Supplier base evaluation and optimization in a manufacturing company.

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Satu Sandholm

1st Examiner: Katrina Lintukangas, Professor

2nd Examiner: Aleksi Arva, M.Sc. (Tech.)

ABSTRACT

Lappeenranta–Lahti University of Technology LUT

LUT School of Business and Management

Business Administration

Satu Sandholm

Supplier base evaluation and optimization in a manufacturing company

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Keywords: Supply base optimization, volume consolidation, supplier management, risk management, supplier categorization, purchasing portfolio model, approved supplier list

This single case study focuses on supplier base evaluation and optimization in a manufacturing company. The study aims to identify ways to manage the supplier base by conducting a literature review of supplier selection processes, supply base optimization, and supplier criteria. The research combines theoretical and empirical data to compare the differences between theory and practice, and to present possible recommendations for improvement.

The study addresses the main research question of how to optimize the supplier base, and examines theoretical concepts such as supply base optimization, volume consolidation, supplier risk management, supplier evaluation, categorization, buyer and vendor power dependency, and supplier development from a strategic perspective. The study also covers theoretical concepts related to the approved suppliers list, supplier performance measurements for classifications and analysis, such as ABC-analysis, Kraljic's matrix, and ISO 9001.

The results indicate that the case company could remove a significant number of suppliers from the supply base, and that workload assignments for category managers should be reconsidered to balance their capabilities to develop supplier relations. The study also highlights the importance of establishing long-term partnerships with suppliers through supplier development, monitoring spending patterns, and continuously managing supplier and risk management to achieve procurement objectives.

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Avainsanat: Toimittajapohjan optimointi, volyymien konsolidointi, toimittajien hallinta, riskienhallinta, toimittajien luokittelu, ostoportfolion malli, hyväksyttyjen toimittajien luettelo

Tämä yksittäinen tapaustutkimus keskittyy toimittajapohjan arviointiin ja optimointiin valmistusyrityksessä. Tutkimuksen tavoitteena on tunnistaa tapoja hallita toimittajakantaa tekemällä kirjallisuuskatsaus toimittajien valintaprosesseista, toimituskannan optimoinnista ja toimittajakriteereistä. Tutkimuksessa yhdistetään teoreettinen ja empiirinen aineisto vertaillakseen teorian ja käytännön eroja ja esitelläkseen mahdollisia parannusehdotuksia.

Tutkimus käsittelee pääasiallista tutkimuskysymystä toimittajakannan optimoinnista ja tarkastelee strategisesta näkökulmasta teoreettisia käsitteitä, kuten toimituskannan optimointia, volyymien konsolidointia, toimittajariskien hallintaa, toimittajien arviointia, luokittelua, ostajan ja toimittajan keskinäistä riippuvuutta sekä toimittajien kehittämistä. Tutkimus kattaa myös hyväksyttyjen toimittajien luetteloon liittyvät teoreettiset käsitteet, toimittajien luokittelua ja analysointia varten tehdyt suorituskyvyn mittaukset, kuten ABC-analyysi, Kraljicsin matriisi ja ISO 9001.

Tulokset osoittavat, että tapausyritys voisi poistaa merkittävän määrän toimittajia toimittajapohjasta ja kategoriapäälliköiden työmääräjakoa tulisi harkita uudelleen, jotta heidän kykynsä kehittää toimittajasuhteita olisi tasapainotettu. Tutkimus korostaa myös pitkäaikaisten kumppanuuksien merkitystä toimittajien kanssa toimittajien kehittämisen kautta, kulutusmallien seurannan, toimittaja- ja riskienhallinnan jatkuvan hallinnan, sekä hankintatavoitteiden saavuttamiseksi.

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ABBREVIATIONS

ASL	Approved Supplier List
COVID-19	Coronavirus Disease 2019
EMS	Environmental Management System
ERP	Enterprise Resource Planning
ESG	Environmental, Social, Governance
GDP	Gross Domestic Product
GMTE	Grow, Maintain, Transfer, Exit
IMS	Information Management System
JIT	Just-In-Time
KPI	Key Performance Indicator
OEM	Original Equipment Manufacturer
OTD	On Time Delivery
QMS	Quality Management System
SD	Supplier Development

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1. Introduction

Competition, supply interruptions, changes in technology, supply and demand weaken organization capabilities to be profitable. Companies need to create procurement strategy to tackle supply risks to minimum and utilize importance of strategic purchasing. (Kraljic 1983). In today's globalized world, supplier management plays a vital role in the success of any organization. The aim of this thesis is to find ways to manage the supplier base effectively. Soolaki and Arkat (2018) describe that supply chain activities start from manufacturing of raw materials and components to final product, which is sent to the end customer. Procurement plays a significant role in the supply chain, meeting the needs of production by following orders and distribution. (Soolaki & Arkat 2018.) Generally, half of the product's manufacturing costs come from procurement and that's why it is critical to develop purchasing strategy to create savings, have better lead-times and higher performance. Thus, it is vital that procurement is implemented in accordance with the company's goals. (Chenini, Iqbal, Qurrahtulain, Husain Mahmood & Aldehayyat 2021.) To create effective environment for bulletproof supply chain the most important tools are supplier approval process, supply base optimization and the ability to use analytics to develop continuously existing supplier base (Sarkar & Mohapatra 2006).

Manufacturer is a company responsible for a design and marketing of the product, final assembly and finishing the product manufacturing. Manufacturer is a buyer company who has suppliers, also called partners and contract manufacturers, which produces sub-assemblies and components for buyer company need. (Buzacott & Peng 2012.) There are various terms to buyer-supplier relationship such as collaboration, supplier-integration or -involvement (Chenini et al. 2021). In manufacturing industry suppliers are used as partners, they share risks and profits, especially if the supplier also works with buyer company's competitors. Partnership allows both-way investments and risk sharing, which benefits both parties. (Buzacott & Peng 2012; Chenini et al. 2021.) Today's global business requires a stable and long-term partnership, and the collaboration is beneficial when there is reciprocal financial advantage, understanding and mutual respect. The relationship becomes particularly important when the buyer, manufacturing company, is a large and the suppliers are small or medium-sized companies. Today's organizations strive to utilize the supply chain and suppliers to improve quality and delivery time, as well as flexibility. (Mohanty &

Gahan 2012.) By outsourcing part of company’s operations, it is easier to focus on its own expertise and thus achieve better competitiveness. Contract manufacturers can be located in other country than the manufacturer, which lead the transfer-of-competence across borders (Buzacott & Peng 2012).

Previous studies have provided various methods for supplier selection and optimization, but there is a lack of research that considers the specific characteristics of suppliers and the industry they operate in. Taherdoost and Brard (2019) highlights the necessity to cultivate novel hybrid approaches for appraising and electing supplier’s contingent on the prevailing market conditions and the nature of the purchased commodity. This study aims to fill this gap by examining the supplier categorization, supply base optimization, and approved supplier list from a theoretical perspective and by analysing research findings to identify the right elements for the case company's supply base improvement recommendations. Additionally, this study aims to categorize different suppliers based on their specific characteristics and analyse the relationship between these factors and total spend. By doing so, this study intends to provide a comprehensive framework for supply base optimization and volume consolidation.

This study's findings and recommendations are expected to be useful not only for the case company but also for other manufacturing companies that seek to improve their supplier base management. The thesis structure includes an introduction, literature review from supply base optimization, tools and analysis methods, the case company supply base optimization process description, conclusions, and recommendations.

1.1 Background in manufacturing industry, research starting point

Purchasing and procurement is also known as strategic purchasing and supply chain management, with the objectives on availability of right materials in good quality and price (Weigel & Ruecker 2017, 2). Strategic procurement and supplier integration directly affect companies' production outcome and effectiveness (Chenini et al. 2021; Soolaki & Arkat 2018). Operative purchasing is dispatching and follow-up of order processes, while strategic purchasing focus on developing long-term relationships and contracts with suppliers (Weigel & Ruecker 2017, 2). Strategic procurement is the key to accelerate the manufacturing lead-time in lowest cost and the best quality, which are important factors for the company in term of success in markets (Chenini et al. 2021). Each component and raw material has requirements defined by the product design that the supplier must meet (Soolaki & Arkat 2018). The duration of wait times in procurement processes can extend to several months, making it imperative to identify areas where potential performance shortcomings exist (Zemmy & Setiyowati 2021).

Risk management history starts after World War II and is mainly used in companies to avoid accidents and losses. Risk management was mainly focused to financial viewpoint, but from the beginning of 2000 after various business failures and scandals caused by weak risk management, government has created regulations to guide the activities of companies. (Dionne 2013.) Today's supply chain in manufacturing industry is vulnerable for many internal and external elements, which are difficult to manage, but it impacts on the business (Arroyo-Lopez, Holmen, & de Boer 2012; Kotula, Ho, Dey & Lee 2015; Sharma, Srivastava, Kumar, Jindal & Gupta 2021; Wang & Giouvris 2020). Supply chain vulnerability means factors and decision which affect negatively to supply chain actions. Vulnerability is prerequisite to supply risks, which causes losses to the company. (Sharma et al. 2021.) These un-controllable factors can be environmental changes, complexity in supply chain relationship or in the organizational structure, different kind of risks regarding information security (Dohale, Ambilkar, Gunasekaran & Verma 2022; Sharma et al. 2021). Catastrophes such as war, terrorism, and epidemics (Dohale et al. 2022; Kotula et al. 2015) along with legal and political risks like changes in taxation and restrictions (Wang & Giouvris 2020) can also be variables that affect negatively. An economic downturn can also affect to companies by reducing turnover, which leads to termination of employment contracts, decrease of inventory balances, and minimized purchases (Krause & Ellram 2014). The company's operations can be weakened by various internal and external problems. As it's been noticed in the last few years, the Coronavirus disease in 2019 (COVID-19) and the Russian invasion to Ukraine have destabilized many companies due to problems with the availability of materials and components, or a decrease in demand, possible even leading to bankruptcy.

For several years manufacturing industry have used lean and just-in-time (JIT) principles to reduce costs and inventory at the expense of increased vulnerability, which is now a main concern in many sectors (Svensson 2000). JIT production was invented by Toyota for the purpose of having necessary materials and component quantities available at the right production phase, minimizing all additional storage requirements (Sugimori, Kusunoki, Cho & Uchikawa 1977). The demands of the world market are constantly growing, the shortening of product life cycles and competition has caused many organizations to outsource part of their production, which increases dependence on the supplier (Arroyo-Lopez et al. 2012). Trends such as outsourcing specially in low-cost countries, globalization, lean stocks, and efficiency-of-operation have resulted stress on supply chains. Companies in an early stage most likely have problems in missing processes and structure, and through increased maturity enables adaptation of the operating environment. (Sharma et al. 2021.) Problems in the supply chain can affect the depletion of stocks or materials. Procurement process should move from single to multiple sourcing and having alternative sub-contractors to mitigate the dependence on others, therefore reducing the risk involved. (Svensson 2000.) In the case company, the lack of descriptions of procurement processes has been identified, and a focus on strategic procurement would operate as a solution to the uncertainty of the market environment. As the company grows rapidly, processes must be constantly developed to guarantee functioning operations. Clear instructions and processes ensure that information is preserved in the company even the personnel changes.

To achieve competitiveness, companies have to offer customized solutions, which weaken the stability of the supply chain, causing long lead times and interference in supply. Environmental uncertainty create risk in supply, manufacturing, and distribution, which can be controlled by flexibility, company size, competitive effectiveness, and preventive risk management. (Sreedevi & Saranga 2017.) Risk management evaluate the impact of the event on the business, and it is part of corporation strategy (Dionne 2013). Corporate management should take the supply chain complexity as a great vulnerability to supply chain continuity. Information sharing between buyer and supplier decrease supply chain interruptions. (Sharma et al. 2021.)

Global competition in the market leads to the fact that companies should produce products at the lowest cost and shortest time. To succeed in the market, the company must plan the supply chain, so that the products are available to all customers around the world. (Soolaki & Arkat 2018.) Rapidly changing environment increase risk, when the company aim for respond to continuous changes in demand and technology. This trend has led to production resilience and strategic sourcing has became a key competitive strategy. Strategic sourcing refers to make-or-buy, and the decision is made according to what is the company's core competence. (Narasimhan & Das 1999.) Companies to continue succeed in the global market, improvements in the company's operations must be taken actively in daily processes.

1.2 Research approach, objectives, and research questions

This study employs a combination of theoretical and empirical data to analyze the supplier selection process and evaluation of existing suppliers through approved supplier list, supply base optimization, and supplier criteria. It compares the differences between theory and practice and presents possible suggestions for improvement. The research questions focus on methods for supplier base optimization and supplier categorization to identify the right elements for supply base improvement recommendations. The case company is a Finnish manufacturing company, and the thesis includes an empirical single case study with a comprehensive literature review. This study's findings will be useful for any company seeking to optimize its supplier base and enhance its competitiveness in the manufacturing industry. Therefore, this study aims to provide recommendations for the case company to improve its supply base through a combination of theoretical and empirical data.

The main objective for this study is to find ways to manage the supplier base. This study seeks through literature review of volume consolidation, supplier categorization, approved supplier list and supplier development, and analyses research findings to discover right elements for the case company supply base improvement recommendations. Research combines theoretical and empirical data. In the theoretical part primary and secondary data are used (for further description see 1.4). As a result, the study compares the differences between theory and practice and presents possible suggestions for improvement. The theory includes the findings of previous studies, and this is compared to practice in the operating methods and processes in the case company. Various tools are presented for the development of existing suppliers and for evaluating the supply base in the future. The approved supplier process in manufacturing business is studied through theory and combined with empirical study, this way qualitative research aims to understand the phenomenon. The main research question is formed as follow:

How to optimize supplier base?

The main research question corresponds to the task given by the case company. The case company identified the need for review supply base and create process for new supplier onboarding. Due to the comprehensiveness of the first research question, two sub-research questions were prepared to support:

RQ 1) What kind of methods there are for supplier base optimization?

Since it is not possible to develop all suppliers or strategic partners, it is necessary to first identify which supplier strategy to use. Therefore, this thesis defines supplier evaluation methods, tools from a theoretical perspective, and utilizes an applicable method through a case study. In addition to improve suppliers' performance, it is necessary to identify the factors that influence various performance metrics. This thesis aims to analyze the relationship between the supplier characteristics factors and total spend of the supplier. Therefore, the second sub-question formulated as follows:

RQ 2) How to categorize different suppliers, considering the specific characteristics of the suppliers and the industry?

To achieve the goal of this thesis and to answer the research questions, an extensive literature review will be conducted. The next section presents the scope of the study by introducing the research framework, key concepts, and limitations.

1.3 Framework and key concepts

This study focuses on manufacturing industry, and how the case company can optimize its supplier base and the relationships between them, so the customers are left out from the analysis. Suppliers are subcontractors, material- and service providers. The framework and concept connections are shown in Figure 1 and explained in more detailed as follow.

Supply base optimization

Volume consolidation	Supplier evaluation according KPI-metrics
	Supplier reduction
Supplier categorization	Supplier management through categorization
	Recommended tactics
Approved supplier list	Supplier on-boarding process
	Existing supplier monitoring
	ISO 9001-standard
Supplier development	Volume consolidation increase power dependency between buyer and supplier

Figure 1. List and descriptions of research concepts

This thesis consists of a few essential sections. At first, methods for supply base optimization and categorization are examined through previous studies. The theoretical findings are found from the academic literature, but they have been evaluated in case-by-case discretion. After the theory part, the case company, the business environment, and the data used about the company are presented in more detail. In the empirical section, the case company solutions are compared to previous research methods, differences, and reasons for these are searched, and finally, possible improvement recommendations are proposed. Next, the main themes of this study are defined, so that the reader can get an idea of the central concepts of the optimization.

Supply base optimization and volume consolidation:

Optimization of the supply base means a procurement strategy to reduce the number of suppliers (Rombough 2014). Procurement strategy includes supplier selection and evaluation according created criteria’s (Ogden & Carter 2008). These measured key performance indicator (KPI) criteria could be lead time, performance (Rombough 2014), cost or ability to adapt changes (Sarkar & Mohapatra 2006). Supply base reduction is continuous development model where the goal is to improve and enhance the relationship between the buyer and the supplier (Ogden & Carter 2008). Volume consolidation could also have negative side effects such as increased supply chain vulnerability (Sharma et al. 2021) and limited supplier base after reduction (Cai, Yang & Hu 2010).

Supplier categorization:

The purpose is to manage suppliers through categorization (Chunguang, Rezaei & Sarkis 2017) for example with Kraljic's purchasing portfolio model (PPM), where suppliers are divided to four categories (1) strategic, (2) bottleneck, (3) leverage, and (4) non-critical (Kraljic 1983). Categorisation is made by evaluation the suppliers according two dimensions profit impact and supply risk (Caniëls & Gelderman 2007; Kraljic 1983). There are recommended tactics and methods for each category, such as create long-term relationships with strategic vendors, for bottleneck products to create safety stocks, for leverage competitive vendor selection and to non-critical vendors volume consolidation. (Hesping & Schiele 2016).

Approved supplier list:

Approved supplier list (ASL) is a tool for new suppliers onboarding and existing supplier monitoring (Manning 2013, 119; Natarajan 2017, 78-80). The purpose is to limit supplier cooperation to those suppliers who meet the company's set criteria (Singh 2020). Created criteria are used for supplier selection and evaluation, as well as for continuous re-evaluation (de Boer, Labro & Morlacchi 2001; Singh 2020). ASL is specified in ISO 9001 quality management standard (Singh 2020), and it leads to cost savings, reduced risks and quality problems, but also improves buyer-supplier relationships (Roy 2003). Approved supplier list is maintained in selection of a new supplier and re-evaluation of an existing one. The result of quality control and audits, supplier can be added or removed from ASL. (Singh 2020.)

1.4 Research methodology and structure of the study

The purpose of research is to answer a question that has no answer or to create something that does not yet exist (Goddard & Melville 2001). Research methods refer to concrete material collection and analysis methods or techniques of empirical research, which in turn can be classified into qualitative, quantitative, and mixed methods. According to Eriksson and Kovalainen (2008) qualitative research produces new information for the practical problems of business contexts. Quantitative research is more structured and standardized, which is why qualitative research is more relevant, when the object of examination is a phenomenon or unstructured business problem. (Eriksson & Kovalainen 2008.) In addition to a comprehensive literature review, the thesis includes an empirical single case study. The case company is Finnish manufacturing company. Single case study has been chosen because the company is a manufacturing company with an extensive network of suppliers. On this account it is reasonable to study the supplier optimization from the perspective of the case company. The case company's internal enterprise resource planning (ERP) data, other secondary data that has been available from the company, and interviews conducted by the researcher within the company are used as primary data. For the study to be qualified and extensive enough, secondary quantitative data have been included in the study to support the main qualitative approach of this study.

In the chapter 2, the literature and existing studies are examined. The purpose of the theoretical part is to find different supplier evaluation and segmentation methods, focusing on the buyer to improve supplier performance and quality. The focus is on academic literature on strategic procurement in different industries, considering their suitability for manufacturing in the semiconductor manufacturing industry. The widely used purchasing portfolio matrix has received criticism and because of this, the study is not limited to Kraljic's (1983) purchasing portfolio model. Instead, it examines later studies and case studies from supplier categorization. The tactics recommended by Hesping and Schiele (2016) have been chosen as supplier development strategies. Tools and analysis methods are presented in chapter 3.

Chapter 4 presents background to the case including description of the case company and the operating environment. This chapter also presents in more detail used ERP data that the company has used for supplier evaluation, as well as the interviews that have been used in the empirical part. Purchase statistics and discussions with the purchasing department are the primary data collection method. Purchase statistics data is received from the case company. The case company’s procurement department employees and supervisors, quality manager and other personnel have also been a source of information for the research. Conversations with the company employees have not been transcribed.

In empirical research, research results are obtained by making concrete observations about the research object and analyzing and measuring it. In empirical research, concrete and collected research material is at the center of the research and serves as the starting point for doing the research. In chapter 5, empirical study includes analysis of the optimization and categorization of the company's supplier base. Chapter 6 includes practice compared to previous studies, discussion, conclusion, and suggestions for further research.

2. Supply base optimization, volume consolidation and analyzation

This chapter goes through the theory and previous studies regarding the process of the supply base optimization. It includes volume consolidation, supplier risk management, supplier evaluation, categorization, buyer and vendor power dependency as well as the development of suppliers from a strategic point of view. In addition to this, the topic includes theory about the approved suppliers list, supplier performance measurements for classifications and analyzation.

History of supply base reduction started from the thought that cost savings comes from increased competition between suppliers and that's why companies had a wide supplier base. From the 1980's importance of quality and development through cooperation started to be important part of the company's procurement management. In the 21st century supply base reduction, closer buyer-supplier relationship and supplier development are the current trends. (Ogden & Carter 2008.) When number of vendors are reduced it will create cost savings, better buyer-supplier relationships, (Cai et al. 2010; Ogden & Carter 2008; Rombough 2014; Sarkar & Mohapatra 2006) improve supplier and supply chain performance leading to increasing revenue (Rombough 2014). Volume consolidation means when buying company purchase a large part of its needs from one supplier, i.e., centralizes purchases. Supplier volume consolidation improves supplier performance, increases information sharing between the companies and improve the learning ability through the whole supply chain. (Cai et al. 2010.) According Rombough (2014, 1) supply base optimization is procurement strategy to decrease the quantity of suppliers and that way an organization can focus on a fewer supplier:

"*Supply base optimization ensures that you are focusing on working with suppliers that are the most productive and beneficial to your business.*"

The supply base reduction process starts with forming team from different stakeholders, such as sales, engineering, and purchasing to get stakeholders standpoints heard and involvement in coming reduction process. Procurement strategy is created and defined criteria for supplier selection. Potential suppliers list should be analyzed through available information, audits or through of a survey that has been sent to the suppliers. (Ogden & Carter 2008.) Assessment on audits focus is on suppliers' performance, product and process management, how the company’s quality management system (QMS) realized in practice. After analysis of suppliers are done according to supplier spend, performance, current inventories, and lead times it’s possible to make decision with which suppliers the cooperation will continue. (Rombough 2014.) Evaluated factors should not only be cost and quality, but also technological and economic features, operating systems, and adaptability to them (Sarkar & Mohapatra 2006). The supplier selection phase includes downsizing the list of potential suppliers and select the most suitable suppliers to meet the company's needs (Ogden & Carter 2008).

Important steps in supply base reduction, shown in Figure 2, are to recognize potential suppliers, supplier selection process and criteria to implement new process to the company actions. Reducing the supplier base is a continuous development model where the goal is to improve the long-term relationship between the buyer and the supplier. (Ogden & Carter 2008.)

Figure 2. Supply base reduction process by Ogden and Carter (2008)

In implement phase it’s not only about reducing supply base, but also specifying new supplier onboarding process and make sure that the whole organization processes prevent misusage of suppliers or purchases. In this way, the amount of work required for monitoring and follow-ups is reduced. (Ogden & Carter 2008.) Supplier performance monitoring happens through set KPI, and metrics used to measure supply chain efficiency can be correctness of the order, cost savings (Rombough 2014), quality and on-time delivery (OTD). Volume consolidation can be measured by the supplier percent share of the total purchases of the buying company (Cai et al. 2010). Once a process has been created to supply base optimization, a plan for the transition should be created, which includes schedules, written contracts from new suppliers and updating contracts with current suppliers (Rombough 2014). In the final phase of continuous improvement, main goal is to make sure that the developed processes are fulfilled, and supplier relations are further developed in a controlled manner in accordance with the procurement strategy (Ogden & Carter 2008). Companies also need to understand that supply base reduction or volume consolidation itself will not enhance suppliers, it is the buyer-suppler cooperation which improve supplier performance (Cai et al. 2010).

Single sourcing means that the company has only one supplier to purchase product from, but the product is also available from other suppliers on the market. Sole sourcing refers to a product for which there is only one supplier on the market whereas multiple sourcing means the product availability is from multiple suppliers. When reducing supply base, it’s good to remember that multiple sourcing enables competitive tendering while dependence on one supplier increases the supply risk (Sarkar & Mohapatra 2006). A sole source supplier provides a critical component that no other supplier can provide. This kind of a monopolistic supplier poses a high risk due to a sudden increase in costs and supply disruption. (Rombough 2014.) Reducing the number of suppliers does not directly guarantee good results, but it provides a framework for its creation by increasing the motivation of the parties to problem solving and tacit information sharing (Cai et al. 2010). Supply chain vulnerability increases when supply base is reduced while the buying organization lacks supplier in case of supply interruption, but on the good side is that it improves supplier quality (Sharma et al. 2021). Volume consolidation has also negative side effect, when buying company has only limited supplier base to work with, it may limit discovery a new potential supplier from the markets (Cai et al. 2010).

2.1 Supplier and risk management

Due to the globalization of the supply chain and the direct impact of suppliers on the company's competitiveness, risks must be minimized, and suppliers must be managed. Supplier management is in the core of company’s strategy, which includes supplier selection, evaluation, control, and development activities. (Weigel & Ruecker 2017, 45–46). Many manufacturing companies manage different units separately. Manufacturing, procurement, and sales have their own managers who pursue the interest of their team. However, to make operational activities more effective, the supply chain should be thought of as a whole and managed in strategic way. (Soolaki & Arkat 2018.) When procurement is integrated to all organization operations it will also improve other functions, such as marketing performance (Chenini et al. 2021).

Supplier evaluation should be measured by performance metrics such as delivery, price, quality, risk, and development capability (Weigel & Ruecker 2017, 52–54). According to ISO 9001 (Weigel & Ruecker 2017, 52):

"The organization shall evaluate and select suppliers based on their ability to supply products in accordance with the organization's requirements. Criteria for selection, evaluation, and re-evaluation shall be established. Records of the results of evaluation and any necessary actions arising from the evaluation shall be maintained."

Risk management means methods that aim to reduce and control risks. Risks can be removed entirely, but effective management will help to understand cause and effect relationship. (Weigel & Ruecker 2017, 87–89.) Companies who had prepared risks and had close co-operation with suppliers, were better prepared for issues like global pandemic. When the company assesses risks and their impact, possible solutions should be considered, such as alternative delivery channels, internal logistics solutions and inventory levels. (Deloitte 2020.)

Environmental risk management has often been treated as an expensive waste of resources, but environmental savings often come from streamlining processes, which creates added value, better financial performance for the company (Li, Jayaraman, Paulraj & Shang 2016), as well as competitiveness, a better reputation and image (Li et al. 2020). Approaches for green supply chain are waste, pollution and material reduction, proactive initiatives such as green-product design, -purchasing, -manufacturing, -information systems (Li et al. 2016; Li et al. 2020), -operations, -supply chain management and environmental investments (Li et al. 2020). The procurement ensures that the suppliers act in accordance with the environmental requirements and green manufacturing is the optimization of internal processes. Thus, the environmental impact of the entire organization processes is reduced, to achieve improvement in the company's financial performance. (Li et al. 2016.) Through collaboration suppliers can improve their environmental performance (Li et al. 2020). Therefore, suppliers should be evaluated for their environmental impact to develop green supply chain. Manufacturer cannot improve supply chain without the involvement of suppliers of parts and raw materials. (He & Chen 2022.) Companies should also develop their own employees' knowledge and commitment of environmental and social practices, for example through reward programs, standards, and guidelines (Li et al. 2020).

Supplier management is the process of identifying, selecting, and managing suppliers to make sure that they meet the company's needs in terms of cost, innovation, and quality. Effective supplier management involves developing strong relationships with suppliers, assessing their capabilities and performance, and continuously improving the supplier relationship. Then again risk management is the process of identifying, assessing, and managing risks that may impact an organization's operations, finances, or reputation. This includes identifying potential risks and impact for the company. Risks can be mitigated by implementing risk management strategies. In summary, supplier management and risk management are closely related, and effective supplier management requires a comprehensive approach to risk management. By identifying and managing risks associated with suppliers, organizations can build stronger supplier relationships, improve performance, and protect their business from potential disruptions.

2.2 Supplier evaluation methods

Strategic sourcing implementation includes analyzing and utilizing the supplier's capabilities according to procurement, manufacturing and organization needs to achieve less risk exposure and greater input (Gao, Ju, Santibanez Gonzalez & Zhang 2020; Narasimhan & Das 1999). Suppliers should be selected through delivery and volume capabilities, separating from traditional cost-and-quality centered thinking. Therefore, the analysis and auditing criteria of the supplier must be chosen carefully according to the company strategy goals. (Narasimhan & Das 1999.) Manufacturing and technology companies are under pressure to enforce sustainable development, and the way to do this is to choose green suppliers (Gao et al. 2020; Orji & Ojadi 2021). When choosing supplier based on sustainable values, evaluated criteria could be emissions, certification, recycling, and waste treatment (Gao et al. 2020). Supplier selection criteria's can be split to three categories, economic, environmental, and social. Economic category is measured by cost and price, quality, and efficient production methods. Environmental is measured through product design, competence, auditing, and development programs, and finally the social dimension by occupational safety, implementation of regulations and social responsibility. (Orji & Ojadi 2021.)

It has been noted that supplier selection, supplier development and supplier performance evaluation improve the company's sustainable development criteria (social, environmental, financial). Sustainability benefits the environment, but it is also important for long-term profitability for the company. If the company's strategy and values are green, the selection and development of suppliers should also be evaluated according to these criteria. (Kumar & Rahman 2016.) Identifying measures for supplier performance is critical factor to evaluate for buyer company objectives. Evaluation criteria could be measured from supplier capability and performance, such as price, reliability, and quality. To find right measures both qualitative and quantitative methods should be used. (Dey, Bhattacharya, Ho & Clegg 2015.)

Supplier evaluation is a critical process in supply chain management to ensure that the right supplier is selected. There are various methods of supplier evaluation, including the cost-based method, which focuses on the supplier's price competitiveness, and the performance-based method, which considers the supplier's quality, delivery, and responsiveness. Other methods include the rating-based method, which assigns scores based on predefined criteria, and the value-based method, which assesses the supplier's contribution to the overall value of the supply chain. Ultimately, the chosen evaluation method should align with the organization's goals and objectives.

2.3 Supplier categorization and purchasing portfolio model

Supply strategy creation goal is to reduce supply vulnerability and take advantage of purchasing profit impact (Kraljic 1983). According to Olsen and Ellram (1997a) there are three focus areas in procurement which are buyer-supplier relationship, managing and developing existing buyer-supplier relationships. Portfolio model is technique where two criteria are used to divide scope to four fields. This technique helps to choose right strategy to suppliers in each four groups. (Caniëls & Gelderman 2007; Hesping & Schiele 2016; Hoek 2020; Weigel & Ruecker 2017, 122–123; Zemmy & Setiyowati 2021.) The purpose of supplier segmentation is to manage several suppliers by dividing them into subcategories

(Chunguang et al. 2017). To create supply strategy the first phase is to solve supplier profit impact proportion to cost, or effect to quality or business opportunities. This way suppliers are divided to four categories (1) strategic, (2) bottleneck, (3) leverage, and (4) non-critical. (Kraljic 1983.) Green supplier segmentation is made according to sustainability dimensions where suppliers are analysed through their willingness and capabilities (Chunguang et al. 2017). Portfolio models are analytical tools which are used to recognize which suppliers deserve more attention than others (Olsen & Ellram 1997b). During COVID-19 has shifted supplier results in PPM a higher risk profile (strategic and bottleneck) and as a result, focus should be more on supplier cooperation and less focus on supplier cost (Hoek 2020).

Portfolio model for procurement includes analysis of the product and supplier relationship and create operation method according to these (Nellore & Söderquist 2000). In procurement the portfolio model can be used for two different application such as commodity group and supplier portfolio. In commodity portfolio model suppliers are analyzed through purchasing volume and supply risk and in supplier positioning portfolio, suppliers are based on market power of supplier and buyer. (Weigel & Ruecker 2017, 123–124.) Kraljic’s purchasing portfolio model (PPM) is the most frequently used model in procurement and supply chain management (Caniëls & Gelderman 2007; Ekström, Hilletofth & Skoglund 2021; Hesping & Schiele 2016), but there are many variations from PPM which are (Padhi, Wagner & Aggarwal 2012, 2):

“mostly builds on and extends the portfolio matrix proposed by Kraljic (1983).”

In section 3.2 Kraljic’s (1983) and Olsen & Ellram (1997) purchasing portfolio models and tactics are explained more detailed.

Power and dependency are seen as a significant part of the supplier relationship, but still the purchasing matrices often focuses only on strategic partners, although not all supplier relationships can be strategic. The concept of purchasing portfolio matrix is to help the buyer identify the characteristics of different suppliers to be able to optimize relationship in the company's procurement. (Caniëls & Gelderman 2007.) Next section presents relevance of buyer-supplier relationship and meaning of power dependency in it.

2.4 Buyer-supplier relationship and power dependency

Buyer and suppliers are interdependent of each other and through this power dependency, the supplier's relationship can be used to the advantage of both parties and misused as a disadvantage (Brown, Lusch & Muehling 1983). It has been argued that supplier dependence increases exposure to risk such as global sourcing, cost efficiency and lack of communication between the supply chain networks (Sreedevi & Saranga 2017). The buyer-supplier relationship forms from recognizing and consciously developing actions. It is possible to leave the relationship at every stage, but after both way commitment, interdependency can become so strong that ending the relationship causes great stress and uncertainty. (Dwyer, Schurr & Oh 1987.)

Buyer-supplier relationship can be divided into two types of a relationship which are formed through a single purchase or deeper collaboration. In a single purchase there is merely non-communication between the parties or to relationship, which is based on cooperation, where the parties can support, trust, and plan the future together. As the dependence between the buyer and the supplier increases, this leads to deeper communication, cooperation planning, risk preventing, and trust between the parties. (Dwyer er al. 1987.) High volume consolidation increase dependence between both buying and selling company (Cai et al. 2010). Power dependency describes when buyer becomes power source of the supplier and vice versa, it's an imbalance of the other party's contribution to the relationship (Caniëls & Gelderman 2007; Mohanty & Gahan 2012). One description is that the relative power of a company over another is a consequence of dependence on the other (Caniëls & Gelderman 2007). The level of dependency reflects how much the results of one party are determined by the actions of the other organization (Krause & Ellram 2014).

Mutuality of dependence means that both parties have power over each other (Krause & Ellram 2014). Balanced dependency could lead to a stronger relationship, a long-term union, reciprocal trust, both way dedication and to create new opportunities (Mohanty & Gahan 2012). Dependence level is higher in relationships where there are relatively few suppliers (Krause & Ellram 2014). Unsymmetric relationship can cause the independent partner to confront greater power and try to take advantage of it. Buyer-supplier unbalance relationship can lead to unproductive partnerships and in the long term for the weaker party's position to decline or even for the partnership come to an end. (Caniëls & Gelderman 2007.) Buyer-supplier relations can be fragile, as changing technology and markets cause uncertainty and risks, which can lead to termination of the relationships (Krause & Ellram 2014). Unbalanced relationships are characterized by conflicts and limited cooperation (Caniëls & Gelderman 2007).

Buyer-supplier relationships are important in the world of business, as they involve two parties with different goals and objectives working together to achieve mutual benefits. Power dependency plays a significant role in these relationships, as it refers to the level of control or influence one party has over the other. The level of power dependency between buyers and suppliers can have a significant impact on the dynamics of the relationship and can even determine its success or failure. For instance, when a buyer has high power dependency on a supplier, they may be more susceptible to supplier manipulation and may struggle to negotiate favourable terms. On the other hand, if a supplier has high power dependency on a buyer, they may struggle to secure better prices and may be forced to accept unfavourable terms. In order to manage power dependency effectively, it is important for both parties to understand each other's needs, goals, and objectives, and to work towards creating a mutually beneficial relationship. This can involve building trust, effective communication, and negotiating fair terms and conditions. Ultimately, a successful buyer-supplier relationship is one that is built on trust, respect, and mutual benefit.

2.5 Supplier development

One of the procurement key goals is to ensure competent suppliers. Supplier development (SD) includes evaluation of suppliers which lead to act of improvements, training, and investments (Krause & Ellram 1997a.) and through these activities it is possible for buyer company to achieve reduced costs, better quality, and more efficient production (Nagati & Rebolledo 2013). Companies strategically develop suppliers and optimize supply base to achieve long-term and sustainable competitive advantage for both parties (Krause & Ellram 1997b; Sunil & Routroy 2018). Improved buyer-supplier relationship increases knowledge transfer through activities like training, education and working together (Nagati & Rebolledo 2013). When buyer company evaluated qualified suppliers according to capabilities, buyer could reward the supplier's efficient operation and development work. These incentives can motivate the supplier if they have desire to develop own operations. SD can deepen relationship, improve performance and capability in life cycle. (Arroyo-Lopez et al. 2012.) SD practices improve manufacturing company’s financial performance and procurement becomes more stable and easier to forecast (Sunil & Routroy 2018). Supplier development needs both way motivation and commitment where key factors are trust and transparency.

Supplier development critical factors are organization management involvement, long-term goals, and objectives. It’s also crucial to identify suppliers critical to the success of a SD program. (Krause & Ellram 1997b.) and suppliers' ability to adopt information (Arroyo-López et al. 2012). Buying companies often interfere to their suppliers' performance and capability problems. Suppliers’ performance is only as good as it needs to be, so it is up to the buying company to determine what they need from suppliers in terms of quality, technology requirement and development acts. (Krause & Ellram 1997a.)

Outsourcing is part of manufacturing industry, but it also brings disadvantages such as problems in global operating environment, regional politics, and investments in foreign country. Problems also occur by not having effective key performance indicators to measure suppliers’ performance or missing follow-up procedures and finding skilled workforce. (Sunil & Routroy 2018.) Measured KPI could be delivery, price, and quality performance, or also flexibility, risk mitigation and supplier development in related to e.g., innovations or strategic importance (Weigel & Ruecker 2017, 53–54). SD actions should not only add new requirements for the supplier but instead increase buyer company support in supplier development actions (Sunil & Routroy 2018). It is difficult to try to develop the relationship if information is not shared between the parties or if the supplier has not been given feedback or training to achieve development activities. Information sharing in business also involves risks, for example information leaks in product development, but the benefits of cooperation are higher than the risk. However, the supplier development act is not intended for all suppliers and therefore it is important to implement supplier analysis at the beginning. Overall, a successful SD program requires a long-term commitment from both the organization and its suppliers, and a willingness to work collaboratively towards shared goals.

2.6 Approved supplier list

Supply chain management should continuously develop and monitor supplier performance (Dey et al. 2015; Manning 2013, 119) and approved supplier list (ASL) is a tool for new suppliers onboarding, as well as for ongoing monitoring for existing suppliers. (Manning 2013, 119; Natarajan 2017, 78-80). According Dey et al. (2015) supplier performance evaluation will not only improve supply chain performance, but it will create new opportunities throughout the organization. Supplier status can be changed for example through auditing or declined performance and that way approved supplier can be removed from ASL (Singh 2020, 1):

"The primary purpose of the ASL is to ensure the placement of purchase orders or contracts are limited to those suppliers that meet the company's established criteria for supplier selection, evaluation, and re-evaluation."

Supplier selection process starts from problem and criteria specification, supplier evaluation and re-evaluation (de Boer et al. 2001; Singh 2020). Although the criteria defined for evaluating of suppliers is essential, these measures are hard to identify and that way a challenging part of the process (Dey et al. 2015). These parameters of supplier analysis can be, for example, supplier capabilities, buyer-vendor relationship type (Arroyo-Lopez et al. 2012), capacity, quality, lead time and performance (Dey et al. 2015). ASL allows organization to create cost savings through buyer-supplier contracts, lower risks in quality problems and lead times, and improve buyer-supplier long-term relationship (Roy 2003). When using suppliers according ASL requirements it will guarantee control in final product manufacturing (Manning 2013, 119). ISO 9001 quality management standard specifies that the company should maintain ASL, but the company must itself determine criteria to add and remove suppliers from the list (Singh 2020). ISO 9001 and ISO 14001 standards are presented more detailed in the section 3.3.

Supplier selection starts by defining the problem and finding the right solution (de Boer et al. 2001). Supplier selection process, shown in Figure 3 below, starts by defining what the company's goals are with supplier selection, determine the criteria and pre-analysing of relevant suppliers before making a final choice. In problem definition phase suppliers are evaluated should they be used or replaced by another supplier. In the second phase criteria are chosen according to the data available on suppliers history and it is used on qualification phase. In the selection phase suppliers are analysed through available data. (de Boer et al.

2001.) Qualitative and quantitative tools are used in supplier evaluation and selection (Dey et al. 2015; de Boer et al. 2001).

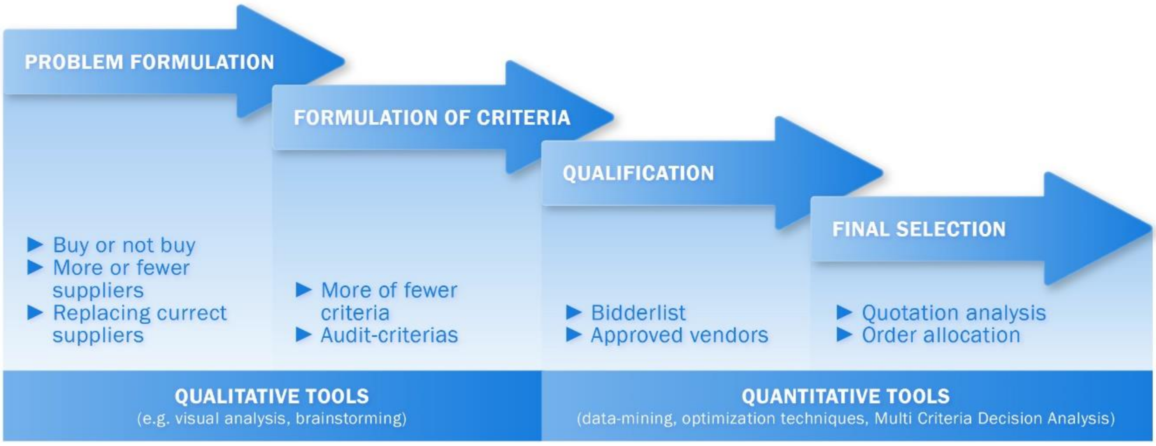

Figure 3. Decision methods in supplier selection (de Boer et al. 2001)

The goal in supplier evaluation and relationship development is to increase the company's profit and turnover, achieve new business opportunities and improve customer satisfaction. To achieve this, supplier performance is evaluated through performance indicators which could be divided in two sections, supplier performance (quality, delivery, cost) and capability (organizational, environmental, social and risk) shown in Figure 4. (Dey et al. 2015.) De Boer et al. (2001) suggested Kraljic's portfolio approach to identify suppliers profit impact and supply risk. Profit impacts can be measured by changes in the product quality or quantity. Supply risks means problems in availability of the goods and suppliers. (de Boer et al. 2001.) When suppliers are evaluated through multiple criteria the buyer company should discuss with the vendor about the action plans for the desired changes. The buyer company evaluates the suppliers progress after an agreed period, to see if the supplier's performance has improved since the previous evaluation. (Dey et al. 2015.)

Figure 4. Supplier performance measurements (Dey et al. 2015)

Approved supplier list must be maintained according to the quality of the products and the results of audits. Supplier can be added and removed from ASL. Procurement is often the team that maintains the list, but they should always inform quality management system process owner, if any updates to the process have been made. (Singh 2020.) Therefore, the ASL is a component of a QMS. An organization's QMS may include processes for selecting and approving suppliers, and the ASL may be used as a reference during this process. The ASL may also be used as a tool for monitoring supplier performance and ensuring that suppliers continue to meet the organization's quality requirements. In summary QMS and ASL are used to ensure that suppliers meet organizations quality requirements.

3. Tools and analysis methods for supplier base management

Procurement is an important function of supply chain management (SCM) and choosing metrics for purchasing are key to manufacturing lead time, effectiveness, and reliable supply chain. Therefore, procurement integration to organization strategy can increase profitability of the company. (Zemmy & Setiyowati 2021.) Procurement strategy means tactic approaches and blend of activities used in purchasing (Hesping & Schiele 2016). Procurement needs data from different sources to analyse the existing supplier base and new suppliers to obtain information to support decision-making. Data can be available from open sources, supplier audits, and market analysis which can be done for example in subcontractor fairs. (Weigel & Ruecker 2017, 111–113.)

Price bidding and cost savings targets often comes from the pressure of the company's management to make company level profit and good tool to it is ABC analysis. Value analysis is based to identify value adding and not value adding actions in the company to enhance value-adding activities and reduce transition times between them. (Weigel & Ruecker 2017, 114–115.) Portfolio models are tools to identify right way of managing the different suppliers. To improve supplier performance the company should conclude approaches they are using with each supplier. (Hesping & Schiele 2016.) With Kraljic’s matrix all suppliers are analysed by profit and inventory risk which are chosen according to the organization strategy. These two criteria’s can be for example cost, quality, lead time or effectiveness of processes. While creating purchasing portfolio matrix criteria should be prioritized according to importance. (Zemmy & Setiyowati 2021.)

Supplier base management is a crucial aspect of procurement and SCM. It involves identifying, selecting, and managing suppliers to ensure the best possible outcomes in terms of cost, service, and quality. There are several tools and analysis methods available for supplier base management, including ABC analysis, purchasing portfolio model, and ISO 9001. In summary, these tools and analysis methods for supplier base management are essential for organizations to effectively manage their suppliers and ensure the best possible outcome. In next sections ABC analysis, purchasing portfolio model and ISO 9001 are presented in more detail.

3.1 ABC Analysis

ABC analysis is the tool to recognize important things from non-essential ones. Assessment type is quantity and cost ratio, where the method describes through analysis that small quantities of high cost affect total value more than a large quantity of small cost. The values are ranked and sorted according to their financial importance. (Weigel & Ruecker 2017, 120.) ABC analysis is a tool used in business and procurement to help categorize items based on their value or importance to the organization. The tool is used to identify the items that are critical to the organization's success and prioritize them accordingly. The ABC analysis tool categorizes items into three categories where A includes most valuable items, but less in numbers, while C is categorised as financially insignificant and includes multiple items (Khurana & Kumar 2017). B products are in between these two. Pareto principle is rule of division in 80/20 and same principle is used in ABC analysis, where few items that bring the most benefit to your business (A items) and the many items that make up a small portion of your business (C items). (Thieuleux 2022.)

ABC analysis aims to classification according to material cost, annual consumption, or inventory contribution. A items annual value cover 70-80% of company total purchases, B items 15-25% and C items 5%. (Khurana & Kumar 2017.) Weigel and Ruecker (2017, 114–115) suggest value analysis in addition to cost analysis. Price and value analysis together create cost savings and cooperation between buyer supplier optimising tacit information sharing. (Weigel & Ruecker 2017, 114–115.)

The purpose of using the ABC or ABCD analysis tool is to help organizations prioritize their resources and efforts by focusing on the most important items, such as A items, and allocating resources accordingly. This method helps organizations to prioritize their efforts and resources on the most important suppliers. This allows organizations to optimize their inventory management, procurement, and supply chain operations. Overall, the ABC analysis tool is a valuable tool for organizations to manage their inventory, procurement, and supply chain operations more efficiently and effectively.

3.2 Purchasing portfolio model

Purchasing portfolio model is a tool which is used when outsourcing decision has been already made. Portfolio models are generally critiqued for their limited suitability. According to many authors three steps are required in PPM, these are examination of the product specifications, the second evaluate supplier relationship and finally match product requirement with supplier capabilities. (Nellore & Söderquist 2000.) Next paragraphs introduce two different models, Kraljic's and Olsen & Ellram's, and how these models differ from each other.

Kraljic matrix:

Kraljic's model divide suppliers in the four categories according two dimensions which are supply risk and profit impact (Caniëls & Gelderman 2007; Kraljic 1983; Padhi et al. 2012). All four categories (1) strategic, (2) bottleneck, (3) leverage, and (4) non-critical need analytical support for tactic decisions making, such as cost and market analysis. Strategic items require precis forecast and market research and the target are to create long-term supplier relationships and contracts to avoid risks. (Kraljic 1983.) Strategic suppliers are recognized as partners and it's important to focus to enhance relationship and do long-term agreements (Hesping & Schiele 2016; Zemmy & Setiyowati 2021). Characteristic for collaboration is information sharing, and if the problem is the sharing of information, it usually prevents the developing the relationship between the parties (Zemmy & Setiyowati 2021). With bottleneck items recommended tactics and tools are vendor control, verifying volume and inventories through demand forecast and market data (Kraljic 1983). With bottleneck vendors practices like trying to find product substitutes, improved stock control (Hesping & Schiele 2016), monitor and starting cooperation with new suppliers can strengthen the situation (Zemmy & Setiyowati 2021). Market data, demand planning and precise vendor data helps in leverage items vendor selection, target pricing and volume estimation (Kraljic 1983). Leverage items possible strategy could be trying to find replacement vendor (Zemmy & Setiyowati 2021), take advantage of the full purchasing power, perform target pricing and spot purchases. Noncritical items have low strategic relevancy, but these are ordered from many suppliers. (Hesping & Schiele 2016.) Recommended tactics are supply base optimization (Zemmy & Setiyowati 2021) volume consolidation and inventory optimizing (Hesping & Schiele 2016). For noncritical items light demand planning can be enough. The focus can be in consolidation to create savings in transportation cost. (Kraljic 1983.) Over time many authors have upgraded Kraljic's matrix and update recommended tactics. Gathering of these different methods is listed in Table 1 below. (Hesping & Schiele 2016.)

Table 1: Recommended tactics based on the Kraljic matrix (Hesping & Schiele 2016)

Non-critical	Leverage	Bottleneck	Strategic
Efficient process Product standardization Volume consolidation Inventory optimization Rationalize supply base Decentralize procurement Systems contracting Blanket order agreement	Competitive vendor selection Exploit full purchasing power Spot purchasing Value added services Target pricing Short term contracts Leverage volume Establish a good relationship	Widen product specifications Extend competition Volume insurance Security of stock Control of vendors Long term contracts Co-operation partnerships Product substitutes Value analysis	Long-term relationships Risk analysis Product development Detailed market research Vendor control Open book pricing Long-term contracts

Olsen and Ellram:

Olsen and Ellram (1997b) created model which is based on two dimensions, the strategic significancy of the purchase and the challenge of managing the purchasing situation, model shown in Figure 5. Evaluating vendors according to Olsen and Ellram's PPM is the first step from three phases analysis. Two dimensions, difficulty of managing the purchasing situation meaning supply base properties relatively to product complexity, and strategic value of the purchase, meaning economic and competitiveness, are evaluated by procurement employees how they feel and see the purchasing situations. The second phase about evaluating the supplier relationship is defined through supplier economic, performance and organizational factors. In the third phase action plans are chosen according to the categories. If the supplier relationship is strong, usually the recommendation is to continue to develop it, and if it's weak one option is change to another supplier. (Nellore & Söderquist 2000.)

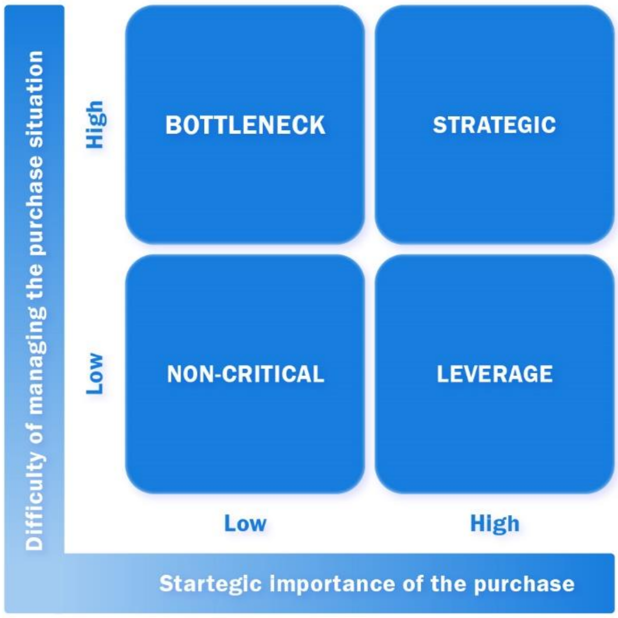

Figure 5. Portfolio model (Olsen & Ellram 1997b)

Even though Olsen & Ellram and Kraljic's use different dimensions in their PPM are the four categories strategic, bottleneck, leverage, and non-critical the same as also the second step where both analyzes buyer and supplier relationship strength. The difference between these two are in the third phase, where Olsen and Ellram create action plans according to product specifications and Kraljic according to analysis of supplier relationship, shown in Table 2. (Nellore & Söderquist 2000.)

Table 2: Differences between Olsen & Ellram's and Kraljic's portfolio models (Nellore & Söderquist 2000)

Step 1	Step 2	Step 3
	Olsen and Ellram	
Two dimensions: Difficulty of managing the purchase situation. Importance of the purchase.	Analyze the supplier relationship for the four categories on two dimensions: Strength of relationship Supplier attractiveness.	Define action plans according product requirements.
	Kraljic	
Two dimensions: Importance of purchase Complexity of the supply market	Investigate supplier and buyer strength for the four categories.	Define action plans to balance relationships.

When suppliers are categorized to PPM it’s possible to identify opportunities and vulnerabilities such as supply risks. The aim is to find balance between different category items and suppliers. When having sole source items, it’s better to create long-term contracts with suppliers and allow higher cost to ensure sufficient supply. (Kraljic 1983.) Portfolio model does not offer the result how to continue from categorization, but it will give a possible operation plans where to choose (Olsen & Ellram 1997b). There are two critics against Kraljic’s model, the design and simplicity having only two dimensions and the problem is that the original PPM is too simple, and the revised models are too complex (Ekström et al. 2021). Based on Hesping and Schiele (2016) research recommends transferring from Kraljic’s matrix, which limits the number of tactics for each quadrant too strictly. In practice, procurement use a combination of all tactics rather than being considered only individual options. The Kraljic matrix can be more useful considered as a tool for discussion and dialogue rather than offering exclusive instructions for choosing the correct strategical approaches. (Hesping & Schiele 2016.) In general, it can be said that management types for all four categories are supply management for strategic, sourcing management for bottleneck, material management for leverage, and purchasing management for non-critical items (Nellore & Söderquist 2000).

To summarize this, the purchasing portfolio model is a broadly used tool in procurement that helps organizations to classify their purchasing items based on certain criteria, such as supply risk and profitability, and to develop a suitable procurement strategy for each category. This model helps organizations to identify which suppliers are critical and require close attention and which suppliers are less critical. Some of the advantages of using PPM in procurement include, better allocation of resources, improved supplier management, more efficient risk management and improved cost management. However, there are also some potential drawbacks to using PPM in procurement, such as inaccurate classification and limited applicability, particularly on cases that involve complex or unique products. PPM can also lead to over-reliance on categorization and a lack of flexibility in procurement strategies, particularly if the criteria used for categorization do not reflect the organization's priorities.

3.3 Quality management ISO 9001 and Environmental management ISO 14001 standards

Semiconductor (semi) manufacturing industry has become a significant contributor to pollution when consumers demand increasingly affordable electronics, which also consume less energy. Also, in semi-processes use different kind of chemicals, which produces emissions and waste. Reducing emissions of the semi-industry will be an important part in the near future, especially if emission restrictions are demanded by the government level. (He & Chen 2022.) In addition to the governmental level, customers are also more aware of factors that stress the environment (Li, Qiao, Cui & Wang 2020). The purpose of anticipation is not only to react to future information, but also proactively evaluate and update existing knowledge and to be ahead of the market. On the other hand, an initiative attitude prevents risks, enables innovations, follow up of market trends and innovations. (Foerstl, Kähkönen, Blome & Goellner 2021.) Often supplier criteria are price, lead time and quality, but growing demand from operating environment and customers could motivate companies to bring sustainable development perspective part of decision making. The same criteria cannot be used for each supplier's product, for example due to material requirements, but environmental, social and governance (ESG) criteria can be considered when evaluating and measuring suppliers' ability while acknowledge the limitations of the product design. (Ji, Ma & Li 2015.) Evaluation methods for external providers can be questionnaire, audit visit, product testing or test order. Supplier selection is made by evaluation and approved suppliers are maintained in approved supplier list. (Natarajan 2017, 78–80.)

Quality management should be involved in process when criteria are chosen for the level of supplier quality, material and service, and what kind of standards are required (Manning 2013, 119–121). The ISO 9000 -series encourages and instructs organizations in systematic, comprehensive quality management, ISO 9001 includes customer focus, product, and supplier management (Pulkkanen 2022). Organization should not only control internal processes, but also products and services which are outsourced or purchased externally. Organization has criteria according to the end products, and the evaluation requirements of external suppliers should be set to achieve the desired result. (Natarajan 2017, 77–78.) ISO 9001 is a guideline for standardized procedures, but not for the final outcome and ISO 14001 correspondingly describe company activities that have environmental effects. Purpose of

ISO 9001 is to implement quality management system containing descriptions of all processes related to the manufacturing of the product or service. (Heras-Saizarbitoria & Boiral 2013.) ISO 9001 describes as follow (Weigel & Ruecker 2017, 52):

“The organisation shall evaluate and select suppliers based on their ability to supply products in accordance with the organization’s requirements. Criteria for selection, evaluation, and re-evaluation shall be established. Records of the results of evaluation and any necessary actions arising from the evaluation shall be maintained.”

ISO 14001 focus environmental aspect such as waste management, emissions and contaminations, recycling, and circular economy (Boiral, Guillaumie, Heras-Saizarbitoria & Tayo Tene 2018; Chiarini 2017).

There are various ways of implement and measure organization environmental impact and even ISO 14001 was designed to reduce the negative impact on the environment it also has increased social and economic outcomes. These improvements in social and economic view can be increased production performance, cost savings, improve financial performance and position in markets. (Boiral et al. 2018.) Customer and employee satisfaction can be measured by questionnaires, but with employee satisfaction can be used also health and safety data, such as noise, dirt and other environmental aspects affected to health and safety conditions (Chiarini 2017).

Risk in applying ISO 14001 practices is to create too much bureaucracy in the company, which increases costs and threatens the company’s productivity. Auditing improvement practices could be focused to critical vendors, ignoring other important stakeholders such as consultants. Disadvantages are usually highlighted only when they are measured, and it is difficult to create a concrete set of indicators for all environmental influences. (Boiral et al. 2018.) According Chiarini (2017) the company has to make expensive investments and the end result of these are uncertain and benefits come in the long term. When manufacturing organization start to implement sustainable standards to its supply chain, problems in implementation is missing knowledge in workforce (Sunil & Routroy 2018). Actions like material saving, waste management, and increased employee environmental awareness connected to daily operations reduce environmental stress, resource consumption, and increase energy savings and main measurement for these are costs (Boiral et al. 2018). Environmental performance should be measured also including consumption and resource savings, while water, energy and consumption savings with recycling and reuse create cost savings (Chiarini 2017). In model of greener purchasing buyer and supplier gain greater profits through recycling, saving materials and product planning utilizing ESG aspects (Ji et al. 2015).

The reason for ISO 14001 implementation growth to many organizations may be increased because Europe's high requirements regarding environmental protection and emission reduction (Chiarini 2017). To success in integration of ISO 14001 practices is management, implementing of new methods to operation, motivation of employees (Boiral et al. 2018) and involving support of top management. Depending on the industry and organization which environmental objectives are relevant to its operational process and therefore objectives need first be identified and defined in order to create environmental strategy. (Chiarini 2017.)

In conclusion ISO 9001 and ISO 14001 are two broadly used international standards that provide a framework for effective quality and environmental management practices. ISO 9001 is a standard that sets out the specifications for a QMS. It aims to ensure that organizations consistently meet the needs and expectations of their customers while continually improving their processes and performance. This standard includes requirements for supplier management, such as supplier evaluation, selection, and monitoring. ISO 14001 is a standard that define the specifications for an environmental management system (EMS). It offers a framework for companies to recognize and manage their environmental impacts, prevent pollution, and comply with applicable environmental regulations. Organizations can become certified to ISO 9001 and ISO 14001 by implementing a QMS and EMS that meets the standard's requirements. Both standards emphasize the importance of continuous improvement, risk management, and stakeholder engagement in achieving effective management practices.

4. Manufacturing business environment

Chapter 4 describes the operating environment of the case company and introduces the primary and secondary data used. Interviews of the company's employees, as well as the company's ERP data and other secondary data has been available for the research. For this presentation, some information has been removed, such as the suppliers' total spend. The names of the case company and suppliers are not mentioned due to the sensitivity of the subject.

Manufacturing companies are moving away from traditional competitive tendering of several suppliers towards a longer-term relationship with a select few suppliers to achieve competitive advantage. This is causing buyer companies to reduce suppliers and develop closer relationships with existing ones. (Krause & Ellram 2014; Mohanty & Gahan 2012) According Chenini et al. (2021) closer buyer-supplier relationship improves product development and quality, information-sharing through collaboration and optimized procurement together with purchasing processes. Buyer company should monitor its supplier performance to achieve more efficient supply chain performance (Dey et al. 2015). A strategic relationship between buyer and supplier can achieve better product availability, cost savings, shorter delivery time, better quality, and information sharing between companies. Sharing forecast and production schedule help partners to develop further. (Ellram & Krause 1994.) Research has found that buyer-team plays the main role in creating supplier relationships, because when purchasing strategy focuses on developing supplier relations, procurement shifts from operational to strategic purchasing. Therefore, buyers' strengths should be in soft skills, such as inspire confidence, communication skills, and commitment. (Mohanty & Gahan 2012.) Because every relationship is unique, to avoid uncertainty and unfair treatment, contract between the manufacturer and a supplier should be created. Contract should specify payment terms in project-specific manufacturing, so that the risks are distributed between both companies, but also indicate who will be responsible for investment and costs. (Buzacott & Peng 2012.)

Precaution helps to protect against potential damage before it happens, but there are events impossible to predict, such as a pandemic (Dionne 2013). COVID-19 have affected global supply chain and businesses when many of jobs and lives have been lost and even forced the factories to close when the supply of materials was prevented, eventually reducing global gross domestic product (GDP) more than five percent (Dohale et al. 2022). Global disruptions in supply chains and the shortage of components slow down the recovery of exports, but as the disruptions ease and export markets continue to grow, exports recover quickly. However, the declining pandemic situation both in Finland and elsewhere in Europe increases the uncertainty of companies and overshadows the recovery from the corona crisis. Disruptions bottlenecks in supply chains and transportation, as well as the rise in the prices of raw materials and energy, have also greatly increased the costs of export companies. (Euro & Talous 2021.)

Industrial production has returned to its pre-pandemic level, although companies report that supply bottlenecks, such as material shortages and logistics problems, are affecting production extensively in Finland. Global supply bottlenecks in the production of semiconductor components such as magnesium and silicon wafers, raw materials, maritime transport, along with rising energy prices have closed factories, extended delivery times, and increased transportation costs and raw material prices since the end of 2020. (Euro & Talous 2021; Lindblad & Sinivuori 2021.) With international travel almost at a standstill, air freight prices have also risen and further increased transport prices (Lindblad & Sinivuori 2021). Labor availability problems and other production bottlenecks limit production, as companies try to recover after the pandemic (Euro & Talous 2021). The reason behind the supply bottlenecks is the change in demand and purchasing behavior. In 2021 almost 70 % of export companies in Finland reported suffering from logistical problems and nearly 60% informed of material shortages. (Lindblad & Sinivuori 2021.)

Strategic sourcing has become more important in the current unstable global supply chain and companies had to change from single sourcing strategy to multiple. Studies show that cost, price, and finance are the most used supplier evaluation criteria in manufacturing business, even if it conflicts with a company's strategic intents. It has been shown that research & development (R&D) and engineering are mandatory in the sourcing process, and other teams are ignored such as operations or sales. Strategic sourcing should be implemented to organization considering agreed company's success factors. (Kotula et al. 2015.)

4.1 Research method and data collection

In this report, a case study of a Finnish technology manufacturing company's supplier base process is presented. The motive for this study arose from the company's need to comprehensively analyse its supplier base. A single case study approach was adopted to gain a deeper understanding of this specific phenomenon through qualitative research. According to Creswell (2014) a qualitative case study is research that includes a thorough, comprehensive study of a single case or phenomenon in a real-life context. The justification for a qualitative case study is in the exploration and understanding of a unique and complex phenomenon. The case study design is appropriate when the research question is focused on how or why a particular phenomenon occurs in a certain context. (Stake 1995.) Business case study is usually practical and as a result, a successful project or a specific business context can be completed (Eriksson & Kovalainen 2008, 116). While the research is limited to a singular company and industry, the findings are informed by the unique research context. As such, the results may not be easily generalizable. However, the choice of a single case study design was intentional, given the manufacturing company's complex network of suppliers. Eriksson and Kovalainen (2008, 119) describes case study as follow:

"Cases are seen as instruments that can be used in exploring specific business-related phenomena, and in developing theoretical propositions that could be tested and generalized to other business contexts or to theory."

The case company's supply base includes total of 259 suppliers and objective is to rationalize suppliers amount to manage the supplier base. Used primary data was interviews of the company's six employees such as category managers, quality manager, product manager and head of supply chain. The material was processed by taking notes and using content wise analyzation. The company's ERP data and other secondary data has been available for the research. Used secondary data was company's internal materials, such as company presentation. The interviews were conducted in the following manner. First, the category managers of each category were interviewed. The observations arising from these discussions were recorded in a supplier Excel sheet, which for example included information on whether the supplier had a framework agreement. Once all the category managers had completed their interviews, the results were discussed with the head of supply chain. Based on the interview with the head of supply chain the first version of the ASL process was created. The ASL draft was presented to the category manager and the process was further developed according to the feedback. In addition, the quality and product managers were interviewed to gather their input on the ASL process development. The interviews consisted of presenting the created process draft and disclose ideas for further improvement. The process was continually refined and developed based on the feedback received. The final version of the process was created in the company's information management system (IMS), with detailed descriptions and instructions.

Without clear guidelines or standards for conducting a single case study, it can be difficult to ensure methodological accuracy and avoid errors in data collection and analysis (Flyvbjerg 2006). The use of case studies has faced criticism due to its primary objective of assisting managers in gaining better control of operations in business organizations. Nevertheless, case studies offer a unique opportunity to comprehend the dynamic and constantly evolving business practices within their social contexts, beyond the limitations of a managerial viewpoint. (Eriksson & Kovalainen 2008, 116.) The limitations and implications of this research methodology are acknowledged, and the findings may serve as a valuable reference for similar industries and contexts. Qualitative research methods are particularly used to investigate the first-hand experiences and concepts in certain group, which is often crucial in understanding complex phenomena. This approach enables the researcher to develop a detailed understanding of the case, as well as identify patterns, themes, and relationships that may not be visible in quantitative research.

4.2 The case company and data used for the case study

In addition to manufacturing, the company also offers various services to its customers around the product it manufactures, such as additional services, research and development, and life cycle services during and after the tool delivery. The case company is classified as an SME. SME stands for Small and Medium-sized Enterprises. It is a term used to refer to businesses that fall within a certain size range. In the European Union, an SME is defined as a business with fewer than 250 employees and an annual turnover of less than €50 million, or an annual balance sheet total of less than €43 million (European Commission 2003). SME’s also tend to be more flexible and responsive to changing market conditions than larger corporations.

Creating strategic procurement starts with examining the organization current situation through data and analysis (Chenini et al. 2021, Weigel & Ruecker 2017, 11–13). In the second phase procurement examinate supplier base and essential supplier markets to create procurement strategy according company's goals (Chenini et al. 2021). Purchasing strategy should implement the company's strategy, values, and targets (Weigel & Ruecker 2017, 13–14). The last stage of strategic procurement is implementation, i.e., the selection of suppliers and supplier development (Chenini et al. 2021). The main steps of the implementation process are shown in Figure 6. For this study first, problem background was formulated and descripted to understand of current state and root causes for the problem. It was decided to have measurable targets, KPI-metrics, such as goal for supplier reduction and approved supplier process. The review of the suppliers started by evaluation by category manager according to sourcing type and value in relation to the total purchases. In each category for the manager, the suppliers are classified according to the type of product the supplier delivers. The supplier can deliver products so that it goes into several categories. In this case, the supplier is evaluated according to the most challenging product. All suppliers were categorized with Kraljic Matrix. Analyzation according to created criteria and a strategy for the development of each supplier category and supplier was decided. Therefore, each category manager analyses own supplier base with the created criteria. As a result, the suppliers are either removed, the co-operation further developed, or old supplier is replaced with an alternative. Through this, the final KPI indicator for the supplier base was discovered.

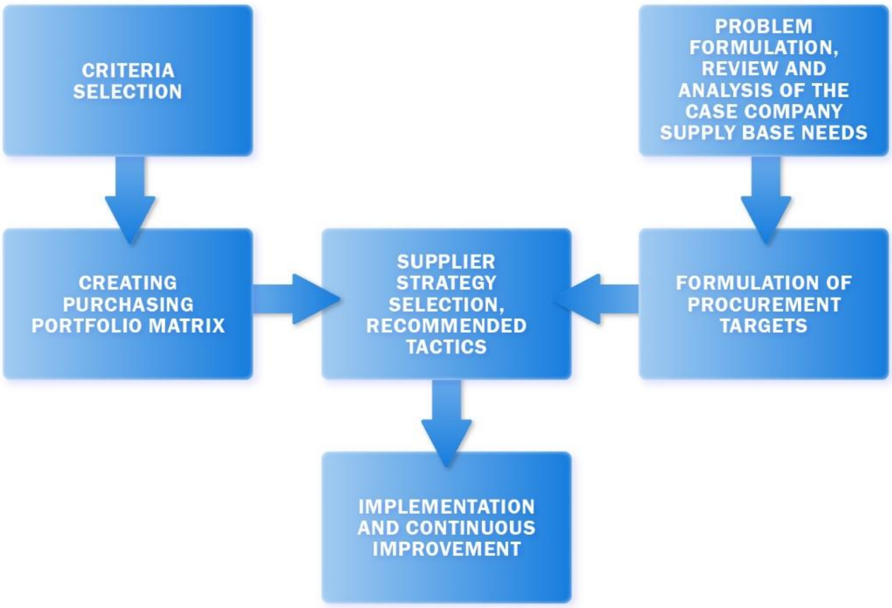

Figure 6. The main steps of the implementation process

For this study, a list was created of all the suppliers used from October 2021 to September 2022, and the annual spend of each supplier. The data was available from the company’s ERP-system. Each supplier was evaluated by category manager according to sourcing type (single, sole, or multiple) and value in relation to the total purchases by ABCD-spend analysis. By examining these criteria, it was concluded whether it is easy or almost impossible to replace the supplier. This information was further used in Kraljic matrix, and through it a recommended tactic for each supplier was obtained. Kraljic's result was a guiding tool for category managers, which strategy should be used with the supplier. However, in the end, the category manager decides which strategy to use in supplier development. Figure 7 presents an example list of how to select recommend tactics based on the guiding tool. Each category manager has been interviewed in the supplier analysis phase. There was total 5 category managers and 259 suppliers.

Supplier	Category	Category responsib	GMTE	Multi-, single-, sole source	SPEND ABC analysis	Difficulty to change supplire (0 = easy, 3=almost impossible)	Kraljic matrix	Recommended tactics
Vendor 1	Key tech	CM 4	Maintain	Sole	A	3	Strategic (B2, B3, A2, A3)	Long-term relationships and contracts
Vendor 2	OEM products	CM 3	Maintain	Multi	A	1	Leverage Items (B0, B1, A0, A1)	Competitive vendor selection
Vendor 3	Welded pipes & valv	CM 3	Maintain	Multi	A	1	Leverage Items (B0, B1, A0, A1)	Competitive vendor selection
Vendor 4	Machined parts	CM 1	Maintain	Multi	A	1	Leverage Items (B0, B1, A0, A1)	Competitive vendor selection
Vendor 5	OEM products	CM 3	Maintain	Multi	A	1	Leverage Items (B0, B1, A0, A1)	Competitive vendor selection
Vendor 6	OEM products	CM 3	Transfer	Single	A	2	Strategic (B2, B3, A2, A3)	Long-term relationships and contracts

Figure 7. Assessment of suppliers according to Kraljic matrix

Additionally, an essential part of this study is how the found criteria and tools are taken into the company's daily processes. For this, processes and process descriptions are created in the company's IMS, as well as linked to more detailed instructions. Created approved supplier process frames are represented in Figure 8.

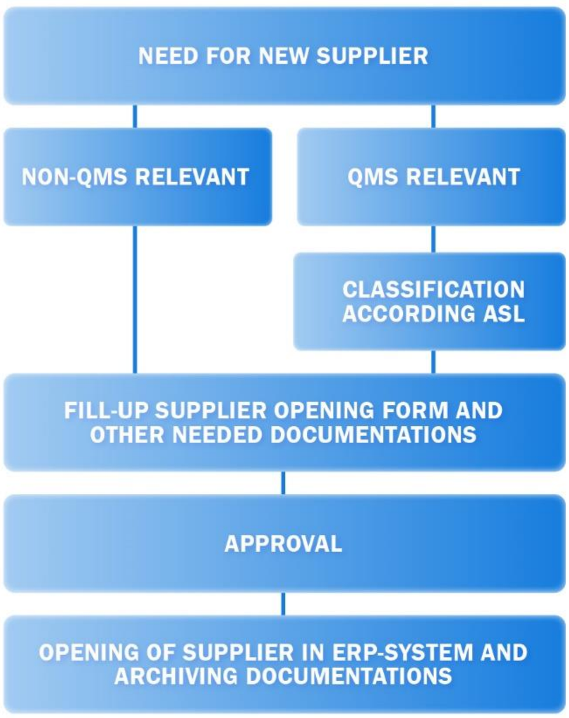

Figure 8. Approved supplier process frames

Opening new vendor starts when company employee noticed that there is need for new supplier and contacts procurement. Procurement defines category manager and is the supplier QMS relevant or not. QMS relevant purchases are parts for final product, including spare parts. The final product is the tool that is sold to the customer. Non-QMS relevancy is such as protos and samples, production consumables, marketing and travelling purchases. If the new supplier is non-QMS supplier, then vendor opening form is filled and approved by business line manager. When the supplier is QMS relevant, then category manager check supplier classification by approved supplier list categories and qualifications is verified accordingly. Approval process depends on the ASL category, approval can be category manager, head of supply chain or supplier quality engineer. When the vendor is approved to ASL supplier quality engineer changes supplier status in the company’s ERP-system, and archive needed documentation.

5. Supply base optimization process description and analysis

Product team and engineering are primarily in the sourcing process, which is growing the number of suppliers in supply base (Kotula et al. 2015). The same items being bought from several suppliers led procurement not knowing all suppliers properly. This includes risk in lack of supplier management, higher costs, and quality issues. Problem persists while there is no process for the selection and management of suppliers and it's missing measurable targets. When procurement managers make purchases without tools or processes, this undesired behaviour is called maverick buying (Scott, Burke & Szmerekovsky 2018). However multiple sourcing enables competitive pricing, while buyer dependence on a single supplier increases supply risk (Sarkar & Mohapatra 2006). Supply base volume consolidation may limit the discovery of new potential suppliers from the market. It is the buyer-suppler cooperation that improves supplier performance. (Cai et al. 2010.) In this chapter the optimization of the supplier base, the categorization of suppliers, and supplier approval process are presented in more detail and studied based on theory. Finally, the discussion and conclusion are in Chapter 6.

To have better understanding on the company's supplier base, each category manager went through their own suppliers. When the analyzes of the suppliers have been done according to the suppliers spend, performance, and delivery times, a decision can be made which suppliers to continue the cooperation with (Rombough 2014). The case company's suppliers are divided for five category managers. Table 3 below shows the percentage of share of each category supplier's total spend, number of suppliers, Kraljic's categories per supplier and finally grow, maintain, transfer, exit strategy decision made by category manager. The term "grow" refers to an increase in a supplier's spend, "maintain" implies that the supplier's spend is sustained at its current level, while "transfer" denotes a decrease in a suppliers spend. "Exit" means attempt to terminate the supplier relationship, which could be prompted by a range of factors such as inadequate quality, insignificant purchases, or other compelling reasons.

End result of the analysis is that the company's supply base is total of 259 and detected the possibility of removing 96 suppliers from the supplier base. Eleven suppliers were identified that can be transferred or partly reduced and thus focus purchases on other existing suppliers.

Supplier optimization improves supplier performance and information sharing between buyer and supplier, (Cai et al. 2010) and through volume consolidation the company can focus on most productive and beneficial supplier for its own business (Rombough 2014). This will achieve the goal of 163 suppliers by reducing and centralizing the current supply base. KPI metric 163 should be set for the goal, which is monitored regularly with the category managers. Supply base optimization and supplier spend Excel should continue to be actively used, for example annually when defining a new goal. Next, the data collected from suppliers has been opened according to each category managers (CM), shown in Table 3.

Table 3: Analysis of the supplier base

	CM1	CM2	CM3	CM4	CM5	Total
Spend %	26,2	18,6	32,8	20,3	0,3	98,3
Total vendors	78	88	29	14	7 (*20)	216 (*236)
Kraljic's Bottleneck	14	20	4	2	0	40
Kraljic's Strategic	3	2	5	5	0	15
Kraljic's leverage	7	3	4	1	0	15
Kraljic's non-critical	54	63	16	6	7	146
Grow (GMTE)	1	1	0	0	0	2
Maintain (GMTE)	31	47	14	12	3	107
Transfer (GMTE)	6	0	3	1	1	11
Exit (GMTE)	40	40	12	1	3	96

* Including freight forwarders and couriers

From total suppliers 259 includes other non-relevant supplier 43 which do not belong to any category managers. Non-relevant suppliers are 1,7 % from total supplier spend. CM1 consist of machined parts, sheet metals, other mechanical parts, screws, and fasteners. CM2 includes automation (drives, motors, servos, logic, instrumentation), electrical components and chemicals. CM3 has responsible for original equipment manufacturer (OEM) items, automation (drives, motors, servos, logic, instrumentation), welded pipes and valves. CM4 contain key technology, software, electrical cabinets and cable harness and subcontractors. CM5 in the analysis consist of packaging and labels, but the category responsibility also includes logistics such as freight forwarders and couriers, which are processed in the company without purchase orders and are therefore separate from reporting.

The target of reducing the number of suppliers was completed out with a case-by-case analysis, considering the special characteristics of each supplier. KPI target that was discovered is in accordance with the company’s current situation, and the review of the supplier base and the achievement of the goals, as well as modification, should be continued regularly. Supplier base optimization is a continuous development model, (Ogden & Carter 2008) where close cooperation between buyer and supplier is improved by reducing suppliers (Cai et al. 2010). When going through the supplier, it became apparent that all category managers have suppliers of small spend that they didn’t know about. In some suppliers, a risk was identified that the supplier also offers products to competitors.

At current situation, green values, or sustainable development, such as the minimization of emissions, are not visible in the strategic goals of the case company's supply chain. It has been studied that, in the long term, sustainable development goals improve the profitability of companies (Kumar & Rahman 2016), but external pressure also steers in this direction (Gao et al. 2020; Orji & Ojadi 2021).

5.1 Analysis supplier categorization

Suppliers are categorized by Kraljic’s purchasing portfolio matrix to four categories, which are analyzed more closely in Table 4. Other non-relevant suppliers total 43 spend 1,7% all with value category C are excluded from the table. Non-relevant suppliers are various service providers, production and warehouse consumption, storage supplies, office furniture etc. Next all four categories are presented more closely.

Table 4: Analysis of supplier categorization

	Bottleneck	Strategic	Leverage	Non-critical
Spend share - %	7,9	41,3	39,3	9,8
Value ABCD PCS	C 11 / D 29	A 13 / B 2	A 7 / B 8	C 6 / D 140
Grow	0	0	0	2
Maintain	39	13	14	41
Transfer	0	1	1	9
Exit	1	1	0	94
Multi	4	3	13	134
Single	20	9	2	9
Sole	16	3	0	3

To analyse the supplier data according to Kraljic's matrix, two factors are considered: the impact of the product or service on the company's goals, and the supply market complexity. Based on this, the suppliers can be divided into four categories: Bottleneck, Strategic, Leverage, and Non-critical.

To categorize the suppliers, the following parameters are considered:

1. Spend share - the percentage of total spend in each category
2. Value ABCD - the segmentation of suppliers based on their contribution to the company's value chain, where A suppliers have a high contribution and D suppliers have a low contribution.
3. Grow, maintain, transfer, exit - the company's strategy towards each category of supplier
4. Multi, single, sole - the number of suppliers in each category

Using the above parameters, we can categorize the suppliers as follows:

Bottleneck:

These are suppliers who have a low impact on the company's goals but a high supply market complexity. Bottleneck category includes total 40 suppliers which are divided for category managers in a ratio of 14/20/4/2/0. Suggested tactics are volume, vendor and stock control through demand forecast and market data (Hesping & Schiele 2016; Zemmy & Setiyowati 2021). Three bottleneck vendors have framework agreement and two separate controls. Half from the bottleneck vendors are single source and 40 percent are sole source. With sole source vendors suggested tactics are to create long-term contracts and allow higher cost (Kraljic 1983). The share of bottleneck suppliers in total procurement is only 7,9 %. The shares of all categories are shown in a pie chart, Figure 9. However, their value indicates that they are critical to the company's value chain, with a high contribution from suppliers in the D category. Furthermore, the company has no plans to grow or maintain its relationship with these suppliers, indicating that they are indeed a bottleneck to the company's operations.

Strategic:

These are suppliers who have a high impact on the company's goals and a high supply market complexity. There are 15 strategic suppliers which are divided for category managers in a ratio of 3/2/5/5/0. Suggested tactics for strategic vendors are create long-term supplier relationships and contracts (Hesping & Schiele 2016; Kraljic 1983, Zemmy & Setiyowati 2021) using risk analysis and market research as support (Hesping & Schiele 2016; Kraljic 1983). 11 from 15 strategic suppliers have framework agreement or separate control. From the remaining three are contract manufacturers and one key technology company where delivery times have met the company's needs. Strategic group has the highest share from total spend, when it’s 41,3 %, meaning that average spend per vendor is 2,8%. They are critical to the company's value chain, with a high contribution from suppliers in the A category. The company has a balanced strategy towards these suppliers, with plans to maintain, transfer, or exit relationships as required.

Leverage:

These are suppliers who have a high impact on the company's goals but a low supply market complexity. Leverage category includes total fifteen vendors which are divided for category managers in a ratio of 7/3/4/1/0. Suggested tactics are replacing by other vendors (Zemmy & Setiyowati 2021), target pricing and competitive vendor selection (Hesping & Schiele 2016). 12 from 15 leverage supplier have framework agreement or separate control. Leverage suppliers cover 39,3 percent of the suppliers' total spend, so it is the second cost significant category after strategic group. However, their value ABCD indicates that they have a low contribution to the company's value chain, with a high number of suppliers in the

C and D categories. The company has strategy towards these suppliers, with plans to maintain and transfer relationships as required.

Non-critical:

These are suppliers who have a low impact on the company's goals and a low supply market complexity. Non-critical category includes total 146 vendors which are divided for category managers in a ratio of 54/63/16/6/7. Suggested tactics are supply base optimization (Zemmy & Setiyowati 2021) and volume consolidation (Hesping & Schiele 2016; Kraljic 1983). There are many non-critical suppliers, but their annual spend is minor. This seems an insignificant category overall and 94 of the suppliers in this category are marked as exit meaning consolidation of the category by 64 %. Based on the data the suppliers in this category have a low spend share of 9.8%. Their value ABCD indicates that they have a low contribution to the company's value chain, with a high number of suppliers in the C and D categories. The company has a mixed strategy towards these suppliers, with plans to transfer, exit, or maintain relationships as required.

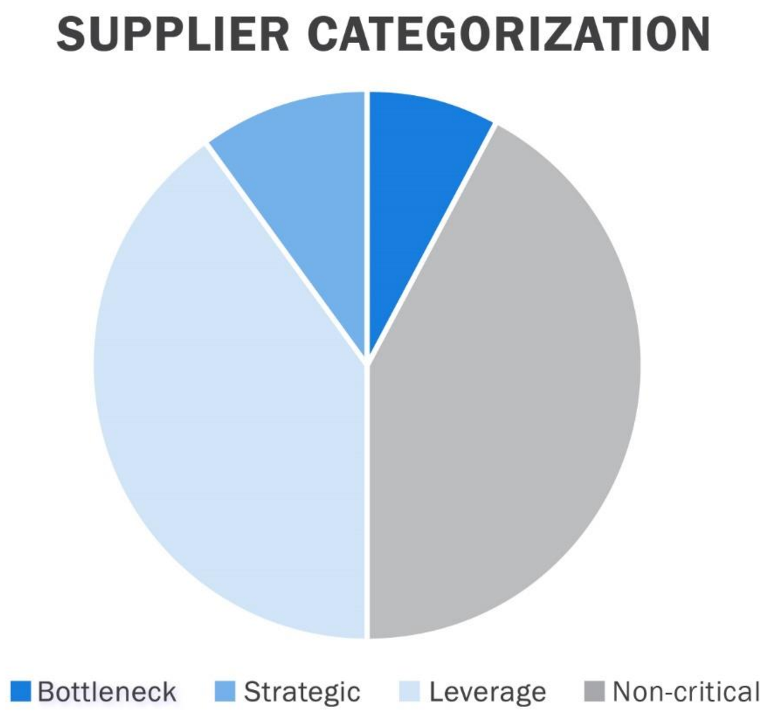

Figure 9. Supplier category shares from total spend

In summary, based on the provided data, it can be noted that the company's bottleneck suppliers are critical to the company's operations and require close monitoring. The strategic suppliers are also critical to the company's goals, and the company has a balanced strategy towards these suppliers. The leverage suppliers have a significant spend share but have a low contribution to the company's value chain, while the non-critical suppliers have a low spend share and a low contribution to the company's value chain.

5.2 Approved supplier list process description

The purpose of approved supplier list is to describe how suppliers of materials, components and services are classified, approved, and re-evaluated. An approved supplier list is a document or database that contains a list of suppliers who have been approved by an organization to provide goods or services. The purpose of an ASL is to ensure that the organization only works with suppliers who meet certain quality and performance standards.

In implement phase it’s not only about reducing supply base, but also specifying new supplier onboarding process and making sure that the whole organization processes prevent misusage of suppliers or purchases. In this way, the amount of work required for monitoring and follow-ups is reduced. (Ogden & Carter 2008.) Creating an ASL involves evaluating and selecting suppliers based on their ability to meet the organization's requirements for quality, reliability, pricing, delivery times, and other criteria. Once a supplier is added to the ASL, they may be subject to ongoing monitoring and evaluation to ensure that they continue to meet the organization's standards. Using an ASL can help an organization streamline its supplier selection process, reduce the risk of working with unreliable or low-quality suppliers, and maintain consistent quality standards across its supply chain.

In the ASL process, the QMS helps to ensure that suppliers are evaluated and selected based on objective criteria related to quality and performance. The QMS provides a framework for defining these criteria, documenting the selection process, and monitoring and evaluating supplier performance over time. The QMS can also help to ensure that suppliers are held accountable for meeting quality standards by establishing clear performance metrics and monitoring their compliance with these metrics. This can help to reduce the risk of quality issues, delays, or other problems that can arise from working with suppliers who do not meet the organization's standards. The supplier classification process involves categorizing suppliers based on their criticality and importance to the organization. This categorization helps organizations to prioritize supplier evaluations and approvals based on their importance in the supply chain.

The approval process involves reviewing the results of the supplier evaluation and qualification process to determine if the supplier meets the organization's requirements. Organizations may also perform site visits, audits, and performance evaluations of the supplier to ensure that they continue to meet the organization's standards. The supplier classification, qualification, and approval process should be documented, and procedures should be established to ensure that it is consistently followed. This can include documenting the criteria for supplier evaluation and approval, defining the roles and responsibilities of personnel involved in the process, and establishing a process for ongoing monitoring and evaluation of suppliers.

Suppliers are classified per product they provide. Classification will be documented on the ASL. If the supplier is classified into multiple categories, the most demanding category should be followed. Supplier classification for each category and approval criteria are presented next.

QMS supplier, ASL qualifications:

1. Contract manufacturing
2. Supplier of custom components and assemblies against the company’s specifications
3. OEM commercial available parts
4. Other service providers /consultants

It should be defined for each category what products are being purchased. Supplier opening form is created and approved by business line manager. For most demanding categories approval criteria can be ISO 9001-certificate or documented QMS, ISO 14001-standard requirements are met, filled supplier self-questionnaire, site audit, NDA (Non-disclosure agreement), quality agreement including quality requirements and financial check. The aim is that the supplier meets these requirements, but the decision whether to accept a lighter method is made on a case-by-case basis. By following a well-defined supplier classification, qualification, and approval process, organizations can ensure that their ASL only includes suppliers who meet their quality, performance, and regulatory requirements. This can help to reduce the risk of quality issues, supply chain disruptions, and non-compliance with regulatory requirements. Interviewee no. 1 said:

“Suppliers should have standardized quality policy. QMS, objectives, analyzing quality claims and preventing quality problems. Process control for defected parts etc.”

Interviewee no. 2 said:

“Significant suppliers must have quality management processes described, such as a documented quality management system.”

When has identified a need to disqualify approved supplier, this needs process. Supplier disqualification is not the first thing, at first you should try to solve the problems. Interviewee no. 3 said:

“Supplier disqualification is not the first thing to do, at first it should try to solve the problems. Changing supplier requires case-by-case consideration, taking into account framework agreements and what type of supplier it is. If it’s a contract manufacturer, changing would be very laborious.”

and continues:

“Problems should be detected before they become major, for example quality issues.”

Depending on the category who is responsible for approving or not QMS supplier to ASL.

Interviewee no. 3 said:

“The tighter the situation, the more people should be involved in the decision making, in the approval process.”

It can therefore be concluded that several people should be involved in the evaluation and approval of the more challenging categories (1 and 2), considering the complexity of the supplier and the product. In the simplest categories (3 and 4), the supplier can be approved by the category manager. Non-QMS supplier can be approved by business line manager. A business line manager refers to a person responsible for managing a specific function or department within an organization. For example, a sales manager would be responsible for managing the sales department of a company.

6. Discussion and Conclusions

The study focuses on the supplier base evaluation and optimization in a single manufacturing company. The aim of the study is to identify ways to manage the supplier base by conducting a literature review of supplier selection processes, supply base optimization, supplier criteria and approved supplier list. The study combines theoretical and empirical data to compare the differences between theory and practice and to present possible recommendations for improvement.

The study's main limitation is that it is based on a single case study, which limits the generalizability of the findings. The study did not consider other companies in the sector, which limits the ability to compare the case company's practices with other companies' practices. Therefore, caution should be exercised when applying the recommendations presented in this study to other manufacturing companies.

The study findings suggest that supply base optimization is a comprehensive process that includes supplier evaluation, categorization, supplier risk management, supplier development, approved suppliers list process, and supplier onboarding process. The results show that these processes are closely related and part of the whole optimization process. The study suggests that the adoption of a supply base optimization strategy, which involves reducing the number of suppliers while increasing the strategic importance of the remaining suppliers, would enable the company to increase its bargaining power, reduce supply chain complexity, and improve supplier performance.

The study's surprising finding was that supply base optimization included everything that the case company assigned in terms of the ASL process and supplier onboarding process. This finding highlights the importance of a comprehensive supply base optimization strategy that considers all aspects of the supplier base management process. The study suggests that further research should be conducted to survey suppliers on relationship development proposals and to investigate the limitations that the criteria create for the supplier. Further research into how supplier optimization actions work in practice is also recommended.

6.1 The research questions and discussion of the findings

This section provides a brief discussion of the results and responses to this study to the research questions presented in chapter 1. In addition, there will be a short discussion on the topic and the results of this study compared to other studies.

The main research question: “*How to optimize supplier base?”*

Before answering to main research question, sub-research questions were prepared to support. At first sub-research question answers are presented:

RQ 1) “What kind of methods there are for supplier base optimization?”

Supplier base optimization is the process of strategically managing and consolidating a company's supplier base to improve its overall supply chain performance. The optimization process typically involves several key components such as volume consolidation (Rombough 2014), supplier risk management (Sreedevi & Saranga 2017), supplier evaluation and categorization (Gao et al. 2020), buyer and vendor power dependency (Dwyer et al. 1987), and supplier development (Krause & Ellram 1997b). In addition, the process often includes the creation of an approved suppliers list and supplier performance measurement for classifications and analysis (Manning 2013).

Volume consolidation:

Volume consolidation involves reducing the number of suppliers a company uses to optimize its purchasing power and increase the efficiency of its supply chain (Rombough 2014). By consolidating suppliers, companies can reduce transaction costs and simplify their procurement processes, which can lead to lower prices, better quality, and faster delivery times (Cai et al. 2010). Supplier risk management is another critical aspect of supplier base optimization. Companies must assess the risks associated with their suppliers and implement strategies to mitigate those risks (Weigel & Ruecker 2017, 87–89). This may include conducting background checks, monitoring supplier performance, and developing contingency plans for supplier disruptions.

Supplier evaluation and categorization:

Supplier evaluation and categorization involve assessing suppliers based on their performance, capabilities, and strategic fit with the company's goals. Companies can use a variety of methods to evaluate suppliers, such as surveys, site visits, and performance metrics (Orji & Ojadi 2021). Categorizing suppliers can help companies prioritize their suppliers and allocate resources more effectively (Chunguang et al. 2017).

Power dependency and supplier development:

Buyer-supplier power dependency is an essential consideration in supplier base optimization. Companies must analyse their power dynamics with suppliers to understand their bargaining position and negotiate favourable terms. Developing strong relationships with key suppliers can also help reduce the risk of disruptions and improve supply chain performance (Mohanty & Gahan 2012). Supplier development is another critical component of supplier base optimization. Companies can work with their suppliers to improve their performance (Arroyo-Lopez et al. 2012), develop new products or services, and create long-term partnerships (Krause & Ellram 1997a). Supplier development can help companies reduce costs, improve quality, and increase innovation (Nagati & Rebolledo 2013).

Approved supplier list:

Creating an approved suppliers list is a key component of supplier base optimization. The list should include only the most reliable, high-performing suppliers, which can help reduce risk and improve supply chain performance. Companies should regularly review and update the list to ensure that it remains relevant and effective. (Singh 2020.) Finally, supplier performance measurement is crucial for supplier base optimization (Dey et al. 2015; Manning 2013, 119). Companies can use a variety of metrics to measure supplier performance, such as delivery times, quality, and cost. Analysing supplier performance data can help companies identify areas for improvement and make data-driven decisions about their supplier base. (Dey et al. 2015.)

In conclusion, supplier base optimization is a critical process for companies seeking to improve their supply chain performance. By consolidating suppliers, managing risk, evaluating, and categorizing suppliers, understanding buyer and vendor power dependency, developing suppliers, creating an approved suppliers list, and measuring supplier performance, companies can optimize their supplier base and achieve better results.

RQ 2) "How to categorize different suppliers, considering the specific characteristics of the suppliers and the industry?"

Categorizing different suppliers is an important task for any industry, as it allows for effective supplier management and helps to ensure that procurement processes are optimized. The categorization of suppliers involves grouping them based on specific characteristics that are relevant to the industry or business (Zemmy & Setiyowati 2021). Some of the key characteristics that may be considered when categorizing suppliers include level of expertise, industry specialization, product specifications, and performance level (Nellore & Söderquist 2000).

Approach to categorizing suppliers is to use a matrix based on factors such as risk, profitability, and complexity (Caniëls & Gelderman 2007; Nellore & Söderquist 2000). The matrix would have four quadrants: strategic, leverage, bottleneck, and non-critical (Kraljic 1983; Olsen & Ellram 1997b). Strategic suppliers are those that are critical to the success of the business and are high-risk/high-profit. Leverage suppliers are those that offer high-profit margins and are low-risk. Bottleneck suppliers are those that may cause issues in the supply chain and are high-risk/low-profit. Non-critical suppliers are those that are low-risk/low-profit and do not have a significant impact on the business. (Kraljic 1983.) The categorization of suppliers can also be based on the type of products or services they offer. For example, suppliers may be categorized as raw material suppliers, component suppliers, or finished goods suppliers. This approach can be particularly useful for industries such as manufacturing, where the supply chain is complex and requires careful management.

Overall, the categorization of suppliers requires careful consideration of a range of factors and may involve the use of multiple categorization approaches. By categorizing suppliers effectively, businesses can ensure that their procurement processes are optimized, and that they are able to build strong, long-term relationships with their suppliers.

According to information sub-research questions provide it can be answered to the main research question: "*How to optimize supplier base?*"

The process of supplier categorization involves the systematic grouping of suppliers based on various criteria such as their importance, criticality, and risk. To achieve this, organizations use a purchasing portfolio model that enables them to categorize suppliers based on their strategic importance and risk, thereby facilitating the prioritization of supplier management efforts and the effective allocation of resources. In the case company, suppliers are divided among five category managers based on the type of product they provide. Each supplier was categorized using the Kraljic matrix, and a final decision was made by the category manager regarding whether to grow, maintain, transfer or exit (GMTE) the relationship with each supplier.

It was discovered that there is a possibility of removing 96 suppliers from the supply base, and CM1 and CM2 both ended up removing 40 suppliers each, leaving them with an unbalanced workload compared to the other category managers. Additionally, CM1 and CM2 have 44.8% of the total spend, making their categories financially valuable. These two categories also have the largest number of bottleneck suppliers, with 34 out of the total 40 bottleneck suppliers, as well as most of the non-critical vendors, numbering 117 out of 146. Therefore, the workload assignments for CM1 and CM2 employees are disproportionate, and it is necessary to reconsider the category divisions to balance the workload and ensure that everyone has the same capabilities to further develop supplier relations.

To address the bottleneck suppliers, it is recommended to establish more contracts, raise stock, and manage suppliers with whom there is no corresponding control yet. With sole source suppliers, it may be acceptable to create long-term contracts and accept higher costs. Among the strategic suppliers, four out of 15 suppliers are missing framework agreements or separate control, so it is advisable to create missing contracts and ensure that contracts with suppliers and contract manufacturers are up to date. The strategic suppliers are the most valuable category and therefore critical to the company's operations. The non-critical category comprises a total of 146 vendors, but their annual spend is minor. Ninety-four suppliers in this category are marked as exit, meaning that the category should be consolidated by 64%. As mentioned in the previous paragraph, the workload is mainly divided between CM1 and CM2.

The buyer-supplier relationship is a critical aspect of procurement that encompasses the interactions between a buyer and a supplier. Power dependency is a concept that describes the extent to which one party in the relationship is reliant on the other. It is vital for organizations to manage these relationships effectively to ensure that they can obtain the best value from their suppliers. Supplier development is a strategic approach that aims to enhance supplier performance by promoting collaboration and training (Krause & Ellram 1997a). This process involves identifying areas for improvement, devising an action plan, and tracking progress to achieve mutually beneficial outcomes (Sunil & Routroy 2018). The goal of supplier development is to establish long-term partnerships that result in improved supplier performance, reduced costs, and enhanced quality (Nagati & Rebolledo 2013).

It is essential for organizations to proactively manage their supplier relationships and identify areas for improvement. This is particularly important in the context of small spend suppliers that may be overlooked by category managers. Through effective supplier development, organizations can improve their relationships with suppliers and enhance overall procurement performance (Arroyo-Lopez et al. 2012). It is also important to identify potential risks associated with supplier relationships (Sunil & Routroy 2018). In some cases, suppliers may offer products to competitors, which can create conflicts of interest and jeopardize the buyer-supplier relationship. By identifying such risks, organizations can develop strategies to mitigate them and ensure that their procurement activities remain transparent and ethical.

Supplier and risk management are critical processes that involve identifying, assessing, and mitigating the risks associated with suppliers of goods and services to an organization. Effective supplier management requires the identification of potential risks, evaluation of the probability and impact of those risks, and the development of strategies to manage them (Weigel & Ruecker 2017, 52–54). Risk management is essential for organizations to ensure that their procurement activities are sustainable, ethical, and compliant with regulations (Li et al. 2020). Effective supplier and risk management also requires organizations to continuously monitor and assess supplier performance (Weigel & Ruecker 2017, 87–89). This involves tracking supplier performance metrics, such as delivery times, quality levels (Weigel & Ruecker 2017, 52–54), and compliance with ethical and sustainability standards (Li et al. 2020). By continuously monitoring supplier performance, organizations can identify potential risks and take corrective actions to minimize their impact (Weigel & Ruecker 2017, 87–89). Furthermore, the use of supplier spend Excel can help organizations to monitor their spending patterns and identify opportunities for cost-saving measures. By continuously managing supplier and risk management, organizations can minimize risks, improve supplier performance, and achieve their procurement objectives.

An approved supplier list refers to a comprehensive roster of suppliers that have been sanctioned by an organization to provide goods or services. The process of creating such a list involves a thorough evaluation of potential suppliers against the organization's established standards of quality, delivery, and cost (Dey et al. 2015). For the present case company, an initial version of the ASL process and instructions has been created, and relevant categories have been identified and incorporated into the system. However, the key to successful implementation is to ensure that the process is continuously improved and updated based on feedback and experiences. The individual in charge of this process must take responsibility for keeping the entire organization informed and updated with the latest information.

During the interviews, it was noted that different perspectives exist concerning supplier requirements. Excessively stringent criteria can limit the number of suppliers, while lax criteria can result in poor quality. To evaluate existing suppliers, the company's guidelines should be considered, and any problems or issues should be discussed with suppliers. The first course of action should be open communication with suppliers to resolve any issues in collaboration with the buyer company. It is also possible to offer orientation, training, and equipment to suppliers in line with the product's quality criteria. Additionally, employees from different departments and levels of the organization should be involved as necessary when evaluating suppliers.

Supplier and risk management, supplier evaluation methods, supplier categorization and purchasing portfolio model, buyer-supplier relationship and power dependency, supplier development, and approved supplier list are all important aspects of supply chain management. Effective management of suppliers is critical for organizations to achieve their strategic goals and objectives. By implementing these practices, organizations can identify potential risks, evaluate supplier performance, categorize suppliers based on importance and risk, develop strong buyer-supplier relationships, improve supplier performance, and ensure that they only work with approved suppliers that meet their standards. It is recommended for the case company to include the perspective of sustainable development in the future to supplier selection and analyzation process.

The study highlights that the adoption of a supply base optimization strategy, which involves reducing the number of suppliers while increasing the strategic importance of the remaining suppliers, would enable the company to increase its bargaining power, reduce supply chain complexity, and improve supplier performance. This strategy also includes the establishment of a standardized supplier selection process that aligns with the company's strategic objectives, as well as the development of supplier relationships that focus on collaboration and value creation.

The research findings further suggest that the company could benefit from creating supplier optimization measurement tool and systematically follow-up supplier performance according to created measurements. It is recommended to implement approved supplier list process, which would enable the company to categorize suppliers based on their strategic importance and level of risk. The adoption of these tools would also enable the company to allocate resources to suppliers more efficiently and develop targeted improvement plans for underperforming suppliers.

6.2 Conclusions

This master's thesis examined the supplier base optimization, evaluation, and selection process in a manufacturing company through a single case study. The research integrated theoretical and empirical data to compare differences between theory and practice and to present recommendations for improvement. The findings revealed that there is a possibility of removing 96 suppliers from the supply base, and category managers workload assignments are disproportionate. Moreover, the study highlights the importance of continuously managing supplier and risk management to minimize risks and improve supplier performance. The study's limitations include the fact that it is based on a single case study and did not consider other companies in the sector. Further research into supplier relationship development proposals and the impact of supplier criteria limitations is recommended. Additionally, exploring how supplier optimization actions work in practice would be beneficial. Overall, this study provides useful insights for practitioners and academics involved in supplier base evaluation and selection in the manufacturing industry.

The study recommends that the case company adopts a supply base optimization strategy and a standardized supplier selection process that aligns with the company's strategic objectives. The company should also develop strategic relationships with its suppliers, implement supplier optimization measurement tool, and categorize suppliers based on their strategic importance and level of risk.

Overall, this study provides valuable insights into the supplier base management practices of a manufacturing company and suggests practical recommendations for improvement. The recommendations presented in this study could be used by other manufacturing companies seeking to optimize their supplier base and improve supplier performance. However, further research is needed to investigate the limitations that the criteria create for the supplier and how supplier optimization actions work in practice.

In conclusion, this study has contributed comprehensive information to the area of supplier base evaluation and selection by examining the theoretical concepts and comparing them with the case company's practices. The results of the study provide a framework for supplier base optimization and supplier performance management, which could be beneficial for other manufacturing companies facing similar challenges. Next, further research topics are presented.

It is strongly advised to conduct an analysis of the effectiveness of the company's supplier evaluation and selection process, in addition to investigating the company's supplier relationship management strategies and their impact on supplier performance. A thorough study of the company's supplier risk management practices and their effectiveness in mitigating supply chain disruptions is also recommended, along with an evaluation of the company's supplier development programs and their influence on supplier performance and overall supply chain efficiency. These suggested research topics have the potential to provide a more comprehensive understanding of the case company's supplier base process and reveal areas where improvements can be made. It should be emphasized that the selection of new research topics should be tailored to meet the specific needs and objectives of the case company.

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