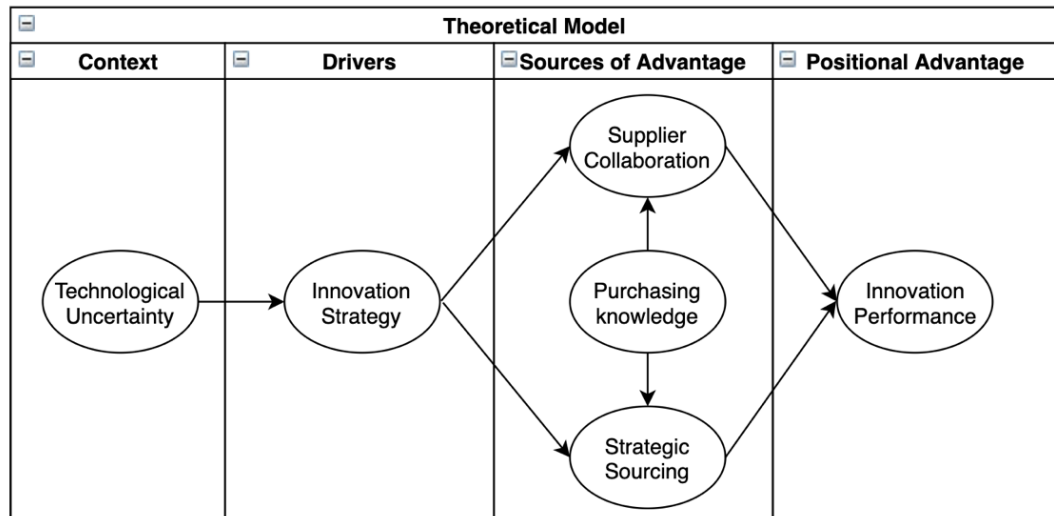
Figure 7. Innovation Strategy Impact on Supplier Collaboration and Strategic Sourcing. Adapted from Luzzini et al. (2015).

Another important aspect which has not yet been extensively studied in the academic field is the early purchasing involvement (EPI). Purchasing should not only facilitate the interaction between company's engineering and suppliers but also contribute with valuable information to engineering for the NPD projects. Six points were recognized to be relevant for NPD projects related to the purchasing work. At the early stages of NPD projects, purchasing knowledge about product's cost, performance, market, availability, quality and reliability is highly appreciated in order to deliver a great outcome. Consequently, purchasing employees enable the best information exchange between supplier and supply needs, through its substantial understanding of the supply market and its alignment with other involved functions in the NPD process. (Johnsen, Calvi, & Phillips 2012.)

Purchasing can deliver a key advantage when facing discontinuous innovation and technologically uncertainty. Picaud, Johnsen, Calvi and Giannakis (2019) have found that 2 sourcing processes can be developed in the NPD projects depending on the technical and market uncertainties. Common sourcing approaches are used when the

perceived technical and market uncertainties are low, in other words, when new technology and specifications are developed only by the engineering department. On the other hand, the uncertainty increases when, for example, unfamiliar suppliers are involved or there is either the application of existing knowledge from other professional fields or the exploitation of potential supplier markets for developing new technology and products. Thus, the usage of purchasing expertise for, e.g., adapting the current sourcing process, searching new technology as well as seeking for capabilities and know-how outside the supply base and traditional markets enables the creation of new sourcing abilities. One of them is the reverse sourcing approach. In this case, the suppliers propose solutions and designs instead of obtaining the fully finalized specifications from the customer and, consequently, firms explore the new technology and innovations available in the market. (Picaud et al. 2019; Johnsen et al. 2012.)

However, Mikkelsen and Johnsen (2018) proposed the existence of two conditions that ought to be fulfilled for an efficient and effective EPI approach for NPD projects with high level of technological uncertainty. Firstly, in order to effective and efficiently manage and support those types of NPD projects, a high degree of ripeness and experience from purchasing department are needed which, in turn, become an indispensable partner for R&D. The second condition is the need of more trust and reliance between involved parties when there is the involvement of unfamiliar suppliers and suppliers from other sectors.

In summary, NPD process takes into account many activities which are essential for producing outstanding results. It requires a great deal of effort and synergy from every stakeholder. Thus, the link holding this process together concisely, usually purchasing, has to be very mature and experienced to achieve the desired goals.

2.5   Purchasing Processes

The purchasing overall view had already been discussed at the beginning of Chapter 2. During the following paragraphs, the purchasing processes were studied in more detail so as to have a better understanding of the core purchasing processes. Therefore, Handfield and coworkers (2011, 41) presented the utilization of purchasing processes as a tool for

identify user requirements, evaluate the user needs effectively and efficiently, identify suppliers who can meet that need, develop agreements with those suppliers, develop the ordering mechanism, ensure payment occurs promptly, ascertain that the need was effectively met, and drive continuous improvement.

Backstrand, Suurmond, Van Raaij, and Chen (2019) studied the different types of purchasing processes in the literature and categorized them in five types. The process models are divided into decision-making, linear, strategic, cyclical and hybrid linear cyclical. The focus of decision-making processes is on the information stream for reaching decisions. It might depend on many stakeholders or only one person. In addition, it can be presented as a flowchart with several questions and a path to be taken according to the answers or developing a decision tree model for "make or buy" decisions. Linear processes present the overall or more specific purchasing processes. They are usually presented as chronological and logical sequence of stages for completing certain task varying from strategic to operational/tactical activities. For the strategic process models, the more long-term aspects of purchasing are discussed, such as how to assist the company in order to achieve its ultimate goals instead of describing the process of invoicing. The aspects related to integration, alignment and global matters as well as shaping purchasing function for future challenges are relevant topics for strategic process models. Cyclical processes are utilized, for instance, when a purchasing process was completed but it has to be executed again in the future. The past experiences and knowledge regarding the cyclical process in question should be taken into account for delivering better results in the future completions. Lastly, the hybrid linear cyclical processes divided the activities in two categories. The process that has to be performed only once, and the one after it which is composed by a cycle of activities. For example, when a supplier selection model divides its first steps from exploring suppliers until final approval. Next, the process starts the cycle of activities for managing the current supply base by conducting supplier evaluation and development as well as relationship management.

As a part of purchasing responsibilities and roles, Handfield and others (2011, 46-49) defined eight main processes as the core activities of purchasing. They are the spend analysis, demand management and specifications, category management and

supplier evaluation/selection, contract management, cost management, managing the procure to pay process, supplier relationship management and establishing the supply management strategy.

The spend analysis is the beginning of the strategic sourcing process used for improving transparency and tracking company's spend. It retrieves information from historic data by either commodity, part or supplier spending. Next, it organizes the data into the proper aggregated level for future analysis. It requires that the spending is classified according to a unit and rate of consumption. The objective is to find opportunities for cost reduction by, for instance, increasing contract compliance, reducing maverick spending and monitoring budget variance. The cost reductions can go up to 25 %. (Pandit & Marmanis 2008, 5; Handfield et al. 2011, 46.)

Demand management and specifications encompass the process of making educated forecasting of consumption for an internal customer using the spend analysis results and its analysis. Optimizing sourcing strategies and mitigating risks of supply shortages by assuring enough capabilities from the supply base are key points. Moreover, revising the part specifications in order to avoid over specified issues through purchasing know-how and expertise is also involved in this process. The category management and supplier evaluation/selection comprise the process of managing external industry awareness, the supplier markets, technological advances, internal strategies and demands for better matching needs and available competences from suppliers as well as supplier best resolutions. As part of this process, the supplier evaluation and selection should take into account stakeholders' opinions. The contract management reserves the right for the purchasing department to grant the purchasing agreements based on the best clauses for both parties as well as to follow up the compliance to those contracts. (Handfield et al. 2011, 46-48.)

The cost management embraces the work after a contract is in place. Breaking down the overall item price in order to understand the total cost of ownership is essential. It includes not simply analyzing the part's cost but also the costs of receiving, utilization and disposal. Thus, giving target costs and desired price productivity for the whole product's life cycle comparing and checking its competitiveness against

the current market conditions must be delivered as results. The supplier relationship management involves the entire process, from beginning to end, of the sourcing life cycle. Establishing a supply management strategy is, in simple words, defined as a master plan for allocating and aligning current resources according to the business and company's needs in the supply chain. A good supply strategy has a process that is standardized and well described for all the related activities, good alignment between company's vertical levels and a clear way of tracking short- and long-term objectives. Lastly, managing the procure to pay process is briefly described as the necessary sequence of steps for acquiring certain product, service or material demanded by an internal customer. The summary of the eight processes can be seen in Figure 8. (Handfield et al. 2011, 48-50.)
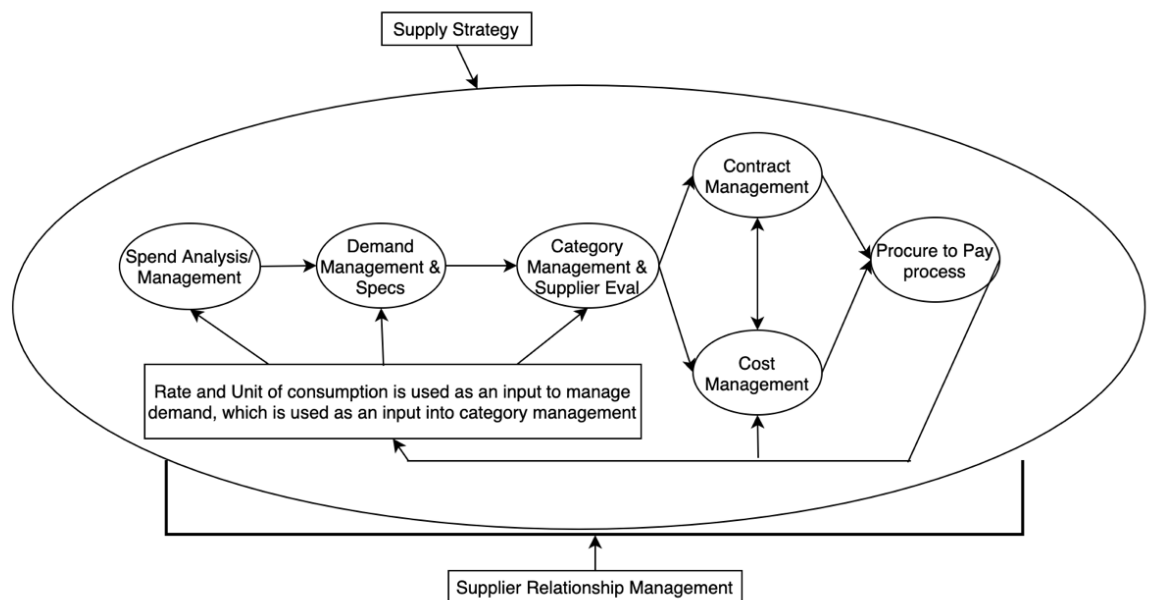
Figure 8. Core Purchasing Process. Adapted from Handfield et al. (2011, 50).

The main steps of the procure to pay process are shown in Figure 9 below in order to clarify one of the most basic processes inside purchasing.
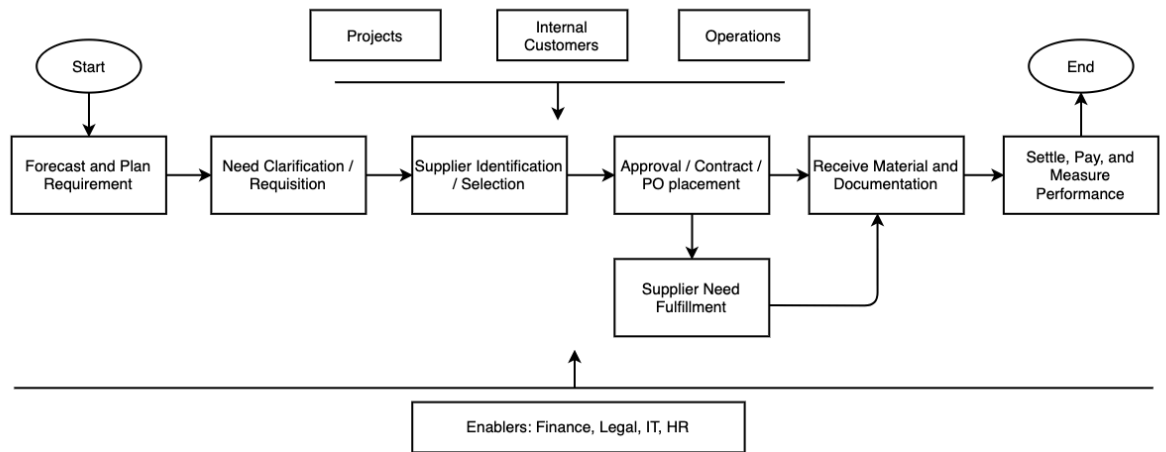
Figure 9. High Level Process Map of Procure to Pay. Adapted from Handfield et al. (2011, 51).

However, Lysons and Farrington (2006, 184) identified a few inefficiencies in the traditional way of executing purchasing procedures which can cause the raise of costs. The first one is performing non-added value activities in a specific process sequence. The next inefficiency is the excessive documentation which records unnecessary information. The third one is when supplier and customer over process orders, spending too much valuable time on this activity. The fourth one is when pure transactional tasks are causing excessive costs compared to its value for the process. In light of those inefficiencies, companies are continuously seeking for improvements in administrative functions, for example, decreasing, removing or combining steps when feasible and reasonable.

Thus, 3 aspects were recognized by experts which are very important in order to have a stout purchasing process in place in general terms. Robust and standardized processes as well as their mastery by purchasing employees through efficient and prime trainings. Moreover, when employees understand the negative consequences caused by deviations from the standard process, the level of compliance is augmented. Next, there is the need of dedicated people for ensuring the correct system inputs. Most of the time, management priorities are related to team management, achievement of schedules and securing the supply of proper equipment. The last aspect is striving for the minimum need of human intervention when entering information into systems. The simplification of data input is essential,

and it should be done, for example, via clear and simple channels and portals. (Handfield et al. 2011, 59.)

One of the main outcomes after all the planning, studying and development of robust purchasing processes is the creation of purchasing procedures. Purchasing procedure is a detailed sequence of instructions to perform one activity or task for any purchasing process. It is the description of how to execute a duty encompassed by a purchasing process. In light of that, the purchasing requisition, purchase order and request for quotation procedures are key for having a paramount purchasing process in place. (Handfield et al. 2011 108-109; Lysons & Farrington 2006, 207.)

Purchasing requisition (PR) is the format of how an internal customer requests the purchase of a material. Its format is decided by the company by best fitting the company's purpose. However, the basic and usual information which is contained inside a purchasing requisition is the material's description, needed volume and date as well as the required authorization for the purchase continuity. The purchase order (PO) is the official form of releasing a purchase to the supplier, validating and establishing the agreement previously signed. The request for quotation (RFQ) is made during the stage of supplier selection. In this procedure the company invites the supplier to bid according to the company's requirements and specifications. (Handfield et al. 2011, 59-63; Weele 2018, 39.)

2.6   Measuring Purchasing Performance

One of the most vital parts of process improvement is the continuously measurement, tracking and stewardship of a business, activity or procedure performance. An excellent process management applies the proper techniques and methodologies by utilizing the correct tools for measuring the process performance. The business direction must be always adjusted according to company's strategy and vision supported by the correct performance measurement in place. (Tupa 2010.)

Weele (2018, 304-305) gives reasons for measuring the purchasing performance. The first reason is that it leads to better decision-making since deviations from the original plan is clearly seen via the numbers and, consequently, the corrective actions can be taken. The second one is eventually leading to a better communication

between internal functions due to better transparency and visibility. The comparison between planned goals and actual achievements enhances the reporting quality and should lead to constructive feedback. When the performance measurement system is correctly built, it can be an ally of employee's motivation and job satisfaction. When the personal development and target setting are taken into account during the creation of performance measurement, the chances of higher motivation among employees is increased.

In light of that, the understanding of two concepts is important when creating the proper purchasing performance approach. They are the purchasing effectiveness and efficiency. The purchasing effectiveness deals with whether achieving the desired result of a goal, activity, strategy or not. The purchasing efficiency relates to the comparison between the planned and actual resources needed to complete a specific purchasing task, activity or goal, for example, the budget. Thus, five dimensions are suggested in order to appropriately measure both purchasing concepts. They are price/cost, product/quality, logistics, supplier relationship and organizational dimensions. A summary can be seen in Figure 10 below. (Weele 2018, 306-307.)
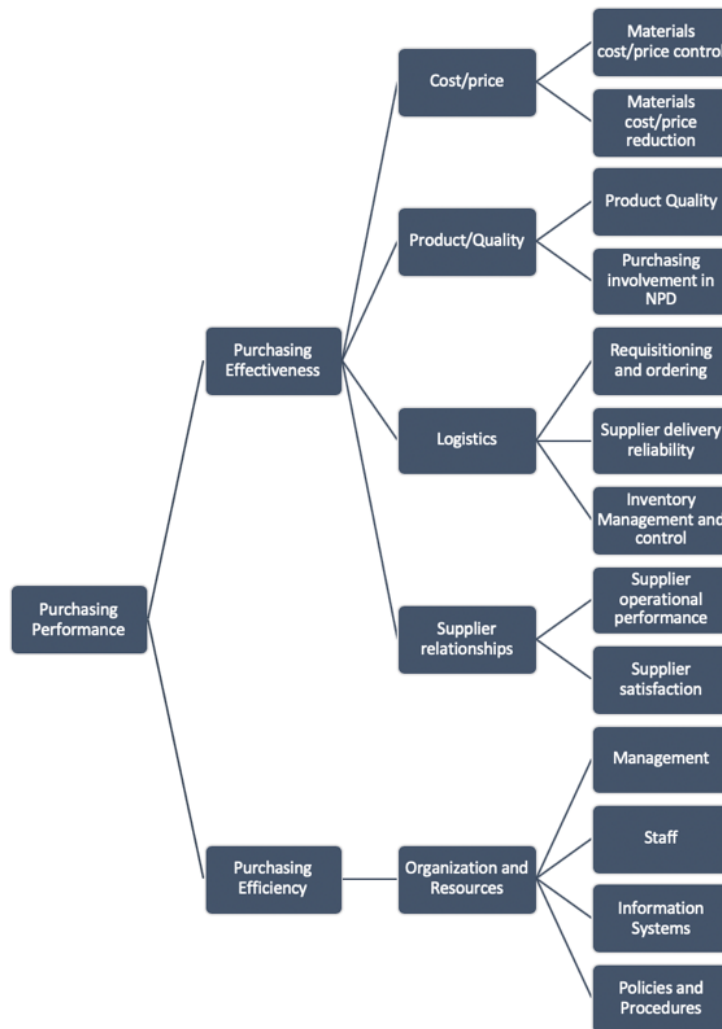
Figure 10. Suggested areas for performance measurement of purchasing effectiveness and efficiency. Adapted from Weele (2018, 307).

However, companies often face some common and usual issues when the topic is performance measurement. Specifically, for the purchasing function, a robust performance measurement system has to avoid basic issues in order to achieve the best outcomes. They are, firstly, too much and/or wrong data, usually by either tracking too many measures or not being relevant according to the company's strategy. The second problem is measuring only short-term goals without considering the long-term and strategic objectives. The next issue is the lack of detail, definition, formal objectives and performance standards. Examples for these can be when the information is too summarized, there is not a proper understanding of basic concepts, such as purchasing effectiveness and efficiency, or there is poor awareness of or willing to use standards. The fourth issue is the heterogeneity of purchasing

between different enterprises. Each company has a different scope for its purchasing department, therefore, different performance measurements should be created based on each situation. The fifth one is driving the wrong performance by measuring aspects which can eventually lead to misleading information or shortcuts, such as number of written purchase orders. Lastly, when there is measurement of behavior instead of accomplishments. There is no assurance whether tracking behavior directs to the desired final target or not. (Handfield et al. 2011, 737-739; Lysons & Farrington 2006, 635-636.). Since it is hard to monitor and improve business elements without standardized processes or activities, a five-step process is suggested in Figure 11 below to create a performance measurement system according to Handfield et al. (2011, 753.)
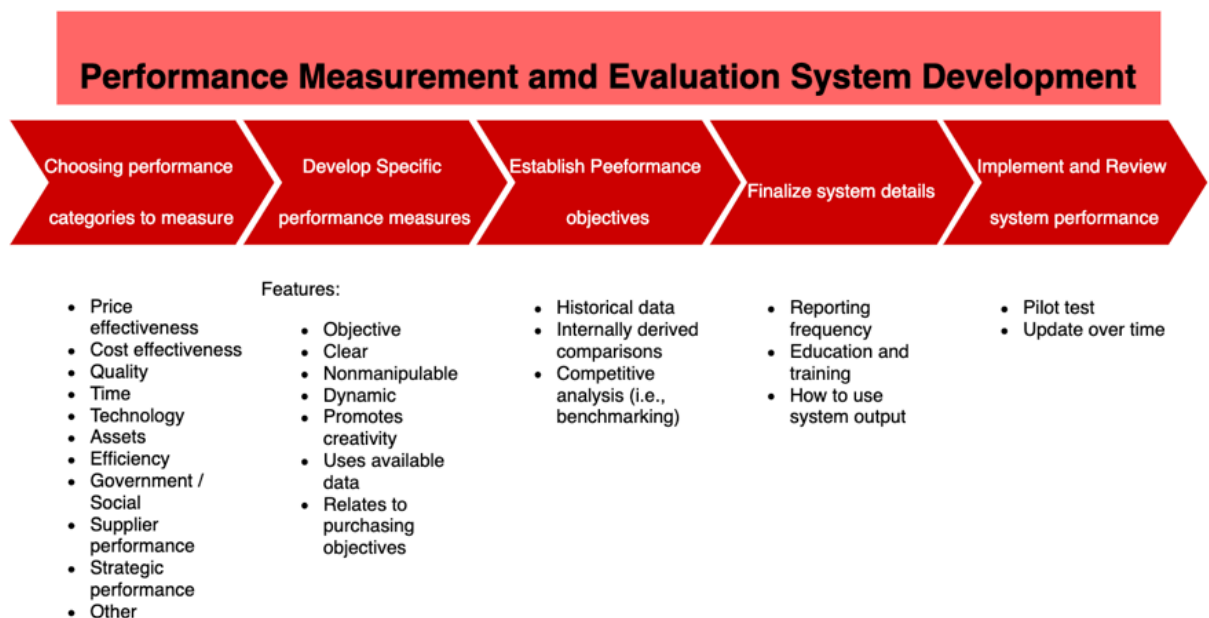
Figure 11. Process for creating Performance Measurement and Evaluation System. Adapted from Handfield et al. (2011, 753).

Tupa (2010) defined two types of performance measurement methods for process management. The first one takes into account only financial figures, for instance, DuPont analysis or Economic Added Value measurement and return on investment (ROI). The second type considers not only financial figures but also different areas in order to manage, track and monitor processes, activities and functions, e.g.,

Balanced Score Card (BSC), European Foundation for Quality Management model (EFQM model), Six Sigma or Value Based Management. Respectively, the second group of approaches, if proper created, may support the financial figures by adding three different points of view, therefore, widening the performance's line of sight. Those different perspectives are the customer's point of view, other internal aspects from the business as well as learning and growth scopes. Those three additional aspects support a better view of overall performance, the direction of efforts and resources towards the correct strategy.

As already extensively discussed, purchasing department deals with plenty of internal and external entities. Therefore, it is wise to also keep track of partnerships and cooperation in business which encompass not only the traditional purchasing-supplier relationship but also several tiers of relationships. When designing a performance measurement system for an industrial collaboration or external relationships in business life, Ukko and Saunila (2020) have found three relevant attributes which affect its formulation and deployment. First of all, determining how valuable the relationship is for the company. Next, there is the need of checking the interoperability and harmonization between current information and performance measurement systems. The last factor is being aware of how the customer's demands affect the enterprise and, consequently, the performance measurement.

3 Business Processes

When the research scope is about business process improvement and NPD, there are some more general aspects inside the business field which should be explained in more depth. Thus, the third chapter is divided into three subchapters, one for describing the basic concepts, one for project management matters and one for the description of process management within an enterprise.

3.1 Basic Concepts

It is wise to start with a definition of a business process. Bititci and Muir (1997) stated that the definition of a business process may vary, but in every definition, "the business process is a collection of various tasks which produce an output". However, the idea of having common business processes which can be implemented in several

and in a diverse range of companies and industries is questionable. Many different researchers have suggested the applicability of, for example, Porter's value chain for general business activities. However, recent studies show that the idea of generic business processes might be true at abstract levels but not when more detailed processes are required. The operational and specific models require particular inputs, and they cannot be generalized or shared between all the environments and activities. (ibid.). In light of that, the concepts and aspects presented in the following paragraphs strive for delivering not only the general matters but also for being closely pertinent to the scope in question.

Ould (2006, 19-23) defines a few basic principles which are important to consider when modelling and managing a process. However, due to the thesis scope, a reduced number of them were contemplated. First, the abstractions must be meaningful. Next, processes have to address and tackle one activity or task at a time. The following principle defines people as the central aspect inside any process because they execute the work, in other words, the process does not happen by itself. Lastly, although people are divided, and they work according to different functions, they do execute processes.

Derived from the last paragraph's idea, according to Harmon (2014, 27-39), a process has to deliver competitive advantage by accomplishing a business initiative based on the company's strategy, and, ultimately, by performing added value activities which are encompassed by the process value chain. A competitive advantage is achieved when the firm can earn more profits than its competitors while selling the products or services which compete. The business initiative is a resolution from the top-level management stating what has to be achieved by the employees, functions or departments, where the focus is on what has to be done instead of the final result.

The strategy deals with the long-term issues of how the company is going to reach its ultimate objectives and vision, as well as what is required to meet those targets. Added value activities are the ones which increase the customer's perceived value and satisfaction with the final product or service. The value chain defines the core process in which all the defined steps add value. Therefore, the importance of

designing an outstanding process and its continuously improvement is clearly seen. (ibid.)

In light of the above, Ould (2006, 145-159) recognizes the significance of describing the types of processes. He characterizes three basic types of processes. They are case processes, case management processes and case strategy processes. First of all, inside the case process, it is necessary to determine the smallest units of it. Each activity or department has a unit of work (UOW), in other words, it is the piece or part of the work which the function, company, person or process deals with on a standard format. An example of this would be a customer complaint to a customer services department or doctor's surgery. Therefore, handling a UOW within a pattern is called a case process. Inside the case process there are several stages and each of the different UOWs might be on the same step or not. In order to make it even clearer, examples of case processes would be handling a purchase order or preparing a report.

The set of case processes which belong to or overlap during the same activity flow are assembled in a case management process. They share resources and assets, and they have to be planned, scheduled, addressed, reported and so on. The clear understanding of both processes is key to developing and analyzing the desired processes effectively and efficiently. Case management processes are, for example, monitoring, scheduling, planning, prioritizing and negotiating. They require the creation of roles such as management teams, managers, boards and supervisors. In summary, the case management processes are responsible for managing the arrival of new case processes until the process is finished. In order to clarify, examples of case management processes are managing the flow of purchase orders or customer complaints. (ibid.)

After extensive research, Bititci and Muir (1997) determined four areas within the main aspects which should be analyzed and evaluated regarding the relationships between different business processes. Those areas are to be considered when managing the case management processes. A summary of this can be seen in Figure 12 below.
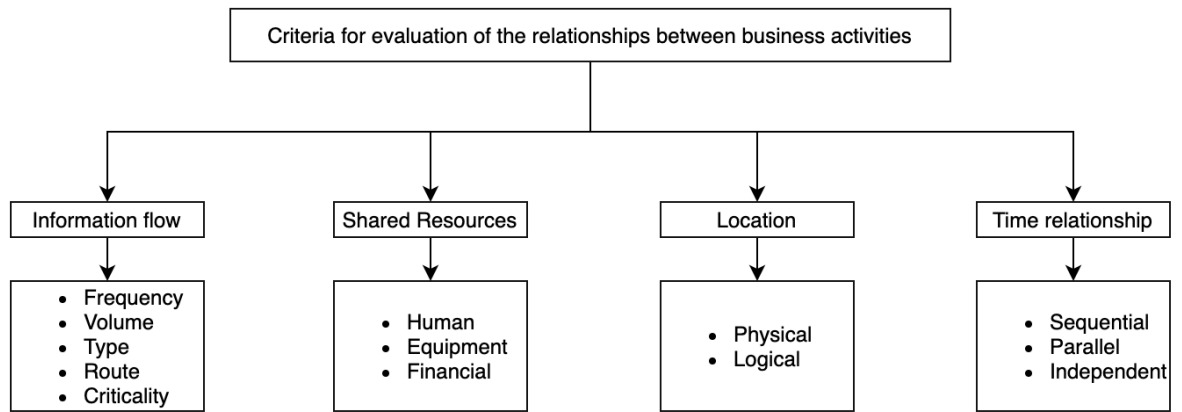
Figure 12. Different criteria for evaluating business process relationships. Adapted from Bititci & Muir (1997).

Lastly, Ould (2006, 166-168) defines the case strategy process as the last step for managing business activities. The processes included in this category have the strategic view for steering the case processes and case management processes into the correct direction. As a case strategy process is event-driven, it takes into account external and internal occurrences dealing with opportunities and threats. On the other hand, when being time-driven, they have regular happenings in order to, for example, review the current market situation and future industry expectations. Mainly, the outcomes are updates and changes of the case processes and case management processes. A summary of the three cases can be seen in Figure 13 below.
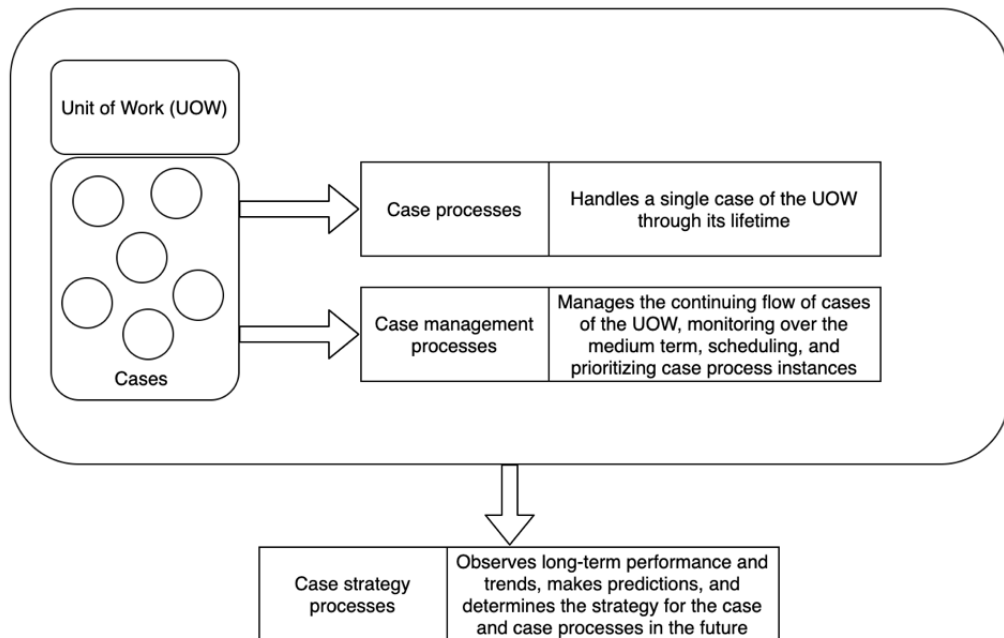
Figure 13. Relationship between the three types of processes. Adapted from Ould (2006, 168).

The basic understanding, as previously described, is essential for the correct creation of a process architecture and definition. Moreover, it has to be considered at all times that many processes do not follow a neat static order but have a great deal of dynamism between their relationships. They can be running at the same time, interacting or activating each other and so on. Therefore, in some cases, the construction of a chronological/hierarchical diagram, process or flow chart is not enough because the dynamic relationships between the processes must also be presented. Figure 14 below shows an example of how to translate a hierarchical and chronological sequence of two steps to a dynamic relationship between them in terms of case processes (CP) and case management processes (CMP). (Ould 2006, 169-171.)
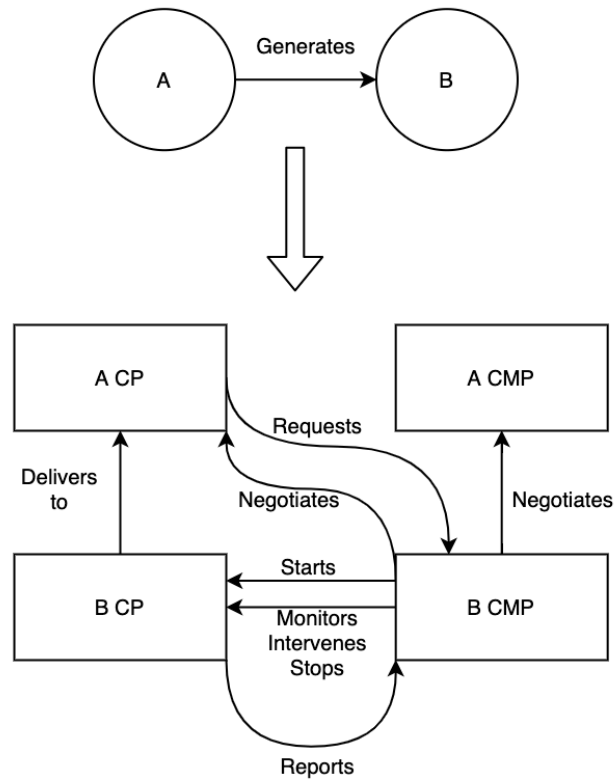
Figure 14. Translating a two-step process to a dynamic process between them. Adapted from Ould (2006, 183).

After all, the background was created for discovering and defining the current processes inside a business by determining its activities and translating them into proper processes descriptions, guidelines and instructions of how, what, who, when and with which purpose they are executed. The summary of it can be seen in Figure 15 below. EBE stands for essential business entities which are the mandatory aspects, either concrete or abstract, which an enterprise has to interact, handle or deal with, depending on the business field. For example, inside the business of modular program administration of a university course, the EBEs would be students' assessment, modules, awards, examiners, curriculum and appeal. (Ould 2006, 172, 266.)
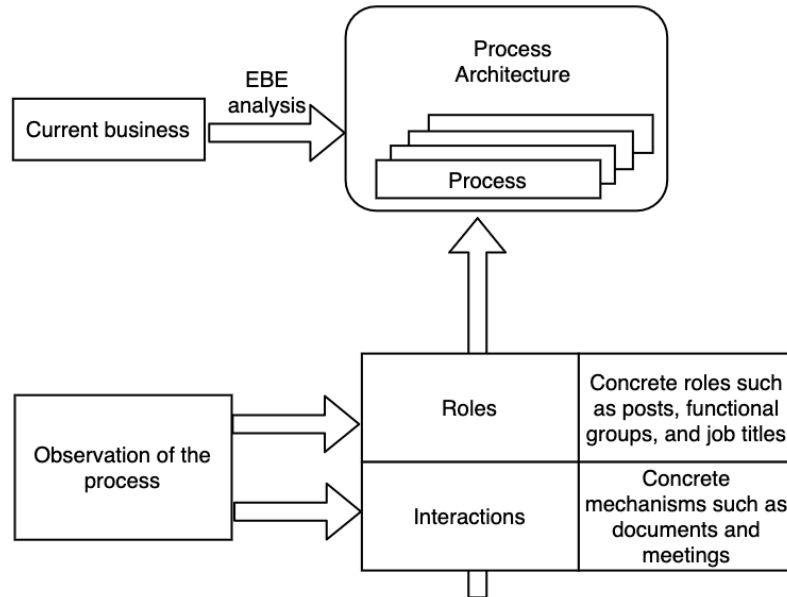
Figure 15. Scheme for discovering and defining processes. Adapted from Ould (2006, 266).

3.2 Process Management and Improvement

Nowadays, there are several process management models and perspectives offered by institutes, researchers and companies. In addition, various process improvement approaches and methodologies are provided by different models. However, those topics were discussed in a more general level in this chapter due to the research scope.

One central element when dealing with process management is the concept of business process management (BPM) group which, in brief, it is the structure and way how an enterprise handles its business. A BPM group might have plenty of emphases, but there are common areas in which BPM groups can be based on. Those common areas can be seen in Figure 16 below. (Harmon 2014, 157.)
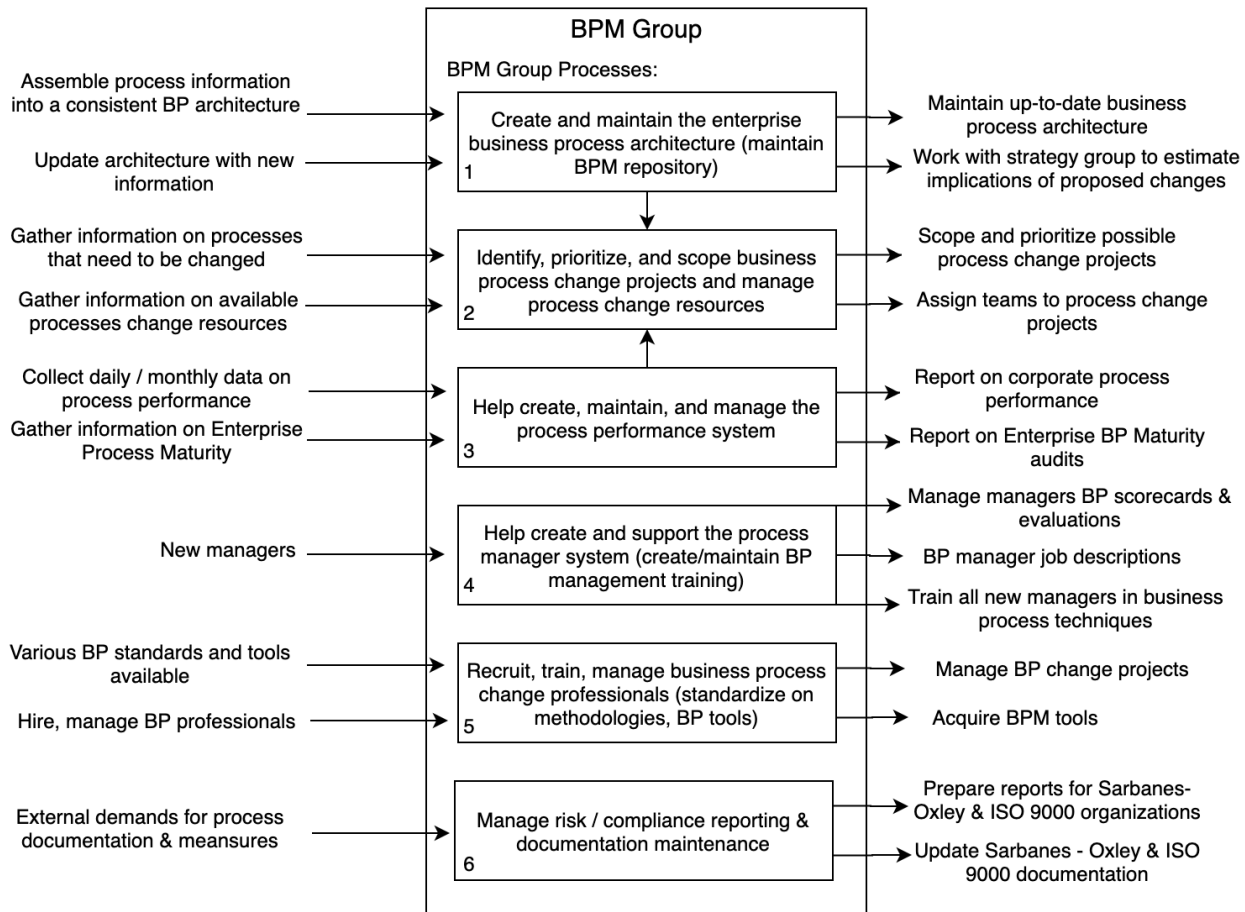
Figure 16. BPM general processes with inputs and outputs. Adapted from Harmon (2014, 158).

Figure 16 presents several possibilities for BPM groups but in order to encompass the scope of managing and improving the current company's processes, only numbers two and three were chosen for a more detailed study. With the right inputs, the processes are properly managed by the BPM group. However, in many cases, companies do not have enough resources to manage and improve all the processes which require a more attentive look. Therefore, it is necessary to identify all the processes in that situation and make prioritization. Furthermore, there are limits regarding the maximum amount of disruption which a firm can handle at a time when changing or improving a process. In summary, the high-level approach number two presented in Figure 16 can be translated into a regular review of priorities and schedules for processes and the correct definition of resource allocation into projects. (Harmon 2014, 159-160.)

The process management is closely related to the process improvement, in other words, recognizing the internal and external opportunities and threats. A BPM group should be aware of the internal overview in order to identify the best chances of developing the process, according to stakeholders' needs and expectations. A BPM group linked to a clear value chain is supposed to best control, coordinate and prioritize the process management, improvement and changes, as well as using the available resources as best as possible. There are several options when dealing with improvements, but five major ones were identified. The first one is redesigning, which accounts for a great deal of effort for analyzing and making significant changes in the process to achieve considerable improvements. The second considers automation, that includes the effort of IT personnel to automate a specific activity, process or task either being complex or not. The next option for improvement is targeting the analysis of an existing process for gradually adding incremental/small improvements, for example, when applying lean or six sigma methodologies. The fourth option is better management, which encompasses a better approach of how the process is planned, coordinated, measured and monitored instead of making major changes. The last alternative is outsourcing, in other words, delegating the execution and management of processes and activities which are not related to the core business and, consequently, they can be more efficiently performed by partners. (Harmon 2014, 160-163.). A summary of those concepts can be seen in Figure 17 below. It contains the main stakeholders as well as opportunities and threats are exemplified for a generic company.
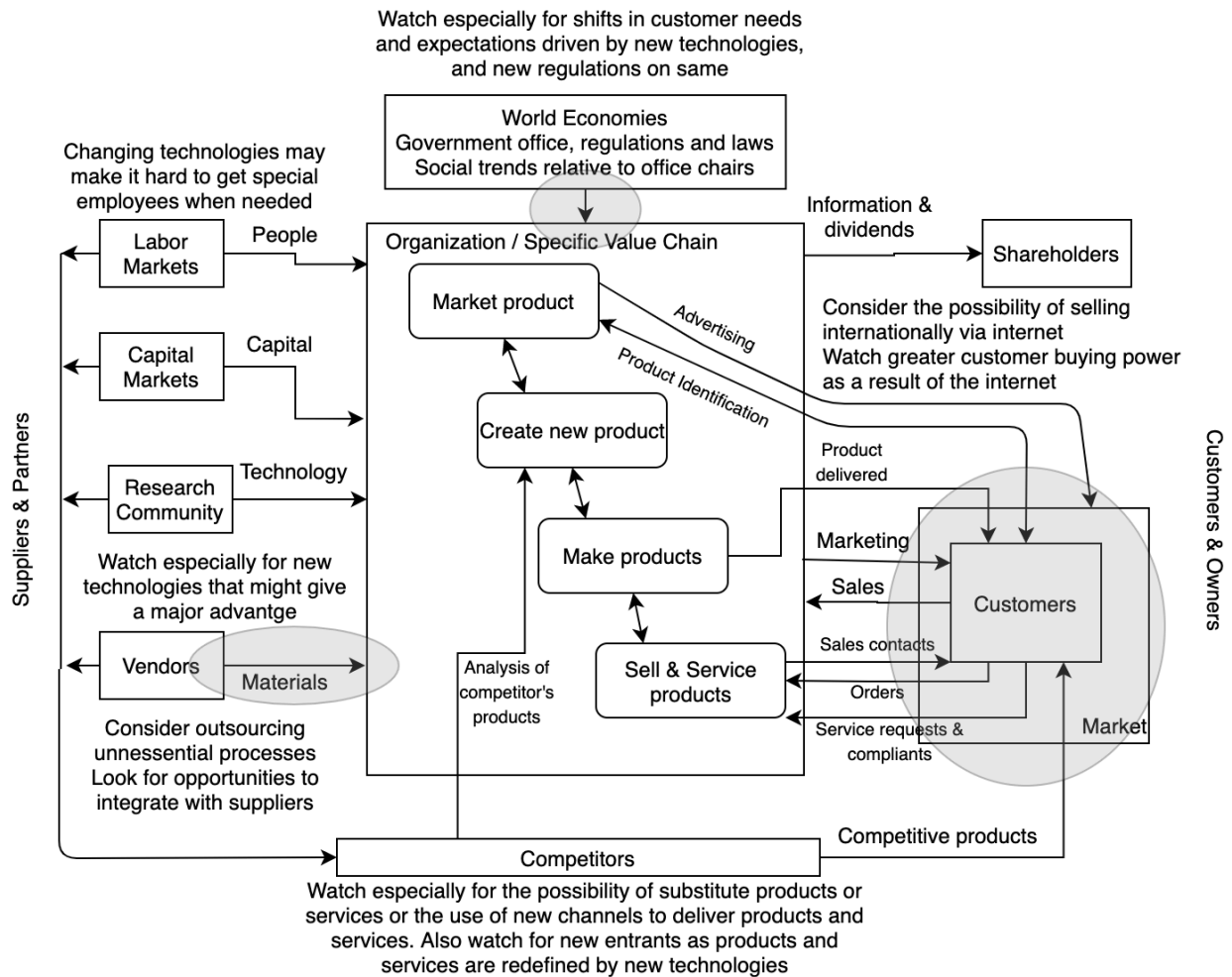
Figure 17. Generic overview of stakeholders and opportunities/threats, with highlighted stakeholder relationships. Adapted from Harmon (2014, 161-162).

In order to better address which kind of improvement and prioritization should be applied to a specific process, Harmon (2014, 163-165) suggested, firstly, the definition of two criteria for determining the type of process. On one hand, the level complexity and the process' interactions (dynamics) must be determined. The complexity factor considers which kind of activities are carried out while executing the process, whether they have only few easy procedures and rules to follow or much more complex standards to follow with many people and policies involved. The dynamic factor can be summarized as whether the process is constantly changing or it is stationary because of, for instance, new governmental regulations or fast changes in markets and customer's needs. On the other hand, the amount of added value that the process adds to the final goal or product must be defined. For example, the process can be strategic, being part of the company's core business or

it can be a mandatory process which needs to be executed in order to continue a higher-level process. In light of that, Figure 18 below presents the summary of a matrix with both criteria and the improvement suggestions according to the process types.
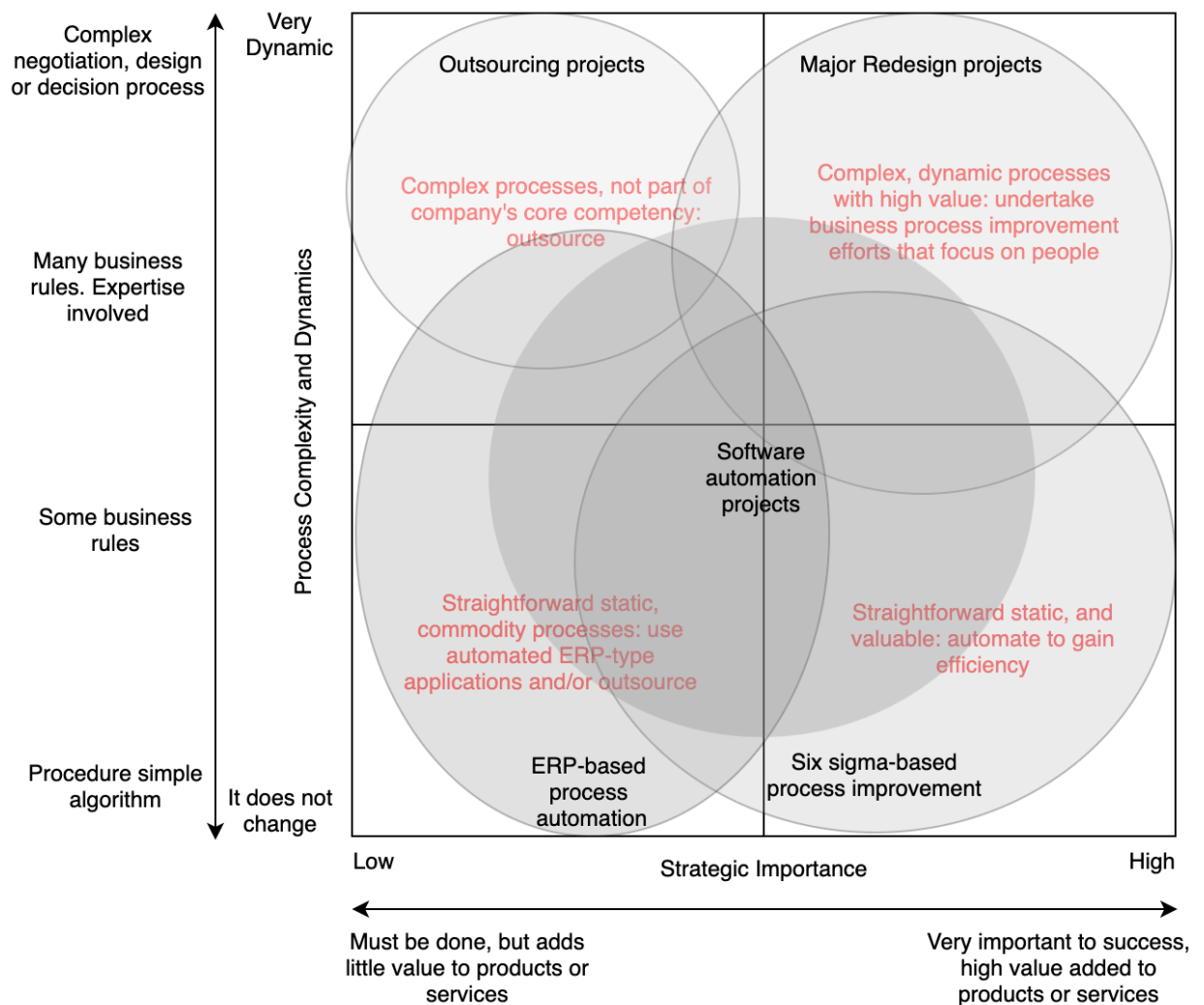
Figure 18. Two criteria for defining process type and its respective suggested improvement types. Adapted from Harmon (2014, 163,165).

In order to decide the correct improvement for the process types, Ould (2006, 270) argues that there are a few questions which guide a BPM group to the right direction. The first question is whether the company is searching for major changes or minor ones, meaning whether the goal is to seek a totally process renewal or incremental developments. The second question is whether the company is focusing

on the process intent or mechanism. It means challenging the process' purpose and objective (abstract process model) or checking whether the process is being executed on the best possible format (concrete process model). Finally, in order to analyze and improve a process, a clear process description and model must be in place. However, in some cases, it is not worth to draw the process as it is currently performed ("as-is" process) and the best idea is to model the process as it should be after improvements ("to-be" model).

Ould (2006, 275-283) found some major areas resulted from the application of the improvements. They are, firstly, reducing overall costs or any kind of resources which are utilized during the process, such as human resources and duplicated work. The second category is decreasing cycle times which usually considers the process' critical path analysis (CPA). The CPA concept is better explained in the next subchapter. The second category includes, for example, reducing the time-to-process for an individual case process which has a big deviation compared to similar case processes. The third topic is increasing the parallelism or concurrency of activities and tasks which are executed during a process. It is considered a positive result since it reduces the length of the critical path of the process in question by decreasing the overall elapsed time. The fourth area is when the cases which need to undergo the same process, are filtered and, consequently, the most complex ones are allocated to more dedicated or specialized personnel while the simpler ones do not need such skilled workforce. Hence, the fourth aspect may lead to a reduction of overall costs in labor costs. The next category is producing a more coherent sequence of steps for the process, cutting tasks which do not add value or outcomes are never used. The last one includes being able to see and fix faults at earlier stages.

Regarding the BPM number three in Figure 16, as already extensively discussed in subchapter 2.6, a seamlessly process performance system is key for monitoring and taking the needed corrective actions according to market changes and company's strategy towards customer's requirements and satisfaction. It is also vital to separate the measurements which are whether dealing with case processes (CP) or case management processes (CMP). CPs are handling only one process at time while CMPs are dealing with the management of CPs. For example, the time between the start of a CP and the achievement of its objective should be clear, therefore, having a clear

picture from where to obtain measurement samples. Furthermore, CMPs are the processes which data for trends and overall results can be collected and, thus, more strategic actions can be taken. (Harmon 2014, 166; Ould 2006, 271.)

Neverthless, the success of a company's process management ultimately depends on the people who work for the firm. Therefore, the enterprise communication process management has a great value for thriving in the business field. Nowadays, there is a considerable amount of available information but only a minor part of it is valuable for the company. The information and communication systems in operation are essential for retrieving data, analyzing and converting into information. These processes depend on managers and employees who are able to transform that information into useful knowledge. The management of such technologies require competent workforce to have a great knowledge management. Consequently, an advantage might become a weakness depending on whether there are skilled and expert personnel to transform the available data and information into good knowledge as well as to manage the process of sharing the knowledge with internal and external stakeholders. (Pomffyova 2010.)

The continuity of a company in its business field depends on how fast and on which way the company responds to quick market and external changes. Those quick changes may require, for instance, the applicability of current knowledge into different areas not yet explored, such as discontinuous innovation, the integration and coordination of processes which were not previously connected and the definition of who is responsible for which activities in a very short time. In light of that, the information needs to not only be promptly accessed but it also has to be understandable, meaning knowledge, and the precise recognition of activities which are carried out during the processes with an outstanding process management in place. The combination of a well-structured and defined process management together with a communication process management can lead to a major competitive advantage. (ibid.)

Consequently, the knowledge process management must be efficiently and effectively done, where knowledge is stored, retrieved and shared on the best possible format, contributing to the overall company's performance. There are

important factors influencing those processes. They are, firstly, the individual active and willingly attitude and support from managers. There are higher chances of a proper application and usage of memory systems, influencing the storage and access to knowledge when both attitudes exist in the work environment. Moreover, the technologies used for organizational process' management by shared systems through the whole company must be the most adequate ones according to firm's integration and maturity level. (Franco & Mariano 2010.). In conclusion, not only the proper process management and improvements must be carefully chosen but the conversion of information into valuable knowledge must be considered as one the key points by employees.

3.3 Project Management

Since the company X's NPD sector is divided into several different projects, the last subchapter of the third main chapter discusses project management in more general terms, but it also has specific points on NPD matters. A few important concepts, methodologies and approaches were studied and are presented in the following paragraphs.

First of all, the clear understanding of the difference between the concepts of project and project management is indispensable. In many cases, those concepts are interchanged although they are not the same. A project is a sequence of steps and activities which aims to achieve an objective. It uses many types of resources while having a defined period of time for starting and ending. On the other hand, project management uses the current company's structure and resources applying the proper methodologies and approaches to require, set the extension, allocate, plan, monitor and correct variations towards the desired project results. (Munns & Bjeirmi 1996.)

There are some aspects which should be taken into account when a project's success is the ultimate objective. They are creating a feasible and clearly defined goal, competition awareness, pursuing customer satisfaction, selecting correct partners, being profitable, market availability, a seamlessly process implementation and the value added by the project completion. From a project management perspective and complementing a successful project, there are matters which should be avoided in

order to manage the project successfully. They are the avoidance of selecting the wrong project leader and team, unclear definition of processes and activities, inadequate background for project, either choosing the wrong project management methodologies, not having them at all or misusing them and, lastly, the lack of managerial support, commitment and project compliance. (ibid.)

In light of that, some overlapping aspects can be seen between the concepts' definitions and the matters that influence them. In order to better identify the general project and project management scopes, Figure 19 below summarizes what the overlapping stages are, and which ones should be emphasized so as to achieve success.
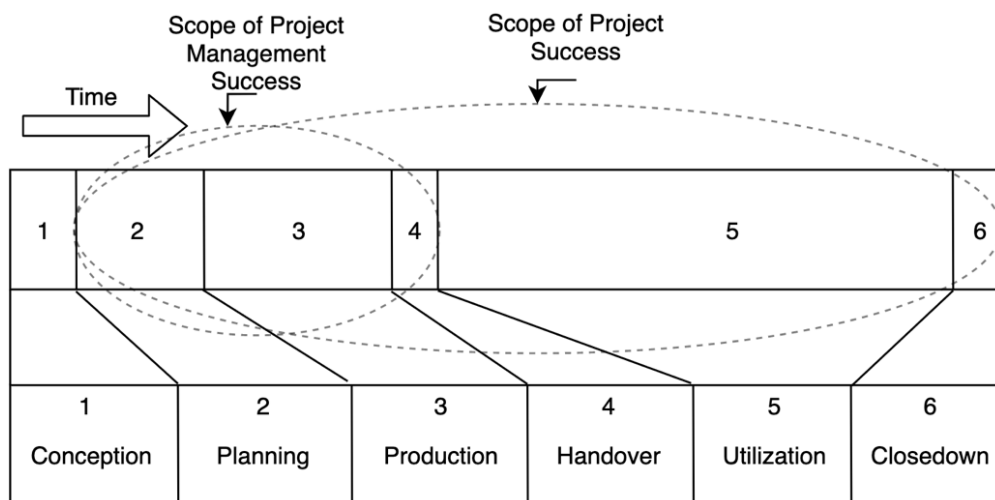
Figure 19. Scope of project and project management success. Adapted from Munns & Bjeirmi (1996).

Supporting this perspective, Mir and Pinnington (2014) have found positive correlation between project management performance and project success. They used the Project Management Performance Assessment (PMPA) model which consists of six criteria for project management performance and five criteria for overall project success. For the project management performance, they are project management leadership, staff, policy and strategy, partnerships and resources, lifecycle management processes and key performance indicators. For the project

success they are project efficiency, impact on the customer, impact on the team, business success and preparing for the future. All of the six criteria have a positive impact on one or more factors for business success, but vary on their impact level. Therefore, it shows the importance of placing a good project management system.

More specifically about NPD projects, Cooper (2019) defines three categories which are the most important success drivers for NPD projects. The first category is the tactical aspects of NPD project, its attributes and characteristics. They encompass, for instance, product differentiation and superiority compared to competitors, the preliminary study of market and technical assessments, and whether the project's scope as well as product requirements and specifications constantly change or not. The next category is related to the company's strategy and organizational structure, in other words, its business factors. They embrace matters such as the correct innovation strategy in place and proper utilization of available technology, strong alignment between company's core competencies and resources with the new product requirements and, ultimately, a positive work environment as well as a virtuous firm's culture. Lastly, the proper techniques, methodologies and processes must be in place for correctly managing NPD projects. It includes aspects such as the quality of process execution, a systematic approach from concept generation to product release, process efficiency and time-to-market cycle times.

In light of the last category from Cooper's study for driving a successful project, the proper set of management tools must be applied in order to deliver great results. Therefore, Barkley (2008) presented a series of techniques, methodologies, approaches and procedures which may be applied for project management. Some of the most appropriate ones are described and explained in the following paragraphs.

To start off, one important matter which should be described is the critical chain concept. The critical chain concept is closely bonded to the necessity and concept of integration, connecting risk management to both time and scope management. When applied to project management, it focuses on the creation of a work breakdown structure (WBS) and the project's network, finding the chronological and logical activity dependencies in order to start and finish all the mandatory tasks on time. The activities which do not follow a pattern and have a major variation in time

are not the priority but doing everything correct as fast as possible at once is the key idea. (Barkley 2008, 67.)

Naturally, without a structured coordination, there is disorder along the project's execution. In addition, on current days the internal business networks are very complex which in turn make the detailed scrutiny of all pertinent risks unfeasible. Thus, the integration process during the project is essential. For example, management tends to make different assumptions when costs and time are being independently managed, and they are not integrated. As a final result, cost and time plans, goals and strategies cannot be merged and integrated. The process of integration compels sharing information in advance, enhancing parallel or concurrent work, active and regular communication between stakeholders, design reviews and information system integrations. (ibid.)

Barkley (2008, 69) defines the integration during a NPD project as managing the cost control. However, he argued the existence of two ways of performing it. The first one is when financial department or accountants take care of whether the actual costs are matching the planned budget or not. The second one includes an integrated cost control which takes into account the overall project performance, quality and value attained by the project as well as balancing and managing costs, risks, value and quality. The integrated cost control is, in simpler words, how much resources are actually used for achieving the desired and planned targets. The integration, when properly conducted, can be seen by the results of many different indicators. For instance, the integration is clearly shown on customer's and stakeholder's satisfaction, positive workplace performance, when all the involved aspects (costs, schedules, value, quality, risks and changes) are considered for developing suitable deadlines and final results, involved staff creates or enhances working relationships as well as when the project lifecycle has no major surprises and changes.

Consequently, it is relevant to determine some of the integration enablers. Integration is all about alignment and linking stakeholders. People are key to integrate and the only ones who can do it. The systems are used to support people's integration. Systems do not integrate themselves. Next, forward integration which focuses on developing communication to deliver value to customers, on adapting

and changing the original plan when necessary is required. The third enabler is the correct work climate and culture for creating integration between employees. The fourth factor is the existence of integrity in every project's topic and personnel. Furthermore, a great accountability must in place. Lastly, developing integration among the high business levels is essential since the world is totally globalized nowadays and companies require a fast pace of information sharing. (Barkley 2008, 70-71.)

Moreover, a topic which is fundamental for the correct critical chain application is the WBS. It is the definition of standard procedures, activities, linkages and processes for a specific family of projects during their lifecycles. All those grouped projects undergo a generic WBS although there might be adaptations and changes according to the need. A basic and generic WBS is divided in four levels of structures. The first level (the deliverable) is the final result or outcome which must be delivered. The second level (the summary tasks) is the basic and big steps which are needed for delivering the final outcome. The third level (subtasks) deals with few activities which are required in order to deliver the second level. The last level (work package) is what really must be done, in other words, the operational and real work. Figure 20 below presents an example of WBS. (Barkley 2008, 115-116.)

1. The building
   1.1. Architectural Drawings
      1.1.1. Get an architect
         1.1.1.1. Build a list of candidate architects
         1.1.1.2. Develop Criteria for selection
         1.1.1.3. Screen candidates
         1.1.1.4. Interview candidates, conduct reference checks
         1.1.1.5. Compile candidate information
         1.1.1.6. Distribute candidate information
         1.1.1.7. Convene meeting
         1.1.1.8. Conduct process of selection
      1.1.2. Prepare preliminary blueprint
      1.1.3. Check standard blueprint template
   1.2. Building supplies
   1.3. Ventilation System
   1.4. Water System
   1.5. Electrical System

Figure 20. WBS example with a four-level structure. Adapted from Barkley (2008, 116).

In order to track current work progress and its completion, it is necessary to consider the fourth level of a WBS as milestones within their needed times for being completed. In addition to it, the dependencies among them must be clearly determined as well as the needed resources. In order to have a clear picture of the workflow, Table 2 below presents the fourth level of the WBS structure from Figure 20 with its relevant information. (Barkley 2008, 117-118.)

Table 2. An example of a WBS fourth level with relevant information. Adapted from Barkley (2008, 118).

ID	Task	Duration (total estimated elapsed time) in weeks	Predecessor (dependency)	Resources
A	Build candidate list	6	0	HR Specialist Plans department
B	Define Criteria for selection	3	0	Project Manager and Architectural drawing Task manager
C	Screen Candidates	50	A	Architectural Drawing Task manager
D	Interview Candidates	30	A,B	Project Manager
E	Reference Checks	25	B	HR Specialist
F	Compile information	35	C	HR Specialist
G	Distribute information	3	F	HR Specialist
H	Conduct Selection process	3	E,G	Project Manager

From Table 2, a network diagram (Figure 21) should be built in order to better view the required paths to finish the fourth level of the WBS. Once the network diagram is built, the definition of its critical path as well as the slacks of tasks are the next steps. The slacks stand for the time slot which a task have for either a late start or late finish. (Barkley 2008, 118-119.)
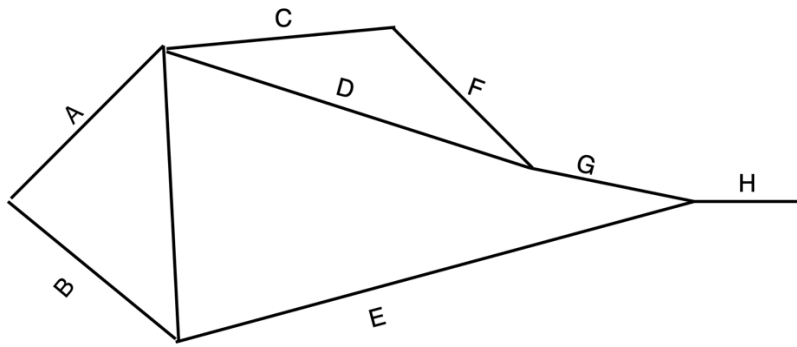
Figure 21. Network diagram from the example given of WBS. Adapted from Barkley (2008, 119).

Three different paths can be clearly seen in Figure 21. The first path, A, C, F, G, H, is called as path one. The second path, A, D, G, H, is called path two. The third path, B, E, H, is called path three. The line connecting B to D means the dependency of task D by the conclusion of tasks A and B. All of them are necessary to complete the whole work package although the longest path is called the critical path. In this example of Figure 21, the critical path is path one with 97 (6+50+35+3+3) weeks of lead time on total. Path two has a lead time of 42 (6+30+3+3) weeks and path three has a lead time of 31 (3+25+3) weeks. With those numbers and paths, a time-based network diagram is constructed, and it can be seen in Figure 22 below. The dotted lines represent the slack which paths two and three have for being accomplished. Finally, Table 3 is created and showed below transforming the representation from Figure 22 into a more quantitative model. The basic rules for creating Table 3 can be seen in Figure 23 below. Ultimately, the most important outcomes are knowing the project duration, critical path and slacks. The project duration is derived from the early start and finish analysis. The critical path comes from the late start and finish analysis following all the tasks which do not have any slack. (Barkley 2008, 119-120, 156-157.)
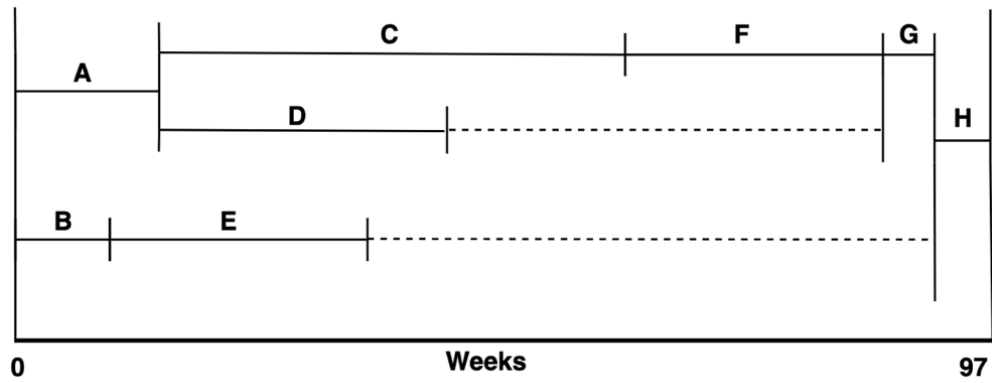
Figure 22. Time based network diagram for the WBS example. Adapted from Barkley (2008, 119).

Table 3. Analysis of early and late starts for the WBS example. Adapted from Barkley (2008, 120,157).

ID	Task	Duration (total estimated elapsed time) in weeks	Predecessor (dependency)	Early starts (weeks)	Early finish	Late start	Late finish	Slack
A	Build candidate list	6	0	0	6	0	6	0
B	Define Criteria for selection	3	0	0	3	66	69	66
C	Screen Candidates	50	A	6	56	6	56	0
D	Interview Candidates	30	A,B	6	36	66	96	60
E	Reference Checks	25	B	3	28	69	94	66
F	Compile information	35	C	56	91	56	91	0
G	Distribute information	3	F	91	94	91	94	0
H	Conduct Selection process	3	E,G	94	97	94	97	0
				Projec Dur	97		Critic Path	A,C,F,G,H

Pass 1 – start with first task
1. If task has no predecessor, then Early start (ES) = 0
2. I task has one predecessor, then ES = Predecessor's Early finish (EF)
3. If task has more than one predecessor, then ES = Max (EF of all predecessors)
4. EF = ES + duration
5. Repeat 1-4 for all tasks
6. Project duration = Max (EF of all tasks)

Pass 2 – Start with last task
1. If task has no successor, then Late finish (LF) = project duration
2. If task has one successor, then LF = Late start (LS) of successor
3. If task has more than one successor, then LF = Minimum (LS of all successors)
4. LS = LF – duration
5. Slack = LF-EF or LS-ES
6. Repeat 1-5 for all tasks

Figure 23. Rules for creating the table of analysis of early and late starts for WBS. Adapted from Barkley (2008, 157).

Although the presented technique is simple, it is very effective for checking the critical path of an activity or task in matters of time and constraints. Nowadays, many trainings and standards for project management tools are extensively studied and developed although it does not mean an increase in the overall performance perceived by senior management. Crawford (2005) have not found a positive statistical relation between the project management methodologies which are taught and developed through standards and certification programmes and overall project management efficiency and effectiveness perceived by senior management. Hence, the way how the company chooses to manage its projects must be carefully selected, pursuing the best practices offered from current tools which best suits the company's needs and background experience.

4 World-class Purchasing and its Processes

Once the general and most important concepts were described for purchasing and business and their processes, the next step was to study and review what the most up-to-date matters, issues and technologies for purchasing and its processes are on current days. Therefore, in this chapter a summary of the most relevant topics is presented.

4.1   General Overview

Handfield and coworkers (2011, 358-359) and Lysons and Farrigton (2006, 16-18) agreed that a world-class purchasing starts with a world-class supply base. There is a very tight relation between supplier performance and the company's supply chain success. Selecting, maintaining and developing the most outstanding suppliers are key for purchasing and, consequently, firm's results. Those suppliers are characterized by continuously pursuing improvements, new and better technologies, creativity and innovation as well as promptly responding to the fast world and market changes.

On the other hand, Weele (2018, 169-172) emphasizes the seeking of a world-class purchasing through its processes, being supplier base management as one of the key strategic management processes. The focus is to divide the most important purchasing processes into strategic management and enabling ones. The strategic management processes englobe few aspects. They are "make or buy" decisions, developing aligned commodity strategies, strategic cost management by, for instance, applying total cost of ownership, and as already described, a world-class supply base management and all its strategic related topics, such as early supplier involvement in NPD, supplier integration and development.

For the enabling processes, Weele (2018, 172-174) recognized a few crucial ones. They are, firstly, the creation of aligned and integrated strategies for the purchasing team, cross-functional teams and organization, as well as for purchasing and supply chain areas. The second enabler is the utilization of globalization as a strong ally. The next enabling process is constructing a paramount system of performance measurement for purchasing and supply chain areas which gives the correct picture of current status. The fourth one is the development of an integrated information system which supports the company's objectives. Lastly, improving the team management by selecting, retaining and developing a great purchasing team. Both types of processes are to be executed in parallel and they are the base for a world-class purchasing and its processes.

In general terms, the ultimate goal for the business is reducing costs whereas maintaining or increasing the efficiency and effectiveness of its core processes,

consequently being profitable and growing the business. In matters of cost reduction, a world class purchasing and its processes are key. Schütz, Kässer, Blome and Foerstl (2020) studied the achievement of cost reduction and strategic performance through a knowledge-based view. They presented the outmost importance of purchasing knowledge for delivering optimal results in matters of costs and strategic performance. Furthermore, when there is an optimal integration inside the purchasing function, the effects of decreasing costs and performance are enhanced. The study showed that the two-way knowledge and informational support from and to purchasing by other functions is essential for integration, hence, for reaching desired goals. In summary, team management is indispensable. In order to support the idea of the paragraph above, Lysons and Farrington (2006, 17) argued that even though there are many different indicators of a world-class purchasing, management and leadership are the most crucial ones being the main predictors of an outstanding purchasing and business performance. If people working for the company are highly skilled and competent, the chances of delivering great results increases dramatically.

In light of that, the most important capabilities and needed competencies for purchasing professionals on current days were collected. Bals, Schulze, Kelly and Stek (2019) analyzed the needed qualities which purchasing and supply chain management (PSM) professionals should have on current and future times. For present days, the professional and transferrable competencies are key. The most relevant qualities and skills regarding the transferrable competencies are negotiation, communication and relationship management. The most indispensable ones for professional and technical competencies are a robust background on strategy and analytics as well as high professional expertise/know-how. Concerning prospective business and the next stages of purchasing, the addition of sustainability and digitization areas is considered essential by PSM experts. Those areas include, for instance, green operations, eProcurement, process automation and innovation.

4.2   Keeping an eye in the future

Once the foundation for developing a world-class purchasing and its processes was described and presented, it is wise to know what to expect for the future of

purchasing. Even though the procurement term englobes a slightly wider scope than the purchasing term, in this chapter they were used as synonymous.

First of all, a great deal of the term "procurement 4.0" has been discussed on current days. Derived from the industry 4.0 concept and its revolutionary advancements, procurement 4.0 relates to the concept of digitalization of procurement processes, activities and supply chain integration. The scope of the term procurement 4.0 can be seen in Figure 24 below. (Klünder, Dörseln & Steven 2019.). Since the scope of this study does not involve the explanation and detailed investigation of the procurement 4.0 concept but the introduction to the possibilities for future developments and improvements in the purchasing field, many terms and aspects presented in Figure 24 were not further discussed.
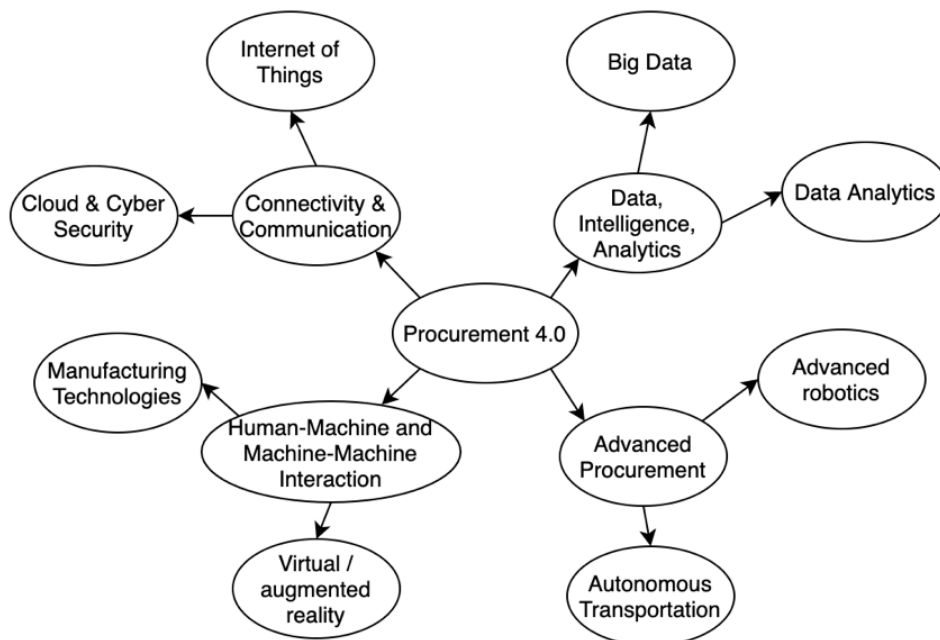
Figure 24. Areas of Procurement 4.0. Adapted from Klünder et al. (2019).

Klünder and others (2019) studied the correlation between the procurement 4.0 and the possible cost reductions derived from its application and implementation. They defined which technologies affected in four cost dimensions and they have found that procurement 4.0 does not yet have a clear influence on specific material range but does affect groups of commodities. For example, commodities such as plastic

products, metal fabrication and components related to motor vehicles had a significant cost reduction. The cost dimensions and the influencing technologies can be seen in table 4 below.

Table 4. Cost Dimensions and technologies which influence them. Adapted from Klünder et al. (2019).

Cost Element	Procurement Step	Technologies
Demand Analysis Costs	Procurement Strategy	Big data, Data analytics, Manufacturing technologies
	Demand Planning	Big data, Data analytics, Manufacturing technologies
	Offer request	Internet of Things, Cloud & Cyber-Security, Big data, Advanced robotics
Supplier Selection costs	Offer Evaluation	Data Analytics, Internet of Things, Cloud & Cyber-security
	Negotiation of conditions	Big data, Internet of Things
	Supply agreement	Internet of Things, Cloud & Cyber-Security
	Determination of Order Quantity	Data Analytics, Advanced robotics
Direct procurement costs	Purchase order	Advanced robotics, Internet of things
	Material transport	Internet of Things, Big data, Data analytics, autonomous Transportation
Supplier Failure Recovery costs, order costs	Material reception and inspection	Internet of Things, Virtual/Augmented reality, Advanced robotics

Indeed, there are factors which are strongly influencing the development of digitization of procurement and consequently supply chains. Bienhaus and Haddud (2018) studied those factors and identified relevant findings. The first one is that Artificial Intelligence (AI) and Big Data play a big role for the next steps of procurement. Those are to support the purchasing department in operational and routine tasks while freeing valuable time for more strategic activities. The proper utilization of big data by artificial intelligence leads to better decision-making process giving real time and accurate information to managers and employees. However, there are challenges to be faced while implementing and improving the purchasing area through new technologies. The current processes and systems which already exist and operate within the enterprise must be considered for choosing the areas of improvement and prioritization. In addition to it, new roles and tasks are emerging and, consequently, they need to be handled accordingly. Therefore, the first step is to plan and agree on the overall strategy, followed by the correct actions to achieve them.

For instance, Gottge, Menzel and Forslund (2020) give a generic framework in Figure 25 below of a purchasing 4.0 processes for premium automotive manufactures when utilizing the new industry 4.0 technologies. It presents a more specific range of processes which could take advantage of the new technologies.
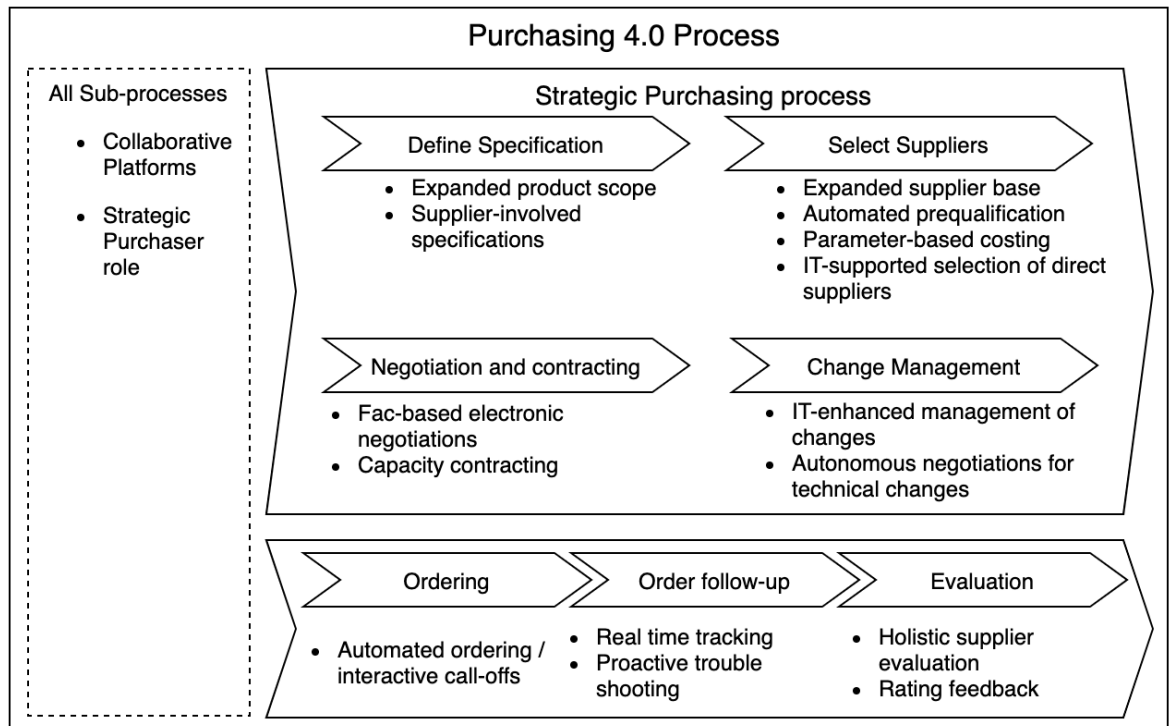
Figure 25. Example of purchasing 4.0 process and the range for the new technologies of industry 4.0. Adapted from Gottge et al. (2020).

Lastly, one important aspect that should be also enhanced within the new and emerging technologies is the traceability and visibility of processes and transactions. For example, the utilization of blockchain technology is gaining more and more room among business fields and it is not different with purchasing and supply relations. Relevant findings were made in the academic field. The first finding is that blockchain might have a big influence on cost reduction for transaction and governance matters. The application of the blockchain technology might especially decrease search and information costs. For example, the tracking of activities and partner performance are much more transparent and easier to be measured because the transactions executed via blockchain are recorded and cannot be changed afterwards. Moreover,

the emerging dynamic and fast transactions as well as the new types of relationships challenge the current supply chain fields and activities, thus, the purchasing function. (Schmidt & Wagner 2019.)

5   Research Methods

In this chapter different research methods were discussed and described although not all of them were applied to this thesis. To begin with, it is wise to, firstly, define what a research is. According to Krishnaswami and Satyaprasad (2010, 2) "research is a systematic and logical study of an issue or problem or phenomenon through scientific method". The definition encompasses three important areas for delivering great results at the end. The first one is the adjectives systematic and logical, meaning that the steps through the study are not randomly chosen, but they have a coherent and organized order. The second aspect includes the words "issue or problem or phenomenon" that limit the scope of the study and the main topic which is being studied and targeted. The third area considers the scientific methodology which, in summary, is a set of basic rules, approaches, steps and techniques in order to objectively produce scientific knowledge.

As already described in the introduction, the study used blended approaches striving for utilizing the most suitable techniques when studying and analyzing the NPD purchasing process. The next following sub-chapters described general research methods and the ones which were applied.

5.1 Literature Review

According to Rowley & Slack (2004) a literature review has the following objectives but are not limited to them. The first one is contextualizing the research within a proper overview of up to date information regarding the field of study. The second one is composed by identifying the most relevant areas for increasing one's expertise and understanding of pertinent theory. The next objective includes assisting the creation of solid research's bibliography. Last but not least, a literature review leads to most suitable research methodologies, ways of analysis and comprehensive forms for presenting the results. Moreover, the collection of academic and professional sources has several options to be attained, such as books, study cases, thesis works

and academic/professional articles. Each of those has a more specific purpose when being examined and used as a source, it depends on the nature of the study and its target. The majorly usage of sources for this thesis was retrieved from books connected to related topics and professional/research articles in order to create a robust base for purchasing and business processes understanding as well as their current state of art.

As an initial brainstorm and organization of ideas, Rowley and Slack (2004) suggested the creation a mind map to, firstly, expand all the possible covered topics in a study. The framework establishes all the possible themes related to the studied topic, determining best searching terms, structure and relationships between them. Therefore, as a starting point, a thesis is the first step which contains all the necessary information to limit and structure the thesis.

Furthermore, in order to limit and enhance the background knowledge and expertise linked to closely bounded topics, three main topics were chosen for the literature basis. They were purchasing, business processes and world-class purchasing processes. They supported the comprehension of a wide range of related areas, creating a solid foundation for the NPD purchasing process analysis and the most appropriate suggestions for improvement and developments.

5.2   Qualitative and Quantitative Methods

Different types of research methods are categorized according to many divisions and subdivisions in the literature review. One of them is the difference between qualitative and quantitative methods. As the names self-explained, qualitative methods produce descriptive data which cannot be described with numbers while being depicted by opinions, beliefs, know-how and people's behaviors (Taylor, Bogdan & DeVault 2015, 5-6). According to Lancaster (2004, 66), the quantitative methods produce results which can be presented in a numerical, mathematical or graphical format. Naturally, quantitative methods are only applied to subjects that can be quantifiable and measured. In addition, due to its nature, quantitative methods are usually analyzed and treated by traditional statistical techniques. A summary of the main characteristics and differences between the qualitative and

quantitative methods as well as the most common methods are presented in Figure 26 below.

Characteristics	
Quantitative	**Qualitative**
• Focuses on testing theories and hypothesis • It is analyzed through math and statistical analysis • Mainly expressed in numbers, graphs and tables • Requires many respondents • Closed questions (multiple choice) • Key terms are: measurement, testing, objectivity, replicability • Methods of data collection: Surveys, Experiments, Observations, Content analysis	• Focuses on exploring ideas and formulating a theory or hypothesis • It Is analyzed by summarizing, categorizing and interpreting • Mainly expressed in words • Require few respondents • Open-ended questions • Key terms are: understanding, context, complexity, subjectivity • Methods of data collection: Interviews, Focus Groups, Ethnography, Case studies, Literature Review

Figure 26. Main characteristics of Quantitative and Qualitative methods. Adapted from Streekferk (2020).

The data produced by qualitative methods is analyzed by other means than mathematical approaches. Saunders, Lewis and Thornhill (2009, 485-498) described formats of analyzing the qualitative data. First of all, the transcription of the collected information, such as interview audios, should be done and it is usually transcribed into actual words within a document. Next, three methodologies are explained for grouping the data. They are summarizing, categorizing and structuring the data. Each of them is applied in the required level for the study's purpose. The Figure 27 below summarizes the meaning of these three methodologies and which aspects are affected by a qualitative analysis. The deductive and inductive aspects shown in Figure 27 are further described in the following subchapter.
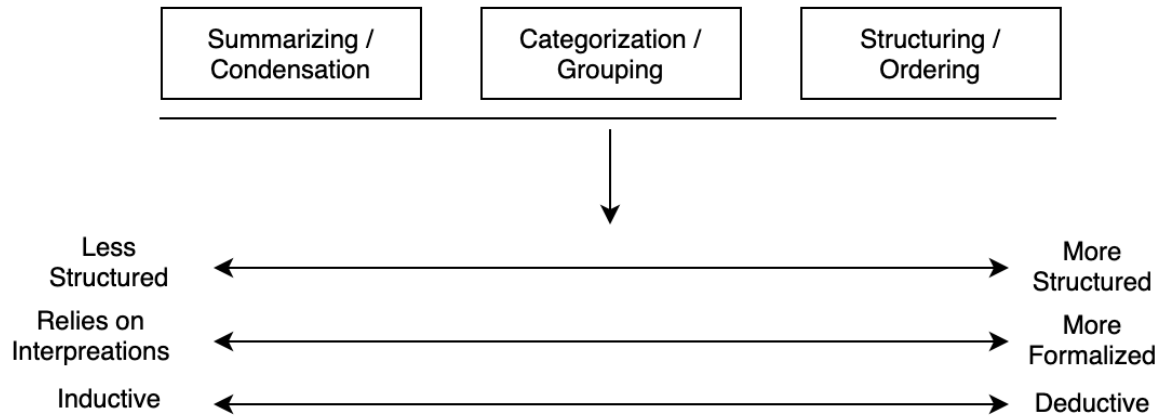
Figure 27. Three methodologies for analyzing qualitative data and their effects. Adapted from Saunders et al. (2009, 490-491).

5.3 Deductive and Inductive Methods

Taylor and others (2015, 6) state that a qualitative research naturally is an inductive work due to its own nature. Qualitative research deals with the construction of theories, principles and concepts rather than the verification and validation of theories and hypotheses. According to Saunders and coworkers (2009, 490), inductive methods do not start with a fixed framework of study. There is an analysis of relations between the factors and aspects from the collected data which provides ground for the creation of hypotheses and propositions which shall be verified afterwards. On the other hand, deductive methods work on the opposite direction of inductive ones. Lancaster (2004, 22-23) declares that deductive method is composed by a study framework which is the basis for developing hypotheses and theories that are either confirmed or denied with the final results. The hypothesis is translated into indicators and numbers which are either accepted or not by the empirical work of observing the real world. It is widely used in the scientific research. Figure 28 below presents the main characteristics of inductive and deductive methods.

Characteristics	
Inductive	**Deductive**
- When there is no or little literature on the subject - There is no theory for testing - First step: Observation - Second step: Define a pattern - Third step: Develop a theory - Conclusions cannot be proven but can be invalidated	- It starts with an existing theory - Verification of hypotheses and theories - It cannot be conducted if a theory does not exist yet - First step: Selecting suitable theory - Second step: Formulating a hypothesis based on the theory - Third step: Collecting pertinent data in order to test the hypothesis - Fourth step: Analyzing the data. Confirming or denying hypothesis. - Conclusions are only true if all the premises are true.

Figure 28. Main characteristics of Deductive and Inductive Methods. Adapted from Streekferk (2019).

Three concepts that are strictly related and important to both methods are the reliability, validity and generalizability. These concepts directly affect the quality of data used and produced during the study. Reliability relates to in which extension the results and data are going to be similar/equal when being measured and analyzed in different situations. Validity means in which extension the collected data is pertinent to the topic being studied. It means whether the measurements and data are correctly representing what they are supposed to describe. Lastly, generalizability is in which extension the collected data can be generalized for different conditions of measurements. Figure 29 below presents the most important questions that a researcher should ask when conducting either a deductive or inductive study concerning those three concepts. (Lancaster 2004, 72-73.)

Questions		
	Inductive	**Deductive**
Validity	Has the researcher gained full access to the knowledge and meanings of informants?	Does an instrument measure what it is supposed to measure?
Reliability	Will similar observations be made by different researchers on different occasions?	Will the measure yield the same results on different occasions? (assuming no real change in what is to be measured
Generalizability	How likely is it that ideas and theories generated in one setting will also apply in other settings?	What is the probability that patterns observed in a sample will also be present in the wider population from which the sample is drawn?

Figure 29. Questions made according to the type of research. Adapted from Lancaster (2004, 73).

5.4 Primary and Secondary Data

One of the main aspects when choosing the proper research methods of data collection is, firstly, defining the nature of the collected data. The distinction between primary and secondary data must be clear in order to apply the correct research methods. Therefore, it is wise to define these concepts. Primary data is the information which has not yet been collected previously and it does not exist anywhere else before it had been produced by the study in question. The secondary data is the sort of data which already exists nevertheless it was not yet used for the purpose in question. It is available data which exists in a different format than the required one. Figure 30 below presents a summary of examples of how to collect primary and secondary. (Lancaster 2004, 65-66; Krishnaswami and Satyaprasad 2010, 86-91.)

⊟ Primary Data collection	⊟ Secondary Data collection
Observation	Statistical Statements
Interviewing	Reports
Survey / Questionnaires	Inventory records
Experimentation	Online indexes
Projective Technique	Production Data
Simulation	Academic researches and books

Figure 30. Examples of how to collect primary and secondary data (ibid).

According to Krishnaswami and Satyaprasad (2010, 87-90) the secondary data mainly has three purposes. The first one is for referencing to gain a background knowledge on the topic. The second one aims the comparison between the research results/findings and similar data, such as local survey findings cross-checked with international numbers. Lastly, the secondary data can be the foundation of a study with a solid base using reliable data. On the other hand, primary data is collected according to the study needs and on the required format. The researcher has plenty of flexibility when conducting the process. This kind of data is used when either the needed data does not yet exist or the available data is, based on the study requirements, inaccurate, unsuitable and out of date.

The decision of utilizing which type of data during a research majorly depends on four factors based on the findings of Kothari (2004, 112-113). They are, firstly, the nature, scope and type of studied object. These aspects are limiting the study as well as defining the usage of either both types of data or only one of them. The second criteria included the available budget for the research. It dictates whether the research uses cheaper or more expensive research methods. The third decisive factor is the given schedule for delivering the results. Some approaches take longer than others to be finalized, analyzed and presented. The last aspect considers how accurate the results have to be. In order to have a better picture of primary and secondary data pros and cons and their best fitting, Figure 31 below presents a summary of their advantages and disadvantages.

	Advantages		Disadvantages	
	Primary data	**Secondary data**	**Primary data**	**Secondary data**
	• Data is collected according to needs • Flexible • Better data interpretation • Greater control • Proprietary issues are minimum	• Cheap and quick source of data • Expands the geographical and time aspects of the research • It enriches the data base which is used for scientific generalizations • Supports the findings of primary data results	• Expensive methods • Time consuming • There might be inaccurate feedbacks • A bigger number of resources is commonly needed	• It may not meet specific needs • It may not be as accurate as required • They can be out of date and obsolete due to the needed time for compiling and publishing them • Availability of sources may not be easily accessed by all

Figure 31. Advantages and Disadvantages of Primary and Secondary Data. Adapted from Saini (2015).

5.5   Interviewing

In order to create theory and concepts, one of the forms is to collect primary data by applying the qualitative method of interviewing people and, consequently, inducting a theory based on the analysis of the collected data. Saunders and others (2009, 320) define three important categories for determining the type of interview which should be conducted during a study. The different categories and their subcategories are presented in Figure 32 below.
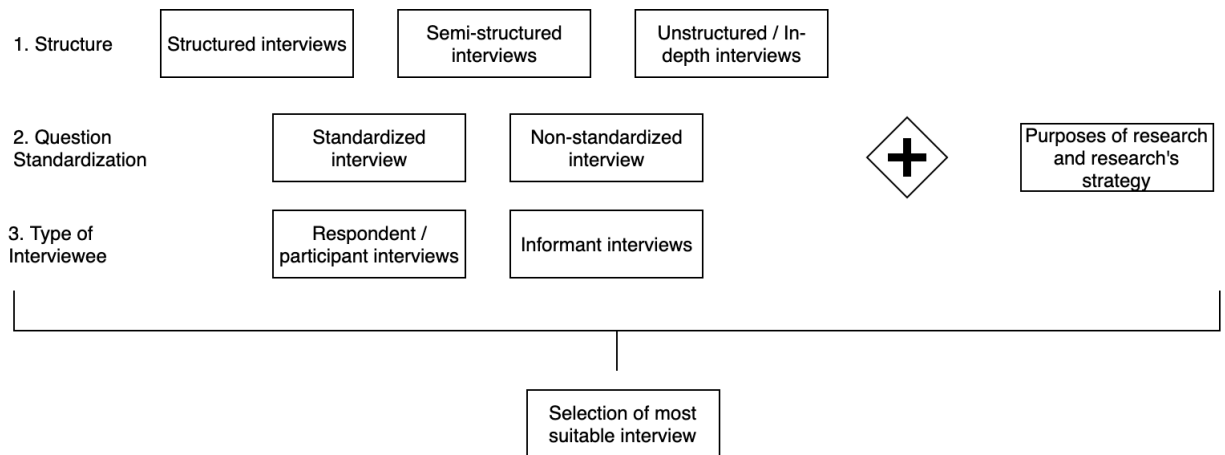
Figure 32. Defining the most suitable interview for a research. Adapted from Saunders et al. (2009, 320).

Structured interviews are very standardized, and they are conducted on the same format with every respondent. They have the same set of questions for all, namely standardized interview. It is mainly used for collecting quantifiable data with pre-determined answers which do not have variation on how they can be replied. By definition, the other two types are non-standardized interviews due to the greater amount of interaction between interviewer and interviewee. On one hand, the semi-structured interviews have an already set of questions and themes which are the main agenda although there might be variations and adaptations on the themes and queries depending on the interviewee and the course the interview takes. On the other hand, unstructured interviews are seen as a casual discussion and do not have a pre-determined set of questions. The only pre-defined aspect is the field which is intended to be studied. The interviewee leads the direction of the interview. Moreover, the informant interviews are the ones which have the interviewee conducting the interview's direction. The participant interviews work on the opposite way, in other words, they have the interviewer commanding the interview's direction. The interviewee answers according to the questions made by the interviewer. (Saunders et al. 2009, 320-321.)

Each one of the interview structures is more often applied to different types of research. The basic types of research are exploratory, descriptive and explanatory. Exploratory research deals with a deeper study regarding a certain phenomenon

which the researcher is not fully confident about its nature. Descriptive research is determining a precise pattern for an already known phenomenon with clear understanding of it. Explanatory research regards the study of relationships and connections between different phenomenon such as their cause-consequence relationships. Figure 33 below presents the relationship between the type of interview and their application frequency depending on the sort of research. (Saunders et al. 2009, 139-141.)

	Exploratory	Descriptive	Explanatory
Structured interviews		XX	X
Semi-structured interviews	X		XX
Unstructured / In-depth interviews	XX		

Figure 33. Type of research vs Interview Structure. Adapted from Saunders et al. (2009, 323).

5.6   Process Mapping

To begin with, it is suitable to define what mapping is. According to Borris (2012, xiii) mapping is "a range of techniques for analyzing the steps (or stages) in a process". As the own definition states, mapping is the application of approaches which have the objective of defining each step inside a process to have a deeper scrutiny of it. Once the process is properly mapped, bottlenecks and flaws can be clearly determined. With qualified professionals and suitable improvement processes, the problems can be mitigated leading to, for example, better efficiency and productivity. Ultimately, the goal is to achieve more profitability by either reducing unnecessary losses, for instance, time and resources, or increasing gains such as product quality or process efficiency.

Borris (2012, xvi) defines 5 basic steps to map a process. The first one is choosing the adequate technique to map the process. The best outcomes are achieved when the correct approach is used. The next step is finding every known issue and negative aspects related to the current process. The following phase is making a list out of those matters. The fourth step includes evaluating the impact of each problem on to company's results. The last stage is creating priorities in order to tackle the most important, feasible and urgent deficiencies based on available time and resources. A summary of the five steps can be seen in Figure 34 below.
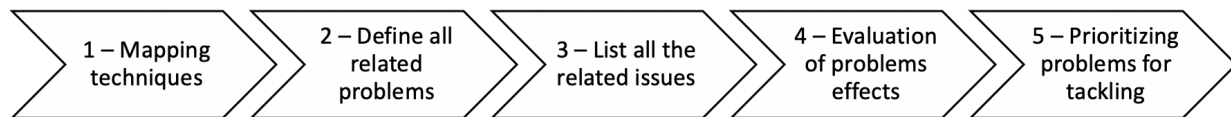
Figure 34. Basic Mapping Steps.

Exactly like an equipment, a process also needs to be regularly checked, reviewed and maintained in order to ensure maximum productivity. However, it does not mean that the company is producing profits only with a great process in place. Assuring the correct process execution and follow up by the "executing team" and stakeholders are essential. Therefore, the correct technique for mapping the process being studied and the cycle of continuous improvement and revision are indispensable for delivering the best throughput. (Borris 2012, 5-9.)

According to Phusavat (2010), the process management is crucial to achieve great results and, hence, establishing the best way of managing the process is fundamental. One of its key factors is performance measurement. From a top-down point of view, the measurement needs a robust definition, and the definition needs a fine understanding on the matter. Without a good foundation and alignment with company's goals, strategies and missions, the chosen performance measurements might lead to the wrong direction and produce deviations from optimal results. With those concepts in mind, four main outcomes from performance measurement are identified. The first one is reaching excellence in information sharing while being transparent and visible towards objectives. The next one is achieving consistency

with high standards of productivity. The third goal is keeping track of company's overall status on specific aspect. Ultimately, the last target is to ensure prime administration and accountability.

The first part of the mapping process is formed by two types of process mapping techniques. In accordance with Borris (2012, 32,52-53), the mapping starts with the whole process being divided into big steps and stages from beginning to end, namely "big picture mapping". It recognizes the key elements for executing the process in question and creating a workflow without much detail. Next, in order to divide the big picture map in smaller and more detailed steps, the creation of a more accurate and better described process flow is required which is called process map. At this stage, the workflow should be tailored and defined according to the needs and requirements for having a clear understanding of the process.

For the process map, Tuominen (2016, 39) stated that there should be 2 types of tracing. The first one is the physical flow of a product or the activity flow in case of a service. The second form of tracing is the information flow. Moreover, in order to be effective, three aspects should be taken into account while determining those flows mentioned above. The first one considers the added value activities which are performed during the process. They are the most important part for developing a value stream afterwards. The second factor is the definition of every iteration along the process. The third matter is describing the timeline and milestones based on the process executing, in other words, pointing out the optimal/planned and realistic aspects.

In order to execute the second and third steps of the process mapping technique in this research, a great deal of data from interviews was analyzed and underwent the SWOT and five whys analysis. They were used to continuously limit the research scope as well as finding the real causes of the process bottlenecks. The data collected from interviews was filtered and organized in a standard template created specifically for the study case. This valuable information was the basis for many stages of the thesis.

The SWOT analysis (strength, weaknesses, opportunities and threatens analysis) is a methodology which has been extensively used for strategic planning and

management process analysis, academic research, early stages of project/ business planning, company's organization as well as the current state analysis of business activities (Gürel & Tat 2017). It does not require much formality and plenty of its input comes from brainstorming, experience and general knowledge of the studied topic. In summary, the SWOT analysis can be characterized as a tool which evaluates topic's factors. Those factors are categorized in two dimensions divided into two categories each. They are internal aspects with strength and weaknesses as subcategories and external aspects with opportunities and threatens as subcategories. (Borris 2012, 50.)

Strengths are internal competences, capabilities and qualities which give competitive advantage over other similar situations, environments, processes or products. A strength is when a company has, for example, an excellent purchasing process flow and execution enhancing its productivity and results compared to other enterprises. Weaknesses are the internal flaws, drawbacks and bottlenecks which reduce the competitive advantage. A weakness is when a company possesses, for instance, up to date ERP (Enterprise Resource Planning) or PDM (Product Data Management) systems but the information flow is not well structured and described, thus, losing efficiency. Opportunities are the external circumstances and factors which are favorable for the growth, development and improvement of a topic. A opportunity can be when two countries, e.g., sign agreements facilitating the importing and exporting of goods, providing favorable conditions for companies to enter new markets and developing existing ones. Threatens are the external circumstances and factors which are not favorable, jeopardizing the potential growth, development and improvement of the topic such as stricter laws and regulations for product manufacturing. (Gürel & Tat 2017.)

In order to have a deeper understanding on the root causes of process bottlenecks and inefficiency, the "five whys" approach was also utilized as one of techniques. According to Boris (2012, 157-159), the aim of this technique is to reach the root cause of a problem inside a process. In many cases, the last effect of a problem is the visible consequence of a deeper flaw of a step inside the process. The approach is quite simple, yet it can turn into very positive insights for developing solutions and improvements. For one specific failure or problem, the continuously inquiry why that

had happened must be asked until the real source of the problem is obtained, in other words, what is causing the deviation from the correct course of action. The number of "whys" is not very relevant but the final objective which is finding the real problem.

When the bottlenecks are then recognized, they should be evaluated and analyzed. There are several forms of evaluating the negative aspects by, for example, qualitative or quantitative methods. Since the study was primarily based on qualitative data, the creation of an assessment criteria for qualitative research was the most natural course to be taken. Bitsch (2005) used an assessment criteria example for qualitative research namely the trustworthiness criteria. It has four dimensions for assessing the data, credibility, transferability, dependability and confirmability. Credibility is related to the internal validity meaning whether the data represents the reality of the topic in question or not. Transferability is connected to the aspects of generalizability and external validity which assesses in which extent the results and data can be transferred and applied to different environments, situations and/or conditions. Dependability is closely bonded to the concept of reliability meaning whether the data is replicable under similar conditions or not. Lastly, confirmability deals with the impartiality of researcher's opinions and beliefs. It is the assessment of whether the data, findings and conclusions suffered subjective interpretations or not. According to those concepts and the specific nuances of the process, the bottlenecks were evaluated as comprehensive and intelligible as possible.

Ultimately, the final step is to determine which hurdles are the priorities and what solutions fit best. There are several ways of finding solutions for issues in processes and they were mostly based on the know-how of experts and the revision of a pertinent literature. In addition, another form of finding the best and most suitable improvements and solutions for specific problems is benchmarking. Phusavat (2010) argues that benchmarking is a technique which facilitates the knowledge enhancement inside a company, more specifically in continuous improvement. However, in order to be properly conducted, the implementation plan and performance measurements should be carefully defined. The key steps for conducting the benchmarking appraise are limiting which process is to be improved,

planning, choosing enterprises to be benchmarked, selecting the most suitable performance measurements, analysis, identification of most valuable practices and finally the implementation inside the company.

5.7   Process Failure Mode and Effect Analysis (PFMEA)

According to Stamatis (2003, 21) the Process Failure Mode and Effect Analysis, also abbreviated by PFMEA, is one of the four types of FMEAs. The other three are System FMEA, Design FMEA and Service FMEA. Therefore, it is wise to define the common denominator between them namely FMEA. Omdahl (1988) and ASQC (1983) defined

> *A failure mode and effect analysis (FMEA) is an engineering technique used to define, identify, and eliminate known and/or potential failures, problems, errors, and so on from the system, design, process, and/or service before they reach the customer.*

As the definition clearly describes, the main goal of a FMEA is to recognize where the flaws are in any of the four types of areas and, consequently, address the problems as best as possible. When the FMEA is properly planned and conducted, it provides four results. The first one is the identification of existing and potential problems. The next result includes recognizing one step further and one backwards related to the issue, i.e., the causes and effects of the problem. The following outcome is the correct prioritization of problems based on the risk-priority number (RPN) which considers the factors of severity, occurrence and detection for each of the failures. The last result is providing corrective actions with suitable forms of tracking whether they are effective or not. There are mainly two ways of defining the failures. They are identified by either historical data and information or inferences based on modelling, simulation and any other mathematical/engineering tool. Therefore, the failures are either known because they had already happened before or due to the existence of a probability of happening. (Stamatis 2003, 21-22.)

The RPN number is the concept used while conducting a FMEA technique to give a rank for failures. It takes into account the severity (S) number which quantifies the negative effect in case the failure occurs. The next consideration is the occurrence (O) number that quantifies how frequent the failure occurs. The last considered

factor is the detection (D) number which quantifies how easy the failure is detected when happening. There is no correct or wrong scale which is used during the technique although usual scales are from one to five or from one to ten. There are different ways of obtaining these RPN numbers and a summary of approaches for the PFMEA are seen in Figure 35 below according to the available data.

If	Then use	Select
The process is under statistical process control (SPC)	Statistical data: reliability data, process capability, actual distribution, mathematical modeling, simulation	Actual data or Cpk
The process is similar to others or historical data exist	Statistical data from either historical or surrogate systems: reliability data, process capability, actual distribution, mathematical modeling, simulation	Actual data or Cpk
Failure history is available with the design itself or similar, or surrogate parts	Historical data based on reliability, process, actual distributions, mathematical modeling, simulation, cumulative data, and/or fraction defectives	Actual data and/or cumulative number of failures
The process is new and/or no quantification for any data is available	Team judgment	Subjective Criteria. Use team consensus and be conservative

Figure 35. Criteria for choosing data and data collection methodology for RPN number in PFMEA. Adapted from Stamatis (2003, 33.)

The types of FMEA follows a standard, chronological and logical implementation which provides a good foundation for its proper conduction and delivery of results. A summary of its steps can be seen in Figure 36 below.
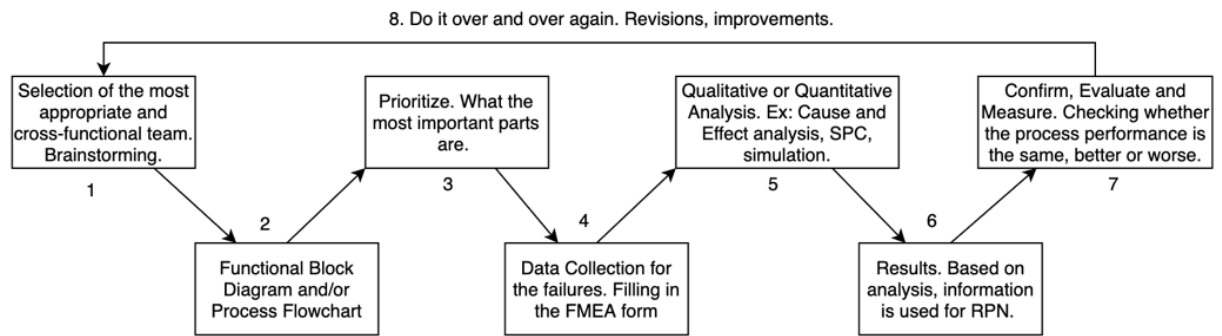
Figure 36. Implementation of FMEA. Adapted from Stamatis (2003, 36-38).

According to Stamatis (2003, 29), each specific application of the FMEA technique should be tackled based on its needs and requirements. However, there is a general approach for defining the columns in a FMEA form. They are the process/design/system/service in question, its description if necessary, potential failure mode, potential failure effect, potential cause, detection method, RPN number derived from the severity, occurrence and detection numbers, recommended action, responsible, deadline, action results and the form of tracking improvement results.

6 The Case Study

This chapter presents the environment and aspects involved during the present study of the purchasing process in question. A more detailed description of the company is given and the factors which influenced the process itself are explained in the following paragraphs.

First of all, company X's suppliers are spread worldwide as well as its customers. Therefore, the purchasing processes themselves already deal with a high degree of complexity. For the specific process in question, which is the NPD purchasing process for the new company's projects, the level of complexity increases due to the involvement of many stakeholders and both internal and external factors. The main stakeholders during the process in question are the suppliers, the company's top-management, the operational purchasing team and the internal departments of Purchasing, Quality, Material planning, Research and Development (R&D) and Manufacturing engineering. The main internal factors which influenced the decisions

were identified as the commodity/sourcing strategies, the systems utilized as well as the required procedures needed for completing the mandatory activities during the process. The main external factors were recognized as the governmental law and regulations, availability of parts as well as the involved elements during the delivery of components.

In order to form a better picture of the stakeholders and factors above, it is wise to briefly describe the roles of each of them. Starting from the stakeholders, the suppliers are critical for the project's success. Without the support and partnership with suppliers, especially for the early supplier involvement, the NPD process does not achieve the desired result. The company's top-management sets high-level directions for aspects such as commodity and sourcing strategies. Besides, it also shares the sourcing responsibility with purchasing for the parts whose costs are over a certain defined limit. The operational purchasing team is placed in a different physical location than the factory itself and handles the tasks and activities which are not considered strategic. The Purchasing Department is engaged in the process from very early stages until handing over the parts to the Material planning department. The Purchasing process starts with the early purchasing involvement with active communication and exchanges with the R&D through the whole process, and ultimately, "prepares the ground" for Material Planning to take over the responsibility. The Quality department deals with the steps that need quality assurance procedures as well as reviews for the parts in question. These procedures include, for example, the final part approval, namely PPAP (Production Part Approval Process), which is needed for serial parts, and it is made by the Quality Department. In other words, all the PPAP documentation must be correct, finalized and approved.

The Material Planning department enters the process at the later stages, when the supplier is awarded a specific part and when Purchasing reports to Material Planning the required information about the supplier. Next, Material Planning handles the internal procedures for preparing and ensuring the supplier capabilities of serial production. The R&D Department is crucial for the development and continuity of the process and its success. The R&D personnel designs and modifies the parts according to stakeholder inputs, market tendencies and new technologies. Lastly, the Manufacturing Engineering Department is the bridge between the R&D Department

and the other internal functions. It, firstly, receives the raw information from R&D through the PDM (Product Data Management) system. Next, it realizes the "make or buy" decisions. Once they are decided, the relevant information is uploaded into the system for the other stakeholders to continue the process.

The factors were divided into internal and external ones. Beginning with the internal factors, there are the sourcing and commodity strategies. They drive the choices and decisions regarding the preferred suppliers, which types of relationships are to be pursued and how the supplier base is to be managed. Currently, the supplier base management has its reduction as a goal. The second factor is the systems in use. They are a critical part for the seamless flow of information and process execution. Company X uses up-to-date systems for PDM, ERP (Enterprise Resource Planning) and it is currently developing improvements in the project management tool for NPD. Furthermore, the Microsoft Excel software is used amongst stakeholders as a support tool. For the tasks which need to be executed and followed during the NPD process activities, for most of the time, there is a standard or already existing policy of how to handle usual tasks. However, the usage of standards is neither suitable nor exits for many situations during the NPD process. As stated above, it is a very complex process which often requires solutions which do not yet exist. Thus, purchasers regularly need to handle unforeseen and demanding situations.

Regarding the external factors, there are the laws, regulations and directives which affect the part designs and developments. Even though they are visible many years in advance, they might cause constraints and issues during the projects if not handled properly. The second factor is the availability of parts. The parts were divided into two different sorts of components: the complex and simple ones. The complex ones need a great deal of effort from the interaction between purchasing, R&D and the supplier in order to deliver a good outcome. Specialized knowledge and engineering expertise are needed for those parts. The simpler ones are chosen according to the catalogues and global standards. Therefore, their availability, in theory, is much higher and the parts are easier to be obtained. Lastly, the deliveries must be strictly done on time for complying and achieving the schedules set at the beginning of the projects. Hence, the company strives for mitigating all the elements which may

negatively affect the delivery and compromise the targeted schedules. A summary of the above is presented below in Figure 37.
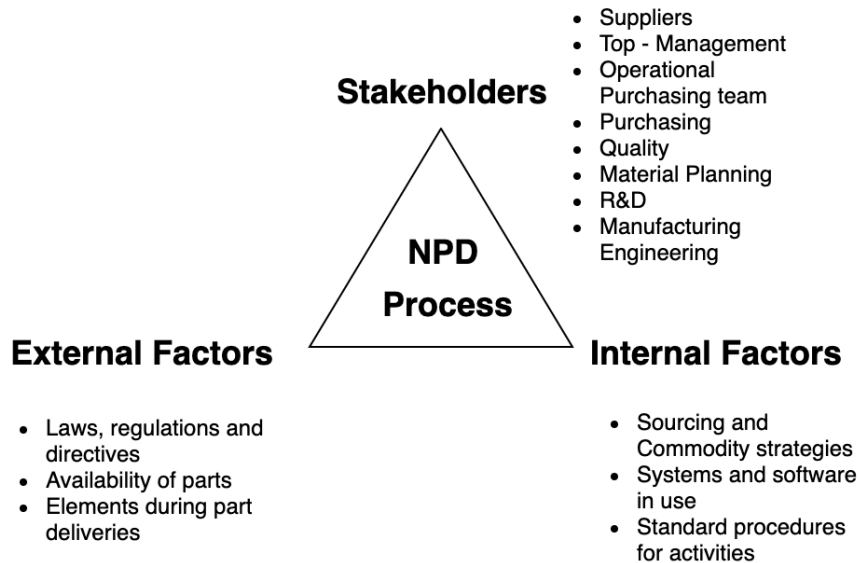
Figure 37. Main Stakeholders & Internal and External factors influencing the NPD process in question.

7   Research Implementation

The aim of this chapter is to discuss how the whole research process was done, its milestones, considerations, reasonings and how the studied methodologies were put into practice. This chapter emphasizes the practical process which the research was based on.

As there was a tight time schedule for completing the present study, many steps were made in parallel with each other in order to optimize time and resources. First of all, some material regarding the NPD process was provided by the company in order to understand the overall picture of the complex process in question. It was studied and analyzed. At the same time, academic research on the topic was conducted. With these as a starting point, a meeting was arranged to discuss the possible and suitable directions, procedures and potential outcomes of the thesis. With a big picture of the entire scope of the thesis, the three research questions were made. As already explained above, the first research question was answered by

a detailed literature review on the pertinent topics. The second research question was answered by interviewing employees from company X and applying different methodologies for treating the data. Both questions were completed at the same time. When both research questions were answered, the answer to the third question was found in the combination of the two previous answers.

Shortly explaining how the second research question was answered, it started with the creation of a semi-structured interview for three different types of target groups, suppliers, purchasing employees and employees from other departments. The questions were based on the studied material, the previous purchasing knowledge as well as the information shared by the company's employees. After being created, they were approved by the NPD manager. The already-made interviews were transcribed on a standard template at the same time as the other interviews were being conducted. Once they were all transcribed, they were all compiled into one single file. The file was divided into three categories (positive aspects, negative aspects and suggestions/recommendations) and subdivided into the main relevant topics. An online meeting was arranged based on that file in order to create priorities for the improvement and development of the NPD process.

Two more courses of action were taken in order to ensure the best outcome from the present study with the same collected and studied data. One of them was the creation of a process map for the NPD purchasing process. Even though it was a very complex process which encompassed several different areas of activities, the main common steps and core process were identified and plotted. Next, the research methodology PFMEA was applied to the process map. The second course of action was a quantitative analysis of the interview results in order to give a good basis for comparison with the other two developed methodologies. At the end, the most feasible and suitable suggestions were made for improving the current NPD purchasing process according to the literature review and the collected and analyzed data. A summary can be seen in Figure 38 below.
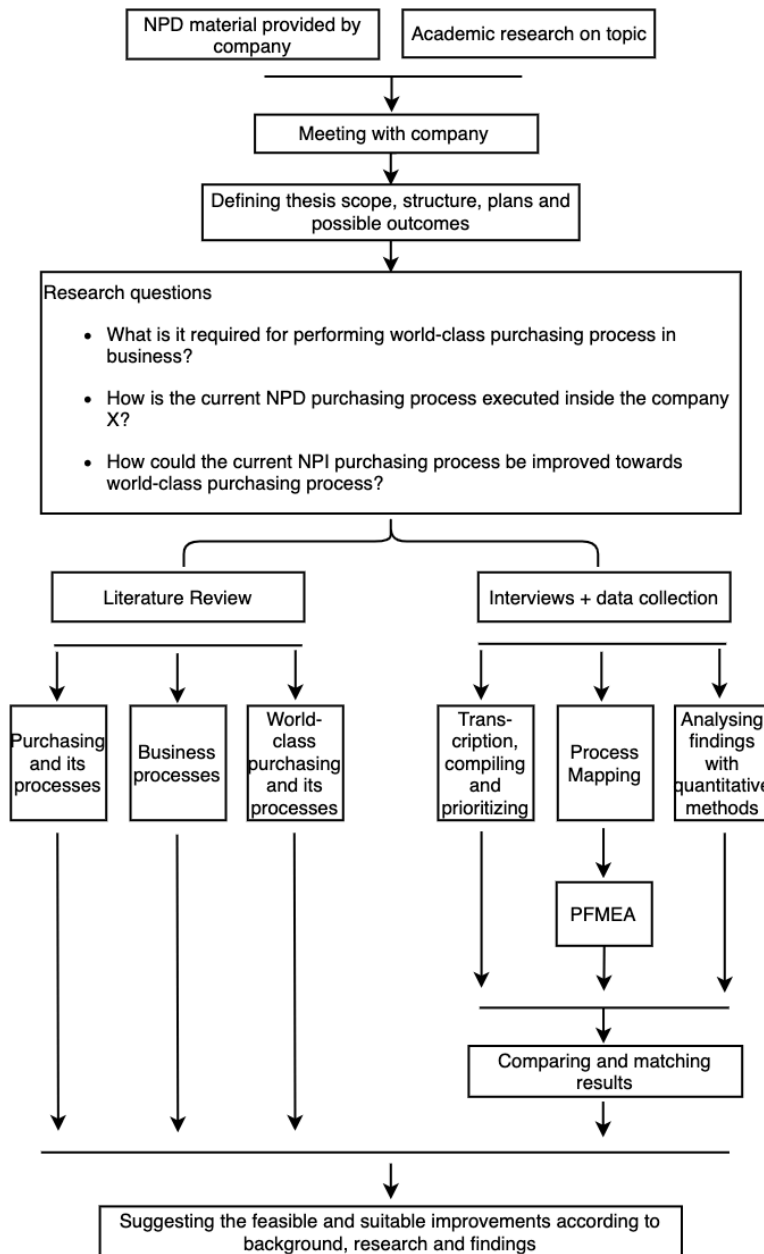
Figure 38. Summary of research implementation.

A few comments about Figure 28 ought to be made. Since there was handling of sensible information related to important internal aspects during the study, a confidentiality agreement was signed regarding certain data and material. For this reason, necessary changes were made on some information, and some material was excluded from the public version of the thesis. However, the non-disclosure agreement did not jeopardize the understanding and quality of the study because the processes and final development proposals did not suffer any changes in their concepts.

8 Results

8.1 Qualitative Approach to the Interview Results

The aim of conducting the interviews was to collect data and information concerning how the NPD process was executed at company X. As already briefly explained, semi-structured interviews were created as basis for interviewing the three different target groups. The questions were based on the information given by the company's employees, the first meeting inputs, the material given by the company and research on purchasing. The three different standard interviews can be seen in Appendix 1. In Appendix 1, there is one abbreviation (VSB) which was not previously described. It stands for the process that components with costs higher than a certain limit need to undergo. All the interviewees had either considerable or high expertise in the purchasing field. However, there was quite a difference between their periods of employment in company X. The interviews were made between the 5th of February and 25th of February of 2020. A summary of the interviews can be seen in Table 5. Moreover, Table 5 includes two of the meetings with the NPD manager which were fundamental for moving the thesis in the correct direction. The column "relatively new at the company" means whether the period of employment is no longer than two and a half years. Ultimately, even though rapport was built with the interviewees, the interviews were conducted in order to strive for impartiality and extracting the maximum of valuable information from the interviewees. The NPD process was always the focus in the interviews although different issues appeared while conducting them, such as the purchasing processes for serial production.

Table 5. Interview summary.

Interview number	Interviewee Role	Duration (min)	Type of Interview	Relatively New at the company
1	Purchaser	55	Purchasing Interview	Yes
2	Purchaser	110	Purchasing Interview	No
3	Purchaser	60	Purchasing Interview	Yes
4	Purchaser	70	Purchasing Interview	No
5	Purchaser	90	Purchasing Interview	No
6	Purchasing Manager	60	Purchasing Interview	No
7	Purchaser	70	Purchasing Interview	Yes
8	Purchaser	90	Purchasing Interview	Yes
9	Purchaser	50	Purchasing Interview	Yes
10	Purchaser	60	Purchasing Interview	No
11	SCA Manager	30	Other function Interview	No
12	Material Planning Manager	50	Other function Interview	Yes
13	Project Leader (core team)	45	Other function Interview	No
14	Manufacturing Engineering (Core team)	65	Other function Interview	No
15	NPD employees	90	-	Yes and No
16	Quality Manager	55	Other function Interview	No
17	Supplier	45	Supplier Interview	No
18	NPD employees	110	-	Yes and No

Average (min)	66,94
Average (hours)	1,12
Total (min)	1205,00
Total (hours)	20,08

All the audios of the interviews were recorded with the interviewees' authorization. Next, the audios were analyzed and transcribed into a standard template. The template had ten mandatory categories. They were crucial parts, key suggestions and comments, future expectations, early engineering/supplier involvement (before official release), NPD process, performed activities, Budapest team, templates / charts / excels, improvements and suggestions, and lastly, general comments. The categories crucial parts and general comments might be difficult to understand. Therefore, it is wise to briefly explain them. Crucial parts are the aspects and factors which have the ultimate importance for delivering a great result in the NPD process. General comments encompass the topics which do not properly fit in any of the other categories but are important for a better understanding of the entire process. Logically, since there were sixteen interviews, sixteen similar files were created. They varied from seven to thirteen pages of information. A summary of the template content can be seen in Figure 39 below.
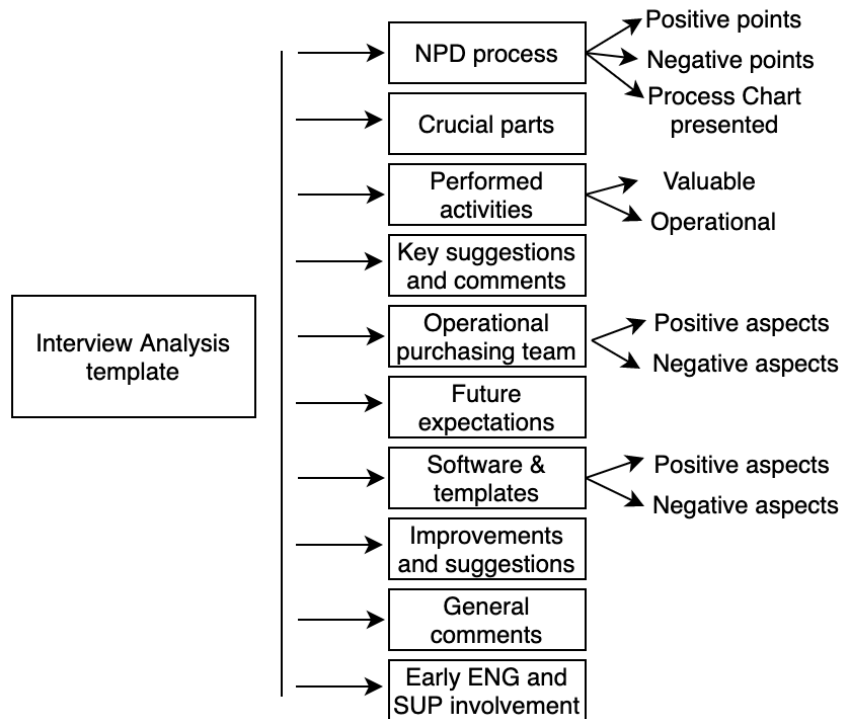
Figure 39. Summary of categories for the interview analysis template.

Next, a compiled document was created from the sixteen interview files. It had sixteen pages of information. Since it was a qualitative analysis, naturally, the repeated themes and findings were counted only once. Considering the main thesis topic which was suggesting improvements and developments for the NPD process, the categorization and organization of the compiled file followed a slightly different way than the interview analysis. The focus was on the best ways of identifying and mapping the current process as well as finding its bottlenecks and flaws. Hence, three main topics were recognized. They were positive aspects, negative aspects and ideas. Subtopics were created according to involved aspects in the NPD process inside each of the three main topics. Inside the negative aspects there were: "during the early stages of the NPD process", "during the process itself", systems / excel / templates, operational purchasing team and other topics. The positive aspects were divided into more specific subtopics because there were not as many of them and because they were not as extensively discussed as the other two main topics. The last main topic was ideas and suggestions. It had the following subtopics: meetings, communication, systems & software & templates, instructions / guidelines / process itself, operational purchasing team, time constraints, other specific topics and

observations. A summary of the compiled file content can be seen in Figure 40 below.
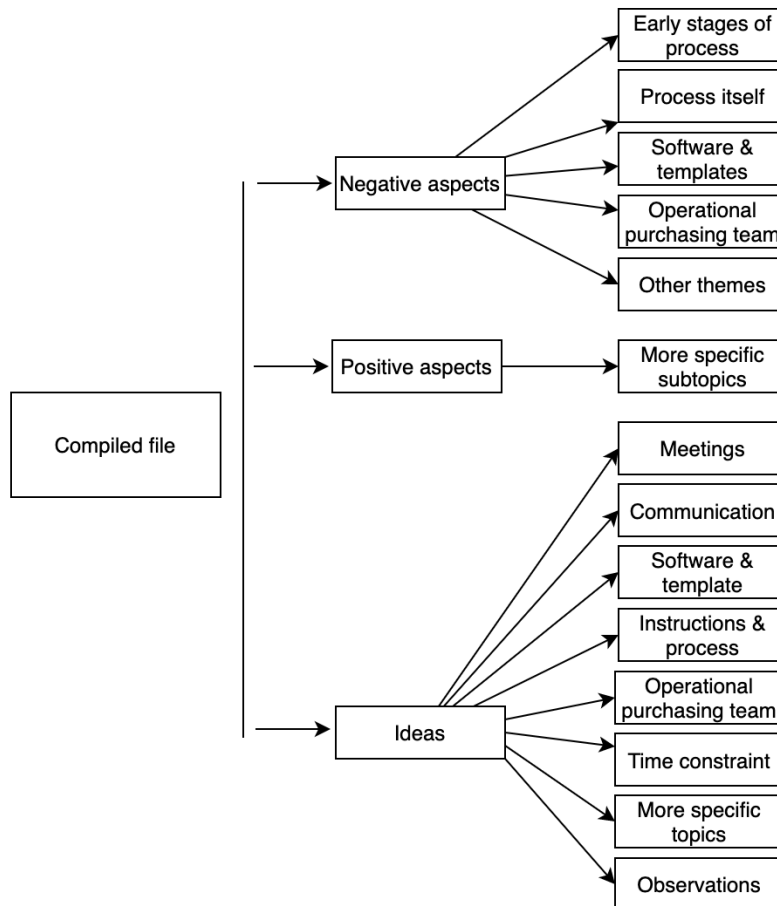
Figure 40. Summary of the categories from the compiled file.

After carefully studying the compiled file, general categories were created in order to organize the findings and, consequently, construct priorities. There were eleven categories. They were the operational purchasing team, VSB, systems, time constraints, R&D, team management / alignment, communication, meetings, early stages of the process, instruction / guidelines / templates and lastly, other topics. The priorities were created according to the available time for implementation, the feasibility of the possible solutions and the company's priorities. In light of that, firstly, the area of systems was not included in the priorities since a great amount of time, knowledge and cross-functional effort must be considered in order to make significant changes and improvements. Moreover, developments in the systems

were already being implemented inside the company. However, the identification of system flaws and restrains was made because it was important for the company to obtain that kind of information.

Next, the categories were revised for creating the priorities. One of the most widely discussed topics during the interviews was the time constraint. It involves several aspects and stakeholders during the whole process, and it is key for delivering great results. Thus, it was chosen as the first priority. The second priority took into account communication, reporting and the structure of the meetings during the NPD process. All the elements involved in the communication area were essential as pointed out in the literature review chapters. The third and last priority embraced team alignment matters. They were the VSB process, the commodity and team alignment. A summary of the priorities can be seen in Figure 41 below.
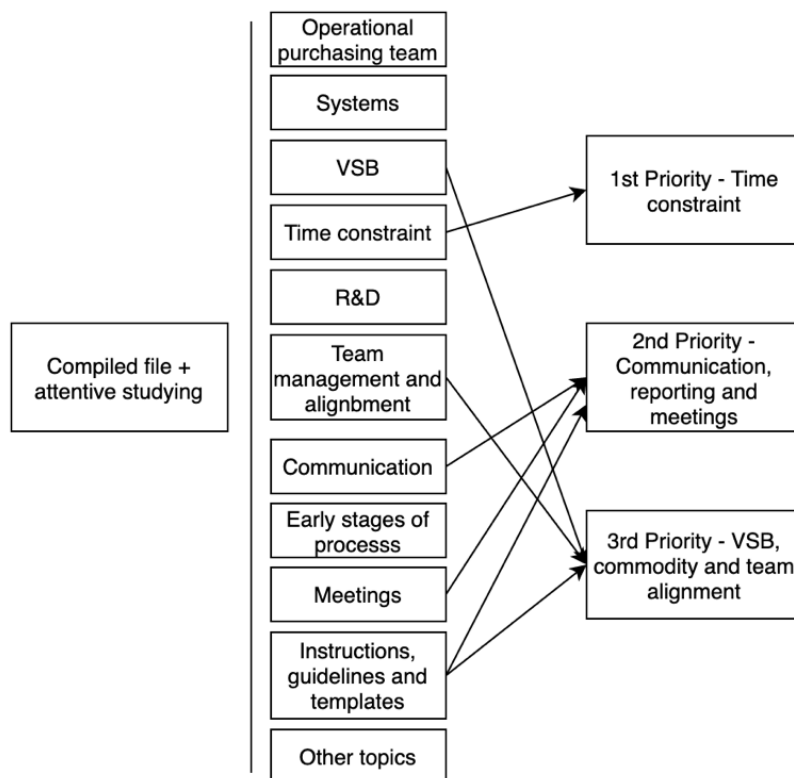
Figure 41. Summary of priorities.

In order to create concrete means of building, analyzing and implementing the priorities, a standard template for the three of them was tailored. Consequently, there were three final documents, each of them including one priority. The document had nine chapters. They were introduction, description, possible causes, recommended actions, benefits, risks, implementation, tracking results and summary. Those chapters aimed to bring the entire big picture of the interview analysis regarding the chosen priorities. A summary of the priority chapters can be seen in Figure 42 below.
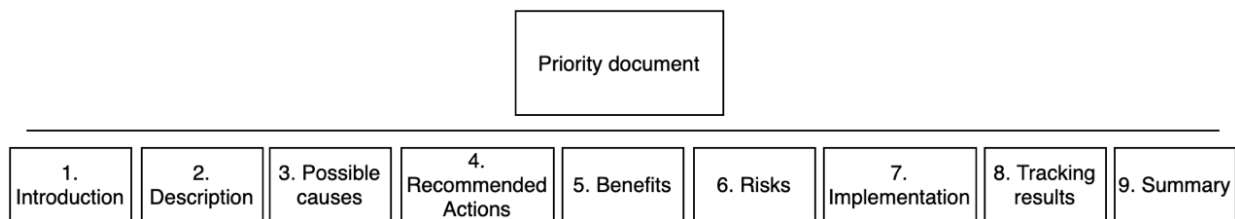
Figure 42. Summary of the content inside the document for priorities.

Although all the elements presented in the document were important for the prioritization, the most relevant ones for understanding the priority big picture were the description, possible causes and recommended actions. A summary for the three topics for each of the priorities can be seen in Figure 43 below.

|	Description	Possible Causes	Recommended Actions
First Priority - Time constraint	- Not enough time to properly execute the valuable activities in the process. Especially with suppliers and R&D - Not able to complete the project in the given time schedule - In some cases, not enough time to make quality and good designs	- Problems with the design releases and/or R&D matters - Not enough resources (for example human resources) - System constraints - Duplicated work between operational and strategic purchasing teams - Not respecting the needed time for properly completing activities	- Delegating more and more all the non-adding value tasks to the operational purchasing team - Developments inside R&D department - Learning from the past projects (time frames, possible risks) - Creation of clear, structured and standard path of work in NPD for different roles
Second Priority - Communication, Reporting and Meetings	- Nonstandard way of handling some tasks and activities related to, but not limited to, information flow - Information mismatch between internal and external stakeholders - Departments are working very independently towards their own targets. No real synergy between them - Uncommon issues appearing during NPD process from R&D side	- Not being aware or willing to use the already existing standard reporting, communication instructions - Not being aware of where to find the needed or most correct information, instructions and guidelines when available - Lack of clear/missing instructions, guidelines and standards for some situations and cases	- Creating and/or improving the internal meetings of PUR and between functions - Developing not only the vertical communication inside the company but also the horizontal level - Defining best channel and format for exchanging information about the "informal" work
Third Priority - VSB, Commodity and Team Alignment	- Discrepancy in the VSB process understanding and alignment - In some commodities, the commodity and sourcing strategy is not clear - Team management issues such as prioritization of tasks, following standards and processes (if available), reporting structures	- Lack of rapport and knowledge between stakeholders - Lack of training in some areas or potential efficiency enhancement - Lack of awareness or willing to use regarding existing patterns, standards and processes - Some commodity strategies are not well defined for the correct period of time	- Refreshing/Updating VSB process for buyers - Encourage active attitude and communication between team members and other involved people - Training in areas which there might be potential increase of efficiency or lack of a good understanding -The commodity strategy must be better aligned in order to avoid the waste of available and productive working hours with daily discussions of the same topics

Figure 43. Summary of description, possible causes and recommended actions for priorities.

8.2 Quantitative Results of Interview Findings

A quantitative form of analyzing the interviews was realized as already previously mentioned. The quantitative analysis of the interviews was conducted by dividing the findings into the same general eleven areas used in the qualitative analysis shown in Figure 41. The description of a full idea, notion or concept inside one category derived from the interview analysis document was considered as one finding. Naturally, one finding could include more than only one category. Hence, the findings did not necessarily have to fit in only one category. One single finding could be added in three different categories at most. Furthermore, since the focus was on finding the constraints and bottlenecks in the process, only the findings related to negative,

crucial and expected matters were taken into account for the quantitative analysis. The positive aspects and improvement suggestions were not considered for the quantitative analysis. In addition to it, all the repeated findings from different interviews were counted for the quantitative analysis. The results from the quantitative analysis can be seen in Figure 44 below.
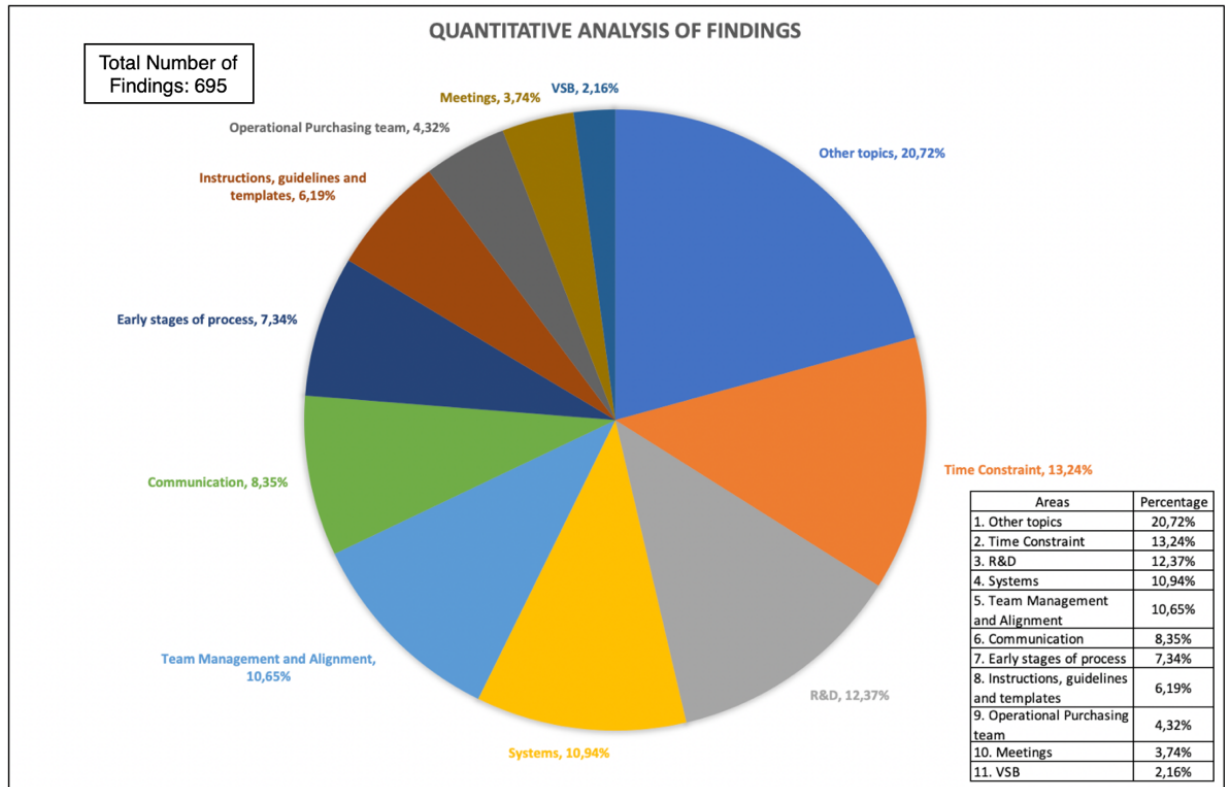
Figure 44. Graph with the results of the quantitative analysis.

There was a total of 695 findings according to the given definition on the previous paragraph. The largest category was "Other topics" with 20,72% out of the 695 findings. It included subjects related to supplier matters, workload division, different types of commodities, measuring performance/project follow up, external factors, new technologies and market advancements, costs, other internal functions, and "others". Among the topics inside "Other topics", the largest categories were supplier matters (41%), measuring performance/project follow up (12,5%) and costs (10,5%). Continuing the main categories, the order, respectively from largest to smallest, was Time Constraints (13,24%), R&D (12,37%), Systems (10,94%), Team

Management and Alignment (10,65%), Communication (8,35%), Early Stages of Process (7,34%), Instructions, Guidelines and Templates (6,19%), Operational Purchasing team (4,32%), Meetings (3,74%) and VSB (2,16%).

8.3 Process Mapping and PFMEA

First of all, a very basic process map was created before conducting any of the interviews in order to better understand the process nuances. The same process map was used during all the interviews so as to improve the information collection and it gave the possibility for interviewees to emphasize which stages and transitions were the most crucial and problematic ones. There was one question specifically about the chart presented during the interviews and the question can be seen in Appendix 1. The first and very basic process chart can be seen in Appendix 2. The first process chart had nine steps and other factors for describing and collecting information regarding the whole NPD purchasing process.

After all the data and information was collected, the process of producing a more accurate process map started. However, based on the research and acquired knowledge from the interviews, the need of dividing the components into different types was identified. Therefore, the need of creating different process charts for each of the three types of components was also recognized. Three different process charts were constructed according to each of the different sorts of components and their own peculiarities and logical order.

The three different process charts can be seen in Appendix 3. The different types of parts are discussed in more detail in the next subchapter 8.4. The process chart for the category of complex parts 1 have a total of thirty-eight steps starting from the beginning of a new project until purchasing hands over the responsibility of the part supply to the material planning department. The other two process charts have the same beginning and end although the order, need and chronology of activities vary according to the component peculiarities. The chart for the category of complex parts 2 have a total of thirty-five steps. The chart for the category of simple parts have a total of thirty-one steps. Inside of the three process charts there are very similar/equal steps, therefore, those ones were coded with the same main task number differing in their sub numbering. They were treated as the same in the

PFMEA analysis. The information and data used for creating the process charts were collected from the interviews, the shared information during the time spent at the company and from any doubt regarding how the process is executed. The doubts were answered by asking the company's employees.

Although the three process charts were created in order to identify the different orders and chronology of different types of parts, the performed activities and steps were quite similar between them. Thus, the PFMEA analysis was made only for the complex parts 1 and its results could be easily transferred and applied to the other two categories. Everything that was negative in the process or not seen as standard was considered as failure even though failure might not be the best concept for defining the aspects which do not fit in standards. Moreover, general activities which do not fit in a specific step along the process can be seen in the process charts in the Appendix 3. Those activities happened in several stages of the process, therefore, they were treated as general activities and adapted for undergoing the PFMEA analysis as well. Sixty-nine failure modes were identified in the PFMEA. Each of them had a failure effect and a failure cause. The PFMEA can be seen in the Appendix 4.

8.4   Other Results

Other results besides the already expected ones were identified after the interview analyses. One of them, as previously pointed out, was the division of the purchased parts into three different categories. The categories were complex and simple parts in which complex parts were divided into other two subcategories. The simple parts are considered as the catalogue parts, with high availability in the market and which do not require a great amount of R&D department's work and effort for designing/selecting. The two subcategories for complex parts were complex parts regarding design, quality or tooling and complex parts which are developed and designed by strategic suppliers according to the company's specifications and needs. For all of the different categories, the process of supplier awarding can be done by two different ways. One of them was the VSB process which takes into account management's and other stakeholder's opinions when selecting the supplier for a component which expenses are higher than a certain limit. On the other hand, when the part is not very expensive, the decision is made by the purchaser based on

his/her expertise and commodity and sourcing strategies. A summary of the categories of purchased parts can be seen in Figure 45 below.
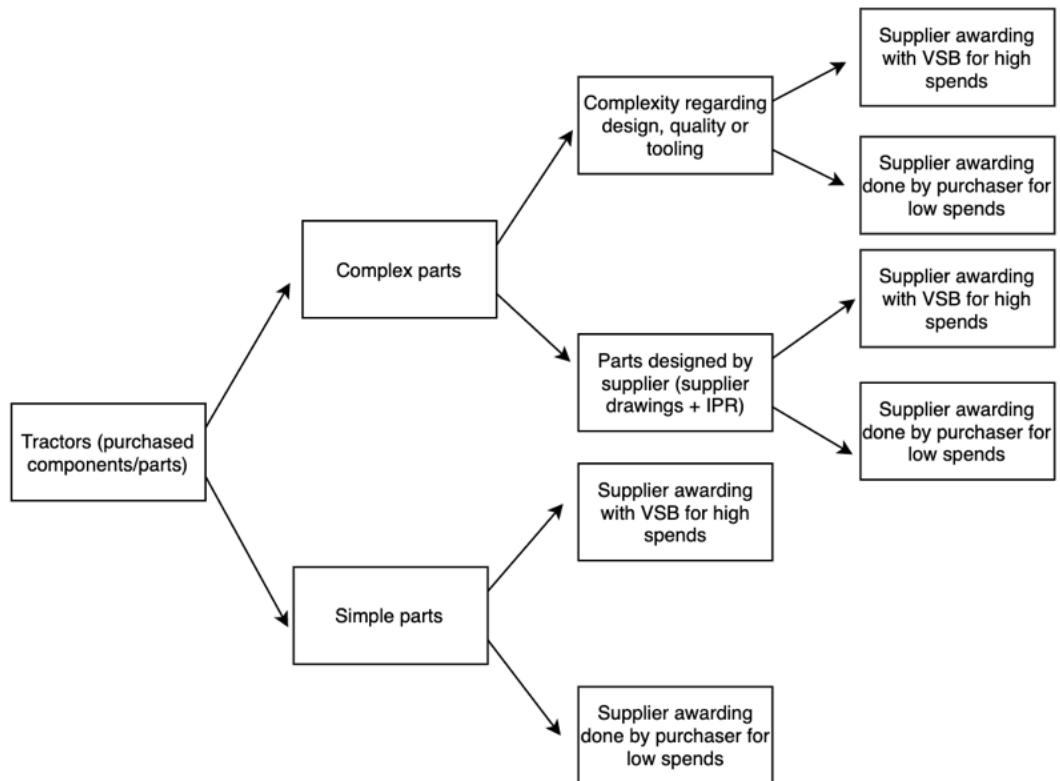
Figure 45. Categories of purchased parts.

There are several commodities regarding the direct purchases, and they are spread among eleven different buyers. Thus, in many cases purchasers have more than one commodity to handle. Each commodity has its own balance between complex and simple parts but some of them can be definitely categorized as either complex or simple commodity. Commodities such as metal castings and plastics are examples of complex commodities since the great majority of their parts are complex in one of the factors previously described. Metal casting commodity is complex due to its tooling and design whereas plastic commodity complexity is ascertained by its demanding quality aspect. Commodities like fasteners and bearings are simpler ones which do not require a great deal of R&D for their designing. There already exist many different global standards for them and they are often selected according to those standards and company's needs.

As previously explained in Chapter 8.3, the NPD purchasing process followed different courses of actions for different types of parts/commodities. Therefore, the creation of three different process charts was needed in order to better define the NPD purchasing process for each type of part. Based on the categorizations of the parts, a summary for the NPD purchasing process according to the sort of part is shown in Figure 46 below.
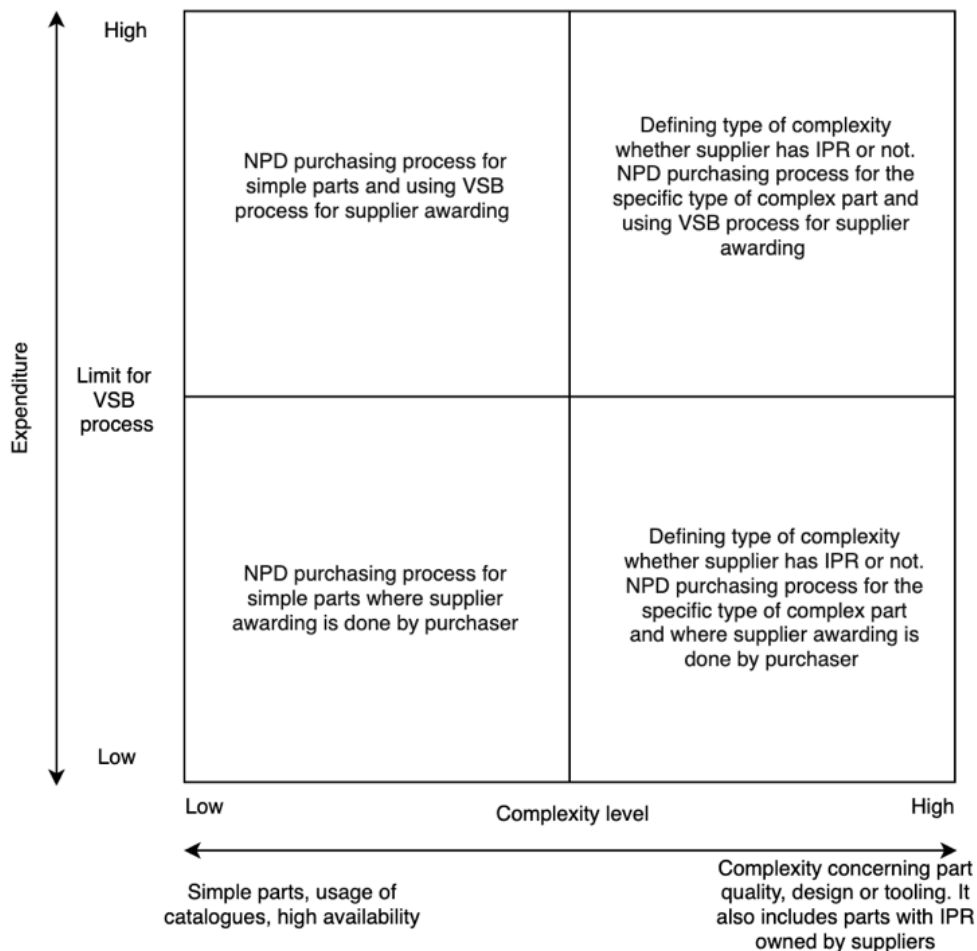
Figure 46. NPD purchasing process according to the different types of parts.

The Figure 46 clearly shows one of the flaws which was debated with NPD employees when comparing the two different types of parts regarding their costs. The lack of visibility and transparency for the low spend parts during the purchasing process was identified. While the expensive parts need to undergo the VSB process giving

visibility and sharing responsibility among stakeholders, cheap parts do not have any sort of process for enhancing transparency.

Another result from the interview analyses was the creation of a SWOT analysis. The SWOT analysis was previously described in the literature review and, consequently, do not need further explanation. It aided the creation and selection of the most suitable and feasible suggestions for the bottlenecks of the NPD purchasing process. It supported aiming at the negative aspects which had the best chances of undergoing modifications with a good balance between needed resources and achievable results while reinforcing the process' strengths. The SWOT analysis can be seen in Figure 47 below.

| SWOT Analysis			
Strenghts	Weaknesses	Opportunities	Threatens
• VSB gives a good foundation for decisions and visibility • There is already a good level of communication between departments • There are flowcharts, tables to describe the process and most of needed templates for using during the process and tasks • Up to date systems • High level of professionalism amongst employees • Striving for commodity alignment and global products/processes • Usage of online tools for RFQ process (such as Synertrade) • Usage of very similar list of suppliers for RFQs going towards strategic and long-term partnerships, good relationship and communication	• The existing flowcharts and tables for describing the process are not up to date • There is no visibility for the low spend parts • There is some confusion regarding roles and responsibilities at some stages • In some cases reporting and communication neither follow a defined standard nor have one to follow • Poor utilization of systems • Information is too spread causing mismatches and misalignment • Striving for optimizing schedules beyond a feasible limit • No clear KPIs or metrics for the NPD purchasing process • There is not always a clear commodity strategy • Not enough resources for the best ultimate outcome • No clear path/way how to record project milestones and problems for after learning from them	• New Tools, software and programs to increase process efficiency • Supplier knowledge for producing better designs and part manufacturability • Benchmarking other industries in order to acquired best practices • Procurement 4.0 for automatizing operational activities inside the process • Company's size attracting good business partners	• Regulations, laws, directives, european and global guidelines defining technical specifications of machinery which have a certain time limit for expiration, therefore, shortening available time for projects • At the moment of the study there was Corona Virus pandemic • Markets and technology are improving and changing fast • Environmental issues

Figure 47- SWOT analysis for the NPD purchasing process.

8.5 Reliability of Results

All the research was conducted as attentive and impartial as possible. The interview structure was decided as semi-structured due to the thesis scope which covered the whole NPD purchasing process and its complexity. There was a need of understanding the relationships and correlations between the aspects inside the NPD purchasing process. Therefore, it was difficult to limit the research scope in a quantitative survey with several and pre-defined questions. The preparation of the questions was based on the knowledge acquired through the material provided by company X and according to the research conducted in the purchasing field, in other words, what the most important aspects for the NPD purchasing process are. Next, the interview questions received feedback and approval from the NPD employees. Even though the focus of the interviews was on the NPD purchasing process and its bottlenecks, the interviews did not exclude the discussions about different topics than the thesis scope or very specific topics in the process which were not supposed to be covered. It was an expected deviation since semi-structure interview gives this kind of opening.

The transcription of the interviews was as faithful as possible because all the audios were recorded. The interviews were either transcribed word by word or adapted to only focus on relevant topics and fit the purpose of the research on the best possible way. The transcriptions were made in order to have only very clear and unambiguous sentences and statements. Moreover, in order to make the analysis more logical and rational, the same standard template was used to transcribe all the interviews, thereby, ensuring the uniformity of information collection. Even though the mother tongue of all the interviewees was Finnish and the interviewer did not speak fluent Finnish, the interviews were conducted in English without major issues because all the involved people spoke fluent English. All the purchasers had a work experience in the purchasing field of at least five years. All the other interviewees from different departments were either managers or part of the core team. Therefore, their professional knowledge and expertise related to their respective areas were adequate to give a solid foundation for the study in question. In summary, the presented results are based on the interviewee's perspectives regarding their

knowledge and understanding of the NPD purchasing process and their professional backgrounds.

One point that should be emphasized is the fact that the process does not possess a clear group of KPIs/performance measurements, therefore, there was no real collection of quantitative data. During the process the main quantitative information available was the open purchasing orders for the parts. Since there is plenty of "informal" work which is not taken into account for calculating the open POs, the data in question was not considered as relevant for the study.

9 Analysis

9.1 Analyzing the Priorities from Qualitative Results

After creating the compiled file from the interviews, priorities were needed because it is not possible to improve and develop every area of the whole process at the same time. Therefore, three areas of priorities were created as previously described. Starting from deciding which areas should be prioritized, the first step was the identification of which factors influenced the selection of priorities. Three factors were chosen as basis for the qualitative analysis, and consequently, for choosing the priorities. One very important factor was the time frame. The priority should be focused on and aligned with the current company's strategies as well as considering whether they are more short-term objectives or long-term ones. Another factor restraining the prioritization was the improvement feasibility. It was not wise to prioritize, for instance, the improvement of current systems in this study because it demands a much more detailed study on the systems. Consequently, it did not belong to the scope of this thesis and system improvements were not embodied in the final priorities. However, system bottlenecks and flaws were clearly recognized and presented in the compiled file. The third aspect considered was the analysis of the benefits and the needed amount of work for completing an improvement. As an example, there might be a higher overall benefit coming from system improvements compared to re-structuring the internal NPD meetings, but the needed amount of work, resources and time are much higher for developing current systems. On the other hand, the communication and visibility between stakeholders are enhanced at

a very low cost of resources when re-structuring the internal NPD meetings. A summary of the factors which influenced the selection of priorities can be seen in Figure 48 below.
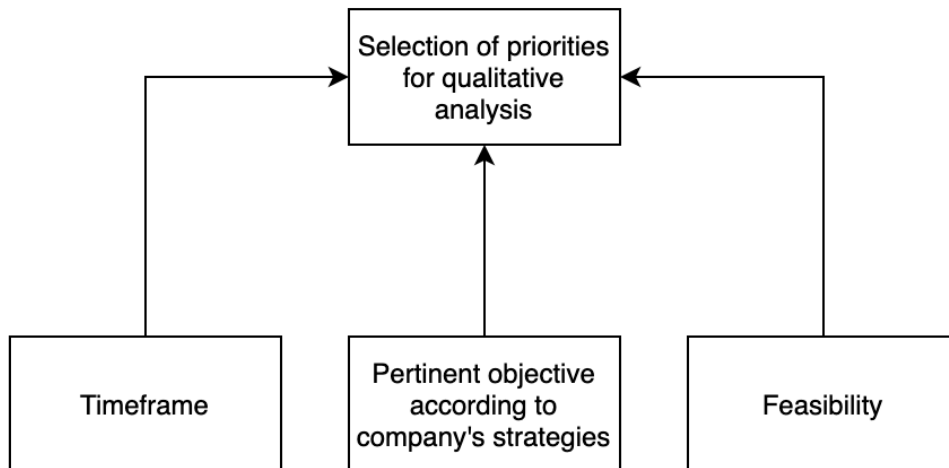
Figure 48. Factors Influencing the Qualitative priority choices.

As the three priorities were chosen according to the basis described in the previous paragraph, a standard document for their description was simultaneously created. The aim of the document was to give a good base, according to the interviews and shared information, for understanding "what, why and how" the priorities were chosen. In light of that, the already described topics in chapter 8.1 were identified. The first point was a short introduction summarizing what work had been done. The second point included the description of the priority itself while identifying what the main problems related to that specific area were. The third topic intended to connect the links between the issue and its root-causes. However, since it was not possible to identify the causes with one hundred percent of certainty, the subchapter received the name of "possible causes". The fourth matter encompassed the most feasible and suitable ideas for developing or solving flaws, hence, the root causes. Those ideas were interview-oriented since the final suggestions were made based on not only the qualitative analysis but also on the other two methodologies and literature review. The fifth aspect was the description of the most visible benefits in solving the priority issues. The sixth category dealt with being aware of the most relevant risks

and trying to mitigate them. The seventh matter was defining how the recommended actions could be implemented. Therefore, suggesting real actions which could be taken for starting the improvement implementation. The eighth topic had the scope of how to measure the advancements and their results. Therefore, selecting forms of tracking whether the developments were producing real improvements or not. Lastly, a mind map containing a summary was created in order to facilitate the priority understanding. In Chapter 8.1, only a summary of the three most relevant topics of the priorities was presented in Figure 43 in order to protect confidential information of company X.

Once the priorities and the topics of the report were chosen, the document started to be filled in. The two most important aspects for producing those documents were understanding the cause-consequence relationships and correctly addressing the improvement ideas to the proper causes. During the interviews the relationships cause-consequence of problems were sometimes mixed and nonlinearly discussed. Therefore, the correct organization and structure of relationships was key for constructing a proper result and document. The second relationship was linking the improvement suggestions and ideas raised during the interviews to the most suitable causes. Correctly tackling the causes is essential for solving the bottlenecks and problems in the NPD purchasing process. Thus, the best and most appropriate developments were chosen and properly addressed. Tackling the problem instead of its cause is a merely corrective action producing a palliative solution. The aim of the thesis was to produce lasting solutions, therefore, solving the causes of the problems. A summary of the relationships previously analyzed before filling in the priority document can be seen in Figure 49 below.
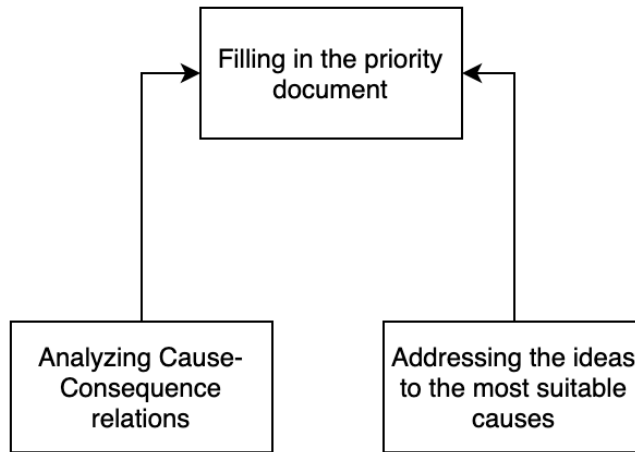
Figure 49. Relationships which were analyzed before filling in the priority document.

The description was very clear and understandable regarding the first priority, namely Time Constraints. The Purchasing personnel was constantly processing faster and quickening the necessary activities for achieving the needed results. In some cases, there was reporting of skipping steps, stages or tasks due to the lack of time. Consequently, the necessary results are achieved although they are not the most optimal ones. There is room for improving time constraint issues and developing purchasing final results. The most common problems were restrained time for performing added value activities related to suppliers and R&D as well as not reaching the given time schedule and, consequently, not performing the NPD process activities properly. Discussions about identifying complex parts, better designs, technical reviews, supplier feedback and negotiations were cited as examples of added value activities by the interviewees. Moreover, the general lack of time was also affecting other areas of work of the Purchasing Department, such as organizational activities and tasks related to serial production.

In light of the clear problem, the most probable causes for the first priority were recognized within three main topics. The first one was the R&D matters. The most common ones were the delays in releasing data, constant part changes during the later stages of the NPD purchasing process and missing or mismatch information between purchasing and R&D. The second one was composed by the system issues. The dispersed information through many different software, quantity of systems, amount of manual work and sometimes their complexity were the usual mentions

about system bottlenecks which lead to time constraints. The third most probable cause related to the plan conformity, in other words, whether the given time schedule is always the same independently of the process implementation or not. This last aspect is about schedule decisions in case delays occur during any process stage, therefore, deciding whether the final deadlines are kept on the same date or not. In affirmative case, it reduces the available time for completing the next stages.

Finally, the recommended actions for the first priority addressed the causes by, firstly, delegating more and more all the necessary work which is operational and non-added value work to the operational purchasing team, thus, freeing up time for strategic activities. The seamless workflow between both teams in terms of alignment and standard actions is strictly necessary for tackling the time constraint issues. The second most relevant suggestion was the development and improvements inside the R&D department. Although it was possible to actually suggest specific recommendations, they were not mentioned in order to safeguard the company's confidentiality. The R&D matters were constantly stated as crucial and in need of a special attention. Ultimately, the last recommended action is closely bonded to the George Santayana's well-known sentence "those who cannot remember the past are condemned to repeat it". The interviewees mentioned that there were no records or documentation regarding the lessons, milestones and main problems from past projects as well as no clear performance measurements for the NPD purchasing process. In light of that, the suggestion of creating a clear process path which could be followed and analyzed after its completion together with the construction of well-planned metrics were the third most relevant idea. The lessons learned during the past projects are key for developing the process and mitigating the most potential risks.

The second priority was simpler assessed and identified as a good communication and information flow inside companies are crucial for executing any process (Olkkonen, Tikkanen & Alajoutsijärvi 2000). As previously seen in Chapter 3.1, people are the center of execution of any process because people perform the required activities to achieve the desired results. Thus, a flawless communication is essential for supporting the achievement of objectives by, for instance, standard reporting, valuable meetings and the utilization of appropriate methods for sharing

information. However, some issues related to the communication among stakeholders were mentioned during the interviews. A few of them were highlighted as they have been raised in many interviews. One of them was the nonstandard format for handling some tasks related to information flow, such as the format which "non-official" information is sent/exchanged from R&D to Purchasing or the report from Purchasing to Material Handling. Another point was the information which different stakeholders were aware of concerning the same topic, such as whether a specific component was already being processed and sourced or not. As an example, in some cases, visualizing a certain kind of information was neither possible through the systems and software nor the systems were not updated. The third most important topic was regarding the meetings during the NPD projects. In some cases, there was negative feedback concerning the information being shared during those meetings. For some purchasers there was no valuable information coming from the meetings and they perceive the meetings as informative and non-valuable. The last very relevant topic was the "synergy" between departments. Even though interviewees commented that all the involved employees were highly professional and worked hard to reach their goals, they lack rapport and more interaction among functions. The communication between departments was stated as already being in a good level most of the time although there were comments about having room for improvement. The overall department objectives were aligned, but some employees perceived that the departments were only looking at their specific goals instead of the big picture.

Following the logical order, the analysis of the probable causes for the second priority was conducted. The interviews with the Purchasing personnel and different departments were paramount for understanding what the most probable causes for the communication problems are. When the topic was discussed during the meetings with the NPD employees, one of the highlighted causes was the possible lack of either awareness of existing standards or willingness to use them. On the other hand, during the interviews, interviewees mentioned that in a few cases standards did not yet exist. Other point was regarding the number of working files and the amount of system data. The difficulty of finding the most correct and updated information was emphasized. Therefore, it caused the mismatch information between stakeholders.

The next subject was the recent personnel changes in different departments. It was seen as one cause for the communication problems. Many involved employees are relatively new at the company and the changes at R&D were given a great deal of importance. The knowledge about the company's processes, policies, reporting and other employees was still being consolidated for many new employees, thus, causing some communication drawbacks. Lastly, the current meeting structures were not well aligned and planned in order to deliver value for all of the participants.

Ultimately, the recommended actions for addressing the second priority were made according to the discussions. First of all, the most natural action to be taken regarding the meetings was to define its re-structuring. Thereby, sending a survey to the "executing" team asking which kind of meeting structure would be required to add value to them. The survey was summarized in collecting information through a survey with defined open questions that narrow their answers to which kind of meetings, information, involved people, frequency and time were needed. The second main suggestion was identifying which standards were needed through the whole process related to communication and reporting. Next, the checking whether they exist or not would be needed. If the standard existed, the action would be either implementing its usage or reformulating for decreasing its complexity. If the standard did not exist, the most natural course of action would be creating one. The third one included handling the communication concerning the "informal" work between departments. In other words, the creation of clear channels of communication for both vertical and horizontal levels when handling "informal" work was the resolution. Moreover, filtering information was a pertinent idea. For example, filtering information from emails to only pertinent personnel was advised to better manage information flow.

The third priority relates to both first and second ones in some extension. Some discrepancies were identified regarding the team and commodity alignment/management when collating and cross-checking the transcribed interviews. The VSB process, for instance, had inconsistencies when compiling its positive and negative characteristics. There were employees which pointed the VSB process as heavier and more complex than it should be whereas others further emphasized its positive characteristics of transparency, good decision-making

process and responsibility sharing. Regarding the topic of visibility, one highlighted point was the visibility for low-cost components. The components which cross the spending limit need to be handled by the VSB process. On the other hand, the expenses and supplier selection of the components which do not reach the given limit do not have much visibility for the company's management. Another example of misalignment was, as previously mentioned, standards were not followed/used in some cases when either reporting or communication was needed. Lastly, a topic frequently raised was the constant discussions about sourcing strategies and commodity alignment. Thereby, these discussions caused the spending of a considerable amount of time deliberating about supplier matters, such as selecting preferred suppliers for sending RFQs. Hence, the connection between this priority and the two above mentioned was clearly seen. When plenty of time was spent for solving team and commodity alignment matters, little time was left for performing more added value activities, such as screening potential new suppliers, negotiations or reviews on part design. Alternatively, communication problems and misusage of standards could definitely cause misalignment inside the team.

The most prospective causes for the third priority were then profiled. They were correlated to more human factors. According to some buyers, the first one was composed by not well-defined commodity strategies for the correct period of time. In those cases, there were not clear annual strategies for supplier selection and sourcing/commodity strategy. Moreover, there was no documentation, record or log on the strategies, thus, making more difficult to follow up or improve. Once more, the topic of either non-existing or lack of awareness or willing to use regarding patterns, standards and procedures was identified as a likely cause for the third priority problems. Furthermore, eventually, since there were many new entries in the departments, there might be some gaps and divergences for general processes' alignment. Even though trainings and updates are regularly conducted, for instance for new tools, the employees have been working together for a short time, thus, creating discrepancies in the team alignment.

Finally, the endorsed ideas for handling the bottlenecks of the third priority were selected based on simple but effective actions which were expected to significantly improve its setbacks. The first one was to encourage active attitude and

communication between team members and other involved people. The second action included updating employees, especially buyers, on the existing standards of reporting and communication as well as receiving feedback on those, and next, either using them, reformulating or creating new ones. One procedure which had especial attention was the VSB. Ratifying the reasoning for conducting the procedure and for the required information were the main points regarding the VSB process. Ultimately, the commodity strategy should be better aligned and well defined in order to avoid the regular discussions, thus, stop spending available and productive hours with long-term strategies. In addition, having input from Material Planning department was highly advised because this department is the one which handled suppliers' affairs in a daily basis for serial production.

9.2   Analysis of Quantitative Results

To start off, having the "Other topics" as the largest category out of the quantitative analysis was not expected. However, since the NPD purchasing process encompassed several different factors and aspects, this result was totally under the scope. Furthermore, the largest subcategory inside the "Other topic" was supplier related matters with approximately 41% of the findings. Considering the fact that suppliers were one the most crucial and relevant stakeholders for the process, it was natural to widely debate about them during the interviews. Consequently, recognizing the problematic factors, crucial aspects and expectations related to them were the main supplier matters. The continuity of the result order was, in some extension, already an expected result according to the interview discussions and the informal information sharing at the company. Therefore, Time Constraints, R&D and Systems were the three largest categories with findings regarding negative matters, essential points or future expectations.

Several findings were added to more than only one category. This was caused due to the close interaction of different stakeholders, procedures and aspects which are involved during the process execution. That was one of the reasons why one finding had the possibility of being added to more than one category. In light of that, some interactions and their bonds were clearly recognized while analyzing the findings. They were the close relation, in many cases, between the time constraint issues and

R&D aspects. As an example, delays in releasing data and constant design changes were extensively discussed during the interviews. Both of them directly affected to the planned time schedule for completing the entire project and process. If there were delays in delivering the required data, specifications and information about the new parts, the time for executing the rest of the process would be shortened. On a similar way, if there were constant changes in new parts, the whole RFQ procedure would be needed and executed again, thus, shortening the actual time for completing the tasks as well as not properly performing them.

The Systems category considered not only the ERP, PDM and project management tools but also the other types of software which were used during the process execution. A great deal of it was also heavily debated because most of the information flow is updated, exchanged and retrieved through the systems. Many system constraints were emphasized, especially the number of different files which were needed and in use, the amount of manual work and either lack or excess of information. However, as already described, system interactions happened through the whole process, from beginning to end. Therefore, depending on the finding and its scope, there were different categories involved. It was neither possible nor reasonable to define one main interaction for the systems category.

The operational purchasing team category was in many cases related to the team alignment and instructions, guidelines and templates findings. As the operational purchasing team was not physically working together with the strategic purchasing team, all the activities, operations and communication were done via systems, emails, phone or video calls. Moreover, the start of the operational purchasing team's work was quite recent, slightly more than one year ago. In light of that, there were no clear standards, procedures or guidelines which the operational purchasing team could rely on previously. Due to those facts, the communication between both teams was constant in order to solve doubts and questions about the process and its peculiarities. Furthermore, the knowledge and familiarity with the process was still being developed through trainings and daily work. However, improvement in the teams' alignment has been constantly performed and instructions have been gradually created.

The early stages of the process had issues very closely bonded to added-value activities most of the cases. Those added-value activities were related but not limited to, for instance, the early supplier involvement and time constraints. The sentences "there is not enough time for performing added-value activities" or "there is not enough time to properly execute the tasks" were very often said. The time issues restrained, for example, the feedback loop between R&D and suppliers which aimed the improvement of parts, their manufacturability, designs, specifications, performance and functionalities. The early stages of the NPD process is the most valuable and contains the best potential savings as previously explained by the literature review and academic research. Hence, "early stages of the process" findings were mostly related to suppliers, R&D and time constraints.

Even though the VSB category was not often debated, it had an unexpected result. Some purchasers affirmed that the VSB process had more positive aspects than negative ones while others disagreed with that idea. Therefore, the team misalignment was clearly recognized and, in many cases, the VSB findings interacted with the team alignment ones.

The instructions, guidelines and templates category was similar to the systems one. Its findings were connected to many areas of the process since procedure/template standards are required for its execution along the entire process. However, several times there was the mention of not having standards or patterns to follow up the process or its achievements. The notion of following a standard NPD process was not well aligned, spread and incorporated among the stakeholders who executed the process. There were two major areas of those. The first one was emphasizing the lack of proper instructions or policies which can be followed. The second one included the lack of either awareness or willingness concerning the existing standards. The company's size and sometimes standard complexity intensified those two major areas by, for example, not being able to find the correct procedure or avoiding the usage of complex standards, which in turn increased the workload.

Lastly, one very strong interaction between the findings was the connection between the categories of communication and team management/alignment. This interaction also partially strengthened by the category of meetings. Many findings overlapped

between communication and team management/alignment. As an example, the reporting format from purchasing to material planning department was misaligned because material planning personnel was receiving the reports in slightly different formats. Hence, they concluded that each purchaser was reporting in a mildly different way. Major issues included information sharing and exchanging aspects. Information mismatches and gaps were extensively declared during the interviews, often the ones between R&D and purchasing were highlighted. One of the factors which emphasized that issue was the fact that there were many new R&D employees thereby not knowing the company's standards and procedures very well yet and lacking rapport with purchasing team. A summary of the strongest relations and interactions between the categories can be seen in the Figure 50 below.
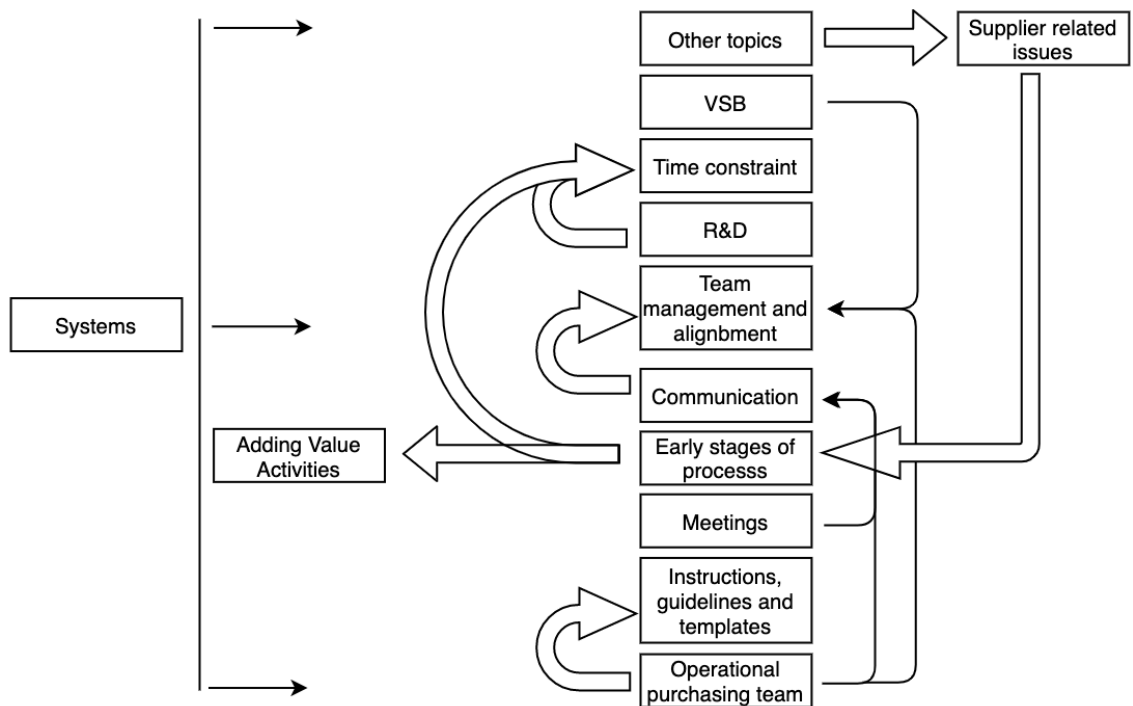

Figure 50. Summary of interactions and relations between categories according to quantitative analysis of findings.

9.3 Process Map and PFMEA Analysis

To start off, the creation of the first process chart (Appendix 2) was made according to the limited knowledge and information about the NPD purchasing process. It was

mainly created for helping the collection of data during the interviews and, a chart where the interviewees had the possibility of highlighting any stage or transition as well as brainstorming. As a general comprehension, all the interviewees agreed that the first process chart was the ideal big picture of the process. However, a few comments and additions were made on that process chart afterwards.

Next, after all the interviews were conducted and analyzed, the more detailed process maps were created. Even though there were over 30 steps each of the three different process charts, they were still considered as big picture process charts because each step can be easily broken down into minor pieces of activities for a more detailed study. The process was very complex, and it involved several different stakeholders and activities for its completion as previously explained. The three process charts followed the most logical, chronological and natural order although in some cases modifications and adaptations were needed. The plastic commodity, for example, required a very tight management and validation due to its strict specifications. Thus, even though this category is not allocated to the supplier drawings category, it needed the supplier selection and awarding at very early stages. Next, the work of part improvement and development was performed between R&D, purchaser and supplier along the whole project. In light of that, the NPD purchasing process suffered modifications to best fit the commodity/part needs. The modifications were exemplified as changing the order of steps and activities, the need of "informal" work which complex parts required while standard parts did not, having the possibility of parallelism of activities as well as whether being able to wait for the official release of data via systems or not in order to continue the purchasing work.

The seven processes which did not belong to any specific step in the process charts were inserted because they were very relevant processes affecting the final results of the NPD purchasing process. Some of them might have a limited area of operation but they did not have a specific step to be allocated. Early PPAP requests, supplier feedbacks and early supplier and purchasing involvement, for example, were performed during the early/prototyping stages of the NPD purchasing process. Moreover, some steps were very similar/equal during different times in the process

charts, therefore, they have received the same name. They were only differed by the sub numbering because there might be slight changes in their execution.

An important factor affecting the process order and execution was the relationship with strategic suppliers for certain critical commodities/items. In some cases, there were strategic suppliers which already had long-term agreements, good communication with the company and delivered a high service level. Those factors affected the search of new potential suppliers in the market, therefore, all the supplier selection related activities which were one of the main points when introducing new components in the serial production.

With the process chart created, the PFMEA was conducted in order to analyze the step dependencies and cause-consequence relations. The failure modes were mainly based on the interviews and academic research. The causes and consequences were identified as diligently as possible according to the interviews and purchasing knowledge. Once the PFMEA was completed, many dependencies were recognized between, for instance, a consequence of a failure in one step and a failure cause of a later step. However, some causes and effects were clearly recognized as priorities due to their appearance several times. One clear cause of many failure modes was the lack of time for properly performing a mandatory activity. If there was not enough time for executing a task, its results would not be as good as they were supposed to be. The most probable causes for the lack of time were characterized as lack of enough human resources, low efficiency and/or very tight schedules. The human resources aspects were commented by many interviewees due to the fact that different sites, which are owned by the same company, employ different purchasers for the NPD projects and for the "traditional" purchasing activities. Low efficiency can be caused by the lack of training and expertise in certain areas of the process. Lastly, the project schedules were decided by the top management and the "executing team" did not have much influence on its decision.

Another highlighted aspect was the matters related to team alignment and communication. In many failures, the misalignment appeared as cause or consequence. The aspect/process which was misaligned would cause plenty of extra work if not easily solved and aligned again. Duplicated work, spending time in non-

added value tasks, searching for the correct/updated information, increasing the workload, reducing the available time for more added-value activities were examples of negative consequences of misalignment. Its causes depended on some aspects. When standard procedures were available for the employees, the awareness or willing to use them, for example, was key for aligning the team. Other example was the unclear commodity/sourcing strategy. Its misalignment caused the constant discussion when at the supplier selection stage. Therefore, it restrained the precious time for performing other activities such as supplier negotiations. In summary, the misalignment factor was very negative for the NPD purchasing process, but its solutions were more feasible and reasonable than, for example, fixing system flaws.

Lastly, R&D issues were extensively referred in the PFMEA. They were mainly connected to the communication and information gaps between purchasing and R&D as well as the design of parts. The work of the Purchasing department cannot be properly performed without the correct information and data from the R&D Department. Supplier answers for RFQs regarding price and supplier feedback on better designs are, for example, totally dependable on the correct specifications and drawings from the R&D Department. Therefore, any issues on this field delayed the procurement period or demanded the re-done of purchasing work and, thereby, wasting resources and the purchasing work completed.

Based on the literature review and the type of available data, the most appropriate way of ranking the failures would be obtaining the RPN number by team judgment. However, due to the subjective nature of the most adequate form of obtaining the RPN number for failures and the difficulty of accessing the team's expertise at the time of the study, the RPN number was not included in the PFMEA. The chances of receiving inaccurate numbers were high because the physical contact and face-to-face information sharing were restricted by the pandemic situation while conducting the research. Therefore, only a qualitative assessment was performed on the results according to the trustworthiness criteria. The creation of a more precise and adequate RPN rank would need further research.

10 Conclusion

This chapter presents a summary of all the compiled results and the interconnection between them. The first subchapter cross-checks their specific outcomes. Next, the most suitable and feasible suggestions are presented according to the comparison of the three results and based on the literature review.

10.1 Comparison of Results of Different Methodologies

First of all, a big picture of the main results of the three different applied methodologies is presented in the Figure 51 below in order to refresh their big picture.
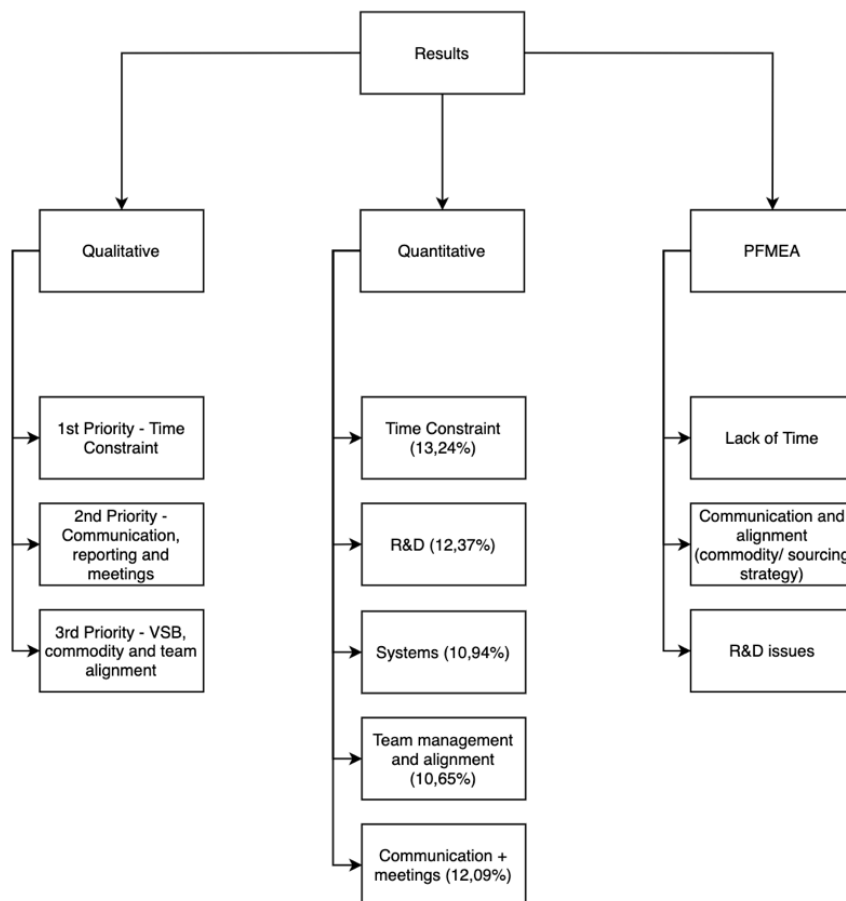

Figure 51. Big Picture of the Main Results of the Three Different Methodologies.

As Figure 51 clearly shows, the outcomes from the application of the three different methodologies for analyzing the interviews were quite aligned. The main topics which resulted from their analyses were very similar among each other. Having the time issues in the first place in all of them definitely called a great deal of attention from company X. Inside this category, the most debated topic was the lack of time for properly performing more strategic activities which bring more value to the overall result of the NPD purchasing process. In other words, playing the strategic role inside the purchasing department whereas delegating the more operational work to the operational purchasing team. This aspect was easily identified while conducting the interviews and, consequently, it was one of the main results of the study. Crescenzi, Kelly and Azzopardi (2016) have found, for example, when performing a (re)search work, time constraints impact on one's perception in different ways. They are the intensification of time pressure perception, increasing the sense of a task's difficulty, reducing one's satisfaction regarding one's performance, enhancing the necessity of working faster and augmenting the need of engagement to one's self-awareness process of learning and handling the task in question. In light of that, time constraints were seen as a major problem for the NPD purchasing process which heavily jeopardized its final outcomes.

R&D hurdles were also extensively discussed, and they were closely connected to the constraints which reduced the amount of time for executing NPD purchasing process. The issues were majorly related to the delays for releasing the data of new parts, the constant design changes due to, for example, design and manufacturability improvements, corrections from theoretical and practical validation as well as supplier feedbacks, and, lastly, the gap of information and rapport between purchasing and R&D departments. In any of their cases, whether by delays, releasing new changes for components at early stages or information mismatches, there would be a reduction of available time for the performing the purchasing process if new deadlines were not set. Furthermore, during the interview with the R&D representative, who was a project leader, R&D matters were also highlighted but from a slightly different perspective. The lack of enough resources together with the high optimized schedules as well as the difficulty of following up different project statuses were the underlined factors.

The third category which was emphasized by the three methodologies was both internal communication and overall internal alignment. Already widely addressed, both topics had a tenuous division line and had a large impact on to the project's progress. The internal misalignment had high chances of causing over processing, duplicated work and unnecessary time consumption on non-added value activities. The clear and unambiguous communication led to the need of transparency and visibility in a complex process as the NPD purchasing process. However, some affairs related to them were plainly noted inside the team. The supplier awarding process which was required for the expensive parts and the need of a final approval by other stakeholders other than only purchasers, namely VSB process, divided the team's opinions between more positive and negative aspects. Another example was the current meeting structures for the NPD purchasing process. The "project follow up meeting" which was weekly conducted did not bring much value for some of the buyers. In addition, eventually the topic about the "synergy" amongst departments was debated. Harris (2004) stated that there are many ways of building the synergy inside the team. However, based on the knowledge and background of the departments, the synergy created by networking, rapport building and the routinely intermeshing of the executing team are essentials. In other words, when peers meet in order to exchange information, ideas and best practices, learning from each other's experiences and, consequently, opening up a path for innovation and cooperation between co-workers.

Ultimately, system constraints related to different software currently in usage by the company were evidently marked during the interviews. Plenty of specific system restraints were related by the interviewees and all of them were transcribed into the interview files. In the qualitative results they were not considered due to the fact that there were already ongoing developments for improving the systems and their solutions needed a more detailed study which was not covered in this thesis. However, as described anteriorly, all the findings regarding their bottlenecks and flaws were indicated in the interview results. During the quantitative analysis, the system constraints were one of the largest areas from the results. In the PFMEA, the systems had the biggest number of individual failure modes, accounting a total of seven failure modes. Therefore, attention should be definitely paid to this category.

10.2 Suggestions for improvements and developments

To start off, the general idea for improvement according to the type of process was based on the literature review and Figure 18 and, therefore, it was utilized in Figure 52 below.
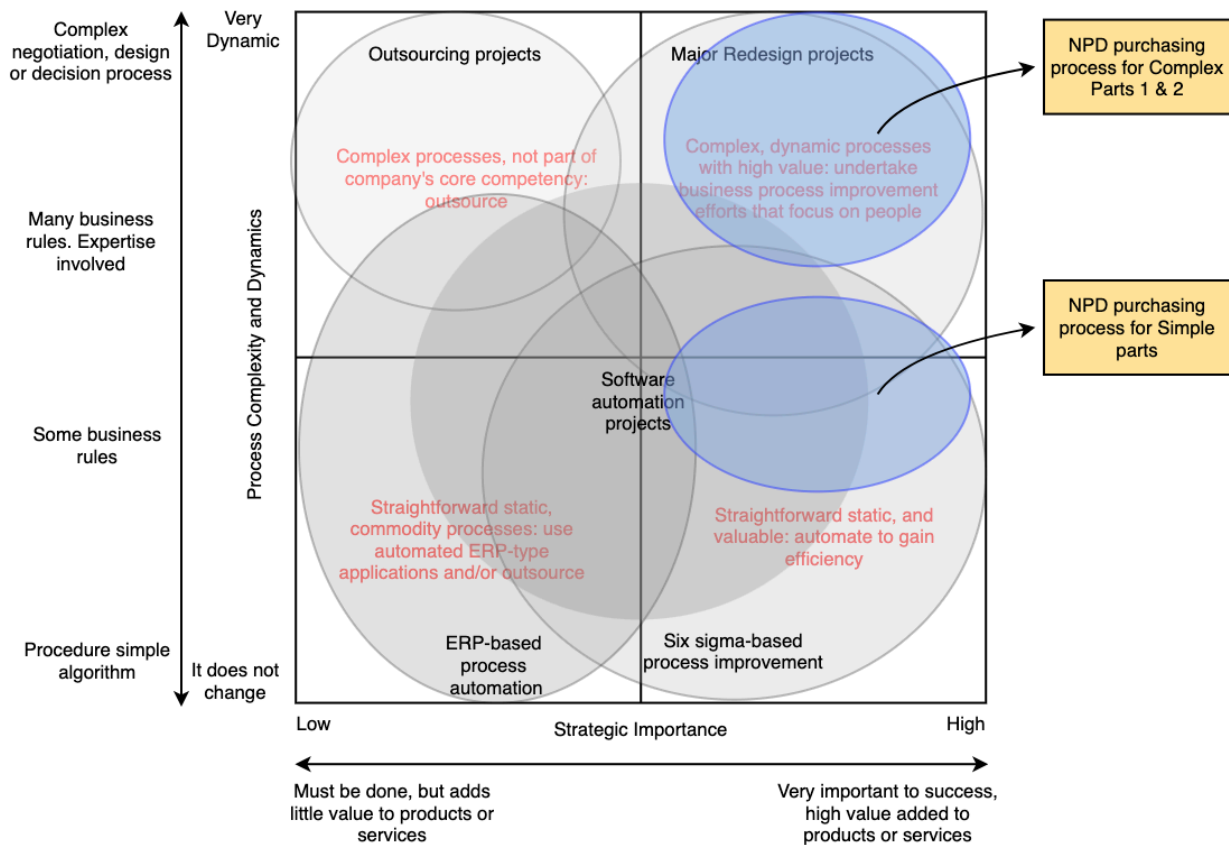
Figure 52. General ideas for improvement according to the type of process.

The NPD purchasing process for both different types of parts was considered a very important topic for the overall result of the company due to its value for short- and long-term objectives. The short-term ones can be exemplified as the completion of the project on time and optimal project's results. The long-term goals are linked to, for instance, supplier development during the project's lifetime in serial production, supplier capabilities to ensure the manufacturing process without disruption as well as the natural enhancement of a partnership with a supplier such as increasing supplier's productivity while improving cost levels. Therefore, both processes had a

high level of strategic importance and were allocated on the right side of the graph in Figure 52 above. However, obtaining the supply of the complex parts, as the name indicates, deals with more dynamic factors in the process. In other words, it needs a much deeper interaction and relationship among supplier, Purchasing and R&D in order to achieve the desired results. On the other hand, simple and catalogue parts follow a more straightforward course of action although it needs purchasing expertise and supplier feedback in order to select the best and most available parts in the market. In light of that, the processes were plotted in the vertical level according to Figure 52. Once they were correctly plotted, the general suggestions for each type of process was quite clear. On one hand, complex parts require the continuous redesign and improvements, the constant seeking for best practices in the market, new technologies, benchmarking as well as strategic partnerships. The focus should be on people who are the key point for developing a successful project/process. On the other hand, simpler parts require efficiency enhancement by, for example, automation, the gain of productivity and, consequently, the decrease of overall costs.

In general terms, the recent concept inside purchasing, namely procurement 4.0, has been a vast field of research which many improvements and developments can be found according to the company's necessity and strategy. According to results presented in previous chapters and academic research on the subject in question, the most adequate ones were identified as the market screening for new manufacturing technologies, the most advanced technologies in components/parts as well as the solutions for systems, software and connectivity. The screening of new potential suppliers was not often performed as it was declared in the interviews, thus, positive supplier opportunities might be lost. Within the fast market changes and technology advancements, the need of continually pursuing the newest elements in the supplier market is required. In addition, regarding the systems, they were stated as already being developed but the feedback of the "daily executing team" should be definitely taken into account along the development process. Volume of parts and the old versions of updated parts, for instance, should be accessed more easily in order to increase efficiency and decrease time constraints.

However, both were general suggestions that require a more detailed study, therefore, they were not further described.

A development which should be taken into account for a better process visualization is the creation of the work breakdown structure (WBS) previously seen in the literature review. Once the workflow of the process was mapped, its breaking down into smaller subprocesses would give a deeper understanding of the process and its peculiarities while easing the recognition of bottlenecks and flaws. The idea is to reach the level of case processes being managed by case management processes, envisioning the next steps for their developments.

Lastly, the creation of clear KPIs and performance measurements for the NPD purchasing process is crucial for the identification of aspects which should be improved as well as setting the correct allocation of resources and efforts. It gives a clear picture of the overall process and employee performance. As a general rule of thumb, for a better employee motivation and satisfaction, metrics should be measuring positive aspects instead of negative ones (Kervola 2019). As an example, instead of measuring the percentage of late deliveries, measuring the percentage of deliveries on time would be the suggested metric. For the issues in the current NPD purchasing process, two examples were specifically given. The first one was monitoring the number of part issues in each project phase. The aim of this KPI was to quantify the R&D affairs by category (such as design changes, new parts, missing information in BOM and missing parts in BOM) and analyzing how they affect the purchasing process. The second performance measurement included, firstly, the calculation of a cost estimation for the PPAP procedure. The next step would be accounting how much of indirect costs is produced by PPAP orders which were not used for serial production. The purpose of the second one was to better control one of the factors influencing indirect costs and collecting data to optimize the best timing for introducing PPAP order requests.

A summary of the more general suggestions can be seen in Figure 53 below. They were also divided according to the most suitable period range for development and creation.
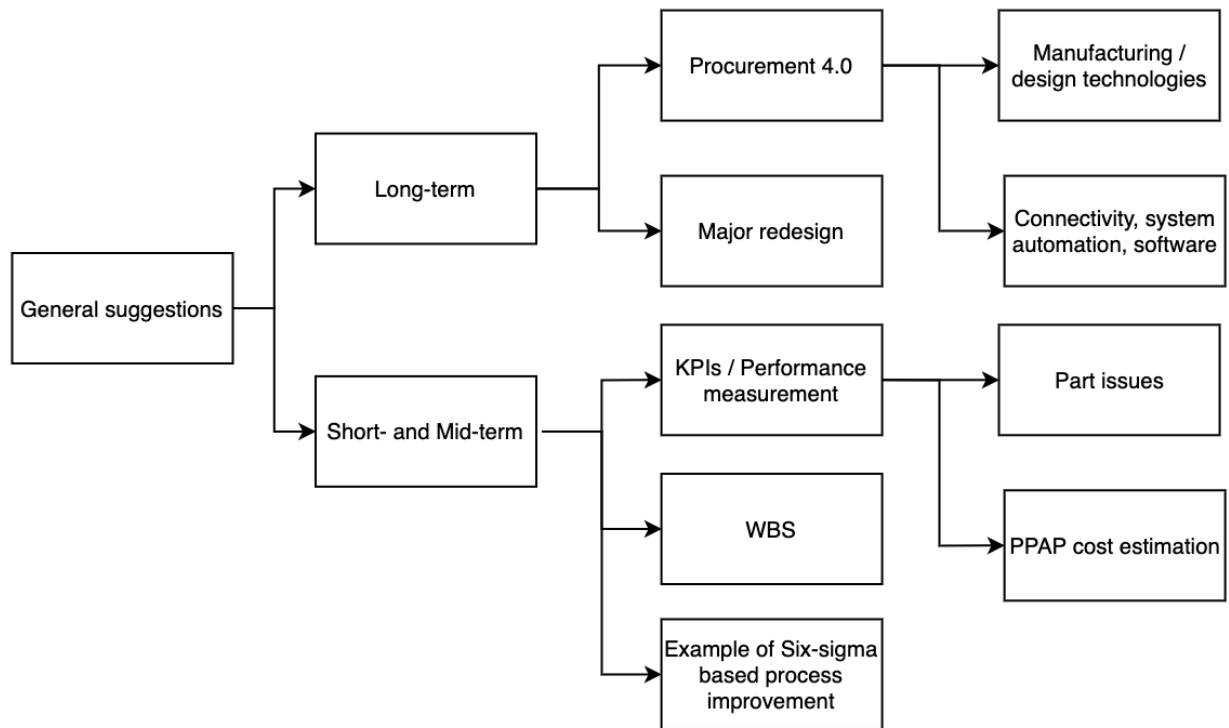
Figure 53. Summary of General Recommendations for Process Development and Improvement.

Turning the attention to the specific bottlenecks identified in this study, a collection of recommendations was then suggested. As Crescenzi and coworkers (2016) have found, time constraints affect employee's performance when performing a task. Thus, mitigating these constraints is crucial as well as focusing on people when a process is very dynamic and complex. The sentence "there is not enough time to perform the activities properly" repeated several times during the interviews was translated as a coefficient equal to, for example, $\frac{unit\ for\ measuring\ valuable\ work}{available\ time}$.

Looking at the coefficient, there were three direct forms of improving its final results. They were changing either the denominator, the numerator or the efficiency of how much is done with one unit of available time. Impacting on the numerator meant increasing the amount of available resources, such as human resources, if the available time would be maintained the same. Affecting the denominator involved lengthening the total available period of time for producing the same results. Lastly, the absolute relation between how much work is done with one unit of time can be influenced by the enhancement of efficiency, in other words, augmenting the throughput with the same amount of resources. In summary, from a different

perspective, there was either lack of resources, low efficiency or very short schedules for completing the desired activities.

Other good point which should be considered is the implementation of techniques, simple or not, in order to have time management under tight monitoring. As an example, in Chapter 3.3 a tool for managing the project schedule was suggested. The first step was the creation of a WBS for a process. Next step was to produce the time-based network diagram for the WBS being studied. Once it was finished, the table of early-and-late starts would be the following phase which gives the rough view of a process' critical path, its minimum period to be finished and which stages can be either delayed or conducted in parallel with others. The tool was simple but good enough in order to deliver a prospective schedule for a subprocess or an entire process. The historic knowledge and learning from past projects are essential for creating a feasible schedule. Although, as interviewees stated, one project was never exactly executed as past projects, these sorts of tools might delivery a good basis for executing future projects and conducting any adaptation when required.

A fundamental topic for a clear picture of where to invest time and resources is the identification and definition of the process value chain, thereby, recognizing the most strategic stages and activities which add most of the value to the final result. Based on the interviews (purchasers' expertise) and the graph from Figure 6, the most added-value and strategic activities are performed at the early stages of the NPD process. The best potential cost savings are located at the beginning. Costs for engineering changes rapidly grows after the product design/development phase. Moreover, the degrees of freedom for purchasing and specifications are much higher at the beginning of the projects.

Regarding the relation between R&D issues and time restraints, a study conducted by Dow, Heddleston and Klemmer (2009) have found the results of effectiveness of iterations when prototyping under time constraints. Both multiple iterations and prior knowledge on the task increased the effectiveness when prototyping under time pressure. Furthermore, the results showed that participants who iterated multiple times without previous knowledge on the task had similar results as the ones who did not iterated multiple times but had previous knowledge. Thus, the

theoretical and practical validation are key when prototyping as clearly seen from the research. The multiple iterations and expertise on the subject are one of the aspects which should be considered when under such a tight schedule for developing a complex project.

The delegation of operational and non-added value activities to the operational purchasing team was the main aspect why the operational team started. When fully aligned, the available time for more valuable activities performed by the strategic purchasing team would be expected to dramatically increase. However, the total alignment between both teams requires time and effort from both sides. Proper instructions, policies, guidelines and trainings are indispensable in order to avoid duplicated work, misalignment and extensive and unnecessary communication. Once roles and responsibilities are clear according to the standard NPD purchasing process, operations are to be smoothened. Plain picture of which tasks are one's responsibility and which kind of status report the strategic purchasers need are examples of what clear roles and instructions require.

Regarding the suggestions directed to the improvement of internal communication and alignment, several ideas were identified but only a few were recommended. First of all, the definition of a clear long-term commodity and sourcing strategy was of utmost importance for fostering an efficient strategic purchasing work. The need of a constant communication between management and purchaser, such as weekly discussions, in order to decide the commodity/sourcing strategy is disruptive and prejudicial to, for example, the supplier selection and RFQ processes. There was an unnecessary time consumption for dealing this frequent communication which should be spent in more added-value activities. In addition, even though there might not be a clear commodity/sourcing strategy in place in some cases, the complex and expensive parts were already tightly managed by company X. On the other hand, simpler and cheaper parts do not have such a close management. The implementation of a more attentive monitoring at simpler and cheaper parts is definitely a manner of reducing costs and improving purchasing results. The tail management and total cost of ownership are examples of models and techniques which ought to be considered.

Moreover, there were some divergencies in procedures and guidelines which should be mitigated. The natural action to be taken is to either create standards for the most usual activities and tasks if they do not yet exist or reviewing and updating the existing ones. Defining the procedure to record how, what, when and why part replacements are made during the prototyping phases is one example of those types of standards. One of the reasons for conducting a part replacement might be the lack of part availability in the market. Consequently, in order to give more visibility to the process and avoid misalignment at later stages, there should be a clear way of recording those replacements. The second action which should be considered is the promotion of training and updates in areas which either the employees perceive there is a potential increase of efficiency or there are discrepancies inside the team's opinion. The VSB process, for instance, received both positive and negative feedbacks. The analyses showed a division inside the team's opinions regarding their appraisal of the VSB process. Therefore, a simple "update" of the process shall be enough to align the team concerning the topic in question.

Lastly, in order to better align the team and improve the information sharing, the existing meetings inside the NPD area should be re-structured because they were not delivering much value for some purchasers. The needs of buyers and other stakeholders should be collected and, consequently, a basis for determining the types of meetings and their frequencies. More technical reviews, for instance, were recommended at the early stages of the process to better identify parts with higher chances of being problematics in any aspect, such as their manufacturability or market availability.

Ultimately, the creation of a dedicated R&D team together with the purchasing department for the development of totally new designs and innovative projects is a recommended action if it is feasible, suitable and does not yet exist. The innovation projects from those dedicated teams should be apart from ongoing and forecasted projects in order to, firstly, have less time pressure and, therefore, improving employee's performance when executing tasks and providing a positive environment for innovation. The second reason was increasing the number of iterations when prototyping which are apart from ongoing and forecasted projects, thus, improving theoretical and practical part validations. Overall, the knowledge base and expertise

are expected to be enhanced by those innovative projects. In addition, if supplier feedback was properly used, the partnership with strategic suppliers would be further developed. A summary of the recommended actions for more specific process bottlenecks is presented in Figure 54 below.
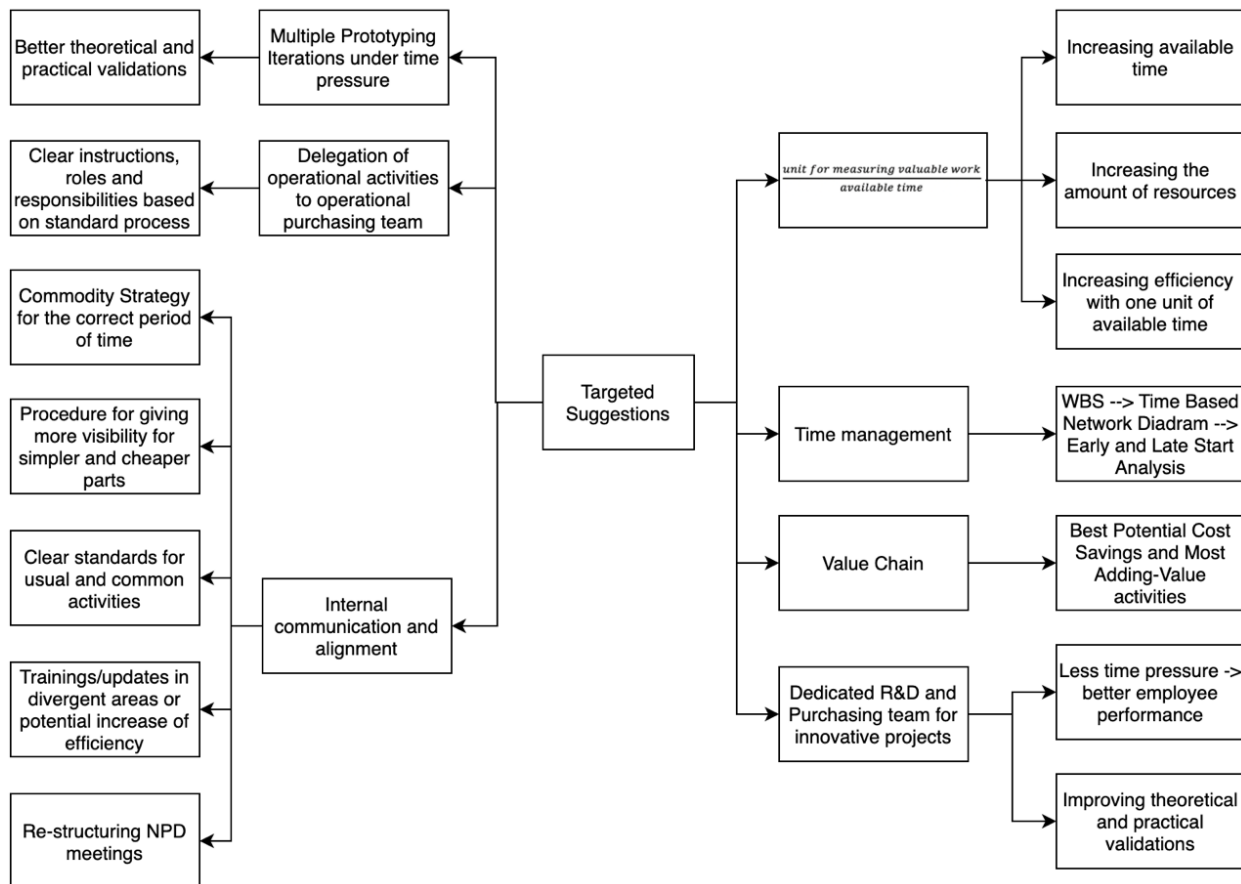
Figure 54. Summary of the targeted suggestions according to process deficiencies.

11 Discussion

This final chapter aims to summarize and merge all the most important challenges and successes of the study regarding the process implementation, results and key findings derived from the results. In addition, the limitations and future research was also discussed based on the current level of purchasing knowledge and the implications arisen from the findings.

11.1 Own perspective

The process of creating this thesis was a real challenge derived from the company X's needs. It involved a very complex and dynamic process of the purchasing field which is the NPD purchasing process inside a big enterprise. The purpose of the study was aimed to directly address the company's needs. It mainly was the identification of bottlenecks and negative aspects from the NPD purchasing process and suitable solutions for them. In light of that, the research scope was limited by gaining insights and knowledge concerning the NPD related topics by academic research, mapping the overall NPD purchasing process and its challenges inside company X. Naturally, after completing those steps, the last stage of the study was the recommendation of improvements and developments for the process in question.

The basis of the study was the information collected during sixteen semi-structured interviews. The application of different analysis methodologies was conducted, and their results were compared. The final results were very aligned among the three methodologies and gave emphasizes on the issues which needed a more careful attention by the company. Moreover, the process was mapped as intelligible as possible according to the interviews and information sharing informally communicated while spending time at the company. The understanding about the process peculiarities was only possible due to the interviews and very supportive employees at the company. One of the perceived aspects was the already existing close management of complex and expensive parts but the lack of a tighter monitoring and controlling of cheaper and simpler components. Furthermore, the results could be used as a start for deeper studies in more specific phases, steps or stages of the NPD purchasing process which are essential and very dynamic.

In general, I believe that the results were quite satisfactory although there is always room for improvement. As examples of good results, the interviews were analyzed in three different formats, the process map included not only the official purchasing work but also informal activities which are crucial for the good progress of the process and the interviews had their findings concerning negative aspects quantitatively accounted. Even though the study took into account expert considerations and opinions on the NPD purchasing process, quantitative data from

systems, for example, is an area which could have been better used so as to enhance the study's reliability and validity. The study has limitations in this area since it did not include quantitative data.

The challenges which the Purchasing Department faced during its daily work were clearly seen as very demanding and time-consuming. I could see that more and more purchasing has been playing a major role inside companies and its most valuable work has been more strategic than operational. The involvement of different stakeholders to accomplish the desired results significantly ensured the enhancement of the process' complexity. The management and alignment of cross-functional teams has definitely been a challenge on current days. A major disadvantage while conducting the research was the pandemic created by the COVID-19 at the end of 2019. Although the pandemic affected the whole globe in every professional and personal field, I fortunately had all the needed support from my supervisors and company's employees in order to finish the thesis on time and as good as possible.

The study took a great deal of effort, time, knowledge, motivation and organization which were not easy to handle. Time management, balance with other activities and the pandemic situation were tough aspects during those three/four months of dedicated work. However, I am very confident that all my effort delivered a great result and I am sure that I have learned plenty of new and useful knowledge in the field of purchasing. All the different employee's perspectives and obstacles which are daily faced as well as the detailed academic research on the purchasing field definitely ensured positive outcomes to the company and to myself.

All in all, I have faith that my work was useful for the company and it will give more insights for the process' improvement.

11.2 Future research

The topics considered in this last chapter takes into account the company's strategies related to company's vision and desires for the future. One of the company's goals was to go towards global processes and part supplies which provides a positive ground for the development and improvement of the NPD purchasing process. One

of them was increasing the interoperability and functionality of systems which are utilized inside the company. Global systems which are used by all the sites and have the required features for an efficient and effective flow of work is a long-term objective that should be considered. In addition, the creation of global standards based on the best practices from different sites is of utmost importance if the goal is to achieve the best patterns of work inside purchasing and all the other departments. To start off with the standards, one example was the different names given by different departments for the same projects. It created unnecessary confusion at the beginning until the employee is aware of all the name variations.

Another topic that was relevant and pertinent to the company's objectives was the continuous process breakdown into smaller steps and stages. The process divided into smaller pieces aids the recognition of root-causes of bottlenecks and the best solutions for them. In addition, the process was quite complex and dynamic in two areas, the flow of information and activities. In order to facilitate the identification of negative aspects, both flows of activities and information should be handled separately. Therefore, their patterns and standards ought to be created separately. The regular review of the patterns of information and activity flows will surely deliver small efficiency improvements which increases the overall purchasing and company's performance.

In summary, the overall thesis result delivered a good synthesis and analysis of the interviewee's knowledge and beliefs on the NPD purchasing process as well as a solid academic knowledge. The thesis work compiled a big amount of collected information and turned it into intelligible knowledge for obtaining insights about deficiencies and improvements. Academic research was majorly conducted with a management-oriented view without much deeper quantitative and mathematical view which plays an important role when defining corrective actions and developments for processes. However, even without quantitative data, the collated information rendered useful results for the company. Moreover, results were not definitive and company X should keep a more detailed research in the future.

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Appendices

Appendix 1. Interviews for three different target groups.

Interview Questions for Purchasing department employees:

- Please describe a bit about your work at the purchasing department at Company X.
- What kind of activities do you perform at work? Could you evaluate those activities regarding the time-spending aspect from 1 to 10? Which of them are the most time-spending?
- What do you consider as adding-value activities and operational tasks in purchasing?
- What do you think of the following process chart regarding the basic NPD process? Do you agree? What is missing in it? (reason: getting the big picture and overall thinking of the buyers about the NPD process)
- About the templates used in the process, what do you think of them? PPTs, Excels, charts, recommendation templates. RFQ template, VSB template, and so on.
- What are the positive aspects of the current NPD purchasing process? What is it being rightly done?
- What about the negative aspects of the current NPD purchasing process? Do you think there is lack of information or do you feel that is missing something in the current process?
- For you, which activities are the most crucial ones in order to deliver great results from the NPD purchasing process?
- Would you have any suggestions or other general comments about the current process? Which aspects could be improved, for instance, getting deeper into total cost of ownership?
- What do you think about the Operational purchasing team? How has it been working so far, in other words, what are the good and negative points about it?
- What could it be done better regarding the Operational purchasing team? How could it be better utilized?
- If you think about your professional background, could you think of anything which would be useful in order to suggest or improve the current NPD process?
- What about your future expectations for purchasing, what are they? How do you see the next level of NPD purchasing process?

Interview Questions for other departments' employees:

- Please describe a bit about your work together/related to the Purchasing department.
- What kind of activities do you perform when it is more specifically related to the NPD process? Could you evaluate those activities regarding the time-spending aspect from 1 to 10? Which of them are the most time-spending?
- Regarding those activities, what do you consider as adding-value activities and more operational tasks from your department point of view?
- Are you aware of the basic steps during the NPD process, how is the workflow?
- Which kind of templates/charts/excels/systems do you use and share with Purchasing during the NPD process? In your opinion, how do they look like? Are they good, easily used and shared?
- What are the positive and negative aspects of the current NPD purchasing process? What is it being done correctly and what is not? Do you think it is missing something or there is lack of information? Are there enough instructions regarding the NPD process?
- For you, which activities are the most crucial ones in order to deliver great results for the NPD purchasing process?
- Would you have any suggestions for improvement or other general comments about the current NPD process?
- What do you know about the Operational purchasing team?
- If you think about your professional background, could you think of anything which would be useful in order to suggest or improve the current NPD process?
- What about your future expectations for the collaboration between your department and purchasing? How do you see the next level of it, and if any, concerning the NPD purchasing process?

Interview Questions for Suppliers:

- Please describe a bit about your work together with Company X, more particularly with Purchasing department.
- What kind of activities do you perform when it is more specifically related to the NPD process? From those, which are the most time-consuming ones?
- Regarding those activities, what do you consider as adding-value activities and more operational tasks from your point of view?
- Which kind of templates/charts/excels/systems do you use and share with Purchasing during the NPD process? In your opinion, how do they look like? Are they good, easily used and shared?
- What are the positive and negative aspects of the current NPD purchasing process? What is it being done correctly and what is not? Do you think it is missing something or there is lack of information? Are there enough instructions regarding the NPD process?
- Do you have any early supplier involvement work with Company X? If yes, how the process is executed?
- What do you think about the communication between you and the purchasing department?
- Regarding the new parts selection, how standard are they? Do you often receive RFQ with not so standard parts?
- For you, which activities are the most crucial ones in order to deliver great results for the NPD purchasing process?
- Would you have any suggestions for improvement or other general comments about the current NPD process?
- If you think about your professional background, could you think of anything which would be useful in order to suggest or improve the current NPD process?
- What about your future expectations for the collaboration between your company and purchasing? How do you see the next level of it, and if any, concerning the NPD purchasing process?