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SPARE PARTS LIFE CYCLE PRICING

Pricing options in heavy machinery spare parts

Master of Science Thesis
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ABSTRACT

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In heavy machinery business, customers want to maximize the uptime and useful life of the machines. Therefore, spare parts have become an important business area for heavy machinery manufacturers. As the competition is constantly increasing, companies are looking for strategic pricing methods that maximize the value captured from the markets. Product life cycle (PLC) approach can be used as the basis for long-term pricing strategies. The demand and other market conditions vary widely from the time a product is first introduced to the markets to the time the product is removed from the markets. Hence, pricing adjustments are needed over PLC. This approach is called life cycle pricing. Existing research shows that life cycle pricing strategies lead to overall higher demand and profitability. However, there is a lack of research in life cycle pricing in business-to-business (B2B) context and moreover in spare parts. Therefore, this study aims to understand spare parts PLC and spare parts life cycle pricing strategies.

The case company of this study has identified the need for spare parts life cycle pricing. However, there is a lack of understanding of the topic in the case company. This study found out that spare parts in the end of PLC are less profitable than spare parts in the beginning of PLC. The objective of this research was to evaluate methods to assess PLC, study spare parts PLC characteristics, and to form a comprehensive framework to use in spare parts life cycle pricing. In addition, the effect of life cycle pricing on spare parts demand and profitability was studied. To reach the objectives, quantitative and qualitative studies were conducted in the case company and combined with existing research. This study focuses especially on the middle and end of PLC as these were perceived as more challenging for companies to manage.

This study suggests that spare parts PLC can be assessed with installed base data combined with spare parts category and type. The research shows that the main determinants for spare parts pricing in general are costs, competition, demand, customer value, spare parts category, customer relationship, and inventory value. By studying the behaviour of these determinants over PLC, spare parts PLC characteristics were formed. When a company can assess the PLC phase of a spare part and understands the PLC characteristics, they can then implement life cycle pricing strategies. Two frameworks for spare parts life cycle pricing were formed. The first framework is for implementing spare parts life cycle pricing by understanding the current situation, setting the objectives, assessing PLC, defining pricing determinants during PLC, creating and implementing the life cycle pricing strategy, and monitoring the results. The second framework is for creating the life cycle pricing strategy. This framework considers the main determinants for key parts and commercial parts in each PLC phase and suggests a pricing strategy based on these.

The results show that life cycle pricing can help to optimize overall demand and profitability of spare parts. Without life cycle pricing spare parts suppliers can price themselves out of the market, or on the other hand, miss the opportunity to charge a premium. This study suggests that it is crucial to consider the spare parts category in life cycle pricing. Based on the results, pricing of key parts can be increased towards the end of PLC when the competition starts to decline. Commercial parts can be priced more steadily over PLC using competitor-based pricing. The case company should follow the implementation framework and evaluate their current PLC assessment method and life cycle pricing strategies. In addition, further research on competitor and supplier behaviour over PLC is needed. The developed life cycle pricing strategies should then be implemented gradually to different spare parts categories.

Keywords: Product life cycle, PLC, spare parts, life cycle pricing, strategic pricing

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TIIVISTELMÄ

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Raskaskonealalla asiakkaat haluavat maksimoida koneiden käyttöajan ja käyttöiän. Siksi varaosista on tullut tärkeä liiketoiminta-alue raskaskonevalmistajille. Jatkuvasti kasvavan kilpailun vuoksi yritykset etsivät strategisia hinnoittelumenetelmiä, jotka maksimoivat markkinoilta saatavan arvon. Tuotteen elinkaarta (PLC) voidaan käyttää pitkäaikaisten hinnoittelustrategioiden perusteena. Tuotteen kysyntä ja muut markkinaolosuhteet vaihtelevat suuresti siitä hetkestä, kun tuote ensimmäisen kerran tuodaan markkinoille, hetkeen, kun tuote poistetaan markkinoilta. Siksi hinnoittelua on tarpeen mukauttaa tuotteen elinkaaren aikana. Tätä lähestymistapaa kutsutaan elinkaarihinnoitteluksi. Olemassa olevat tutkimukset osoittavat, että elinkaarihinnoittelustrategiat johtavat kokonaisvaltaisesti suurempaan kysyntään ja kannattavuuteen. Nykyisessä tutkimuksessa on kuitenkin aukko elinkaarihinnoittelusta business-to-business (B2B) kontekstissa ja edelleen varaosien osalta. Tämän tutkimuksen tavoitteena on siten ymmärtää varaosien PLC:tä ja varaosien elinkaarihinnoittelustrategioita.

Tämän tutkimuksen case-yritys on tunnistanut tarpeen varaosien elinkaarihinnoittelulle. Case-yrityksessä ei kuitenkaan ole kokonaisvaltaista ymmärrystä aiheesta. Tutkimuksen myötä selvisi, että PLC:n lopussa olevat varaosat ovat vähemmän kannattavia kuin PLC:n alkuvaiheessa olevat varaosat. Tämän tutkimuksen tavoitteena oli arvioida menetelmiä PLC:n määrittämiseksi, tutkia varaosien PLC-ominaisuuksia sekä muodostaa kattava viitekehys varaosien elinkaarihinnoittelulle. Lisäksi tutkittiin elinkaarihinnoittelun vaikutusta varaosien kysyntään ja kannattavuuteen. Tavoitteiden saavuttamiseksi tehtiin kvantitatiivisia ja kvalitatiivisia tutkimuksia ja yhdistettiin tulokset nykyisen tutkimuksen kanssa. Tämä työ keskittyy erityisesti PLC:n keski- ja loppuvaiheisiin, sillä näitä pidettiin haastavimpina vaiheina hallita yrityksille.

Tämä tutkimus viittaa siihen, että varaosien PLC voidaan määrittää laitekannan tietojen sekä varaosakategorian ja -tyypin perusteella. Tutkimus osoittaa, että varaosien hinnoittelussa yleisesti tärkeimmät tekijät ovat kustannukset, kilpailu, kysyntä, asiakasarvo, varaosakategoria, asiakassuhde ja varaston arvo. Tutkimalla näiden tekijöiden käyttäytymistä PLC:n aikana muodostettiin varaosien PLC-ominaisuudet. Kun yritys pystyy määrittämään varaosan PLC-vaiheen ja ymmärtää PLC-ominaisuudet, yritys voi implementoida elinkaarihinnoittelustrategioita. Kaksi viitekehystä muodostettiin varaosien elinkaarihinnoittelulle. Ensimmäinen viitekehys kuvaa varaosien elinkaarihinnoittelun implementointia, joka tapahtuu ymmärtämällä nykytilanne, asettamalla tavoitteet, määrittämällä PLC, määrittämällä hinnoittelutekijät PLC:n aikana, kehittämällä ja implementoimalla elinkaarihinnoittelustrategia ja seuraamalla tuloksia. Toinen viitekehys on elinkaarihinnoittelustrategian luomista varten. Viitekehys ottaa huomioon tärkeimmät hinnoittelutekijät avainvaraosille ja kaupallisille varaosille jokaisessa PLC-vaiheessa sekä ehdottaa sopivaa hinnoittelustrategiaa.

Tulokset viittaavat siihen, että elinkaarihinnoittelu voi auttaa optimoimaan varaosien kokonaisvaltaista kysyntää ja kannattavuutta. Ilman elinkaarihinnoittelua varaosatoimittajat saattavat hinnoitella itsensä pois kilpailusta tai toisaalta menettää mahdollisuuden veloittaa kalliimpaa hintaa. Tutkimus viittaa siihen, että elinkaarihinnoittelussa on kriittisen tärkeää ottaa huomioon varaosan kategoria. Tulosten perusteella avainvaraosien hintaa voidaan nostaa PLC:n lopussa, kun kilpailu alkaa vähentyä. Kaupalliset varaosat voidaan hinnoitella tasaisemmin PLC:n aikana käyttäen kilpailuperusteista hinnoittelua. Case-yrityksen tulisi seurata implementointiviitekehystä ja arvioida heidän nykyisiä PLC:n määrittämismenetelmiä ja elinkaarihinnoittelustrategioita. Lisäksi tarvitaan jatkotutkimusta kilpailijoiden ja toimittajien käyttäytymisestä PLC:n aikana. Kehitetyt elinkaarihinnoittelustrategiat tulisi implementoida asteittain eri varaosakategorioihin.

Avainsanat: Tuotteen elinkaari, PLC, varaosat, elinkaarihinnoittelu, strateginen hinnoittelu

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PREFACE

The thesis process has been a very interesting and rewarding process. I have really enjoyed deep diving into spare parts PLC and pricing topics. It feels great to finish my studies with this thesis even though finishing this stage of my life feels bittersweet. I found the beginning of the thesis most challenging as the whole work was still ahead. After some time, the process started to flow well and overall, I really enjoyed working on the thesis. Looking back now, I have learned much during the process.

I want to thank professor Teemu Laine for valuable comments and guidance throughout the process. His comments helped me to clarify the subject and move forward.

I also want to thank the case company and my former supervisor for giving me this opportunity to conduct my thesis as a case study. Conducting the thesis in the case company was motivating as the results felt meaningful in a real business environment. Special thanks to my coworker who also acted as my thesis advisor from the case company. I really valued their professional guidance and detailed comments throughout the process.

I want to give special thanks to my friends with whom we have gone through the entire university journey together. I found the peer support that we gave each other very valuable throughout the whole studies, but especially when we were all working on our theses at the same time. I also want to thank my family for always supporting me.

Tampere, 6.1.2026

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LIST OF ABBREVIATIONS AND SYMBOLS

B2B	Business-to-Business
B2C	Business-to-Consumer
GM	Gross Margin
GM%	Gross Margin Percent
LCC	Life Cycle Costing
MOQ	Minimum Order Quantity
OEM	Original Equipment Manufacturer
PLC	Product Life Cycle
PLM	Product Life Cycle Management

1. INTRODUCTION

1.1 Motivation of the study

Servitization has become a trend changing the way companies are doing business with their customers. Customers now expect to receive services in addition to the traditional products. (Frank et al., 2019) Another trend changing the industry is sustainability. The goal of manufacturing is no longer to produce in the most efficient way possible, but rather to provide the functions needed while minimizing material and energy consumption. (Takata et al., 2004) Customers want to maximize the life cycle of their machines. This means that maintenance and spare parts are becoming more important ways of doing business.

As the spare parts business has risen, firms need to develop new strategies to price the spare parts. One common pricing strategy is to try to match the market demand to optimize profit. New studies show that considering product life cycle (PLC) is an essential part of forecasting demand (Singhal et al., 2024; Sun et al., 2024). However, existing research in dynamic pricing is mostly based on fixed demand although demand is constantly changing over the PLC (Sun et al., 2024). Firms need to predict sales considering PLC and make changes to pricing to match the potential demand in order to increase profit (Sun et al., 2024), plan and follow their strategy (Singhal et al., 2024), survive in the competitive environment (Nnamdi, 2018; Singhal et al., 2024) and manage inventories (Nnamdi, 2018). Although some research exists around life cycle pricing, relatively few studies focus on life cycle pricing in business-to-business (B2B) markets and furthermore in the context of spare parts. Spare parts are often industry-specific since different industries have different kinds of spare parts with varying life cycles (Nnamdi, 2018). Therefore, spare parts should be studied in the context of a specific industry. This study aims to fill a gap by understanding how life cycle pricing can be implemented in heavy machinery spare parts.

The PLC concept explains the market growth, profit, marketing strategy and competition of the product from the moment the product is introduced to the markets to the moment product is removed from the markets (Levitt, 1965). Different phases of PLC can be described as the introduction phase, growth phase, maturity phase and decline phase. In the introduction phase, when a new product is introduced to the markets, demand grows slowly. In the growth phase, demand grows rapidly until it reaches the maturity

phase. In the maturity phase, the market reaches its highest point and market saturation occurs. Finally in the decline phase, demand steadily decreases until market saturation is reached. Most products follow this classic PLC curve. (Bahrami & Yaghoubi, 2024) However, due to the heavy relation to the usage and maintenance of the primary product, the spare parts PLC curve can be challenging to estimate (Kennedy et al., 2002). Hence, this study focuses on describing the PLC and assessing the PLC phase of spare parts.

Life cycle pricing refers to a pricing strategy that considers the PLC phase that the product is in. Especially the end of PLC can cause problems to companies. When third-party and competitor options become available towards the end of PLC, companies can price themselves out of the market if not considering the PLC phase. (Nnamdi, 2018) In addition to the PLC phase of the spare part, the useful life of the primary product should be considered. Cullbrand and Levén (2012) found out that, in the machinery industry, there is a high risk of losing spare parts sales towards the end of the primary product's useful life if customers perceive the price as too high. Customers can then choose to buy a less expensive non-original part or even scrape the primary product if the nominal value is already low. If the spare part price is low enough, the machine can be kept running and the customer kept happy. This also creates the opportunity for the supplier to sell more spare parts in the future. (Cullbrand & Levén, 2012)

Forecasting the risk of spare parts approaching the end of their PLC and offering pricing discounts for these parts has been identified as an appropriate proactive strategy to avoid excess spare parts inventories in the elevator industry (Nnamdi, 2018). However, with spare parts, it can be difficult to simulate the demand and assess the PLC phase since the demand is related to the installed base and some parts may only be needed when they suddenly break down or wear out. Customers do not necessarily want to buy a spare part just because the price is attractive if they do not need the part. In addition, the cost of producing the spare part tends to increase towards the end of the life cycle as the volume decreases. It is then more common to increase the price towards the end of PLC to secure profit. (Cullbrand & Levén, 2012) With these contradictions in mind, it can be rather difficult to define the optimal price for a spare part to match its PLC phase, the useful life of the primary product as well as demand and supply in the markets. Hence, this study aims to clear this topic and generate ideas on spare parts life cycle pricing strategies.

There are three key concepts related to the study: spare parts, PLC, and pricing. All these concepts are related to each other. An initial view on how these relations form is represented in Figure 1. First, it is considered that every spare part is in some of the PLC phases that is determined by different qualities of the spare part, for example demand.

Second, the PLC phase should influence the pricing strategy that is chosen for the spare part. Third, the price that is set for the spare part, affects the demand and profitability of the part, which can again affect the PLC.

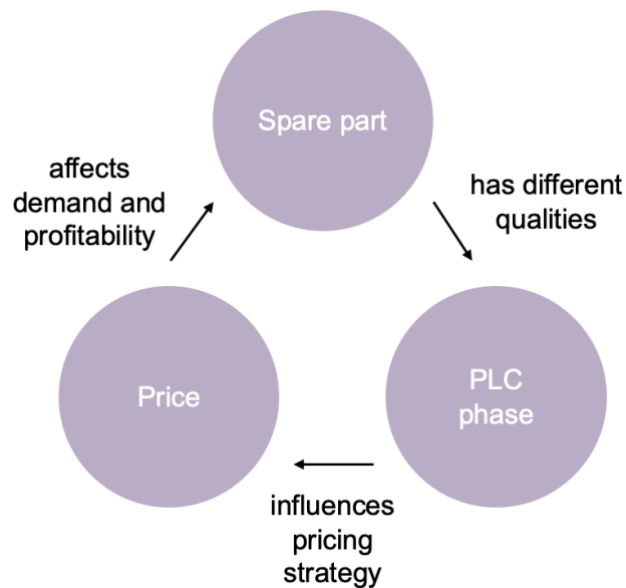


Figure 1. Initial view on the key concepts of the study

All three topics are widely studied in their own context. For example, Kennedy et al. (2002) study spare parts and Kohli and Suri (2011) study pricing. In addition, topics have been studied in pairs, namely, pricing of spare parts (e.g. Cullbrand & Levén, 2012), life cycle pricing (e.g. Asl-Najafi & Yaghoubi, 2021), and spare parts PLC (e.g. Inderfurth & Mukherjee, 2008). However, there is a lack of research combining these three topics into spare parts life cycle pricing, and more specifically, in the context of heavy machinery industry. It is believed that by taking PLC into account in spare parts pricing, pricing will better reflect customer value and demand as well as create more profit (Nnamdi, 2018; Singhal et al., 2024; Sun et al., 2024).

1.2 Case context

This study has been conducted as a commission from a large Finnish heavy machine manufacturer company. The head office of the company is in Finland, but the company has several subsidiaries globally. The company is very service-oriented, offering a wide range of spare parts as well as maintenance, modernization, upgrades, leasing, and rental services. The company offers over 110 000 different spare parts which can be bought from the company's online store, through the company's sales team or through a dealer depending on the customer and the market. Customers are operated through the central organization or through the subsidiary depending on the location and the size

of the customer. The goal of the company is to provide all needed spare parts regardless of the age and condition of the machine.

The pricing team of the case company does not have a clear vision on how the PLC of spare parts should be considered in pricing. However, the problem has been identified, and spare parts are classified under five PLC categories: unknown age, other items, early-, mid-, and end-of-life items. Based on this, the price is sometimes increased if a part is identified to face the end of its PLC soon and the team thinks that there might be upcoming cost increases due to that. Also, items becoming obsolete are identified by the demand planning team and then sold with discounts in the outlet section of the online store. It is assumed that new parts are already priced appropriately. Therefore, this study focuses on identifying and pricing spare parts in the middle and end of their PLC. One of the objectives of this study is to find out whether the current PLC categorization of spare parts is suitable for the needs of life cycle pricing.

The company's aim has been to move away from cost-based pricing and strive for customer value instead. This study is important for the business since the company gains more knowledge about spare parts PLC and life cycle pricing. Also, based on the study it is likely possible to create new pricing strategies to use in pricing. Parts life cycle pricing could better reflect the customer value and the demand on the market. In addition, life cycle pricing could strengthen the company's competitive position in spare parts in the middle and end of PLC. At the same time, the goal is still to optimize profit for these spare parts.

There are some challenges identified before starting the study. There is a wide range of different parts in the company's large offering. Due to the large offering and the nature of the spare parts business in heavy machinery, some parts are not sold frequently and therefore the cost and lead time might also not be updated. This can create difficulties in estimating the PLC phase. It is also acknowledged that the long useful life of the machines and the fact that the same parts can be used in several different machine models over time can be a challenge in identifying spare parts PLC.

1.3 Research objectives

The objective of this research is to investigate options for life cycle pricing in heavy machinery spare parts in B2B markets. As a result, this study aims to fill a gap in research and bring managerial implications to spare parts life cycle pricing. Research will focus especially on spare parts in the middle and end of PLC since these phases can be more challenging for both the case company and other companies (Cullbrand & Levén, 2012;

Nnamdi, 2018). The aim is also to compare research around the topic to the case company's current procedures and determine if these are optimal.

The first research question focuses on understanding the PLC of spare parts and assessing different PLC phases of spare parts. This is important since it is unclear whether spare parts PLC phase can be identified similarly to the primary product. Identifying the PLC phase of the spare part is essential for implementing life cycle pricing. Therefore, the first research question is:

RQ1: What kind of methods can be used to assess the PLC phase of a spare part?

The second research question aims to create insights on how the PLC phase of a spare part can be considered in pricing. Aim is to bring ideas and highlight the factors that should be taken into consideration in spare parts life cycle pricing rather than producing perfect numerical values. As a result, there will be a framework to utilize when considering life cycle pricing implementation for spare parts. The second research question is then:

RQ2: What kind of framework can be utilized in spare parts life cycle pricing?

RQ2a: What factors affect the pricing of spare parts in different PLC phases?

RQ2b: How do life cycle pricing strategies affect the demand and profitability of spare parts?

The second research question has two sub-questions. The first sub-question helps to understand what factors in each PLC phase can be used in the framework to determine the price. This is important since it is possible that different factors are meaningful in different PLC phases. The second sub-question focuses on how life cycle pricing affects the demand and profitability of spare parts. This question is crucial to address as optimizing profitability and demand can be seen as the objective for life cycle pricing.

Meeting the research objectives would mean new academic knowledge about life cycle pricing of spare parts. Also, managerial implications about life cycle pricing would be given for heavy machinery spare parts businesses. Although the study focuses on heavy machinery context, the goal is that the results can be used on applicable levels in other industrial sectors as well.

1.4 Research process

This thesis is conducted as a case study. The thesis is divided into two parts: the theoretical part and the empirical part. The theoretical part is conducted as a literature review based on existing literature and research. This part consists mainly of the following topics: product life cycle, spare parts product life cycle, pricing strategies, spare parts pricing, and life cycle pricing. Using these topics as search terms, existing research is investigated, and suitable articles and book chapters are collected. The goal is to form a clear view on what is already known about spare parts PLC and life cycle pricing and also what could be the factors defining spare parts PLC and life cycle pricing.

After the theoretical part is ready, the process on the empirical part will begin. The empirical part consists of quantitative data analysis and qualitative interviews. Quantitative data analysis will help to understand the current state of the case company. With the help of the literature review and the data analysis, interview questions are compiled. The goal is then to find answers to the research questions that are not yet answered.

This study is executed as a thesis which sets a limited timeline for the study. The research process started in May 2025 with roughly the following timeline:

May – Preparing the research plan. Starting the literature review.

June – Finishing the literature review.

July – Drafting and conducting research methodology. Starting the quantitative data gathering and analysis.

August – Finishing the quantitative data analysis. Preparing the interview questions.

September – Conducting the interviews.

October – Analysing the qualitative data.

November – Conducting the discussion and conclusions. Collecting feedback from the case company.

December - Adding finishing touches.

1.5 Structure of the thesis

This thesis is divided into seven chapters: 1) introduction, 2) product life cycle, 3) pricing, 4) research methodology, 5) empirical findings, 6) discussion, and 7) conclusions. The first chapter, introduction, explains the motivation of the study, or in other words, why the

study is important. In addition, the context of the study in the case company and the research objectives are explained. The research process is also briefly discussed.

The purpose of the second and third chapter is to create an understanding of the subject under study with the help of literature review. The second chapter includes existing theory about product life cycle and product life cycle management. In the end of the chapter, the goal is to form a view on how existing theory describes spare parts life cycle. In the third chapter, pricing is discussed. The chapter includes research's view on the role of pricing, different pricing strategies, and pricing of spare parts. Finally, life cycle pricing is discussed.

After the theoretical part, research methodology will be discussed further. This chapter will present research methodological choices made in this study, including research philosophy, research strategies, and procedures. The current state of the case company will be covered to form a clear view of the context and the starting points of the study. In addition, data gathering and analysing methods will be presented. The goal of this chapter is to give a clear view on what are the starting points of the study and how the research will be carried out.

In the fifth chapter, the empirical part of the study begins. The chapter will discuss data analysis and its empirical findings. First, quantitative data analyses of the current state of the case company will be discussed. After that, the results conducted from the interviews will be discussed. The aim of this chapter is to thoroughly discuss the empirical findings in the case company context.

The sixth chapter, discussion, will set empirical findings in the context of existing theory. The goal is to conduct answers for the research questions utilizing all the results. The chapter will discuss assessing spare parts PLC and spare parts PLC characteristics from a pricing point of view. In addition, frameworks for implementing and creating life cycle pricing strategies are formed. Lastly, recommended actions in the case company are presented.

The last chapter of this thesis will present conclusions of the study. This chapter will discuss whether the research objectives have been met. Contribution to existing research, managerial implications, limitations of the study, and suggestions for future research will also be presented.

2. PRODUCT LIFE CYCLE

Life cycle is a pattern commonly used by companies and other stakeholders to try to predict future events. Life cycle typically consists of a sequence of phases – like a biological life cycle from birth to death. Life cycle approach can be applied to different concepts, such as industries, markets, technologies, brands, and products. (Routley et al., 2013) This study focuses on studying life cycle on a product level.

This chapter includes theory related to the PLC concept. The goal is to form a clear understanding of PLC to be able to continue to the life cycle pricing topic. In the first subchapter, different PLC phases and their characteristics will be discussed. In the second subchapter, we will discuss the meaning of the PLC concept in business strategy. In the third subchapter, product life cycle management will be briefly discussed. In the fourth subchapter, spare parts characteristics will be discussed to better understand the spare parts context. The fifth subchapter will aim to collect methods for spare parts PLC assessment.

2.1 Different phases of PLC

PLC refers to the market life of a product, meaning how market conditions change from the time a product is first introduced to the markets until the product is removed from the markets (Levitt, 1965). PLC should not be confused with a product's life cycle which usually refers to the useful life of a product. The PLC concept originated from the early 20th century and is based on the theory of diffusion and adoption of innovations (Rink, 2017). The different phases of PLC are well established in research (e.g. Bahrami & Yaghoubi, 2024; Nagle et al., 2024a). Most products follow the classic PLC demand curve, which has four phases: introduction, growth, maturity, and decline (Bahrami & Yaghoubi, 2024). This classic bell-shaped PLC curve is presented in Figure 2.

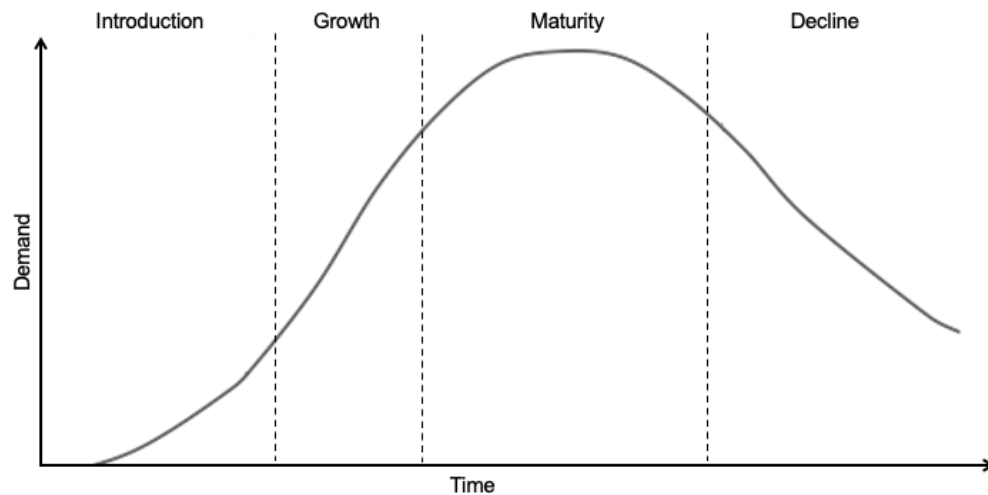


Figure 2. Demand over different PLC phases (adapted from Bahrami & Yaghoubi, 2024)

In the introduction phase, a new product is launched, and sales volume stays low for a while. This is because the customers are not yet familiar with the product. In the growth phase, demand turns upwards, when customers show positive reactions to the quality and price. (Asl-Najafi & Yaghoubi, 2021) In the maturity phase, demand does not grow anymore as there starts to be enough supply on the markets (Bahrami & Yaghoubi, 2024). Finally, in the decline phase, demand starts to fall since the product is not attractive anymore (Asl-Najafi & Yaghoubi, 2021).

To be able to implement life cycle pricing, it is important to identify and understand the different PLC phases. The changes in demand over PLC are explained by different characteristics of the phases. These characteristics are presented in Figure 3. The introduction phase is characterized by slow market growth and few competitors (Bahrami & Yaghoubi, 2024). Retail price is typically in its highest value since customers are more willing to pay more in the early stages of the PLC. However, the costs are high, which can turn the profits negative. Pricing strategy concentrates typically on market penetration. In the growth phase, market growth is high, but there starts to be a growing number of competitors, hence pricing competition occurs. Costs are now lower due to the learning effect, while retail price stays high. Pricing strategy is usually competitive. The maturity phase is characterized by moderate market growth, normal retail prices, low costs, and high profits. Pricing strategy stays competitive or alternatively discount strategies can be implemented. In the decline phase, where market growth turns negative, retail prices, costs, and profits are low. Competitors start to leave the market. Pricing strategy can be based on discounts or bundling. (Bahrami & Yaghoubi, 2024)



Figure 3. Characteristics of PLC phases (adapted from Bahrami & Yaghoubi, 2024)

It is important to acknowledge that, while most products follow this classic PLC curve, the shape of the PLC curve can vary. PLC is a generalized description of the demand cycle of a product, rather than a completely valid representation of all products (Rink, 2017). Therefore, it is crucial for companies to understand their products and customer behaviour in the market. As previously described, technology advances can cause significant changes in PLC, but also other factors, such as the emergence of new competitors and changing customer needs, can affect the PLC substantially (Asl-Najafi & Yaghoubi, 2021). With supplementary uses by customers, products can even regress to a previous phase, making the PLC curve a lot different (Rink, 2017).

In addition to the shape of the PLC curve, the length of the PLC is different for different products. This means that some products stay in the market longer than others. The length of the PLC is also affected by different variables in the market environment. One of these variables is the technology and how fast it is upgrading. For example, smartphones tend to have a short PLC (1-3 years), since technology develops rapidly, and new products replace old ones in the markets. On the other hand, most household appliances, like fridges and washing machines, tend to have a longer PLC (10-20 years), since the basic technology develops slowly. It is also possible to affect the structure of the PLC by different choices. This topic will be discussed further in the next subchapter.

2.2 PLC in business strategy

To understand the importance of PLC, the meaning of PLC in business strategies will be discussed. According to Hofer (1975) the PLC phase is the most fundamental factor in determining an appropriate business strategy. Major changes in business strategy are usually required throughout the PLC, at least in the introduction, maturity, and decline phases. (Hofer, 1975) As previously described, each PLC phase has unique characteristics, therefore necessitating careful planning for operations and strategy. One benefit of the PLC concept is that it acts as a forecasting tool for demand and other market conditions, aiding companies to make more informed decisions and market strategies (Asl-Najafi & Yaghoubi, 2021; Bahrami & Yaghoubi, 2024; Rink, 2017). PLC has even been described as a base for marketing programs (Rink, 2017). Understanding the PLC phases is crucial for companies to also understand their products and manage their supply chain (Bahrami & Yaghoubi, 2024).

Another benefit of understanding PLC is understanding that the length and structure of PLC can be manipulated with different choices. The optimal idea is generally to proactively aim to extend the length of the growth, maturity, and decline phases to gain more sales and profit over the whole PLC (Asl-Najafi & Yaghoubi, 2021; Bahrami & Yaghoubi, 2024). The introduction phase should be kept short. For example, Bahrami and Yaghoubi (2024) found out that, by advertising, the length of the phases changed and higher demand was achieved. In this scenario, the introduction phase was shorter, which means that the curve shifted left and up enabling higher sales faster. (Bahrami & Yaghoubi, 2024)

The PLC can be influenced with decisions and innovations related to strategy planning, supply chain management, inventory management, pricing, marketing, and customer needs (Asl-Najafi & Yaghoubi, 2021; Bahrami & Yaghoubi, 2024; Rink, 2017). Extending the product's presence in the markets allows companies to gain more profit and enhance their competitive edge by larger market share (Bahrami & Yaghoubi, 2024). Overall, understanding PLC can help companies to make more aware decisions and gain more profit. This study will focus on how PLC can help to make more informed decisions in spare parts pricing strategies.

2.3 Product life cycle management

To understand spare parts business, product life cycle management (PLM) needs to be addressed. PLM refers to the business activity of managing a company's products across their life cycles in the most effective way possible (Stark, 2011, p. 1). PLM refers to the

physical life cycle of a product, whereas PLC refers to the market life of a product. In other words, PLM is about the life cycle from the conception of the product to the retirement and disposal of the product. PLM can be divided into five phases: imagine, define, realize, use/maintain/support, and retire/dispose. (Stark, 2011, pp. 1–3) The five phases of product life cycle management are illustrated in Figure 4.

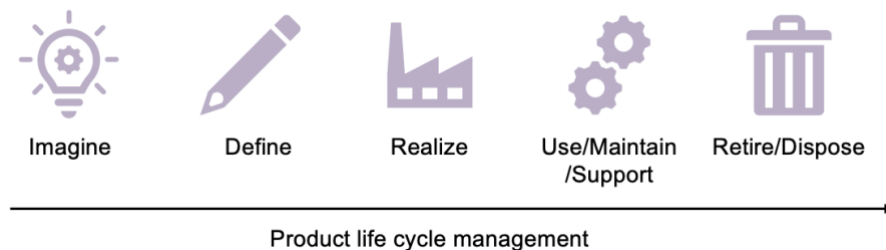


Figure 4. Product life cycle management

In this study the focus on PLM is on the primary product, meaning the machinery that spare parts are provided for. Spare parts business takes place in the middle of the primary product's life cycle, in the support and maintenance activities. Of course, spare parts have their own PLM and useful life of their own. The objective of PLM is to minimize material and energy consumption during the life cycle of a product (Takata et al., 2004), while still increasing product revenues, reducing costs, and maximizing the value of the product for the customer (Stark, 2011, p. 1). This is why maintenance and spare parts are crucial parts of PLM (Takata et al., 2004). Understanding the life cycle of the primary product, and when spare parts are needed, helps to understand the spare parts business.

2.4 Spare parts characteristics

Spare parts have different characteristics related to PLC that differ from usual goods. Spare parts are not finished or semi-finished products that tend to have an independent and fast-moving demand (Van der Auweraer et al., 2019). Spare parts are rather products that keep the primary equipment in operating condition when something breaks down (Kennedy et al., 2002). This creates a challenge in the spare parts business, where demand for spare parts is heavily related to the primary equipment. Spare parts are often designed along with the primary product (Inderfurth & Mukherjee, 2008), and spare parts sales are not necessarily controlled by trends or marketing, but by customer need for maintenance (Kennedy et al., 2002). For example, in the introduction phase, it is most likely that spare parts sales stay low since there is no customer need, compared to usual goods, where there might be a customer need, but sales stay low since customers are not yet familiar with the product.

Kennedy et al. (2002) summarize the unique aspects of spare parts as follows:

- Maintenance policies, rather than customer usage, dictate the need for spare parts. If a machine breaks down, one way to restore functionality is either to repair the part or replace the part. If there are little redundant parts in the machine, there is a greater need for immediately available spare parts.
- Reliability information is generally not available making it hard to predict failure times and life cycles. Continuous equipment monitoring systems can bring a solution to the problem.
- Part failures are often dependent, and the relation is often unknown.
- Demands for spare parts may face cannibalism from other parts or units.
- The costs of being out of a spare part can include quality, lost production, and increased risk to personnel costs. These costs are difficult to quantify.
- Spare parts are subject to becoming obsolete. It is difficult to determine how many spare parts to keep in stock for an obsolete machine.
- Spare parts are more likely to be stocked than complete machines, and repair may be preferred over replacements if possible.

Due to the relation to the primary product and the nature of spare parts as consumables, spare parts can have unpredictable, intermittent and sporadic demand. Some spare parts can face long periods of no sales, and then sudden demand. (Chien et al., 2023; Jouni et al., 2011) This can make it challenging for companies to assess the PLC of spare parts and price them accordingly.

2.5 Assessing PLC of spare parts

Availability of spare parts is often a significant competitive advantage for spare parts suppliers (Inderfurth & Mukherjee, 2008). Hence, it is crucial to forecast the long-term demand of spare parts to ensure availability, but to avoid excess stock in the end of PLC. In addition, life cycle pricing requires a technique for recognizing when a product is approaching different phases (Dean, 1976).

The complex demand patterns related to spare parts have been widely studied in the existing literature (e.g. Chien et al., 2023). These, however, are not observing the whole PLC, but rather studying the demand patterns during the maturity phase. By combining different studies, a few methods that can help determine a spare part's PLC curve were gathered. First, it is suggested that spare parts are categorized based on their

characteristics and nature (Jouni et al., 2011; Nnamdi, 2018). Second, spare parts demand is controlled by the chosen maintenance strategy (Kennedy et al., 2002; Takata et al., 2004). Third, demand forecasting can help to determine and understand the PLC (Inderfurth & Mukherjee, 2008; Van der Auweraer et al., 2019). Each of these methods will be discussed in the following subchapters. Possibilities to implement these methods in the PLC phase assessment in heavy machinery spare parts will be discussed later.

2.5.1 Spare parts categorization

It is suggested that parts should be categorized in order to forecast the demand pattern and PLC. Applying the same PLC model to different categories will lead to inaccurate results. (Nnamdi, 2018) In addition, spare parts suppliers often have a large offering of spare parts, and categorization can create manageable groups to focus management efforts more efficiently (Jouni et al., 2011). Categorization should be done based on the nature of the spare part (Nnamdi, 2018). For example, one spare part can be designed by the company, while another part is a common bulk material. The categorization should also help to understand the demand pattern of the product. This is because spare parts with intermittent demand end up with excess inventory towards the end of PLC more easily, compared to spare parts with continuous demand. Also, the length of the life cycle varies for different spare parts, which is why it is crucial to consider the nature of the spare part when designing the PLC forecasting model. (Nnamdi, 2018)

Jouni et al. (2011) designed a spare parts categorization framework using two dimensions: supply and demand. The framework is illustrated in Figure 5. In the supply dimension, parts were divided into three categories based on availability risk. These categories are commercial parts with low risk, industry specific parts with moderate risk, and key parts with high risk. Commercial parts are common bulk materials that are used across industries, such as screws and bolts. Industry specific parts are parts that are easy to manufacture and copy by competitors, but they are used in a specific industry only. Key parts are the most complex parts that are made-to-order. In the demand dimension, parts were divided into categories based on demand variability and material price. Demand scale was divided into three: no demand, low demand, and high demand. Within high demand there were also three different demand patterns: stable demand, unstable demand, and sporadic demand. Material price was categorized as low or high. Based on the demand and supply dimensions a categorization matrix was formed. This framework was utilized to analyse distribution chain performance, such as service performance. (Jouni et al., 2011)

		<i>demand category</i>					
High price	High demand	Stable demand	x	x	x		
		Unstable demand	x	x	x		
		Sporadic demand	x	x	x		
	Low demand	x	x	x			
Low price	High demand	x	x	x			
	Low demand	x	x	x			
	No demand	x	x	x			
			Key parts	Industry specific parts	Commerical parts	<i>supply category</i>	

Figure 5. Spare parts categorization matrix (adapted from Jouni et al., 2011)

A similar framework could be utilized in other businesses as well (Jouni et al., 2011). A somewhat similar categorization on the supply category level exists in the case company. According to Nnamdi (2018) spare parts move to different categories based on their PLC phase. For example, in the maturity or decline phase, when key parts become available by third-party and competitor solutions, they should now be classified and priced as industry specific parts. (Nnamdi, 2018) This explains the transition on the supply axis. As the PLC progresses, the demand of the spare parts changes, which explains the transition on the demand axis. For example, during the growth phase, a spare part can move from low demand to high demand.

2.5.2 Maintenance strategies

The demand for spare parts largely follows the maintenance strategy of the primary product, rather than customer usage (Kennedy et al., 2002). There are different types of maintenance activities and strategies related to PLM, which affect the demand of spare parts. Takata et al. (2004) categorize maintenance strategies based on three factors: criteria for providing treatment, opportunity of maintenance task execution, and type of treatment. Criteria for providing maintenance and type of maintenance were found the most relevant for this study. The criteria for providing treatment can be based on a trend analysis, aiming to forecast when a replacement is needed (Takata et al., 2004). This may sometimes lead to unnecessary maintenance causing disruption to normal operations. That is why symptoms of failures are often detected by using diagnostic techniques. Again, maintenance might be unnecessary, if the machine or the spare part is not critical. In this case, breakdown maintenance can be used. This means maintaining the machine only when a failure occurs. The type of maintenance can be servicing, repair, replacement, or design improvement, meaning an upgrade on the functional level. (Takata et al., 2004) For example, a broken unit can be either repaired with other parts, or it can be fully replaced to a new one. Based on this categorization, the maintenance strategies presented in Table 1 were formed.

Table 1. Maintenance strategies (adapted from Takata et al., 2004)

Criteria for maintenance	<ul style="list-style-type: none"> → trend analysis → symptom of a breakdown → breakdown → design improvement
Maintenance strategy	<ul style="list-style-type: none"> → preventive maintenance → corrective maintenance → breakdown maintenance → upgrade

The table considers the criteria for maintenance, which then defines the maintenance strategy. Preventive maintenance aims to service the machine before any failures. Corrective maintenance aims to repair all the little failures so that the machine stays in operating condition. Breakdown maintenance strategy waits until something critical fails. The last maintenance strategy is upgrade, which is for design improvements. It is good to note that some customers may use multiple different maintenance strategies.

Understanding the primary products' life cycle phase and the maintenance strategy will help to understand, in which kind of situations and what kind of spare parts are needed (Kennedy et al., 2002). For example, if a customer wants to buy the spare part only when the machine is down, or if the customer aims for preventive maintenance to keep the machines running when they are needed. With preventive maintenance, the demand for a spare part is more predictable (Kennedy et al., 2002), but of course, spare parts can still suddenly break down and cause unexpected demand. According to Kennedy et al. (2002) repair may be preferred over replacement if it is possible. This is because some major units are expensive as whole, but parts of the unit can be produced less expensively. (Kennedy et al., 2002)

It should also be considered if the spare part is usually needed for servicing or upgrades since this can affect the target group and how the demand behaves. For example, upgrades might come along later, towards the middle and end of the primary product's useful life, whereas replacement might be needed already in the early stages for spare parts that wear down quickly.

2.5.3 Forecasting demand

Forecasting the long-term demand pattern, considering spare parts categorization and maintenance strategy, is considered an efficient way to determine spare parts PLC. However, it can be challenging, since spare parts demand is characterized by high

variation in demand size and time intervals (Kennedy et al., 2002). In existing literature, there are essentially two options for spare parts demand forecasting: historical data and installed base information. According to Nnamdi (2018) it is possible to forecast parameters and demand of spare parts via historical data, such as sales orders. Van der Auweraer et al. (2019) argue that the most precise way to forecast spare parts demand is to utilize information about installed base, rather than using historical data that does not consider the PLC and its phases.

The demand for spare parts can be hard to predict using historical data, since there usually is not accurate enough information about failure times and reliability. This is especially the case with new equipment. In addition, other spare parts characteristics described earlier, such as the intermittent demand patterns and relation to the primary equipment, also challenge demand forecasting with historical data. However, some equipment has continuous monitoring systems that will help the operator to predict when a part will need repair or replacement. (Kennedy et al., 2002) These systems can help to produce more accurate historical data.

Inderfurth and Mukherjee (2008) have divided the spare parts decision environment into two: during PLC and post PLC. During PLC refers to the time during primary product's PLC. Post PLC refers to the time from end of primary product's production to the end of service provided for the primary product. Post PLC is usually more challenging for companies to manage their spare parts. During PLC the consumption of spare parts is easier to forecast due to dependence on primary product demand and availability of up-to-date data. After ceasing the production of the primary product, this scenario changes completely. Although there is no demand for the primary product, spare parts still get consumed for maintaining the existing products. However, the demand for spare parts is now more complex due to nonexistence of product demand. (Inderfurth & Mukherjee, 2008)

Rather than using historical data, Van der Auweraer et al. (2019) consider the demand-generating factors when explaining spare parts PLC. The demand of spare parts generates from the maintenance activities in the installed base of the primary product. Therefore, it is crucial to know the characteristics, such as age and usage, of the installed base. Spare parts PLC can then be analysed by considering the maintenance strategy, the installed base, and an estimation of failure rates of the spare part. (Van der Auweraer et al., 2019) Figure 6 illustrates how installed base size increases until the primary product reaches the decline phase. This figure also explains spare parts demand, or PLC, in relation to the installed base.

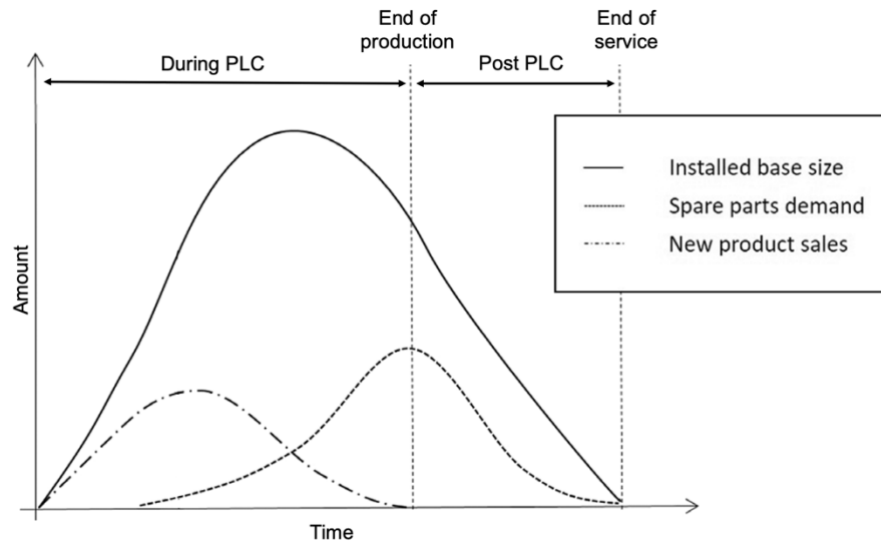


Figure 6. PLC, installed base, and spare parts demand (adapted from Van der Auweraer et al., 2019)

Spare parts often have very specialized use cases in specific machines, which is why they are subject to becoming obsolete (Kennedy et al., 2002; Van der Auweraer et al., 2019). This can create problems in maintaining the customer's equipment if a part is obsolete and there is no stock (Kennedy et al., 2002). That is why companies often keep spare parts in the inventory until the last machines are taken out of operation (Van der Auweraer et al., 2019). On the other hand, obsolete stock also creates costs. Thus, forecasting the demand accurately is crucial. Especially heavy machinery may continue to generate spare parts demand even decades after the end-of-production (Van der Auweraer et al., 2019). Forecasting the risk of obsolescence for products with long life cycles and their spare parts can be very challenging, but it is considered a suitable proactive method for spare parts management (Nnamdi, 2018; Van der Auweraer et al., 2019). Using installed base estimation, obsolete spare parts stock can be effectively reduced or even eliminated (Van der Auweraer et al., 2019).

3. PRICING

The 4 Ps explain the key elements of marketing: product, promotion, placement, and price. The first three elements – product, promotion, and placement – are the company's efforts to create value in the markets. Price, on the other hand, is a company's effort to capture some of the value by gaining profit. In other words, successful product, promotion and placement efforts sow the seeds of business success, and pricing is the harvest. (Nagle et al., 2024c)

The markets are constantly changing, which is why effective pricing strategies are needed to result in financial success. Most companies still make pricing decisions reactively to the market changes, rather than proactively. To be able to achieve successful pricing, it needs to be integrated into strategy. Strategic pricing is making careful decisions about what to offer customers, how to communicate value, how to price differently across customers, and how to manage customer price expectations. (Nagle et al., 2024c) According to Nagle et al. (2024c) a pricing strategy should include three principles: value-based, proactive, and profit-driven. Value-based approach means that pricing should reflect customer value. A proactive approach means that companies should anticipate disruptive events and change prices accordingly, for example based on PLC. A profit-driven approach means that a company should evaluate its success in price management by what it earns compared to alternative investments rather than comparing to its market share and growth in relation to its competitors. In conclusion, the objective of a pricing strategy should be to capture more value, rather than making more sales. (Nagle et al., 2024c)

In this chapter, we discuss pricing related topics. In the first subchapter, the role of pricing in business is addressed. In the second subchapter, different pricing methods are explored. In the third subchapter, we will move onto pricing of spare parts. Lastly, life cycle pricing will be handled.

3.1 Role of pricing

As said, pricing is a key element of the marketing strategy (Kohli & Suri, 2011). Pricing is often described as the “biggest marketing headache” for managers. Especially in high technology firms, where the PLC is short due to constant technology improvements and launching of new products, optimal pricing has become a critical decision that ultimately determines their overall success and viability. (Smith et al., 1999) Pricing has a central

role in business, as it directly affects profitability, competitiveness, demand, and customer perception. Price is one of the factors that a customer considers before buying the product, and therefore pricing should reflect the value of the product. The benefit of careful pricing management is that it does not require significant investments or resources, yet it can have a remarkable impact on both revenues and profitability. Therefore, companies should not waste the opportunity to earn more profits by carefully planning their pricing decisions and strategies. Pricing should be considered as a creative exercise in math and behavioural economics. (Kohli & Suri, 2011)

It is argued that pricing is the most powerful lever to manage profitability and it is easy to adjust pricing. Small adjustments in pricing can have a significant impact on sales and profitability. Based on a global study, the average operating profit was 9,1%, with 66,4% variable costs and 24,5% fixed costs. With these numbers, a 1% increase in price would lead to an 11% increase in operating profit, whereas a 1% increase in sales would increase the profits by 3,7%. If a company would try to achieve better profitability by reducing costs, a 1% decrease in variable costs would improve profitability by 7,2% and a 1% decrease in fixed costs would increase the profits by 2,7%. Therefore, pricing has the highest leverage on profitability. (Kohli & Suri, 2011) The impact of pricing on profitability is illustrated in Figure 7. This example assumed that other factors would remain unchanged (Kohli & Suri, 2011). However, it speaks for the importance of pricing, that even if sales volume would decrease by 2%, when increasing the price by 1%, net impact on operating profit would be 3,08%. Pricing is also very accessible compared to sales or costs, which are not that easy to change quickly. In short, even fine tuning the price can have a major effect on profitability, and companies should not ignore that when chasing profits. (Kohli & Suri, 2011)

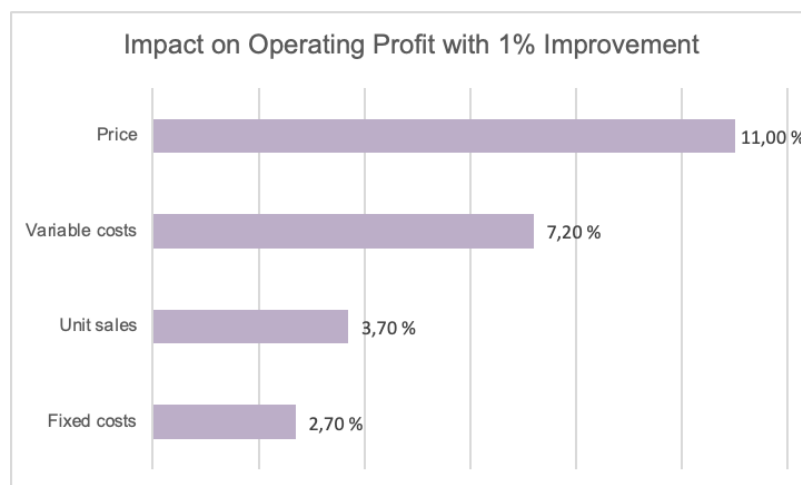


Figure 7. The impact of pricing (adapted from Kohli & Suri, 2011)

While pricing has high potential in profitability, it also comes with a great risk: too high a price can lead to significant losses in sales. Katie Paine, the founder and CEO of KDPaine & Partners, describes pricing as follows: “The moment you make a mistake in pricing, you're eating into your reputation or your profits”. Pricing is a complex and strategic competency that affects all levels of an organization (for example marketing, sales, IT, operations, finance, accounting, and executive leadership) and the market it operates in, including both customers and competitors. Pricing management involves people, processes, technologies, and information. These features of pricing can create obstacles and disagreements between stakeholders, which is why the pricing process should be carefully planned and openly shared in the organization. (Meehan et al., 2012)

3.2 Pricing process

The pricing process should be considered as a continuous and repetitive process rather than a one-time decision that is done differently by every case (Shiple & Jobber, 2001). Shiple and Jobber (2001) describe the pricing process as a wheel of pricing, which includes a sequence of activities: deciding the strategy role of price, prioritizing pricing objectives, assessing all pricing determinants, deciding price strategy, selecting the pricing method, and implementing and controlling the price. This process is presented in Figure 8.



Figure 8. The pricing wheel (adapted from Shiple & Jobber, 2001)

The logical starting point of the pricing process is to determine or reappraise the role of price in the overall marketing strategy. This means that companies should determine

whether price is promoted heavily in their marketing strategy or if the competitive focus is on other factors. Next, pricing objectives should be set and aligned with the company's broader objectives and the product's marketing strategy. These pricing objectives, however, should be flexible enough to fit into the changing broader strategies and objectives over PLC. For example, a company could initially pursue a growth strategy, where pricing's objective would be to gain market share or sales volume. Later in the PLC, the marketing strategy may shift to a hold strategy, where pricing's objective would be to generate profits. Companies may have several pricing objectives, why they should be prioritized into a flexible hierarchy. The most important pricing objectives identified in research are, for example, profits, survival, sales, volume, sales revenue, market share, image creation, competitive advantage, barriers to entry, and perceived fairness. (Shiple & Jobber, 2001)

Assessing all pricing determinants refers to internal and external factors that affect pricing. Most prominent determinants that are usually analysed before price setting are customer demand, competition, and cost. Demand analysis should also consider customer price sensitivity. Price sensitivity describes how much a customer's willingness to buy is affected by price. After assessing all pricing determinants, it is time to decide the pricing strategy. Pricing strategy involves many dimensions. Two of the most important issues are price positioning and new product pricing. Price position refers to the level the price should be when considering customer benefits, but also competitors' positionings. (Shiple & Jobber, 2001) According to Nagle et al. (2024b) pricing an innovation is often considered the most challenging pricing problem. However, not all new products are necessarily innovations, such as spare parts. Therefore, new product pricing in the introduction phase is less focused on in this study.

The pricing methods should be chosen based on the pricing determinants. Pricing methods will be discussed more in the next chapter. Lastly, there is implementing and controlling the price. Careful analysis of customer, dealer and competitor reactions is needed for controlling the price. Correcting steps need to be taken if unexpected reactions occur. Also, detailed analysis of all internal and external pricing determinants should be maintained, and the pricing wheel should be revisited if significant changes happen. (Shiple & Jobber, 2001) This could happen when the PLC phase changes, for example.

The pricing wheel can be utilized, when market and company conditions vary, and prices need to be changed. There already is a pricing process in the case company. The strategic role of price, overall pricing objectives, and price strategies should be judged by each company and their market conditions and strategies. Hence, we will next focus

on what the existing research thinks could be the determinants and methods to use in spare parts life cycle pricing. The pricing wheel will also be used to evaluate and develop the current life cycle pricing process in the case company. This is according to the idea of the pricing wheel being a process of continuous improvement (Shiple & Jobber, 2001).

3.3 Pricing methods

In this chapter, we will focus on exploring the most common pricing methods to be able to understand spare parts pricing, and later, life cycle pricing. There are three prominent determinants that affect pricing effectiveness: company's cost structure, demand for the product, and competitor prices (Shiple & Jobber, 2001). Based on these, Shiple and Jobber (2001) define the three most common pricing methods, which are cost-based, competitor-based, and demand-based pricing. Nagle et al. (2024c) adds value-based and customer-driven pricing methods. In this study, we will combine these into three different methods. The first pricing method presented in this chapter is cost-based pricing. The second subchapter will describe competitor-based pricing. Third, value-based pricing including customer-driven and demand-based aspects will be described. Many companies focus on using one of these methods alone when setting prices, but they should be utilized together to enhance the pricing strategy (Shiple & Jobber, 2001). Therefore, dynamic pricing combining these methods and adding time-varying pricing will be discussed last.

3.3.1 Cost-based pricing

Cost-based pricing – or cost-plus pricing – is the most widely employed pricing method across many industries and countries (Kohli & Suri, 2011; Nagle et al., 2024c; Shiple & Jobber, 2001). As the name suggests, cost-plus pricing is based on a logic where a predetermined profit markup is added on top of an average cost estimate. The average cost estimate is based on a calculation of fixed and direct costs related to the product, like producing and transporting the product, divided by forecasted demand volume. If using strictly cost-based pricing, other factors are not considered in pricing. (Shiple & Jobber, 2001)

The benefit of cost-based pricing is that it is simple to implement and maintain, and the price is easy to justify to customers. However, many disadvantages are recognized among researchers. Cost-based pricing completely ignores competitor prices, customers' reactions and price sensitivity. The only objective is to meet the desired markup. The logic behind pricing is usually twisted, meaning that price is derived from

the volume estimate, when in reality, price determines the sales volume. For example, if the price is set too high, volume will fall, and average cost estimate will increase and lead to an even higher sales price. (Shipley & Jobber, 2001) This means that cost-plus pricing leads to overpricing in weak markets and underpricing in strong markets, which is opposite of an effective strategy (Nagle et al., 2024c).

It can be extremely difficult to allocate fixed costs between company's multiple products, possibly leading to inaccurate average cost estimates. Because of this, it is usually more beneficial to use direct costs as a base for pricing decisions. This also allows companies to take short-term opportunities that require price levels below average cost estimate since anything above direct costs will help to meet the fixed costs or to profit. (Shipley & Jobber, 2001)

While cost-based pricing can be appealing in the sense that costs are covered, researchers recommend to move on from using this logic alone (Kohli & Suri, 2011; Shipley & Jobber, 2001). The role of cost analysis may of course be beneficial when determining whether the company can make profit at the price level that markets find acceptable. In the long term, companies must exceed their cost to make profit, so it is important for companies to understand their costs. Pricing based on purely costs, however, is non-efficient. (Shipley & Jobber, 2001)

3.3.2 Competitor-based pricing

Competitor-based pricing is a pricing method that either aims to match competitors' prices exactly or, match competitors' price changes proportionately. Following competitors' price changes is a more common method, and it allows companies to preserve the price differences among competitors. Companies need to constantly monitor their competitors' prices and price adjustments to react to them. Moreover, companies need to predict how their competitors will respond, if they are to make price adjustments themselves. Price information can be collected from web shops, customers, distributors, advertisements and so on. (Shipley & Jobber, 2001)

A competitor-based approach is easy to manage and allows the company to benefit from common price increases. This method can also prevent price wars as competitors know that price reductions will be copied. However, competitor-based pricing alone also has some downsides. Competitor-based pricing alone ignores the company's costs as well as cost differences between competitors. This may lead to pricing with negative margin. This approach also ignores the potential to use pricing initiatives for the benefit of the company. Another challenge is that it can be difficult to collect accurate data of competitor prices and the discounts that competitors are offering. Also, a competitor-

based approach does not ensure competitiveness, since price is not the only factor to affect customers' buying decisions. (Shiple & Jobber, 2001)

3.3.3 Value-based pricing

Shiple & Jobber (2001) describe demand-based pricing as methods involving estimates of how highly customers value the offering, demand, and customer price sensitivities and then setting the prices accordingly. This is similar to Nagle et al.'s (2024c) value-based approach, where differences in pricing across customers or products reflect differences in the value to customers. Thus, value-based pricing is used as a term from now on. A pricing strategy cannot be established effectively without considering the value of customer benefits (Shiple & Jobber, 2001). Value-based pricing is usually considered the most efficient pricing method since companies can achieve much better margins, compared to cost- and competitor-based pricing. Value-based pricing aims to understand customer price sensitivity and the value that the offering creates for the customer. Price is then the cost that customers are willing to pay for the perceived value of the product. If the price is above the perceived value, rational customers will not buy. If the price is below the perceived value, the company is losing an opportunity to gain more profit. In value-based pricing, customer price sensitivities should be considered, which results in prices that customers are willing to pay. Value-based pricing is also a way to control the demand by setting the prices according to what the traffic will bear. (Shiple & Jobber, 2001)

Value-based approach should derive already from product development. Companies should listen to the markets and determine the benefits that customers are seeking. Then, a target price, that customers can be convinced to pay for the product, should be set. Based on the target price, companies could then determine how much it can cost for them to produce the product. (Nagle et al., 2024c)

Value-based pricing allows for different price levels to be set in different segments based on the perceived value and the price sensitivity. This helps to maximize overall profitability and competitiveness. However, estimating the monetary value created for the customer may be difficult. (Shiple & Jobber, 2001) Costs and competitors' prices should also be considered for an appropriate value-based pricing strategy combined with efficient value creation and communication to the customers. (Nagle et al., 2024c)

Value-based pricing may sometimes be confused with customer-driven pricing methods. Customer-driven pricing aims to consider market conditions in pricing, usually meaning that price aims to reflect customers' willingness to pay for the product. This can lead to prices that are very flexible, and in the end, buyers will note that and can misuse the

flexibility. Also, offering customers prices that they are willing to pay is not the objective of strategic pricing. Companies should rather aim to raise the customers' willingness to pay to a level that reflects the real customer value. (Nagle et al., 2024c)

3.3.4 Dynamic pricing

Since it is not optimal to use only one of these methods, Shipley and Jobber (2001) present an integrative pricing method, which incorporates all the above-mentioned methods as well as many other relevant factors. In their model, the highest possible price is determined by the value of customer benefits, and the lowest possible price is determined by the costs. All other relevant pricing determinants should then help to set the price somewhere in between these points. The pricing wheel also enables price switching in case of changing objectives or pricing determinants. (Shipley & Jobber, 2001) This means that the model is suitable for dynamic pricing.

Dynamic pricing refers to a pricing strategy where the price of a product is changed over time based on information about supply and demand, customer behaviour, competitor pricing, and other market factors to optimize revenue and profit. Dynamic pricing has become more popular in recent years as technology develops and enables real-time data analytics. For example, airlines use dynamic pricing to maximize capacity utilization and profit, or supermarkets can offer price reductions on products that are approaching their best before date to encourage sales and reduce waste. In dynamic pricing, the price is adjusted to match the forecasted demand either by increasing prices when supply does not meet the volume demanded, or by decreasing the prices when there is not enough demand. (Nagle et al., 2024a) In relation to this study, dynamic pricing is utilized when price adjustments are made during PLC (Bahrami & Yaghoubi, 2024; Sun et al., 2024).

It is important to note that dynamic pricing should be done in a way that makes sense to the customer. Otherwise, customers can get frustrated with the price changes. Therefore, it is crucial to consider the price sensitivity of different customer segments. It is often more convenient to adjust pricing for customers that are more price sensitive, and keep the prices high for less price sensitive customers, to maximize profits. (Nagle et al., 2024a) In addition, the timing of price switching is crucial to match the potential demand. The optimal timing of price adjustments can be made using estimation of PLC. A dynamic pricing strategy should also include detailed analysis of the competition and the market environment. (Bahrami & Yaghoubi, 2024)

Another factor related to dynamic pricing is price elasticity of the product. Price elasticity is a more quantitative measure, and it is observed on a product level, whereas price sensitivity is more qualitative and it can be observed on a customer level. Price elasticity

is generally defined as the change in demand divided by the change in price (Nagle et al., 2024c). If the demand is elastic, price increases could decrease revenue. If the demand is inelastic, it is possible to increase the price without losing sales. This means that the profitability of a price increase will depend upon whether the loss in sales is not too great. This concept should also be considered when decreasing the price, meaning that the profitability of a price decrease will depend upon whether the gain in sales is great enough. It is important to note that price elasticity changes based on purchase context and customer needs. Generally, the demand is more price elastic when prices are increased. This means that customers are quick to switch to less expensive options when prices are increased, whereas when price levels decrease, customers tend to stick with the cheaper options and not switch to the more expensive ones. (Nagle et al., 2024c)

There is a wide range of research regarding dynamic pricing and price switching policies. However, the influence of PLC on pricing decisions has not yet been studied as widely. (Bahrami & Yaghoubi, 2024) Life cycle pricing topic as one type of dynamic pricing will be continued in chapter 3.5.

3.4 Pricing of spare parts

Spare parts have some unique aspects related to pricing due to their unusual nature. Spare parts and other aftermarket services are generally high-margin and long-term businesses (Cohen et al., 2006). Customers buy spare parts during the whole life cycle of the machine, whereas the machines are bought less often. Aftermarket services often account for a large part of a company's profits. For example, businesses earn on average 45% of their gross profits from aftermarket, while it accounts for only 24% of revenues. Companies can even adopt a strategy where they sell the primary product with low margin and aim to generate the profits from the aftermarket. However, if not optimized, spare parts tend to become obsolete and have slow inventory turnover, which ties up capital and lowers profitability. (Cohen et al., 2006)

According to Nagle et al. (2024c) and Shipley and Jobber (2001) a pricing strategy should always consider at least costs, competitor prices, and customer value. Gathering from spare parts literature, a spare parts pricing strategy should also consider the categorization of the spare part (Jouni et al., 2011; Nnamdi, 2018) and the PLC phase (Nnamdi, 2018), in addition to market competition (Cohen et al., 2006), cost structure (Hu et al., 2018), customer value (Kennedy et al., 2002), and demand (Nagle et al., 2024a; Nnamdi, 2018). Some or all of these determinants often define the pricing method used for spare parts. Summary of these main spare parts pricing determinants is illustrated in Figure 9.

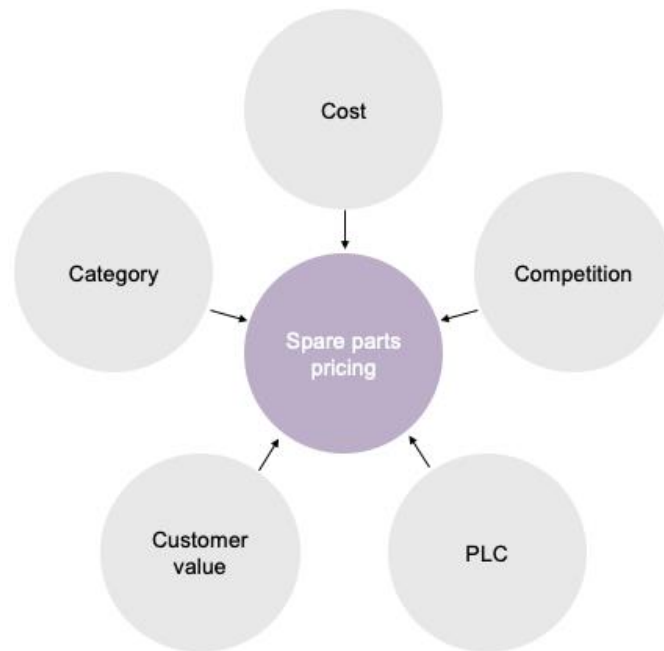


Figure 9. Main determinants for spare parts pricing

Next, we will discuss how these determinants shape spare parts pricing strategies. Each generation of equipment often has different spare parts, so companies end up with 20 times more items in the spare parts business than in the manufacturing function, which can make price management challenging (Cohen et al., 2006). Usually the spare parts vary widely in cost, supplier, and order frequency. (Cohen et al., 2006) This is why spare parts categorization is helpful in pricing activities as well (Jouni et al., 2011; Nnamdi, 2018). One way to categorize spare parts is the supply-based categorization presented by Jouni et al. (2011), which was discussed in chapter 2.5.1. Different pricing methods can be more suitable in one spare parts category than in another. For example, commercial parts might be priced with cost- or competitor-based factors, whereas key parts could be priced value-based.

Cost-plus pricing in spare parts is commonly used by companies since it is easy to manage for the large offering of spare parts and a general expectation for gross margin can be set for all items to cover indirect costs and profit (Gallagher et al., 2005). As discussed before, spare parts can be categorized in different categories which affect pricing. For example, high technology and low technology spare parts require different pricing strategies. Smith et al. (1999) argue that buyers have a greater pricing power in low technology products because of the great supply of the products and the great availability of pricing information about competitive products. Therefore, cost-plus pricing is more logical in low technology spare parts. Still, cost-based pricing alone does not consider the market conditions and potential value in the markets. With high technology products, that are not as easily available, price competition is not as intense (Smith et

al., 1999). Therefore, it is easier to justify the value of a high technology spare part to the customer. Using only cost-based pricing, companies can then miss the chance of pricing spare parts according to their real customer value (Gallagher et al., 2005). Therefore, pricing strategy should be considering the nature of the spare part.

The large number of spare parts can also create a significant amount of inventory, sourcing, item management, and opportunity costs which are not directly visible in the costs of the items (Hu et al., 2018). These costs should be considered in pricing whether using cost-based pricing methods or not. This requires careful cost-analysis to make sure that the price covers the costs. Acquiring spare parts causes ordering costs (Nnamdi, 2018). Spare parts inventories cause holding costs and excess inventory can cause obsolescence costs. On the other hand, shortage costs and weakened customer relationships can occur when there is no stock and an important service opportunity is missed. (Nnamdi, 2018) Therefore, companies sometimes must decide whether acquiring a spare part with low profit is worth it to serve their customers on a high level. Original equipment manufacturers (OEMs) often have to supply spare parts for even their oldest models to protect their brand and reputation (Gallagher et al., 2005).

Price competition in the aftermarket is intense, which is why many companies utilize competitor-based pricing. Still, OEMs often lose sales to third-party competitors. (Cohen et al., 2006) Usually, OEMs set the upper limit for the price level. If OEMs try to compete with solely price, competitors will follow the price decreases and profits will fall in the market. Rather than following only price, one strategy is to try to understand the competition that a spare part faces. One vehicle manufacturer from North America divided their spare parts into three categories: none, some, or heavy competition. The company then tried to understand the customer buying behaviour, and found out that in case of emergency repairs, customers did not have time to shop around. On the other hand, some parts were bought frequently, which tells that the price level is appropriate. With this knowledge the company increased the price for some parts and decreased the price for others. This strategy improved the gross margin by 30%. While effective, the challenge in this approach is that companies might lack the information needed. This includes, for example, data about competitor prices, how parts are used in the field, and where competitors are making inroads. (Gallagher et al., 2005)

Aftermarket customers often expect fast service and availability due to the machines being critical for operations. This could indicate that price is not always the most important competitive advantage, but rather the quality of customer service. The customer's need for a spare part depends on maintenance strategy and spare part's criticality for operations. If preventive maintenance applies, immediate customer service

is not always needed. However, when a critical spare part has broken down, the customer needs quick service and delivery. Thus, companies should keep in mind that it is possible to differentiate from competitors with other factors than price. For example, companies can create value with high-quality customer service and availability of spare parts. This also allows companies to add value-based elements to spare parts pricing. Studies show that there is a direct correlation between prices and the quality of aftersales services. (Cohen et al., 2006)

Life cycle costing (LCC) is one of the primary methods of evaluating the entire PLC (Takata et al., 2004). LCC is a method used in PLM for calculating all the costs that occur over a product's useful life. LCC is mostly used as a tool in cases, where there is a comparative situation, to help decision-makers in selecting the best option. For example, LCC can be used to compare alternative options in competitive products, maintenance plans, or end-of-life scenarios. LCC can also be used to identify cost drivers. (Kambanou, 2020) Moreover, LCC can be used to assess and justify the customer value of a spare part. In many cases, a maintenance-based life cycle has lower life cycle costs because the product is maintained functional for a longer period (Kambanou, 2020). This means that usually, it is more beneficial for a customer to invest in a spare part rather than a whole new machine. Using this logic, customer value can be perceived as savings compared to a new machine or a competing option. On the other hand, spare parts can be crucial for the continuity of customer's operations and being out of a part can create costs for the customer that are difficult to quantify (Kennedy et al., 2002). These costs can include, for example, lost production and increased risk to personnel. (Kennedy et al., 2002) Therefore, it can be rather difficult to estimate customer value, when thinking of using value-based pricing in spare parts. In addition, the large number of spare parts offered can be a restricting factor since it can be rather difficult to build a model that estimates customer value for each spare part.

Lastly, the PLC phase of the spare part should be considered (Nnamdi, 2018). PLC also covers the need for demand analysis which is suggested by Shipley and Jobber (2001). Life cycle pricing of spare parts addressed in research is discussed further in chapter 3.5.2.

3.5 Life cycle pricing

Life cycle pricing refers to a dynamic pricing strategy that considers the PLC phase of the product in pricing decisions. A dynamic pricing strategy focusing on the PLC can bring companies significant competitive advantage (Bahrami & Yaghoubi, 2024). Understanding the need to adjust pricing proactively to a changing market is crucially

important for sustaining relatively high profits over the entire PLC of a product (Nagle et al., 2024b). Also, switching the product's price over PLC helps to gain repetitive orders from customers to retain sales. Creating a dynamic price switching policy is a complex challenge since the goal is to change the price according to the demand and other characteristics in the PLC phase, while the price also affects the demand at the same time. (Bahrami & Yaghoubi, 2024) In this chapter different life cycle pricing objectives and strategies will be discussed. In addition, existing research on life cycle pricing of spare parts will be explored.

3.5.1 Life cycle pricing strategies

In this subchapter, we will consider pricing strategies in the light of the varying characteristics of different PLC phases. A few studies exploring the PLC approach in pricing were found. Bahrami and Yaghoubi (2024) studied price switching policies under advertising effect and a dynamic environment in the supply chain using a life cycle approach. Using dynamic models for analysing market demand and pricing decisions according to the properties of PLC phases, they found out that strategic timing considering PLC in price adjustments results in overall higher demand and profitability. Asl-Najafi and Yaghoubi (2021) developed a dynamic model for time-varying price in a closed-loop supply chain, also considering customer price sensitivity over PLC. Their results say that a profitable PLC structure needs careful planning and price optimization, aiming to lengthen the growth, maturity, and decline phases. Sun et al. (2024) created a dynamic surge pricing model to utilize for fast upgrading technologies throughout PLC. The study proved that their dynamic pricing model is more profitable compared to a linear demand model, which suggests the necessity for life cycle pricing. Rink (2017) developed a modified PLC model to utilize in skimming price strategy. In addition, Nagle et al. (2024b) have recognized the need for life cycle pricing.

While these above-mentioned studies focus mainly on consumer products, it is believed that the findings and models can still be utilized in a B2B context. Only one study of life cycle pricing was found to focus on an industrial context. Smith et al. (1999) studied life cycle pricing under market turbulence (rate of change in technology) comparing pricing strategies in high and low technology industry companies. The study was conducted using a questionnaire sent to purchasing managers. They found out that low technology products can be priced more consistently during their PLC. The study also integrates evidence from consumer-based life cycle pricing research into industrial context. (Smith et al., 1999) A summary of the examined papers and main findings related to this study is presented in Table 2.

Table 2. Main sources for life cycle pricing

Study	Focus of the study	Main findings
Asl-Najafi & Yaghoubi (2021)	A dynamic model for closed-loop supply chain optimization	Price optimization helps to lengthen the PLC
Bahrami & Yaghoubi (2024)	A dynamic model for price switching under advertising effect	Strategic timing of price adjustments leads to an overall higher demand and profitability
Rink (2017)	A modified PLC pricing strategy	PLC concept enables forecasting, thus helping companies to develop more effective pricing strategies
Smith et al. (1999)	Pricing strategy under market turbulence, utilizing PLC approach	Low technology products can be priced more steadily over PLC
Sun et al. (2024)	A dynamic surge pricing model for life cycle pricing	Pricing models based on PLC are more profitable compared to models based on linear demand

First, we will discuss the timing of price changes. The basic understanding in the existing research is that price adjustments should be made in the beginning of each phase (Bahrami & Yaghoubi, 2024; Nagle et al., 2024b). However, there are various strategies considering the timing. Bahrami and Yaghoubi (2024) suggest that later price reduction in the growth and maturity phases, and earlier price reduction in the decline phase is the optimal choice in terms of overall demand and profitability. Asl-Najafi and Yaghoubi (2021) utilize a model where the price is changed constantly even in between the PLC phase changes. Also, in the dynamic pricing model by Sun et al. (2024) price is changed constantly based on sales forecasts of total sales and change in sales. In conclusion, the research agrees that price adjustments should be made over PLC, at least around the PLC phase changes. The timing and frequency of price adjustments should be considered depending on the situation in each company. For example, lack of resources or a large number of items can restrict the amount of price changes that can be done. According to Bahrami and Yaghoubi (2024) it is operationally more logical that the price adjustments occur only in between the phases.

Second, it will be discussed how the price should be adjusted in each phase. Most studies suggest that price should be set at its highest point in the introduction phase and then reduced over the PLC (Asl-Najafi & Yaghoubi, 2021; Bahrami & Yaghoubi, 2024; Nagle et al., 2024b; Smith et al., 1999). Price decreases are justified by increasing competition and price sensitivity (Asl-Najafi & Yaghoubi, 2021; Nagle et al., 2024b). In the growth phase, emerging markets require aligning value with price. New competitors arise and price sensitivity increases, which forces price decreases. Companies may even have to sacrifice short-term profits to stay in the price competition. However, price adjustments are usually possible without making loss due to economies of scale and

increasing demand. When the maturity phase occurs, customers start to have the ability to evaluate and compare competing products, which forces companies to lower prices even more to stay in the competition. (Nagle et al., 2024b)

Price reductions during PLC are supported by Asl-Najafi's and Yaghoubi's (2021) findings about customer price sensitivity over PLC. At the beginning of PLC, especially in the growth phase, product demand tends to be inelastic, meaning that customers are willing to buy the latest technologies with higher prices. Towards the end of PLC, especially in the maturity phase, customers become more price sensitive because of the growing number of competitors and substitute products. This means that, towards the end of PLC, other drivers, like price, reliability, and functionality guide customers' buying decisions. (Asl-Najafi & Yaghoubi, 2021)

In their dynamic model, Bahrami and Yaghoubi (2024) use a price reduction coefficient η ($0 < \eta < 1$) which is used to reduce the price in between each phase. The initial price p is then adjusted as follows:

- introduction: p
- growth: ηp
- maturity: $\eta^2 p$
- decline: $\eta^3 p$

Asl-Najafi and Yaghoubi (2021) utilize exponential decay in price over time. In this model as well, price gets its highest value in the beginning of PLC to cover initial expenses, like development and launching costs. In the growth phase, price is still high but declining to gain profit from great amounts of market demand, but also to discourage newcomer rivals. In the maturity phase, price is on a usual level, but reducing the price continues to maintain market share. In the decline phase, price should be low enough to get rid of the remaining stock before obsolescence. In their model price decay rate λ_i ($0 \leq \lambda_i \leq 1$) is constant during each phase, and price is changed with respect to time t at phase i . The price decay rate in the next phase is always higher than in the previous phase. Price p follows function $p(t) = pe^{-\lambda_i t}$. (Asl-Najafi & Yaghoubi, 2021)

Different from the previous studies, Sun et al. (2024) and Rink (2017) suggest different strategies, where the price does not always decrease over PLC. According to Sun et al. (2024) companies should start with a low price to open the market in the introduction phase, then raise the price in the growth phase to seek greater profit and then decrease the price towards the end of PLC to reduce loss. Sun et al. (2024) present a dynamic surge pricing model that has two basic rules for price adjustments. The first rule is that

price increases when marginal sales are positive and decreases when marginal sales are negative. The marginal sales are the change in sales per unit of time, which enables an immediate response to potential demand change. The second rule is that the price decreases as the total sales increase due to limited potential demand in the market. Their model also considers the dynamic competition between two firms. The price p at time t for firm i ($i=1,2$) is then

$$\begin{cases} p_1(t) = p_1(0) + \lambda \dot{q}_1(t) - \mu(q_1(t) + q_2(t)) \\ p_2(t) = p_2(0) + \lambda \dot{q}_2(t) - \mu(q_1(t) + q_2(t)) \end{cases}$$

where λ is the coefficient of marginal sales and μ is the coefficient of total sales, $p_i(0)$ is the initial price, and $\dot{q}_i(t)$ is the forecast of marginal sales based on the system. (Sun et al., 2024)

Rink (2017) studied skimming price strategy in the introduction phase and developed a modified PLC model to utilize in this strategy. Using a skimming price strategy has some requirements, such as little or no threat of competition, inelastic demand, fast upgrading technology, and expected short PLC, which makes the strategy most likely not very suitable in the context of spare parts. However, after the introduction phase, pricing strategy changes and some of the ideas from this model can be utilized. In Rink's (2017) modified PLC model, price acts as a mirror to the PLC curve, meaning that the price is reduced until demand reaches its highest point in the maturity phase. In contrast to other studies, the price will then be increased. According to Rink (2017) price can be increased at the end of PLC depending on the circumstances, such as customers' reactions to price change. Some brands are strong enough to sell the products with the old or even a higher price. Costs tend to increase towards the end of PLC when unit volume falls. Price reductions can then be hard to implement. (Rink, 2017) However, Rink (2017) argues that demand may become more inelastic in the decline phase, which means that companies could raise prices and pass the cost increases to the customer without decreasing sales.

Lastly, we will discuss other relevant findings from the papers. Bahrami & Yaghoubi (2024) note that considering only PLC can lead to a conservative pricing policy and less profit. For profit maximization, companies should also consider nuances of market demand and customer behaviour in their life cycle pricing strategies (Bahrami & Yaghoubi, 2024). In addition, according to Smith et al. (1999), it is important to consider the differences between high and low technology products in life cycle pricing. PLC is usually shorter in high technology products. High technology companies find that their prices decrease more relative to product performance in the early phases of PLC. Price is gradually decreased as competitive solutions become available and products become

commodities. In high technology products, there is not much flexibility to meet the price competition in the maturity phase because of high product development costs. That is why the profits must be recovered from introduction and growth phases. On the other hand, low technology products with longer life cycles are generally less challenging for companies to develop consistent pricing strategies for each PLC phase. With low technology products, companies were able to maintain their price positions relative to their competitors, even when product performance declined over PLC. This enables long-term pricing strategies, meeting price competition in the maturity phase, developing market entry barriers over PLC, and extending the maturity phase for maximal sales and profit. (Smith et al., 1999)

As said, price competition can get intense especially in the maturity phase. Nagle et al. (2024b) present several tactics for margin enhancing opportunities in commoditized products. First, companies can unbundle their products and services. As competitors start to be skilful at imitating the differentiating aspects in the leading company's bundle, it might be easier to develop just the one superior part and allow customers to buy other parts from competitors. If buyers are forced to buy as a bundle, the most aware customers will move to less expensive or more innovative competitive products. Therefore, it is most likely better to focus on products where the company can create the most value and profit, rather than trying to be superior in all parts. Second, companies can utilize improved estimation of price sensitivity. In the maturity phase, the source of demand is mostly repeat buyers, which means that companies can better estimate price sensitivity, and see if fine-tuning of price can improve profits. Third, in the maturity phase, companies should complete a careful cost analysis to see which products and customers do not have high enough margins. Costs can then be considered in pricing. If demand cannot support higher prices, items should be eliminated from the offering. The same applies for customers. If some customers require special support disproportionate to their contribution, customers should be charged for the services. While the growth phase enables developing products and new customer accounts, maturity should be the time to cut losses on those that have not begun to make profit. Lastly, primary products' profit can be enhanced with additional goods or services that can be priced more profitably, such as spare parts. (Nagle et al., 2024b)

In conclusion, there are several different ways to form a life cycle pricing strategy. Companies need to consider timing and logic of price adjustments, design a suitable pricing model, follow costs, evaluate the performance of the model, and possibly respond with corrective actions.

3.5.2 Life cycle pricing of spare parts

It is necessary to study life cycle pricing of spare parts separately as spare parts' nature differs from other products due to their relation to the primary equipment. No studies focusing on this topic solely were found. Instead, we will discuss applicable findings from research that could be utilized in building a life cycle pricing model for spare parts. The focus will particularly be in the maturity and decline phases, as those seem to be the most challenging phases in the case company and, according to Nnamdi (2018), in other companies as well.

Nnamdi (2018) has acknowledged the importance of life cycle pricing of spare parts in managing spare parts inventories. In his study, lack of life cycle pricing was found to be one of the root causes for excess and dead inventories in the case company from the elevator industry. Life cycle pricing was then suggested as a proactive method to avoid excess spare parts inventory towards the end of PLC. This method was based on forecasting sudden decreases in demand and applying discounts for spare parts approaching their decline phase. (Nnamdi, 2018) In addition, life cycle pricing has been noted as a crucial factor in maximizing sales and profits over the whole PLC of a product (Bahrami & Yaghoubi, 2024; Nagle et al., 2024b). This applies for spare parts as well.

As spare parts differ by demand patterns, PLC curves, and primary product's life cycle in each industry (Nnamdi, 2018), it is important to determine the life cycle pricing strategy case by case. It is believed that the price adjustment methods from previous studies can be utilized in spare parts business if judged carefully in each context. As said, a pricing strategy that acknowledges only PLC is not optimal (Bahrami & Yaghoubi, 2024). Considering only the demand for a product leaves out other important factors, why companies should also consider other main components of spare parts pricing (cost, competition, category, and customer value) in each phase to maximize profit. These components and their dynamics also tend to change as the PLC goes on, as described by the characteristics of different PLC phases. For example, some spare parts may face significant cost increases towards the end of PLC. This would usually cause price increases, which may lead to even further decline in sales. However, in some industries demand may become more inelastic in the latter phases (Rink, 2017). This could be the case with spare parts, since often it is more beneficial for the customer to invest in a spare part, that is slightly more expensive than usual, than in a completely new equipment (Kambanou, 2020). According to Shipley and Jobber (2001) price sensitivity tends to be low for items that customers need urgently and that compete against few alternative solutions. Therefore, in addition to costs, companies should also consider, for example, the competition on the market (for example, if a customer can get the part

cheaper or faster from a competitor), and how much the customer values the spare part (for example, if the part is critical for operations).

Next, the possible scenarios for each pricing component over PLC will be discussed. As described in the previous chapter, there are a few different strategies for life cycle pricing. Sun et al.'s (2024) and Rink's (2017) pricing strategies, where the price should be increased in the decline phase, are supported by the fact that costs related to spare parts are generally higher post PLC of the primary product (Inderfurth & Mukherjee, 2008). Production costs increase as manufacturing facilities may not be available anymore. During PLC, overstocking and understocking costs are on a regular level. Costs are mainly possible backordering costs due not filling customer orders in time. Post PLC, there are more overstocking and understocking costs due to increased opportunity costs. Opportunity costs can be risks of losing capital on spare parts that may never be used, or missing critical service opportunities due to no stock. (Inderfurth & Mukherjee, 2008) These costs should be optimized but also considered in the life cycle pricing of spare parts to make sure that profit is secured. Therefore, it sometimes makes sense to increase the price towards the end of PLC. In some cases, costs can remain or even decrease (Bahrami & Yaghoubi, 2024). In this case, implementing Bahrami and Yaghoubi's (2024) or Asl-Najafi and Yaghoubi's (2021) pricing strategy, where price is decreased over PLC, could be more suitable to secure profit and demand.

One of the key factors of spare parts pricing is competition (Cohen et al., 2006). In the decline phase, the number of competitors is often declining as the market is not as attractive anymore (Bahrami & Yaghoubi, 2024). This can lead to a situation, where the price of a spare part can be increased, if the spare part is valuable enough and there are no other suppliers for the part. If the competition remains, it might be beneficial to decrease the price to create competitive advantage.

According to Smith et al. (1999) low technology products can be priced more consistently throughout their PLC. It is believed that this approach can be utilized in spare parts pricing strategy as well. Categorization could be used to assess the approximate technology level of the spare part, and determine how significant price adjustments are needed during PLC (Nnamdi, 2018). For example, low technology commodity items might be priced very constantly throughout the PLC since companies compete with price, and the costs stay moderate even towards the end of PLC. On the other hand, high technology key parts can be priced higher in the early phases of PLC as there is no competition, but prices may have to be reduced heavily as competitor solutions become available in the latter phases. (Nnamdi, 2018)

One of the key factors of strategic pricing is customer value (Nagle et al., 2024c). However, it is unclear how the customer value of a spare part acts over PLC. It could be that customer value remains high, if the spare part is critical for operations, and the spare part can be provided quickly. Customer value can also be measured as how much the customer saves by buying a new spare part versus scrapping the old machine and buying a new one. If the spare part is not critical or if it is a commodity item, customer value might remain similar or even decrease throughout the PLC.

In conclusion, all the pricing components are somewhat related to the PLC phase as described by the characteristics of different PLC phases. This means that cost, competition, customer value, and the categorization of the spare part can vary during the PLC. Spare parts PLC is then not only about the demand curve, but also about the changes in the other characteristics of the spare part. A life cycle pricing strategy should then include estimations of both the demand development and the development of the market conditions. It is crucial to remember that pricing should also be a way to actively influence the demand curve as opposed to just reacting to demand. The objective is to create a strategy that lengthens the PLC of the spare part and maximizes demand and profitability, but also to serve customers and their machinery at a high level.

3.6 Synthesis of the theoretical part

Based on the literature review, there are several studies of PLC, a few studies concentrating on spare parts PLC. Based on these findings, it is possible to better understand the PLC of heavy machinery spare parts. Existing literature of life cycle pricing was found, but no comprehensive studies about life cycle pricing for spare parts exists. As spare parts have unique qualities and aspects, it is necessary to study these topics further. Still, the literature review lays a solid background for answering the research questions. A synthesis of the studied subjects is presented in Figure 10 in the form of an initial framework for implementing spare parts life cycle pricing. The pricing wheel from Shipley and Jobber (2001) was utilized as a base for the framework. The framework helps to understand the topics studied, and how they are related to each other.

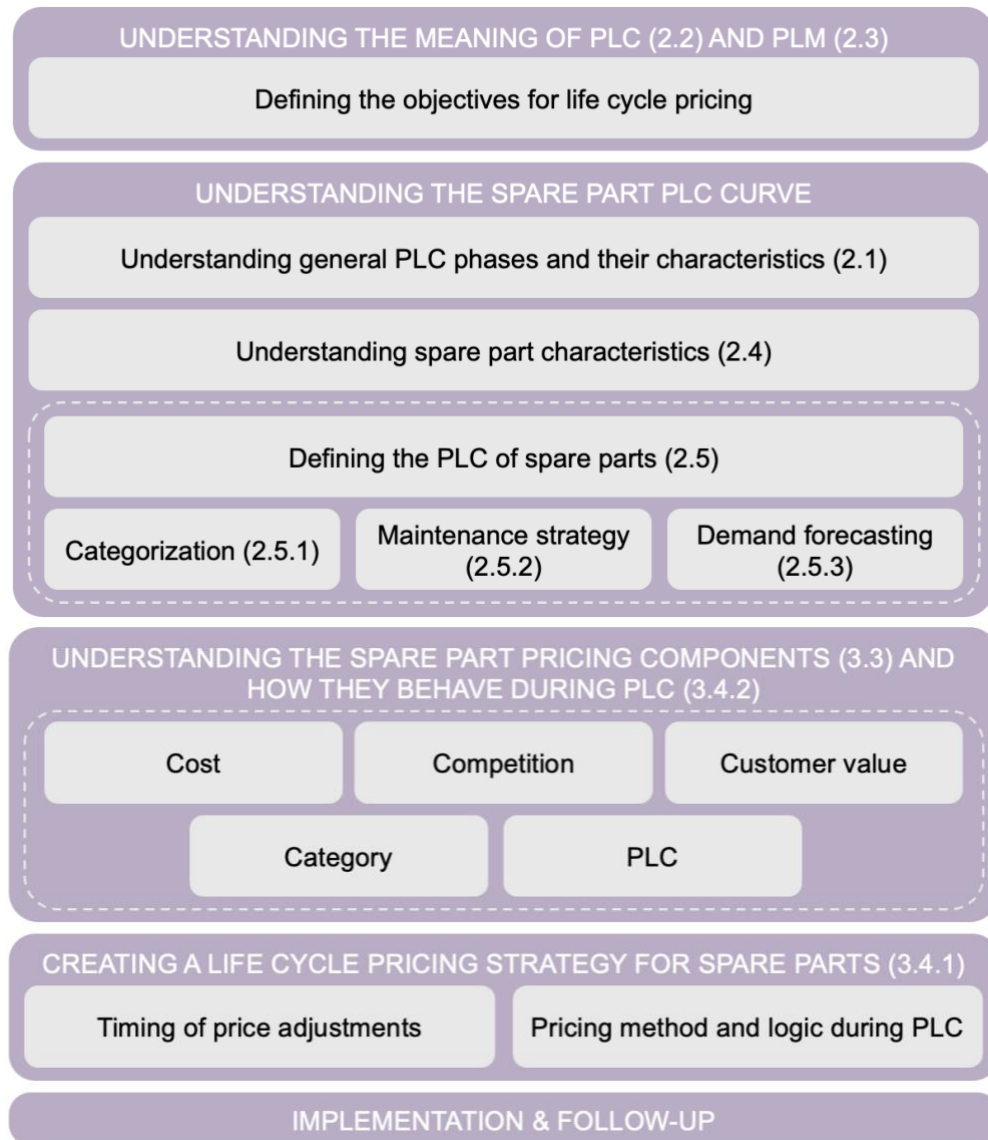


Figure 10. Initial framework for implementing spare parts life cycle pricing

First, it is crucial to understand the meaning of PLC in business strategy to define the objectives for life cycle pricing. Major changes in business strategy are needed in over PLC (Hofer, 1975). Understanding the PLC of a company's products and making decisions based on that, can bring companies competitive advantage and help maximize profit. Usually, the goal is to proactively aim to lengthen the PLC. One way to do this is pricing. (Bahrami & Yaghoubi, 2024)

Second, to implement life cycle pricing for spare parts, it is necessary to understand the PLC of spare parts. Spare parts have some unique characteristics, for example their relation to the primary equipment and tendency to intermittent demand (Kennedy et al., 2002). When defining the spare parts PLC, spare parts should be categorized by different qualities in order to create suitable strategies for each category (Jouni et al., 2011; Nnamdi, 2018). Maintenance strategies can help to understand when spare parts are

needed, or in other words, when there is demand for a spare part (Kennedy et al., 2002; Takata et al., 2004). Lastly, it is possible to forecast spare parts PLC utilizing historical data of demand, breakdowns and/or installed base of machinery (Inderfurth & Mukherjee, 2008; Van der Auweraer et al., 2019). This part partially answers the first research question about the PLC phase assessment for spare parts. Further research is needed to form a clear understanding on how these approaches are or could be utilized in the case company.

Third, companies should evaluate their spare parts pricing components, and how they change during PLC. In the literature review, costs (Hu et al., 2018), competition (Cohen et al., 2006), customer value (Kennedy et al., 2002), categorization (Jouni et al., 2011; Nnamdi, 2018), and demand (Nagle et al., 2024a; Nnamdi, 2018) were found to be the main components of spare parts pricing. However, there are multiple different scenarios, how these components can behave during spare parts PLC. Therefore, it is crucial to study the spare parts PLC further, since no comprehensive model of the PLC phases and their characteristics for spare parts was found. It should also be studied, if some pricing components stand out in different phases to answer the research question RQ2a.

Fourth, based on the understanding of spare parts PLC in a specific industry or category, a life cycle pricing strategy can be created. There are a few options in the current literature for the timing and logic of price adjustments during PLC. Price can be adjusted regularly (Asl-Najafi & Yaghoubi, 2021; Sun et al., 2024), or only when a phase change occurs (Bahrami & Yaghoubi, 2024). The latter is usually the more practical way. Later price adjustments in growth and maturity phases, and earlier adjustments in the decline phase is found to be an optimal method to maximize overall demand and profitability. (Bahrami & Yaghoubi, 2024) It is recommended by researches that the price is only reduced from the initial price at least until the decline phase occurs (Asl-Najafi & Yaghoubi, 2021; Bahrami & Yaghoubi, 2024; Nagle et al., 2024b; Rink, 2017; Smith et al., 1999). Rink (2017) suggests that the price is increased in the decline phase to secure profit in case of cost increases, while others continue the price reductions. Sun et al. (2024) suggest a more dynamic model where price could be increased or decreased any time in case of shift in sales. A suitable life cycle pricing strategy should be chosen depending on the industry and characteristics of a spare parts category (Nnamdi, 2018). Lastly, the life cycle pricing strategy can be implemented into the existing spare parts pricing strategy. Follow up is needed to develop the strategy further.

Further research is needed to answer the second research question. To form a suitable framework for life cycle pricing, it is crucial to study the characteristics of spare parts in the case company. Literature review lays a solid foundation for exploring different options

for this. In addition, to answer research question RQ2b, it should be further studied how life cycle pricing strategies affect demand and profitability of spare parts over PLC. Table 3 shows the examined topics in the literature review and the main insights and sources from each topic.

Table 3. Examined topics in the literature review

Topic		Main insights	Main sources	
PLC	Different phases of PLC (2.1)	PLC consists of introduction, growth, maturity, and decline phases, which all have different characteristics.	Bahrami & Yaghoubi (2024)	
	PLC in business strategy (2.2)	Proactively making decisions based on PLC is crucial for business strategy to maintain competitive advantage and maximize profits.	Bahrami & Yaghoubi (2024) Hofer (1975)	
	Product life cycle management (2.3)	Spare parts business takes place in the middle of the primary product's useful life, in the support and maintenance activities.	Stark (2011) Takata et al. (2004)	
	Spare parts characteristics (2.4)	Spare parts demand is heavily related to the primary equipment and maintenance strategies. Demand for spare parts is intermittent and sporadic.	Chien et al. (2023) Kennedy et al. (2002)	
	Defining PLC of spare parts (2.5)	Categorization (2.5.1)	Spare parts should be categorized based on the nature of the part to determine a suitable PLC model.	Jouni et al. (2011) Nnamdi (2018)
		Maintenance strategies (2.5.2)	Understanding the primary products' life cycle phases and the maintenance strategies will help to understand, in which kind of situations the spare parts are needed.	Kennedy et al. (2002) Takata et al. (2004)
		Forecasting demand (2.5.3)	Spare parts PLC can be forecasted using historical data or information about the installed base.	Indefurth & Mukherjee (2008) Kennedy et al. (2002) Van der Auweraer et al. (2019)
Pricing	Role of pricing (3.1)	Pricing is the most powerful lever to manage profitability. Pricing directly affects the profitability, competitiveness, demand, and customer perception of a company.	Kohli & Suri (2011)	
	Pricing process (3.2)	Pricing is a continuous process that includes a sequence of actions. It is important to determine the objectives of pricing and determinants that affect the price before choosing the pricing strategy.	Shipley & Jobber (2001)	
	Pricing methods (3.3)	Cost-based (3.3.1)	Cost-based pricing can seem a tempting pricing method for a large number of spare parts.	Shipley & Jobber (2001)
		Market-based (3.3.2)	Following competitor price changes allows companies to benefit from common price increases.	Shipley & Jobber (2001)
		Value-based (3.3.3)	Value-based pricing aims to consider the value of customer benefits. This is considered the most effective pricing method.	Nagle et al. (2024c) Shipley & Jobber (2001)
		Dynamic pricing (3.3.4)	In dynamic pricing, price is changed over time to adjust to market changes. Life cycle pricing is a type of dynamic pricing.	Bahrami & Yaghoubi (2024) Nagle et al. (2024a)
	Pricing of spare parts (3.4)	Costs, competition, customer value, categorization and PLC should be considered in spare parts pricing.	Cohen et al. (2006) Gallagher et al. (2005) Smith et al. (1999)	
	Life cycle pricing (3.5)	Life cycle pricing strategies (3.5.1)	There are different viewpoints on how life cycle pricing should be done in terms of timing and logic of price adjustments.	Asl-Najafi & Yaghoubi (2021) Bahrami & Yaghoubi (2024) Rink (2017) Smith et al. (1999) Sun et al. (2024)
Life cycle pricing of spare parts (3.5.2)		Different pricing components change during PLC, which should be considered in pricing.	Bahrami & Yaghoubi (2024) Indefurth & Mukherjee (2008) Nnamdi (2018)	

In conclusion, the theoretical part partially answers the research questions and lays a solid foundation for the empirical part. In the empirical part it will be studied, what is the current state of life cycle pricing in the case company and how it is compared to current research. Based on this analysis, it will be determined how the processes or methods can be improved in the case company. Also, a more comprehensive framework for life cycle pricing of spare parts is needed in the case company. This will also complement current research.

4. RESEARCH METHODOLOGY

This chapter gives an overview of the methodological choices made in this research to meet the research objectives. The first subchapter considers the research setting by assessing the research philosophy, approach to theory development, and research design. The second subchapter explains the methods related to data collection and the third subchapter explains the methods related to data analysis. Finally, the quality of the research methodology will be discussed.

4.1 Research setting

To define the research setting, Saunders et al.'s (2019, p. 130) research onion will be used as a basis. The research onion explains that research methodology is not just the data collection and analysis methods, but also the decisions that lead to those methods. The research onion consists of six layers: philosophy, approach to theory development, methodological choice, strategy, time horizon, and techniques and procedures used for data collection and analysis. (Saunders et al., 2019, pp. 128–130) Figure 11 presents the research onion with the methods used in this study.

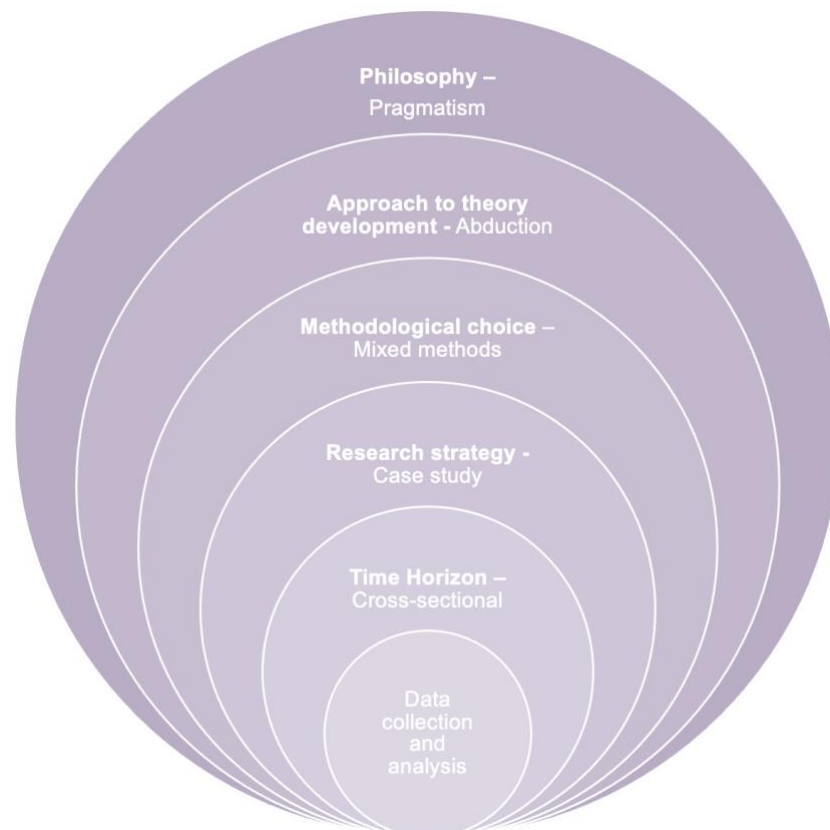


Figure 11. The research onion (adapted from Saunders et al., 2019, p.130)

The first layer, research philosophy, refers to the researcher's belief system and view on the development of knowledge. (Saunders et al., 2019, p. 130) In business and management research, the most common research philosophies are positivism, critical realism, interpretivism, postmodernism, and pragmatism (Saunders et al., 2019, pp. 144–145). Pragmatism was found to be the most suitable for the research problem as well as the researcher's belief system. Pragmatism emphasizes the practical meaning of knowledge in specific contexts (Saunders et al., 2019, p. 145). The philosophical approach is then to start from the research problem and then seek for practical solutions (Saunders et al., 2019, p. 151) This makes pragmatism a well-suited philosophy for seeking practical solutions to the problem in the case company. In pragmatism, concepts and methods that support action are preferred. (Kelemen & Rumens, 2008, p. 40). Therefore, pragmatism allows the use of multiple research methods (Saunders et al., 2019, p. 151), which is necessary in this study.

The second layer of the research onion is the approach to theory development. There are ultimately three approaches to theory development: deduction, induction, and abduction (Saunders et al., 2019, p. 152). Abduction was found an appropriate method for this study. Abduction combines deductive and inductive approaches by moving from theory to data (as in deduction) and data to theory (as in induction). This means that abduction moves back and forth between building and testing theory. (Saunders et al., 2019, p. 155) Abduction prioritizes the empirical world, but building theories at the same time (Van Maanen et al., 2007). This approach was found to be suitable for this study since the study starts from the literature review, moves on to testing the theories by interviews, and building managerial implications and new theory by combining knowledge from the theoretical and empirical parts. In addition, the abductive approach is used to identify themes and explain patterns, as well as to generate a new theory, to modify an existing theory, and to test these theories (Saunders et al., 2019, p. 156). Therefore, it is possible to answer the research questions with this approach.

The next three layers - methodological choice, research strategies, and time horizon - formulate the research design (Saunders et al., 2019, pp. 172–174). The research design explains the general plan of how the research questions will be answered. The nature of the research design in this case is exploratory, since the goal is to understand the topic as well as gain more information and new insights. The third layer concerns methodological choice, which is about whether the study includes quantitative, qualitative or mixed methods, which combine both quantitative and qualitative aspects. (Saunders et al., 2019, pp. 172–174) Mixed methods are needed in this study to collect credible, reliable, and relevant data to answer the research questions. This is according

to the philosophy of pragmatism, where the methods should be chosen based on which methods enable the suitable data to address the research problem (Saunders et al., 2019, p. 181). Mixed methods provide more evidence for studying the research problem (Creswell & Plano Clark, 2017, pp. 12–13). Also, it allows to maximize the strengths and minimize the weaknesses of both qualitative and quantitative methods. Qualitative methods allow understanding the humane context, whereas quantitative methods help to ignore personal interpretations made by the researcher. (Creswell & Plano Clark, 2017, pp. 12–13) Data will be collected sequentially, first quantitative and then qualitative data.

The fourth layer considers the research strategy or strategies. Case study will be used as a research strategy in this study. The goal of a case study is to conduct as diverse and holistic picture of the situation as possible (Vuori, 2021). Therefore, several data sources are combined in the case study. (Vuori, 2021) A case study is found especially suitable for this study, since it sets the topic into a real-life setting and allows for managerial implications (Yin, 2018, cited in Saunders et al., 2019, p. 196). It is necessary to carefully choose and define the ‘case’ to be studied (Saunders et al., 2019, p. 196). The case in this study refers to the life cycle pricing process in the case company.

The fifth layer of the research onion considers the time horizon. This can be either a snapshot of the situation at a particular time or a representation of events over a given time period (Saunders et al., 2019, p. 212). In this case, a snapshot, or cross-sectional, time horizon was chosen to be appropriate, because of the time constraints related to the thesis. (Saunders et al., 2019, p. 212) In this study, interviews are conducted over a short period of time. Also, this research aims to clarify the situation in the case company at the particular time, which justifies the cross-sectional horizon.

After defining the research philosophy, the approach to theory development, and the research design, data collection techniques and analysis procedures in the centre of the research onion can be assessed. The collection and analysis methods will be discussed in the next chapters.

4.2 Data collection

The research process consists of five phases presented in Figure 12. First literature review was completed. Second, quantitative data was gathered and analysed. Third, interviews were held and the data collected was analysed. In addition, a problem with one quantitative data set was discovered in the interviews. Hence, the research process went back to editing the quantitative part slightly. Fourth, empirical findings were put in

the context of theory found in the literature review. Lastly, feedback was collected from the case organization. In this chapter, data collection methods used in the study will be discussed.



Figure 12. Research process

There are necessarily three data sources used in this study: literature review, internal data of spare parts, and interviews. These data sources were chosen for this study, as multiple data collection methods and sources are usually required in case studies (Vuori, 2021). Mixed methods, as well as multiple data sources provide a more comprehensive premise to answer the research questions (Creswell & Plano Clark, 2017, pp. 12–13; Vuori, 2021). Multiple data-gathering methods better guarantee diverse viewpoints for analysis and limitations of one method can be addressed by other methods (Saldana, 2011, p. 76). According to Saldana (2011, p. 76) multiple data-gathering methods and sources also improve the credibility and trustworthiness of the research. One way to ensure sufficient data-gathering is to utilize triangulation. Triangulation refers to the use of at least three different data sources. (Saldana, 2011, p. 76) Next, the data collection methods for each data source will be discussed.

4.2.1 Literature review

The data collection process started from the literature review to gain a basic understanding of the discussed topics. There were three main topics related to this research: spare parts, pricing, and PLC. The goal was to establish what is already known about these topics on their own and as combined phenomena. Literature review was found necessary for the research since theory can be used to provide focus, scope and direction for the study (Tashakkori & Teddlie, 2010). Existing research was searched based on keywords from each of the three main topics. Andor, provided by Tampere University, and Scopus were used as the primary databases. In addition, citation pearl growing strategy was used to find other relevant papers based on the references of the relevant papers found by searching the database. Studies less than 10 years old were prioritized, due to the recent appearance of the life cycle pricing topic in literature. Older studies were accepted if the topic was more universal. Based on the literature review, it was possible to create an initial framework for implementing spare parts life cycle pricing. Based on the framework and the overall literature review, some interview questions were prepared to gain a more comprehensive and pragmatic view of the case.

4.2.2 Quantitative company data

After finishing the literature review, quantitative data was gathered from internal data sources. The main goal of the quantitative part was to gain a clear understanding of the current situation of spare parts PLC categorization and life cycle pricing in the case company. To better understand the current situation, two other points in time were chosen in addition to the time of the study. The current PLC categorization was implemented a few years before the study. Hence, three data points were chosen between the implementation of the PLC categorization and the time of the study. The data points will be referred to as T1, T2, and T3, which are certain periods of time. Secondary data from internal sources was collected for this part of the research. Secondary data refers to data that was initially collected for a different purpose (Saunders et al., 2019, p. 338). Hence, using secondary data can help to save time and resources, while still enabling answers to research questions. (Saunders et al., 2019, p. 338) The quantitative data in this research was collected from two sources. First, historical spare parts sales data was collected from an internal historical sales data report. Second, historical spare parts pricing, cost, and PLC categorization data was collected from exports from the case company's pricing tool. These exports were initially used to prepare price revisions. In addition, the same information was exported from the pricing tool at the time of the research to assess the current situation. In addition, information about the current life cycle pricing methods were collected from the pricing tool.

There is a need to select a sample, if it would be impracticable to collect data from the entire population (Saunders et al., 2019, pp. 294–295). The case company manages a large number of spare parts in total. However, only one fourth of the spare parts have a price at the time of the study. Therefore, the priced items from each year's item list will be used as a sample, when analysing spare parts PLC categorization in the case company. This sample is also useful, when analysing spare parts life cycle pricing. Items that did not have purchase price information available were deleted from the sample. As a result, a few thousand lines were deleted from each year.

4.2.3 Interviews

Lastly, interviews were held with different people from the case organization to gain different viewpoints on the topic. Non-probability sampling was used when choosing the interviewees. This means that the interviewees are selected non-randomly, using subjective judgement (Saunders et al., 2019, p. 315). To be more specific, purposive sampling was utilized. Purposive sampling, or judgmental sampling, allows the researcher to use their own judgement to choose the cases that will most likely enable

answers to the research questions and objectives (Saunders et al., 2019, p. 321). Purposive sampling is suitable for working with small samples, such as in case studies. (Saunders et al., 2019, p. 321) Heterogeneous sampling as one type of purposive sampling was utilized to achieve maximum variation in the data collected. Heterogeneous sampling uses judgement to choose interviewees with diverse characteristics, and it enables data that explains the key themes that can be observed (Saunders et al., 2019, p. 321). This method was used to make sure that many different suitable viewpoints could be collected. In addition, the goal was to unravel the key themes considering the topic in the case company. In total, 12 interviewees were selected. Interviewees were chosen both from the corporation and from the subsidiaries to collect diverse and rich data. The interviewees, their background, and the duration of each interview are presented in Table 4.

Table 4. Interviewee information and interview durations

Organization	Interviewee	Role	Department	Interview duration
Corporation	C1	Director	Pricing	30 min
	C2	Manager	Master data Management	79 min
	C3	Director	Parts Product Management	34 min
	C4	Senior Manager	Demand Planning	30 min
	C5	Head	Services Sourcing	30 min
	C6	Manager	Parts Lifecycle	42 min
	C7	Senior Manager	Documentation	57 min
	C8	Manager	Planning and Logistics	38 min
Subsidiary A	S1	Manager	Spare parts	26 min
Subsidiary B	S2	Head	Services	29 min
Subsidiary C	S3	Director	Services	30 min
Subsidiary D	S4	Director	Country	23 min

The interviews were conducted as semi-structured interviews, which is suitable for an exploratory study (Saunders et al., 2019, p. 443). Semi-structured interview consists of a predetermined list of themes and some key questions related to these themes (Saunders et al., 2019, p. 437). Semi-structured interviews allow the interviewer to probe a response, meaning that the interviewer can ask the participant to explain or build on their previous answers. In addition, this method allows the interviewer to guide the discussion into areas that are significant to addressing research questions or objectives, therefore leading to a detailed and rich set of data. (Saunders et al., 2019, pp. 444–445) Semi-structured interview was seen as a suitable method for this study as very likely leading to rich data and due to the possibility to steer the discussion during the interview.

A framework developed by Kallio et al. (2016) was utilized to develop the interview guide. The framework has five phases: identifying the prerequisites for using semi-structured

interviews; retrieving and using previous knowledge; formulating the preliminary semi-structured interview guide; pilot testing the interview guide; and presenting the complete semi-structured interview guide. Interview guide refers to a list of questions, which guides the discussion to the research topic. (Kallio et al., 2016) First, it was identified that semi-structured interview is suitable for this study, as described above. Second, previous knowledge was gathered using literature review, which created a comprehensive understanding of the subject. Third, the preliminary interview questions were formed. Fourth, the preliminary interview questions were pilot tested using field-testing. Field-testing refers to a technique where the interview guide is tested with the potential interviewees (Kallio et al., 2016). Based on the field-testing it is possible to re-formulate the order and form of the questions to make the interview guide more practical. (Kallio et al., 2016) The first interviews acted as field-testing in this study, after which the interview guide was re-formulated based on the identified needs. Lastly, the complete semi-structured interview guide was formed based on the re-formulating needs identified in the field-testing.

With the corporation level interviews, the goal was to establish the current situation of demand forecasting and life cycle pricing of spare parts in the case company. In addition, the aim was to gain insights about how the interviewees think life cycle pricing should be done and what kind of phenomena can be linked to the topic. Subsidiary level interviews were conducted to find out how the end customers behave during spare parts PLC and what kind of factors they value in different PLC phases. Some of the interview questions were drawn from theory. This means that the applicability of the theories are tested in the context of this case study, in accordance with the deductive approach (Saunders et al., 2019, p. 438). Some interview questions were drawn from discussions with colleagues and from the researcher's experience. This is according to the inductive approach, moving from data to theory (Saunders et al., 2019, p. 438). Interview questions were left open-ended, to allow the interviewees to discuss their thoughts more openly. The interview structures can be found in appendix A, B, C, D and E. Presenting the actual interview questions allows other researchers to assess the results in relation to earlier knowledge and to test and develop the method (Kallio et al., 2016).

Interviews were conducted as one-to-one interviews. According to Saunders et al. (2019, p. 441), these are interviews conducted between the interviewer and single interviewee. Interviews were held face-to-face, if possible. Face-to-face interviews may lead to more open conversation, leading to rich and bias-free data (Saunders et al., 2019, p. 442). If face-to-face was not possible, the interview was held via Google Meet. Interviews were conducted in either Finnish or English, depending on the preference of the interviewee.

The interviews were recorded using Google Meet with the consent of the interviewee to help the analysis process. The interviews were also transcribed with the help of Google Meet, if the interviews were held in English and the interviewee gave consent to transcribing the interview. It was not possible to produce automatic transcripts in Finnish with Google Meet. Hence, interviews held in Finnish were transcribed by the researcher with the help of the recordings. According to Saunders et al. (2019, p. 463), recording allows the researcher to concentrate on questioning and listening and enables re-listening the interviews during data analysis. However, recording may inhibit some interviewee responses. (Saunders et al., 2019, p. 463) The benefits are still seen as outweighing the potential downsides, and the risk of inhibiting interviewees is seen low in this context. Interviews held in Finnish were translated to English by the researcher during the transcription process. In addition, notes were made during the interviews. Notes allow the researcher to record their own thoughts and the interview context and events that are not evident from the recording (Saunders et al., 2019, p. 461).

The interviewees were contacted to ask for an interview via company email. The planned interview questions were sent to each participant beforehand. Informing the interviewee gives the opportunity for them to prepare themselves for the discussion, and therefore possibly leading to richer data (Saunders et al., 2019, p. 452). After the interviews, transcriptions were handled as anonymous to protect the confidentiality of the interviewees.

4.3 Data analysis

Quantitative data was analysed using Microsoft Excel. The charts presented in this research were finally conducted in Google Sheets. Data was first analysed for each year under review. PLC categories, sales, costs, and profitability were analysed. By analysing the quantitative data, it was possible to gain an understanding of how the PLC categorization and life cycle pricing topics have developed in the case company. Exploratory data analysis was used to analyse the quantitative data. Exploratory data analysis emphasizes the use of graphs to better understand the data and is especially useful in the initial data analysis phases (Saunders et al., 2019, p. 581).

Qualitative interview data was analysed using thematic analysis. The goal in thematic analysis is to search for themes or patterns that recur across the data set (Braun & Clarke, 2006). Thematic analysis is considered a useful and flexible analysis method for qualitative research. (Braun & Clarke, 2006) Thematic analysis was considered appropriate for this study, since, according to Saunders et al. (2019, p.651), this method can be used to help integrate data from different transcripts, identify key themes or

patterns from the data set, and draw and verify conclusions. To follow a systematic approach, Braun and Clarke's (2006) framework for thematic analysis was used. This framework is presented in Figure 13. A data analysis software called ATLAS.ti Web was used to help in the analysis process. The software proved to be useful since it was easy to track the quotations and codes found within the data.



Figure 13. Phases of thematic analysis (adapted from Braun & Clarke (2006))

The data analysis started from familiarizing with the data by repeatedly reading the transcriptions and noting down what is interesting about the data. This step is crucial for understanding the depth and breadth of the data set (Braun & Clarke, 2006). The second phase involved generating the initial coding of the data. Code refers to a basic segment of the raw data that is interesting in terms of the study (Braun & Clarke, 2006). In other words, data is organized into meaningful groups (Tuckett, 2005) that have similar meanings (Saunders et al., 2019, p. 653). Third, broader themes were searched among the list of codes that were identified from the data. A theme is an upper-level category that incorporates several codes related to one another (Saunders et al., 2019, p. 657). Fourth phase included re-examination of the candidate themes. In this phase, some themes might get merged together, some themes might need to get broken down, and some themes might get dismissed if there is not enough data to support them (Braun & Clarke, 2006). Patton's (1990, cited in Braun & Clarke, 2006) dual criteria was used for judging the themes. According to the criteria, themes should be internally homogenous while externally heterogeneous. (Patton, 1990, cited in Braun & Clarke, 2006) It was first made sure that all the data in one theme formed a coherent pattern. After that, it was examined whether all the themes together form an accurate presentation of the data set. These steps are necessary to understand the different themes and how they explain the data set (Braun & Clarke, 2006). The fifth phase is about defining and redefining the themes to identify the essence of each theme and analysing the data within them (Braun & Clarke, 2006). A detailed analysis was conducted for each theme to understand what is interesting about each theme and the theme in relation to other themes when considering the research questions. Also, themes were named for the final analysis. Finally, in the sixth phase, final analysis was made, and the report was conducted.

As a result of the thematic analysis, six themes were formed, each with three levels of codes. In total, 397 different codes were formed from the interview data. These codes were then categorized with similar codes to form the second level of coding. These were

then further categorized with other similar meanings, now already forming broader codes. Finally, themes were searched within these third-level codes. The themes and two highest levels of codes can be found in Appendix F. The results of the thematic analysis will be further discussed in the empirical findings.

The aim of the thematic analysis was to follow an inductive approach and form conclusions based on observations from the interviews. The goal was that the conclusions could be generalized, at least in the context of the case company, but also in other industrial contexts with some modifications. After conducting the empirical results, they were analysed in the light of premises concluded from existing theory, thus following a deductive approach. This procedure further supports the abductive approach chosen when planning the research setting.

4.4 Quality of the research methodology

To assess the quality and trustworthiness of the research, validity and reliability of the research are discussed. Both validity and reliability need to be ensured to result in good-quality research. Using terms validity and reliability in qualitative research is contested (Saunders et al., 2019, p. 213). However, according to Saunders et al. (2019, p. 216), the concepts can be adapted to qualitative research as well. Therefore, validity and reliability will be used to assess the quality of the research in the whole study.

Reliability refers to replication and consistency of the study. The research design is considered reliable, if the research design can be replicated and it results in the same findings. Validity, on the other hand, refers to the appropriateness of the measures used, accuracy of the analysis and generalizability of the findings. (Saunders et al., 2019, pp. 213–214) Saunders et al. (2019, p.214) divide validity into three aspects: measurement validity, internal validity, and external validity. Measurement validity intends to answer if the measures being used actually measure the phenomenon they are intended to. Internal validity refers to whether the intervention studied is truly caused by the independent variable, rather than by other confounding factors. External validity refers to how well the results of the study can be generalized to other relevant contexts. (Saunders et al., 2019, pp. 214–216)

To ensure reliability, the data and methods used were described as transparently as possible. This allows others to judge the quality of the study for themselves (Saunders et al., 2019, p. 215). There are several threats related to reliability, such as participant error, participant bias, researcher error, and researcher bias. (Saunders et al., 2019, p. 214) Participant error was minimized by choosing as diverse group of interviewees as

possible. Participant bias was minimized by ensuring the anonymity of the interviewees and communicating that to the participant. To reduce researcher error, the researcher prepared themselves for each interview as well and thoroughly as possible to minimize the risk of misunderstandings during the interview. Researcher bias was acknowledged throughout the whole process, making the threat small, although possible due to the researcher's own experience in the field.

The validity of the research data was ensured by triangulation. As mentioned, triangulation involves using three or more independent data sources (Saldana, 2011, p. 76). Triangulation can be used to confirm the validity of research data (Saunders et al., 2019, p. 218). Measurement validity was considered by utilizing methodology theory and ensuring appropriate measures. Internal validity was ensured by testing the preliminary interview guide. This can make the questions more understandable and relevant (Kallio et al., 2016). External validity was considered by choosing a sample that represents the population as well as possible. Although this research is conducted as a case study in one company, the aim was that the results could be generalized across the heavy machinery spare parts industry. However, it still might be that the study cannot be generalized to other contexts (Saunders et al., 2019, p. 216). Therefore, the study would need to be replicated in other contexts to achieve statistical generalizability. (Saunders et al., 2019, p. 216)

Trustworthiness of the thematic analysis was considered throughout the whole process. In the first phase, the engagement with data was extensive and the researcher's thoughts were documented carefully. In the initial coding phase, a systematic approach was used to go through the data. When searching for themes, detailed notes about the development of themes and diagrams of the theme connections were made. Lastly, the process was described in detail. According to Nowell et al. (2017), these are all measures that help to establish the trustworthiness of a thematic analysis.

5. EMPIRICAL FINDINGS

In this chapter, findings from the empirical part will be discussed. First, the PLC categorization in the case company will be explained. Next, the empirical findings will be discussed. These are divided into two parts. First, findings from the quantitative analyses will be discussed. Second, findings from the qualitative analyses will be presented.

5.1 Understanding the PLC categorization

According to the interviewees, there is one type of categorization in use in the case company that could be used to describe the PLC phase of a spare part. The aim of this chapter is to explain what each category means to be able to understand the following analyses. The criteria for the categorization were clarified in the interviews. According to the master data management manager, there are five categories in use. In this research these categories will be referred to as A1, A2, A3, A4, and A5, as it is mostly based on the age of the machinery. To be more specific, the categorization is based on installed base data and latest construction year of the equipment whose spare parts manual the spare part is included in. Thus, the first category, A1, includes spare parts supplied for new machines within the last X years. A2 includes spare parts supplied for new machines between X to Y years ($Y > X$). A3 category covers spare parts where the latest machine was delivered Y or more years ago. This categorization aims to class A1 spare parts as being in the beginning of their PLC, while A2 being in the middle of their PLC, and A3 heading towards the end of their PLC. A4 spare parts are items whose age is not known. This can be, for example, due to the primary machine being so old that the spare parts manual is not available in digital form. The last category, A5, is called other items. The age is also unknown for these items, but the category is separated due to internal reasons in the case company. In this study, a sixth category, NA, will be used to describe the spare parts that do not have the PLC categorization. The PLC categories can be seen in Table 5.

Table 5. PLC categorization in the case company

PLC Category	Criteria
A1	Latest equipment has been delivered within the last X years
A2	Latest equipment has been delivered X to Y years ago
A3	Latest equipment has been delivered more than Y years ago
A4	Unknown age
A5	Other items (unknown age)
NA	No PLC category

According to interviewee C8, the criteria for categorization were changed a few years before the study to make the categorization more convenient for the need of the business. Before that, A1 spare parts were delivered in new machines within the last Z years ($X > Z$), A2 spare parts within the last Z to X years, and A3 more than X years ago. Later, A1 was changed to the current definition of spare parts included in machines delivered within the last X years. The internal promise of the case company is to offer spare parts solutions for Y years since delivering the machine. Hence, A2 is now used to describe the gap between X and Y years. The case company believes that during this time, demand will drop, and companies can start to reduce the portfolio by combining the spare parts into bigger units, while still offering these as solutions for the customers. Furthermore, A3 is now used to describe the time after the Y-year support level offered by the case company. After Y years, the case company can start to evaluate whether it is worth supporting these spare parts, depending on the business opportunity and the importance of the customer relationship.

5.2 Quantitative analyses of the business

The quantitative analyses aim for a comprehensive overall picture of the current situation of PLC categorization and life cycle pricing of spare parts in the case company. The first subchapter will help to understand the sizes of the PLC categories and their development throughout the years. The second subchapter will discuss the sales and demand of the different categories. The third subchapter will analyse the profitability of the different PLC categories. This will help to understand how the profitability acts throughout the PLC of spare parts. Lastly, current life cycle pricing methods in the case company will be discussed.

5.2.1 Size of the PLC categories

The number of items in each PLC category will be discussed to understand the distribution of the items between these PLC categories. The number of items in each category at times T1, T2, and T3 are presented in Figure 14.

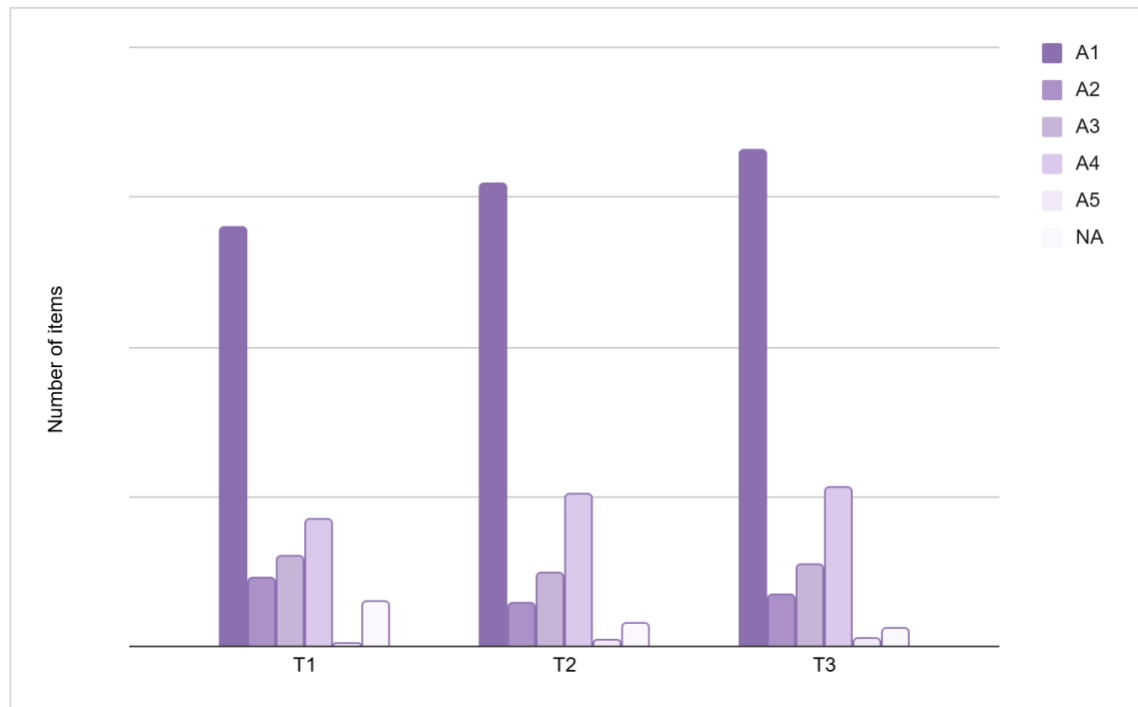


Figure 14. Number of items in each PLC category at times T1, T2, and T3

Most items have a PLC category at time T3, making the NA category the smallest it has been since T1. However, almost 20% of the items are categorized in the unknown age category (A4). Also, it can be seen that the distribution of items is not even. Most items are categorized as A1. In fact, over 60% of items in scope are categorized as A1 at time T3. This raised the question if the categorization is suitable for the need of the life cycle pricing, if the categorization is too broad to describe the PLC. Based on this distribution, items might become obsolete or replaced before they reach the A2 or A3 categories. However, this can partially be due to the process of reducing spare parts portfolio complexity as the items get older.

5.2.2 Sales and demand of the PLC categories

To further understand the categorization, sales of different PLC categories will be analysed. Figure 15 presents the sum of sales in each PLC category during the review period of each data point. It is noteworthy that the review period of T3 is about half of the review periods of T1 and T2. The sales follow largely the distribution of the number of items. The A1 category is dominant in sales in addition to being the largest category in number of items. However, at time T3, A2 parts have greater sales compared to A3 parts, even though the A3 category is bigger in number of items. This indicates that the demand or profitability lowers as the spare part reaches the decline phase, which is in line with the PLC concept.

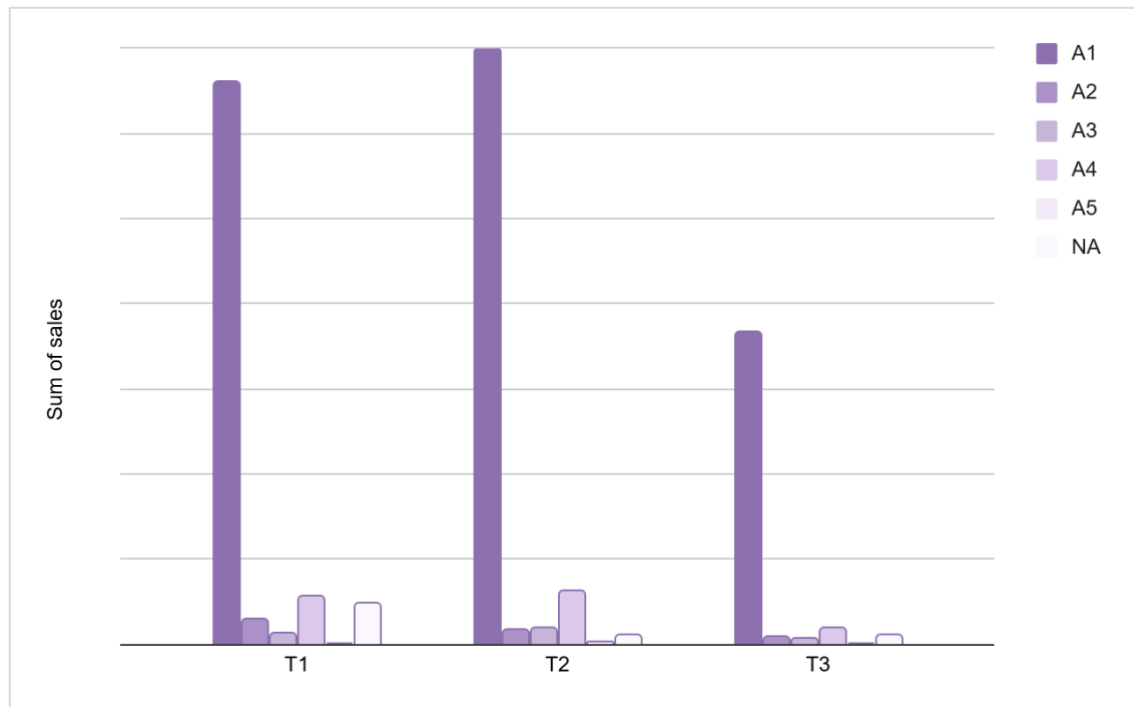


Figure 15. Sales of each PLC category at times T1, T2, and T3

To understand the demand of each category, it is analysed, how many of the items that are offered have sales. This is done by counting the number of items that have sales and dividing that by the number of items in each category. This share of items with sales each review year is presented in Figure 16. In A1 category, the share of items with sales is high each review year. However, the share of items with sales decreases when going down the categories. This could indicate that the overall demand for spare parts reaches its highest point somewhere in A1, and the demand begins to decrease after that. On the other hand, it could also indicate that the marketing strategy of the case company, including pricing, is ineffective in the other PLC categories, which makes customers switch to competitors' offerings, and lowers the demand towards the case company. Not being competitive could also be the reason why other items (A5) have a low share of items with sales. It is still unclear why items with unknown age and items with no PLC category have such a low share of items with sales.

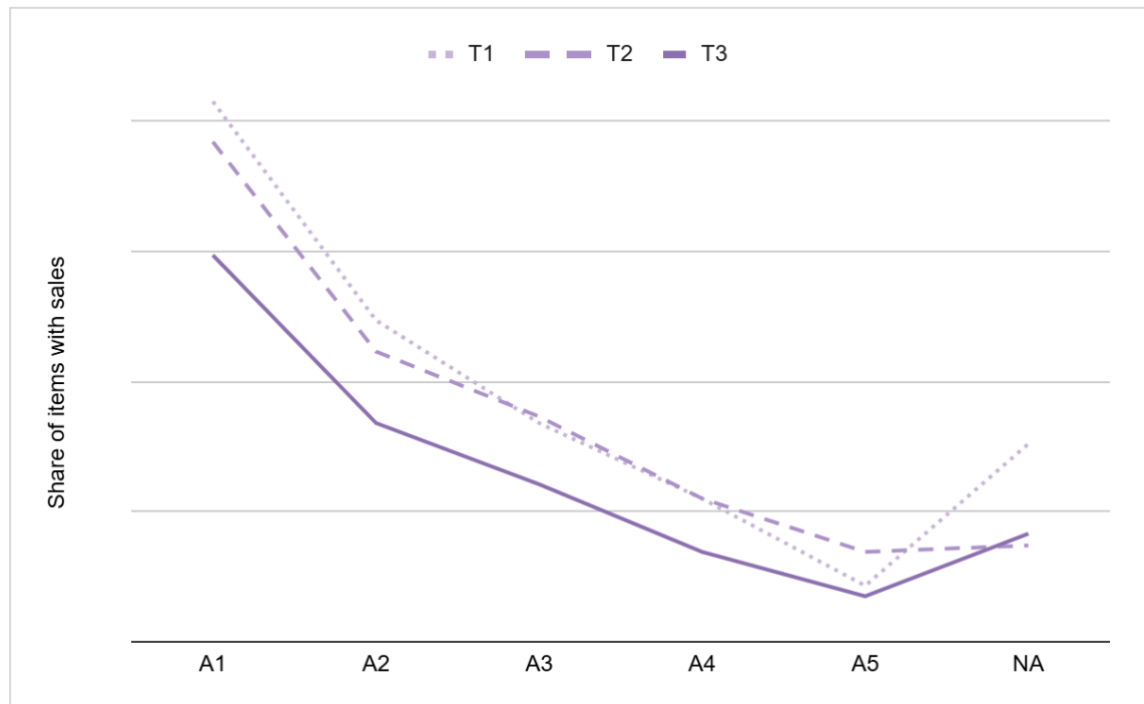


Figure 16. Share of items with sales by PLC category at times T1, T2, and T3

From these analyses it was possible to gain an overview of the different PLC categories. By analysing the number of items and the sales in each category, it was possible to understand the size and magnitude of each category. Based on the analysis, it is evident that the A1 category includes most of the offering and has the highest sales. In addition, the share of items with sales is also the highest in this category. Therefore, A1 can be seen as the most significant category for the case company's business. However, there remains an interest to study if there is a way to improve the business opportunity of the items that are heading towards the end of their PLC.

5.2.3 Profitability of the PLC categories

Next, profitability of the different PLC categories is analysed to understand the pricing and cost structure. Gross margin (GM) will be used as a measure for profitability. In this study, GM is calculated as price minus direct purchase cost. Other costs are not considered since those costs can be hard to allocate between items. To get gross margin percent (GM%), GM is divided by the price. Two different versions of GM will be used. These are calculated GM and realized GM. Calculated GM means the GM calculated from the list price, while realized GM is the actual GM achieved after customer discounts.

First, calculated GM% of each PLC category in each review period will be analysed. Based on Figure 17, the difference in profitability between the categories has decreased by T3. Especially the profitability of A2 and A4 categories has been improved since T1. A1 consistently has high GM% across all three review years appearing to be the most

profitable group. This indicates effective pricing. A5 remains clearly least profitable at time T3. End-of-life items (A3) have even profitability throughout the years, but there could be a possibility to improve the profitability as the group achieved high profitability at time T1. Profitability of items with no PLC category (NA) has been increasing throughout the years but it remains less profitable than A1-A4 categories.

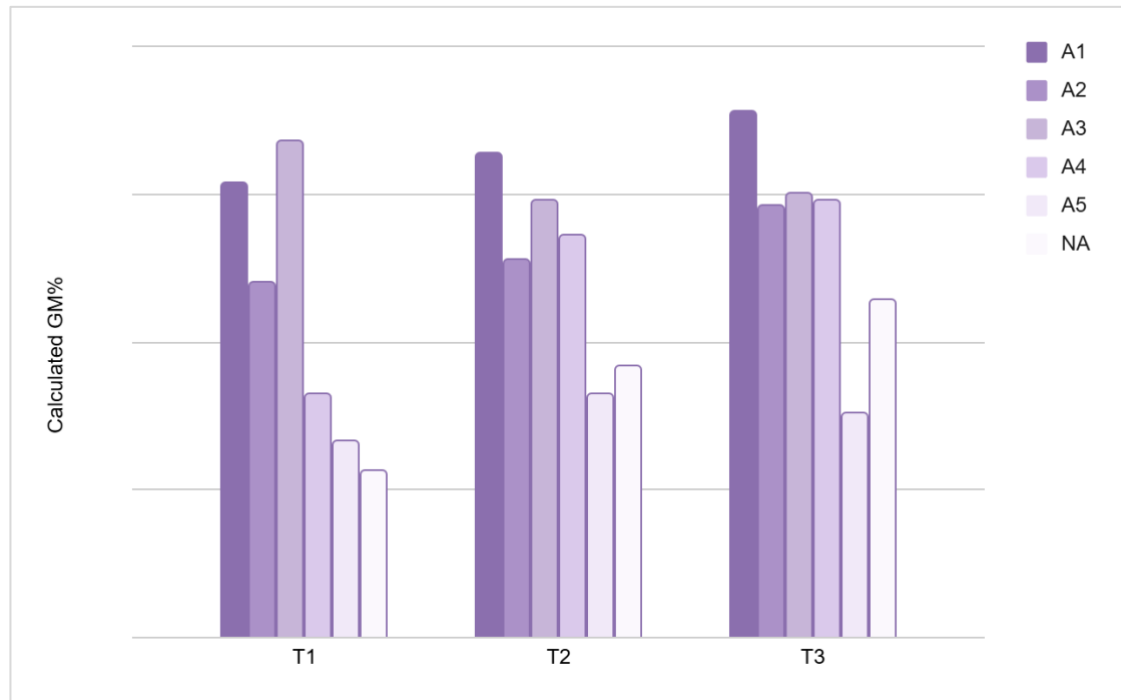


Figure 17. Calculated GM% of each PLC category at times T1, T2, and T3

To further understand the actual profitability of the categories, calculated GM is analysed side by side with realized GM. This analysis was done for T3 to focus on the current situation. The results are illustrated in Figure 18. A1 category is the most profitable category in realized GM% as well. It can be seen that realized margin is lower than calculated margin in all the categories, which is natural. However, the difference grows as the categories go down. This could be that A2-A5, and NA categories end up being sold at higher discounts, or higher costs appear in these categories. The biggest difference in percentage points is in A4 and NA categories, which could indicate that knowing the age and PLC category helps to achieve higher profitability. This means that these items could benefit from PLC categorization since the sales are still relatively high.

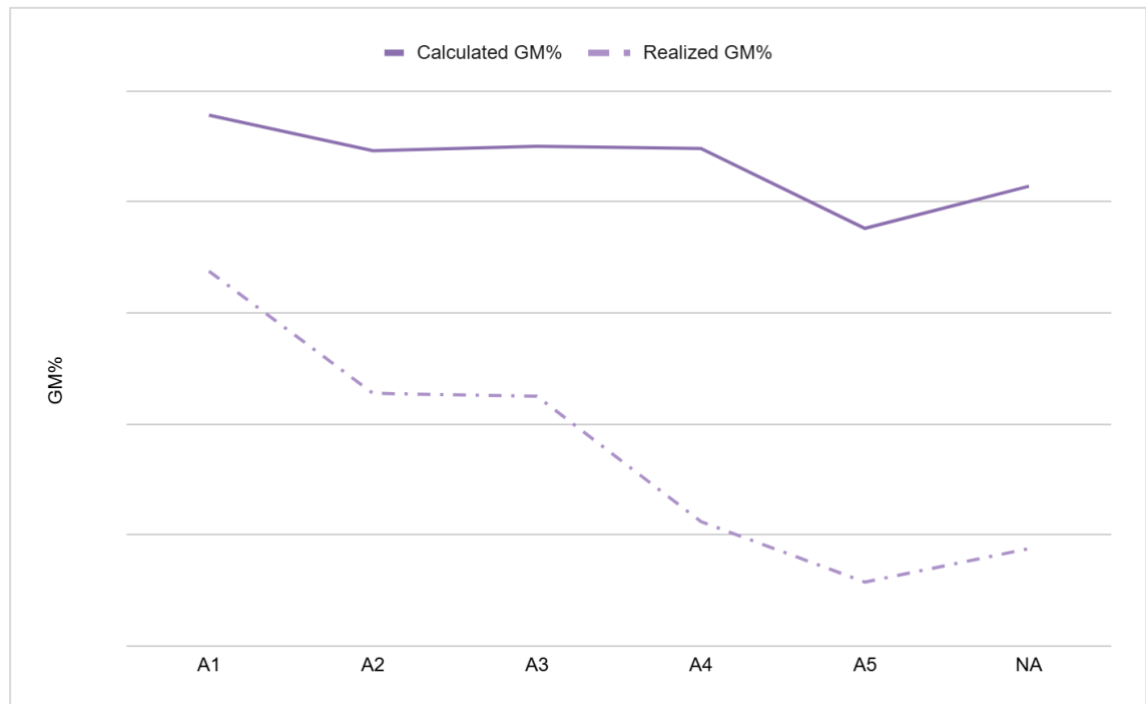


Figure 18. Calculated GM% and realized GM% by PLC category at time T3

Overall, items in the beginning of their PLC (A1) are the most profitable in the case company both in calculated and realized margins. A2 and A3 items have achieved better profitability at time T3, but the realized margins are slightly lower than with A1 spare parts. Based on the analysis, spare parts profitability could be increased when the PLC category is known, since A4 and NA categories have lower GM% than A1-A3 items. However, it is also possible that A4 and NA categories include certain groups of spare parts that have lower realized margins for another reason. The types of spare parts in each PLC group were analysed to study the possibility for this. The supply categorization presented by Jouni et al. (2011) was used as similar categorization exists in the case company. The distribution of these types across PLC categories at time T3 can be found in Figure 19.

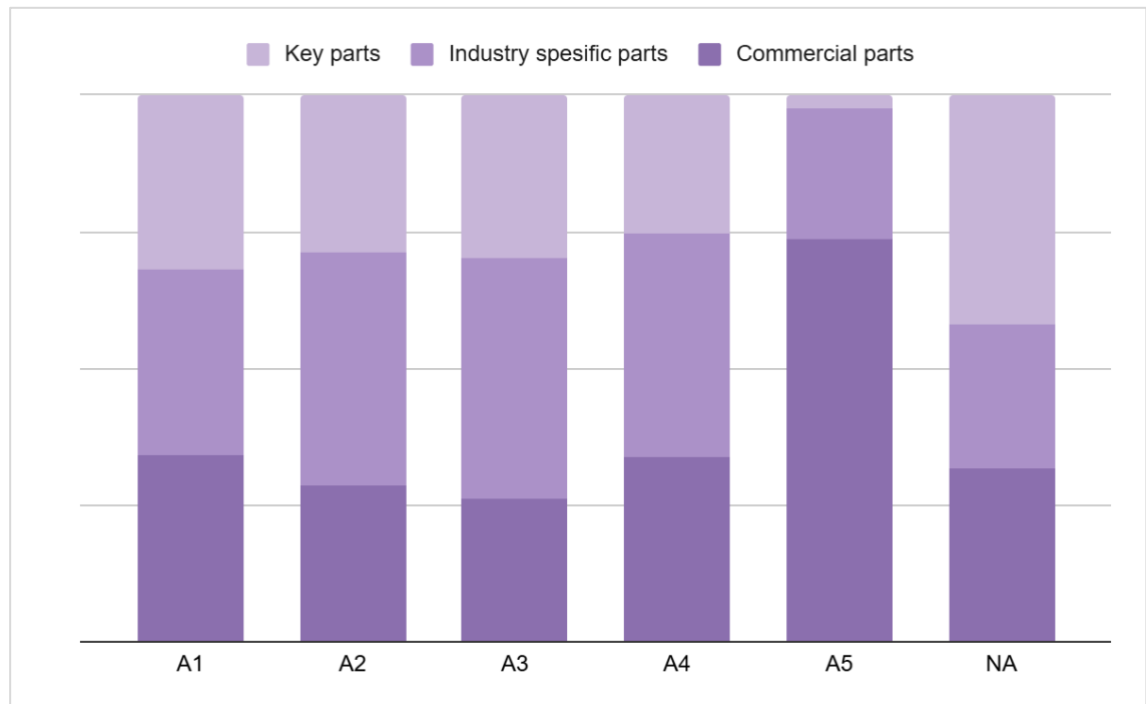


Figure 19. Distribution of spare part types by PLC category at time T3

The general pricing policy in the case company is that key parts have the highest margins, while commercial and industry specific parts are less profitable. It can be seen that A4 has a slightly higher share of commercial and industry specific parts than A1-A3 which could explain the weaker profitability. However, the calculated margin is still on the same level as A1-A3 which means that the A4 parts probably end up being sold at higher discounts, or there appears unexpected costs that lower the profitability. In addition, it is unclear why items with no PLC category (NA) have the largest share of key parts, yet they still have a big gap between calculated and realized margin. Considering these factors, this could further indicate that PLC categorization enables more effective pricing and therefore leading to higher profits. However, it is still acknowledged that other factors might affect the profitability of these groups.

In addition, the distribution of spare part types in A1-A3 categories were analysed to possibly explain the difference in realized margin in A2 and A3 categories. A1 items have a slightly larger share of key parts which possibly explains the difference in calculated margin. However, it is unclear why mid- and end-of-life items have such a difference in realized margin. Further study is then needed to investigate if the profitability can be improved.

Before starting the research, the general perception in the pricing team was that as the item ages there would be cost increases due to the lower demand and therefore higher unit costs. To further investigate the profitability and cost development of spare parts,

average cost increase by each PLC category was analysed. The results of this analysis are illustrated in Figure 20. The cost in this case considers the latest purchase price information available in the pricing tool at the time of data gathering. The analysis was done by comparing the cost at time T3 to the cost at times T1 and T2. The NA category was missing important data and was therefore excluded from this analysis.

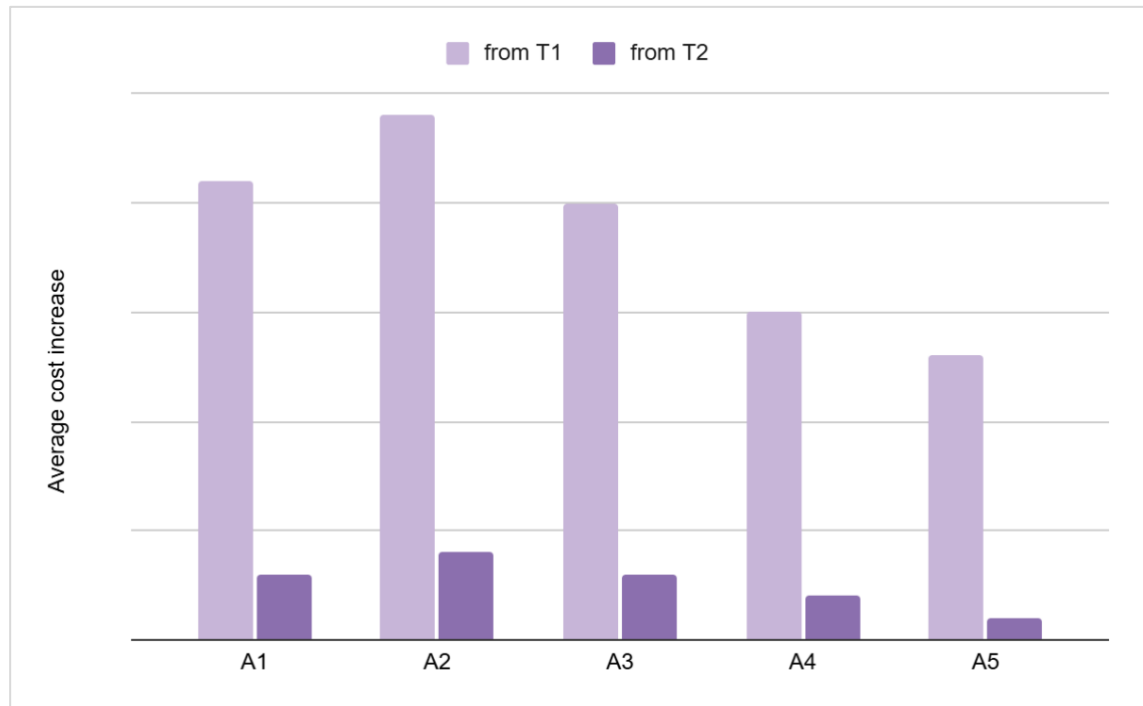


Figure 20. The average cost increase from T1 and T2 to T3 by PLC category

Unlike the team believed, the highest average cost increases fall upon A2 items, followed by A1 items, and then on A3 items. However, the average cost analysis does not tell if there are some larger cost increases for individual items. This analysis could also be linked to the GM% analysis, where A2 was noted less profitable than A1 and A3. The high cost increases could be one reason why the profitability is lower.

Another take from this analysis is that other items (A5) have the lowest average cost increases both from T1 and T2. This could indicate that the suppliers of these items have more stable pricing and do not practice life cycle pricing. On the other hand, this could also indicate that these items have a long PLC and are staying in the maturity phase for a longer time. Overall, it is acknowledged that items might face cost increases in all the categories and PLC phases for various reasons. The question is whether these cost increases can be forecasted, and whether the impact can be minimized with proactive price adjustments.

5.2.4 Current life cycle pricing methods

This chapter will look at the concrete life cycle pricing methods already implemented in the case company. The analysis was done by searching for price equations that utilize the PLC categorization. Based on the analysis, there are two types of life cycle pricing methods in the case company. The first method is to increase pricing once the spare part reaches A3 category. The second method is to first increase pricing once the spare part reaches A2 category and to implement further increases once the spare part reaches A3 category. The amount of price increase can vary depending on the price equation and item family. However, it was noted that most item families do not have any price equations that include these life cycle pricing strategies. It is noteworthy that many of the price equations also use a classification related to sales times per year, which lowers the target price if there has been little or no sales. This means that if an item in A2 or A3 category faces little or no sales, these factors will most likely cancel each other out and there will be no impact on pricing.

Based on the calculated margins, these methods are probably accurate since margins of A1-A3 items are on an appropriate level. However, based on sales and share of items sold, it could indicate that the demand is weaker for A2 and A3 items. This could be that the overall demand on the market is lower, or the pricing is considered too high for these items which makes customers switch to competitors offering. Based on the realized margin, these items might be sold with larger discounts, which again could indicate that the pricing is ineffective and considered too high. However, there are many factors that can affect the demand and profitability of spare parts, which we hopefully clarify through interviews.

5.3 Qualitative analyses

The goal of qualitative analyses was to further clarify the current situation of PLM and life cycle pricing of spare parts and search for opportunities where the life cycle pricing area can be improved. All the key functions related to spare parts, and the PLC categorization were interviewed to gain various insights and a comprehensive view of the topic. In this chapter, the overview of the interview results is first presented. After that, the results will be discussed in more detail one theme at a time.

5.3.1 Overview of the qualitative analysis results

Six themes were conducted from the thematic analysis. The themes are 1) Current state of the case company, 2) Objectives for life cycle pricing, 3) Spare parts business characteristics, 4) Understanding customer value and behaviour during PLC, 5) Spare

parts PLC, and 6) Spare parts life cycle pricing. The themes, the top level of codes, and the number of references in each code or theme are presented in Table 6.

Table 6. Themes and the highest level of coding

Theme or code	References
Current state	64
Case company strengths	10
Case company challenges	42
Current state of pricing	5
Current state of life cycle pricing	7
Objectives	25
General business objectives	18
Life cycle pricing objectives	7
Spare parts business characteristics	28
General characteristics of the market	7
Competition	16
General challenges in the market	5
Understanding customer value and behaviour	109
Customer value	45
Customer relationships & maintenance strategies	10
Customer behaviour in spare parts business	22
Customer behaviour thorough the life cycle of the machine	32
Spare parts PLC	106
Assessing spare parts PLC	10
Uses of the PLC categorization in the case company	9
Challenges related to the PLC categorization	11
Life cycle of the machinery	19
Spare parts PLC characteristics	57
Life cycle pricing	65
General pricing strategies	34
Life cycle pricing strategies	31

In the next chapters, the results will be presented by discussing each high-level theme. Only the codes with most references and the codes that are found most relevant for this study will be discussed. To be transparent in interpreting the results, some relevant quotes from the interviewees will be presented and discussed. This will help to understand how the codes have been conducted from the data and what the interviewees have actually said.

5.3.2 Current state of the case company

The current state of the case company sets the premise for studying and implementing life cycle pricing in the case company. The current situation covers the strengths and challenges of the case company that are related to the PLC of spare parts, in addition to the current state of general pricing and life cycle pricing.

Case company strengths and challenges

A few strengths were drawn from the interview data. Multiple interviewees mentioned that the case company provides service and spare parts for all the ages of the machines. This was seen as a strength in a way that the case company might be able to provide spare parts that are heading towards the end of their PLC. In addition, a strong web store and ability to support all spare parts that a customer might need were expressed as strengths.

However, the ability to support all the ages and types of machines fully comes with a challenge. The case company has a very complex portfolio of spare parts that it has to manage. There are various spare parts for multiple generations of different product lines broken down into the smallest components. One of the interviewees summarizes the situation as follows:

“In production you need to purchase one transmission. That’s the one part which you need and have available, while if we go to services, it’s getting broken down to different seals, sensors, and smaller parts.” (C4)

Also, many interviewees stated that the collaboration between designing the machines and the services has been little, which might partly be the reason why the spare parts portfolio has increased. The complex portfolio might be a challenge when implementing and managing life cycle pricing as well.

Availability of spare parts was also seen as a challenge by many of the interviewees. This refers to the ability to deliver spare parts quickly from the case company’s own stock or the supplier’s stock. Also, obsolescence of spare parts was mentioned as a challenge, meaning that a spare part might become unavailable from the market, and the company has to find a replacement.

The case company uses many OEM suppliers in the design of the machines, which makes the spare parts more vulnerable to competition since they are easily available from the market. Related to this, one of the biggest challenges in the case company based on the number of references is the share of key parts. This means that the interviewees were not happy with the number of spare parts that are designed by the case company and therefore not so vulnerable to competition. Key parts were seen as an opportunity to lock in customers, since finding replacements from the market would be harder. Key parts were also seen as an opportunity to increase margins:

“Making it unique is the best way to do that. And again, it doesn’t give you the license to just sell with whatever price. But still, I think it should allow us to make more margins.” (C7)

Current state of pricing

The pricing director of the case company was interviewed in order to gain an understanding of the current state of the pricing in general and especially the current state of life cycle pricing. The general pricing is daily work, in addition to which prices are updated regularly in collective updates. Based on the answers, it was concluded that some of the life cycle pricing happens by a reactive approach. According to the pricing director, there sometimes appear surprising cost increases, which forces the team to react with price increases. In addition, there are no margin targets set for the different PLC categories. The pricing director describes the challenge of implementing life cycle pricing as follows:

“The challenge has been that we haven't really had any information about it. We may have had some kind of assumption about what happens there, but when I think about it, we've probably seen these kinds of individual cost shocks for individual components. But have we been able to see the big picture, like what happens to engine parts as they age? So, should we try to understand more about our suppliers' logic, for example?” (C1)

This describes the lack of knowledge related to life cycle pricing in the case company. As described in the quantitative analyses, the case company uses the different PLC categories in the current life cycle pricing methods to increase pricing towards the end of the PLC. According to the pricing director, this is a way to anticipate the expected cost increases towards the end of the PLC. They also stated that these price increases are mostly applied to the key parts designed by the case company, rather than commercial or OEM parts. On the other hand, sometimes the case company decreases the prices of older spare parts to stimulate demand. This can be seen as one kind of life cycle pricing method, since sometimes these are end-of-life spare parts that are remaining in the stock.

5.3.3 Objectives for life cycle pricing

As already stated in the literature review, it is important to set the objectives for life cycle pricing. Clear objectives will help to design appropriate pricing strategies. Most interviewees were not very familiar with pricing, hence the most suitable answers regarding life cycle pricing objectives were collected from a smaller group, mostly from the pricing director. However, other business objectives stood out in the interviews. These are also important to keep in mind when discussing objectives for life cycle pricing.

General business objectives

From the general business objectives, it stood out that the case company has committed to support spare parts for Y years for their new machines. This is not something that is mandatory, but something that the case company has promised to their customers. The case company's objective is to always find some solution to support at least the machines that are less than Y years old. As mentioned before, the case company does support older machines as well. However, it is not necessarily seen as a business opportunity to supply these older spare parts in the case company. This objective is seen as a good basis for life cycle pricing, since it is clear that the case company wants to support older spare parts, but some pricing adjustments may be needed. One of the interviewees stated:

"I won't say that we won't hold your hand after Y years, but we can be a bit smarter and work with different pricing at that point." (C3)

The other business objective that stood out was capture rate. Capture rate refers to the percentage of total potential spare parts demand related to the case company's machines that the case company has. Of course, pricing is one of the factors that affect this objective.

Life cycle pricing objectives

For life cycle pricing objectives, healthy margins over the whole PLC of the spare parts were mentioned by a few interviewees. One interviewee described the objective as follows:

"We want to make the most margin that we possibly can because services and parts make up such a large portion of the profitability of our company. So again, having solid margins on our parts throughout the life cycle is extremely important for our overall business health, I think." (S2)

In addition to the overall profitability, the pricing director stated that the case company should ensure the profitability of older spare parts, as the case company has noted that there might be increasing and unpredictable costs towards the end of PLC. This is most likely because the spare part becomes more difficult to acquire from the market, and the unit costs rise as the demand decreases. This is something that should be considered, and also what has been the objective of the current life cycle pricing methods in the case company. The pricing director talks about the situation like this:

"... we have noticed that as a spare part gets older, their availability may become more challenging, and perhaps they will be ordered less frequently from suppliers, and it may be that the cost surprises us compared to what we paid for it last time."

So that's the other side of it, that the costs are not always very predictable the older the spare part is." (C1)

According to the pricing director, one objective for life cycle pricing could also be about improving competitiveness in the spare parts market for older machines. The case company has noticed that their market position is not as good for old machines as it is for new machines. There can be multiple reasons for this. For example, the price can be too high, or the case company is not able to provide the spare parts fast enough. The pricing director described about their ideas for life cycle pricing objectives as follows:

"I would assume that life cycle pricing is intended to increase our competitiveness. That would be one goal, at least. Namely to increase competitiveness with slightly older machines. Our understanding is that the older the machine gets, the less customers buy spare parts from [the case company]." (C1)

In addition, one interviewee emphasized that the overall pricing strategy should be clearly determined to successfully design and implement the life cycle pricing strategy. Before setting the life cycle pricing strategy, it should be clear, in which segments the case company wants to compete with price, and where the case company wants to charge premium price. This will also guide the life cycle pricing strategy. The interviewee described the choice of pricing strategy as follows:

"I think first and foremost, we need to differentiate ourselves and say 'what is our pricing strategy? Do we want to be premium? Do we want to be competitive in pricing in terms of being cheap?' Because I think that everyone can be in that segment and try to compete." (C6)

In conclusion, based on the interviews, the objectives for life cycle pricing should be ensuring profitability throughout the whole PLC and improving competitiveness with older machines while keeping in mind the case company's goal to support spare parts for at least Y years and improving the capture rate. Also, a clear strategy should be set in order to implement life cycle pricing.

5.3.4 Spare parts business characteristics

In addition to the current situation in the case company described earlier, it is necessary to also consider the wider picture of the spare parts business. The interview data included many valuable points about the spare parts business characteristics that should be considered when designing the life cycle pricing strategy. These include general characteristics of the spare parts markets, competition in the market, and general challenges in the market.

Characteristics of the market

The profitability of the spare parts business in general was noted by a few interviewees. It was also noted that there might be legal requirements to support spare parts for a certain period of time. Other notes about the spare parts business included the demand shift to electric equipment. According to one interviewee this can bring opportunities in new areas but also add even more complexity to the case company's portfolio.

In addition, spare parts are generally bought for need. Thus, when a spare part breaks down, the customer is not going to be happy with a long lead time. This kind of purchasing behaviour also makes it difficult to utilize different campaigns to stimulate demand. For example, it can be difficult to assure a customer to buy a left side mirror on top of the right side mirror to get a better price if only the right side mirror is broken. In other words, customers generally buy because of need, not only because of the cheap price. This is important to keep in mind when considering life cycle pricing. One of the interviewees commented:

"These parts are usually purchased when needed, not because they are cheap at the moment." (C1)

Competition in spare parts business

The competition on the market is high, especially with the commercial items. However, if competitors notice enough demand on the products designed by the case company, they will start to compete with their own alternative solutions. Hence, the interviewees thought that the case company will always compete on price and availability of spare parts, whether it is a key part or not. One interviewee from one of the subsidiaries described the competition on the market in this manner:

"This is really now a business, which runs on that high level, that you always have some competition on the market. You cannot say 'okay, this is [case company] branded and [case company] is the only one who can serve'. So, this thinking we should forget, because there's always some other companies behind there trying to catch the fish." (S1)

It was also noted by the interviewees that pricing needs to be competitive to survive in the market. Some also mentioned that it is fairly easy for customers to compare prices online, which adds price competition. One interviewee from another subsidiary commented pricing related to the portfolio and competition as such:

"When we're a manufacturer that has such a broad product range, pricing has to be very competitive in the market." (S4)

In addition to the general competition in the market, the case company can also have their own suppliers as competitors. This is because the case company uses components from different OEM suppliers in their machines. These parts are often easy to source from the market which adds more competition and weakens the case company's market position, according to the interviewees. One of the interviewees stated the competition with suppliers like this:

“Our suppliers in some cases are also our competitors, and they compete on availability. So, they will position themselves near a large installed base and make sure they have the parts on the shelf so they can get same day delivery.” (S4)

As competition is heavy on price and availability, the interviewees think that it is hard to differentiate on the market, and it is acknowledged that the case company needs to compete with other factors as well. One interviewee from corporation explained:

“We must have some pretty good assets then, so that we can also compete with cheaper and perhaps sometimes even better suppliers.” (C2)

General challenges in the market

In addition to competition, lead times were another most mentioned challenge in the spare parts market. The lead times from suppliers can be over 200 days. This can be crucial when combined with irregular and unpredictable demand for spare parts which can make it difficult to decide which spare parts should be kept in stock. This was also acknowledged in the interviews.

5.3.5 Understanding customer value and behaviour during PLC

To implement life cycle pricing, it is also necessary to address customer value and customer behaviour during the whole PLC. This section is divided into four parts: 1) factors affecting customer value in spare parts business, 2) different customer relationships and maintenance strategies, 3) customer behaviour in spare parts business, and 4) customer behaviour throughout the life cycle of the machinery. These areas will help to understand how different attributes in customer value and behaviour change during PLC of spare parts. This understanding is further needed to appropriately design a life cycle pricing strategy that supports these changes in the market.

Customer value in spare parts business

There are many different factors that create value for the customer in the spare parts business. The most mentioned factor in the interviews was availability of spare parts. The machines are usually critical for the customer's operations, and if a machine breaks down, they need spare parts quickly. Hence, the customers usually prefer that the spare

parts supplier has the item in stock or at least the supply chain planned, which means that the delivery time will be shorter. Otherwise, it can take time for the supplier to first look for a suitable vendor for the item, then make the order, and deliver the part to the customer. One comment from an interviewee was as follows:

“... it's very important to have the parts available for the customers. So, every time when we have the parts available either if it's from stock or we do have the price and the lead time ready, the customer is more willing to buy from us.” (C5)

It was also noted by a few interviewees that a good availability brings so much value for the customer that it may enable slightly higher pricing. As said, the machines are often critical for the operations, which can make customers compromise on pricing, when it comes to availability and quick delivery of spare parts. One interviewee described customer behaviour like this:

“... we not only need to be competitive on the pricing, but we need to also be competitive on the delivery time. The price doesn't matter when the machine is not operating. They need parts fast and they need them within hours, maximum within days.” (C5)

The case company might sometimes consider lead times over price when sourcing the spare parts, to deliver the spare part quickly for the customer. The head of services sourcing commented:

“We can give a little bit of our direct material costs, because we still have a good margin and we push for the delivery time instead. And that's how we also create value to our customers, that we have the right quality, but we also have the best delivery times.” (C5)

Another frequently mentioned factor was the data and web store that the case company provides for its customers. Using data, the case company can provide different recommendations for the customer. Customers can also check if a spare part is suitable for their machine using the web site. The customer value of this feature was described by one interviewee as follows:

“In our business the value that I see on behalf of our customers is having a digital platform that makes it easy for them to identify parts quickly. So, there's a time element, efficiency.” (S4)

The case company supplies mostly OEM spare parts, which keeps the quality high. This was also seen as one of the most significant factors creating customer value in the case company's spare parts business. Customers prefer high-quality spare parts as they most

likely last longer. The quality is also related to the whole machinery, and that the machine operates well. The interviewees emphasized that if the spare parts of the machine would fail earlier than expected, the customers would not come back for new machines and spare parts. One interviewee explained with an example from consumer environment:

“Of course, they don't mind replacing part if it's expected, but same at home - whatever you have, you don't expect to replace the water pump on the washing machine every week. So, then you would not be buying that brand again. ... So of course, what's also important is the quality of the parts that we are selling.” (C7)

Some of the interviewees thought that quality is highlighted especially when buying the more complex and expensive spare parts. This is because the customers do not want to risk the spare part failing sooner than expected, or not working at all due to bad quality. Some of the interviewees thought that customers are willing to pay a premium for the case company's spare parts. However, the premium still must be reasonable. This emphasizes the importance of value-based pricing. The director of one of the subsidiaries explained as follows:

“I often hear customers say that they're willing to pay a small premium for dealing with [the case company] because of the quality of the parts, the warranty, and the systems that we use to order the parts. But that value still has to be relative. They won't pay 30% more for the part because it's coming from [the case company].” (S4)

It is good to note that other interviewees thought that customers do not value quality as much. However, most interviewees thought that quality is one of the key competitive factors at the case company. When asked if the customers see the case company's spare parts as more valuable, one interviewee commented:

“I would say no. Again, at the end of the day, they want their equipment running. They want the parts to be reliable, but at the end of the day it realistically comes down to the pricing.” (S2)

In addition, the quality of communication and customer service is also important. Sometimes the customers need answers quickly, which requires fast and high-quality customer service. The importance of customer service was explained by one interviewee as follows:

“I think it's the communication and the quality of the communication (that creates the most customer value), because usually when the customers are coming to us, they do have a need for something. Either they are coming because they would like to have better prices or better lead times or the machine is down, and they

would like to buy the parts immediately. So, if we have this good relationship with the customer and we are able to respond faster and those responses have a good quality, then the customer will come back.” (C5)

Another important factor is the customer value of uptime of the fleet. As already mentioned in the quotations, at the end of the day, customers want to keep their machines running. The uptime of the machines sums up the above-mentioned factors. Spare parts suppliers can help to support uptime by providing spare parts quickly, easily, and in high-quality. One interviewee explained as follows:

“I think the most important value that we create is the uptime of the machine, and then how we create that uptime, that's a different value for each customer if it depends on the availability, the pricing, or us providing recommendations and then stocking them. But I think the value we create for our customers and should be creating in the future is to ensure uptime on their machines and their fleet.” (C6)

Other factors related to customer value included total cost of ownership, consistency of service quality, and partnerships. In conclusion, machines are usually critical for the customer's operations. Therefore, the customers usually value spare parts that are available quickly and effortlessly and that are the right quality.

Customer relationships and maintenance strategies

There are different types of customer relationships that affect the customer value and the customer behaviour during PLC. Therefore, it is important to consider these different kinds of customer relationships that the case company has. Some customers are on a partnership level, where they buy almost all their spare parts from the case company. These customers were described as such:

“They are totally focused on their core business. When it comes to the technical side and when it comes to the machines, they say ‘Okay, we need a partner. The partner should be able to service the machines, and the partner should be able to guarantee that the machines are operating’.” (S1)

Other customers have their own sourcing departments and choose the best supplier for each spare part in terms of price and availability. Therefore, the appropriate price level also depends on the type of customer.

Different customers also have different maintenance strategies. As previously stated in the literature review, maintenance strategy can affect the buying behaviour and then the PLC of a spare part. According to one interviewee, preventive maintenance is still rarely

used by the customers, which makes it difficult to predict demand. However, another interviewee commented that preventive and scheduled maintenance is more common nowadays due to the increasing amount of data available. The comment went like this:

“... it depends on their business, but they do the preventive maintenance, they do the scheduled maintenance, they do the corrective maintenance as well. ... It used to be pretty manual but today they can see the equipment running, they can see how it's performing, and they understand how many hours are on it in real time.”

(S2)

Typically, the smaller customers do not have a maintenance strategy and still use breakdown maintenance. These customers often use the cheapest source for spare parts. However, sometimes using proactive maintenance and paying a little more for the right part, is less expensive than waiting for the whole unit to break down since it may cause more damage. More proactive customers usually realize this. One interviewee explained as follows:

“So, when the part fails, sometimes it causes further damage, and they need more parts than if they change them proactively. ... normally customers that are more proactive also recognize that they might need to pay a higher price for the right part versus a customer that doesn't understand the equipment in the same way, waits for the parts to fail and then often sources the cheapest” (S4)

Customer behaviour in spare parts business

Results about customer behaviour are divided into two parts. First, the general customer behaviour in the spare parts business is discussed. One of the most discussed topics in the interviews was the role of price when a customer is choosing a spare parts supplier. Most customers would say that price and availability are the most important factors when they are choosing their supplier. One of the interviewees commented:

“As I said, big portion (of the customers) are quite immature in their buying behaviour, and they really go for the cheapest price and the not always best availability but cheapest price unless it's a machine down” (C6)

The price is especially important for small customers, as they are more flexible to handle many different suppliers. One of the interviewees discussed:

“I would say smaller, more flexible customers who may have some expertise of their own, not big bureaucratic organizations. I would say that for them, the traditional value is that it's cheap and fast, and I would say that of course it applies to everyone, that it's as cheap and fast as possible.” (C2)

Overall, it was agreed among the interviewees that price and availability is something that the customers consider the most important factors, but in reality, there are other factors as well that can make the customer compromise on price. These are similar factors related to the customer value. Two of the interviewees discussed as follows:

“If you ask customers, they will tell you the price and availability most likely. And it is important, but we do have other factors that we can help them with, and I think that is perhaps most important going forward.” (C3)

“So, it's a combination of the availability and the price, but customers accept some higher prices in case we are organizing everything, like if we are organizing the service.” (S1)

Of course, if the price is too high, it might cause customers to start looking for other options. Therefore, the price must be relative to the customer value. One of the interviewees commented as follows:

“High prices may encourage customers to search for cheaper replacements.” (C4)

As already discussed, availability is another important factor for a customer choosing their spare parts supplier. The willingness to pay for the spare part can also be relative to availability. One of the interviewees discussed as follows:

“I would say the price is relative to the availability as well. If the part is readily available and it's the right quality, sometimes the customer will pay a premium. But it varies depending on the industry segment. The larger [customers] keep their own stock. So, availability becomes less of an issue versus a smaller customer that doesn't have their own inventory and relies on our availability.” (S4)

Other factors that can affect customer buying behaviour in spare parts are quality and level of support. The buying behaviour is of course relative to the type of customer relationship and the size of the customer, as discussed before.

The factors that create customer value in the case company's spare parts business and the factors that affect the customer buying behaviour are summarized in Table 7. Availability and quality of spare parts are listed under uptime of the machines since availability is a key element when a machine needs maintenance quickly to get back running, and quality spare parts are expected to have the machine running for longer. Also, data, recommendations and webstore together with the high-quality customer service were found key elements in making the buying process easy and fast for the customer.

Table 7. Factors creating customer value and factors affecting buying behaviour conducted from the interviews

Factors that create customer value	Uptime of the machines Availability and quick delivery Quality of spare parts Easiness of buying Data, recommendations, and web store Quality, speed, and consistency of customer service Total cost of ownership Partnerships
Factors that affect customer buying behaviour	The level of customer relationship Size of the customer Type of business Sourcing process Maintenance strategy Age of the machinery

In conclusion, there are many factors that create value for the customers in the case company's spare parts business. These should be considered in pricing. In addition, there are many factors that affect which factors are the most important for each customer and what kind of buying behaviour and attitude towards price they have.

Customer behaviour throughout the life cycle of the machine

Second, customer behaviour over the life cycle of the machine is discussed. Approaching the topic through the machine's life cycle was found more appropriate than using the spare parts PLC. This is because the customer behaviour was found primarily related to the machines rather than spare parts.

The interviewees thought that the customers' attitude towards price and other factors changes during the life cycle of the machine. Based on the interviews, the life cycle of a machine can be roughly divided into four parts: the warranty period (beginning of the life cycle), after the warranty (middle of the life cycle), end of the life cycle, and final part of the life cycle.

In the beginning of the life cycle, when the warranty is still valid, uptime of the machinery is the most important, since the customers want their new machine to operate on a high level, and not break down quickly. One interviewee explained:

"Uptime is absolutely (the most important factor) in the beginning. They don't want the machine to break down quickly." (C6)

Therefore, availability is highlighted, as the customers want to keep their machine operating, and they do not have to worry about price due to the warranty. One of the interviewees explained:

“I would say that during the warranty period the customer is usually not even caring about the pricing because it's under warranty and they would just want to have parts available as soon as possible, possibly within the hours.” (C5)

In the middle of the life cycle, availability remains important, as the machine is still fairly new, and customers still expect the machine to operate well. However, the price also enters the picture, as customers must start paying for the spare parts. If the spare part is not urgent, the customer can search the market for alternative, cheaper options. On the other hand, quality of the spare parts is still important, as the machine is relatively new. One of the interviewees summarized the customer behaviour in the middle of the life cycle as follows:

“Then when the warranty period ends, we've still got this period where the machine is quite brand-new and then there is an importance of the pricing but also availability. That's my best guess, because then the customer has the possibility to screen the market for the different sources and if we are not competitive with pricing then they can choose something else. But to some extent the quality of the spare parts is also very important because, as said, the machine is quite new, and the customer is willing to pay a little bit more to have the original parts.” (C5)

When the machine moves from the middle of the life cycle towards the end, the pricing becomes increasingly important. This is because customers may start compromising on quality since the machine's current value is lower, and customers may start moving the machines to secondary operations, which means that the machine is not so critical for the operations anymore. It was widely agreed among the interviewees that when moving towards the end of the machine's life cycle, customers may start looking for alternatives. A few of the interviewees described the behaviour as such:

“Then the last, let's say the part when the machine is [X] years old, it's already considered old and then I would say that the most important for the customer is pricing. They are then using a lot of substitutes. They are not caring if it's an OEM part or not. They just want to have the part. They want to have it cheap and that's it because they are already planning to have probably some new generation machines being ordered within the next couple of years.” (C5)

“The older the machine gets the more prices matter because it's taken more and more out of the primary operations or it's not being dependable in the way that it was in the beginning of the life cycle.” (C6)

“When we talk about old machines and old parts, customers are becoming more and more price conscious, and I wonder if that means they are ordering more from [a competitor] and other competitors.” (C2)

It was agreed among all the interviewees from the subsidiaries that customers do expect spare parts to be available until the very end of the machine’s life cycle. One of the comments went like this:

“They still want that level of support and they paid money for the machine. The machine is still able to do its job. So, they still expect to be able to buy the parts and the components to keep the machine working.” (S3)

Therefore, towards the final part of the life cycle of the machine, there might again happen a switch in the attitude towards price. Customers may accept higher price level again, as the spare parts are less available from the market, and customers still want to keep the machine operating. Nevertheless, the spare parts are usually still less expensive than buying a whole new machine. The next comments describe the behaviour:

“Most likely they will take it because they have no other option. It's obsolete even from the original, the OEM. ... Customers are not looking at the price so much then.” (C7)

“But still, it's better than if he has to buy a new [machine] and then it would cost him [x amount of money] ... I think then the price becomes less relevant. Then it's about can I get the part to keep my machine because again, if you think that those customers who have a machine that is [x] years old, they're not most likely going to buy a new one anyway. They have a few machines running them and then they're not going to invest into a new machine every [x] year. They're going to keep that, and they just want to keep it going.” (C7)

According to the interview data, there are different types of customers, or more specifically, types of machine owners. The first customer that gets the brand-new machine from the case company is usually the most essential for the case company. Pricing can be kept high because the machine is in the beginning of its life cycle and the customer appreciates availability and quality over price, as described above. The first customer also might be a bigger corporation, who has the resources to buy new machines and OEM parts for them. One of the interviewees commented:

“The first customer is obviously the most important one for us, and then we can perhaps keep the price higher if we have other good things to offer, such as speed, predictability, information, and all that.” (C2)

After the most efficient period of operating is over, the big corporations often sell the old fleet to other companies and buy new machines to keep the operations on a high level. The second owners are usually smaller customers that are more price sensitive. The price competition increases, and it is harder for the case company to compete. One of the interviewees described:

“I would think that they would become more price conscious, and people would also have a better understanding of what they are buying and what they are paying for it, and perhaps there would be more agility and expertise.” (C2)

In conclusion, the price of a spare part is less relevant in the beginning of the machine’s life cycle, as customer value is based on quick delivery and quality of spare parts. Pricing becomes more important as the machine ages, and there are multiple alternatives available on the market. Towards the final part of the life cycle, pricing may become less relevant again, as there are not many options on the market, and customers want to keep their machines running. The results of the customer value and behaviour during the life cycle of the machine are presented in Figure 21.

Beginning of the machine’s life cycle	Middle of the machine’s life cycle	End of the machine’s life cycle	Final part of the machine’s life cycle
<ul style="list-style-type: none"> •Uptime, availability, and quality found the most important •Price is not relevant during the warranty period 	<ul style="list-style-type: none"> •Uptime, availability, and quality found important •Price becomes a factor in the buying decision after warranty •Some customers start searching for alternatives 	<ul style="list-style-type: none"> •Machines are moved to secondary fleet or sold to new owners •Pricing becomes increasingly important •Some customers start compromising on quality and looking for cheaper alternatives 	<ul style="list-style-type: none"> •Customers still expect service for their machine •Customers may accept higher price level again as the supply decreases in the market

Figure 21. Customer value and behaviour during the life cycle of the machine

In addition, the customer’s size, maintenance strategy, and type of relationship with the supplier may affect the relevance of price in buying decisions. Therefore, understanding customer value and behaviour throughout the life cycle of the machine is essential for understanding the role of price in buying decisions over the PLC of a spare part. However, what makes it complicated is that the machine’s PLC is not always in line with the spare part’s PLC, as there might be multiple generations of machines with the same spare part. This will be discussed in the next chapter.

5.3.6 Spare parts PLC

Understanding spare parts PLC is of course necessary, when designing a life cycle pricing strategy for spare parts. This chapter is divided into five topics: 1) assessing spare parts PLC in the case company, 2) uses of PLC categorization in the case company, 3) challenges related to the PLC categorization, 4) life cycle of the machinery, and 5) spare parts PLC characteristics. While the PLC categorization in the case company was already addressed in chapter 5.1, it is necessary to further study the categorization and other options for assessing spare parts PLC via topics 1-3. The other topics will help to understand different factors affecting spare parts PLC and help to define characteristics for each spare parts PLC phase.

Assessing spare parts PLC in the case company

According to the interviewees, the current PLC categorization based on the age of the machinery can be used as an indication of the PLC phase of a spare part. The PLC categorization was also found clear and easy to use. Two of the interviewees commented the PLC categorization in PLC assessment:

“That might be one parameter. I cannot think of any other parameter that we have today.” (C3)

“It gives us this indication about the parts lifetime.” (C4)

Other possibilities for assessing the PLC of a spare parts could be making a more detailed analysis of the installed base or historical sales data or using the age of the spare part itself. Here are two explanations from the interviewees:

“Well, you can also refine it more precisely, like, which years the part has been delivered a lot ... or how many machines have included that part in each year, so you can go a bit deeper and look at the annual quantities, and then you can see that ‘OK, this is still [A2] part’, but in reality there are a couple of years when only a handful of machines were delivered ... and then in reality most of the machines were delivered much earlier.” (C2)

“I think this age of the population fleet can also give us some trend, that if we know that we haven’t sold any new machines since quite many years then we can expect that the demand will go down.” (C4)

Uses of the PLC categorization in the case company

Based on the interviews, the PLC categorization is mainly used in demand planning, but also for prioritization of work in other teams. In addition, the PLC categorization is used

for the current life cycle pricing methods and reducing spare parts complexity, as described earlier.

In demand planning, the PLC categorization is considered in various decisions, such as deciding whether a spare part should be stocked or not. The senior manager of demand planning explained:

“So, if we have the [PLC category] called [A3], we haven’t sold any machines since [Y] years, and we also know a little bit what the lifetime of our equipment should be. ... So that gives us inputs, how we should take a look when it comes to availability. We should consider that in demand planning.” (C4)

“As the [PLC category] goes forward from [A1], then it’s less favourable to keep the items in stock.” (C4)

The PLC categorization is also used in the master data team to prioritize different projects. In customer support team, the inquiries can be prioritized based on the age or the PLC category of the requested spare part. One of the interviewees discussed:

“If this priority three customer asks for a part that is [x] years old, then we can say ‘okay, it is a prior three case’.” (C3)

As described before, the PLC categorization can also be used to manage spare parts complexity. This means that spare parts are not broken down into the smallest parts but only offered as bigger units. This makes it easier for the case company to manage its spare parts portfolio, while still supporting the older machines. This could also explain why A1 category is much bigger in number of items, than A2 and A3. One interviewee commented:

“The reason for that was then we could identify [A2] so we could start to reduce the part complexity. We could start reducing our offering because, again, the demand would be starting to drop away.” (C7)

Challenges related to the PLC categorization

Some challenges related to the PLC categorization were found through the interviews. The main challenge according to the interviewees was lack of data. The lack of data causes data errors and that some spare parts cannot be categorized. This has created the unknown age (A4), other items (A5), and NA categories. These items are naturally harder to manage since the knowledge about these parts is incomplete. One of the interviewees discussed as follows:

“When it comes to the [A5] items, it's that in many cases we don't know what the original source is. Sometimes we are even buying the parts from our competitors.”
(C5)

The lack of knowledge also might cause the profitability to be lower for these items. The pricing director discussed the situation as follows:

“Perhaps in general, the more gaps there are in our knowledge, so if we know almost nothing about that part except perhaps the name or description and the supplier, then we don't really have the opportunity to control the margin target very well, so it falls into this general category. Or if there are even bigger gaps, it may well be that we don't even know the actual costs, so it could be quite off the mark.”
(C1)

It was also noted that the PLC categorization is not always up to date. For example, the information might not be correctly connected in the system. Another challenge was that some spare parts can suddenly move back in the categories, as they are delivered with new machines. These can cause misinterpretations. In addition, the size of A1 category was noted. The definition, use and challenges related to the PLC categorization in the case company are summarized in Table 8.

Table 8. Summary of the PLC categorization

Definition	Based on the latest construction year of the machine In compliance with the promise to support the machines for Y years
Use	Assessing the PLC phase (at some level) Demand and inventory planning Prioritization of work Managing spare parts complexity
Challenges	Lack of data (some items are missing the category) Misinterpretations due to outdated or faulty data Size of A1 compared to other categories

In conclusion, the PLC categorization can be used as one parameter to estimate spare parts PLC, and there are other use cases. However, there are multiple challenges related.

Life cycle of the machinery

Next, the life cycle of the machines will be discussed to further understand the PLC categorization in the case company as well as spare parts PLC. Based on the interviews, the useful life of the machinery is considered to be around Y years within the case company, which is also the top limit of A2 category. However, the life cycle can reach over double the Y, but usually not in the primary fleet operating on a high level. This also

depends on the machine type, since the useful life of the smaller machines can be much less. Two interviewees commented:

"[Y] seems to be the norm, but then all the machines can go much longer so that's why of course the [A3] still is an important area, and I think that was also the idea when we created this [A3] logic." (C7)

"When it reaches a certain age it's perhaps not the primary machine. It's perhaps a backup machine and things like that." (C3)

The useful life can also be assessed with operating hours which gives more specific answers than years. This is because some customers use the machines around the clock, while others only in one shift a day, for example. Also, customers have different practices regarding whether to use the machines until they wear out or sell them on when problems arise. One of the interviewees described the customer behaviour as follows:

"For the first [x] years, it can be in the primary fleet, where it is actively used, and then new machines are purchased for the primary fleet and the old ones are transferred to the secondary fleet, where they serve as backup machines, and then they break down one by one, and it really depends on the customer how each one operates." (C2)

"There are customers who use the machine for [x] or [y] years, and as soon as it starts to develop more problems, they just throw it away at some price." (C2)

Nevertheless, machines are often operating until the very end of the life cycle, at least with the second or third owner. Thus, Y years can be used as a guideline for the machine's useful life in the case company.

The interviews also gave information about the optimal window, or prime time, for selling spare parts. This refers to the window where the demand is highest for spare parts in relation to the age of the machine, so in which part of the machine's life cycle spare parts are needed most. Based on the interviews, the prime time settles somewhere within the A1 category, the peak being around $\frac{3}{4}$ of X years. This is also supported by the quantitative analyses, where it was noted that the spare parts demand might meet its highest point somewhere in A1 category. One of the interviewees commented:

"It ranges on the model, but between [Z] and [X] years depending on the machine." (C6)

As already stated in the literature review, spare parts PLC is also related to the PLC of the machinery. In the case company, the PLC of the machine again depends on the machine model and type, but in general it is around X years. Using this information about

the useful life and PLC of the machines with the installed base data, it should be possible to forecast the spare parts PLC quite accurately. One of the interviewees discussed:

“I would say maybe around [X] years is a generational shift.” (C6)

Spare parts PLC characteristics

A few characteristics related to spare parts PLC were found in the qualitative data analysis. The one characteristic that stood out the most was cost development. There appears to be increases in cost due to decreasing demand. When the demand decreases, the suppliers may take the item out of the series production, and the production costs increase for one unit. The head of services sourcing discussed:

“I wouldn't call it a trend maybe, but there within the centre cut of certain categories of parts, like for example gearboxes or engines, if a gearbox is no longer a serial item, but it's only delivered for the spare parts, then it's usually on a different production line for the supplier and the costs are increasing.” (C5)

The decreasing demand also forces the case company to order smaller quantities, so that items are not left in stock after obsolescence. Usually, this also increases the unit costs. The order quantity also depends on the type of spare part. The demand of some spare parts can be very sporadic, for example if the spare part is not a part that wears but is only replaced after an accident. The head of services sourcing continued as follows:

“If we're talking about the light steel items, like sheet metal parts, the price is highly dependent on the MOQs (minimum order quantities). And we want to keep MOQ one for those types of parts, because they usually break when there is an accident. So, they also have that difference in pricing, because of the volumes. So, I would say this type of, if we can call them trends, I can recognise when working for services.” (C5)

Sudden and high increases in cost towards the end of PLC was already mentioned as discussing current state in the case company and life cycle pricing objectives. However, it was not clear whether it is a systematic pattern or just individual cost increases. The surprising cost increases may be related to the events described above, but the cost increases just appear higher than usual for some items. The pricing director discussed as follows:

“It could be that costs rise when smaller batches are produced. That could be one reason. But when you think about it, is it really that simple, and can we generalize it to the entire portfolio? If we think about buying an engine part from [an OEM

supplier], have we been able to assess whether this is the case there? In other words, do we pay [the OEM supplier] more for a new engine part than for an old one? I can't say whether this is even a problem with suppliers like this.” (C1)

Competition over the spare parts PLC can be hard to understand. It may vary depending on the type of spare part. It could be that the key parts do not have competitors in the beginning, while the spare parts that have a lot of alternatives in the market can have high competition right in the beginning of PLC. Also, it is unclear at which point the competitors start leaving the market when the demand drops at the end of PLC. It should also be studied how the amount of competition on the markets affects customer price sensitivity and willingness to pay. The pricing director discussed about the competition as follows:

“But it would probably be worth conducting a separate study to try to understand whether there is more competition (depending on the category) and, if so, how much more. Or does the supply of filters on the open market decline as they get older? At first glance, one might think that competition will increase with a slight delay, for example, when a new filter is introduced. There won't be much competition at first, but then there will be. But how long will that competitive situation last, if we're talking about a very old part? And then this situation is probably very different if we are talking about our very specific part, whether there is any competition at all. And if there isn't, how does that affect customers' willingness to pay, or can that age be used in some way in pricing the item, other than just trying to anticipate those cost surprises?” (C1)

According to one interviewee, if there is enough demand, competitors will appear on the market. If the competitors can produce the spare part for less, the case company also must decrease margins. The interviewee commented:

“I think the one thing that could erode margins for us long term on older parts is that there's enough volume out in the market that you have these Chinese knockoffs coming into the market.” (S2)

Next, demand planning will be discussed around the relevant topics. In general, the demand planning of spare parts in the case company is based on various parameters, where historical sales and number of transactions are one of the most important ones. When it comes to the beginning and end of spare parts PLC, there might be challenges related to forecasting and planning demand. In the beginning of PLC, there is no historical sales data, so demand must be forecasted based on the expertise in the company and sometimes comparing the item to other similar items. The middle of PLC

is regular planning. Later, in the end of PLC, uncertainty of the demand becomes a challenge. There might be cases where the case company knows that the item is soon no longer available from the markets, so the case company must decide how much to stock to cover the demand to support its customers. The senior manager from demand planning described the situation as follows:

“It’s tricky because the demand goes down but we also have this commitment to the customer that we should keep parts available. So, I think this kind of uncertainty is the challenge here.” (C4)

Lastly, the sourcing related topics will be discussed. There appears to be multiple challenges related to sourcing end-of-life spare parts. As said, the costs of spare parts can increase towards the end of PLC, but also the availability of the items can cause challenges. There might be multiple reasons for the increase in cost and obsolescence of spare parts in the end of their PLC. The reasons were discussed by a few interviewees:

“I would guess that one thing is perhaps that the push towards the supplier is not that hard from us or anyone else and that perhaps makes them also able to increase the price. That is purely a guess.” (C3)

“The biggest challenge we’ve got in the spare parts business is that we need to maintain a lot of different part numbers that are not even active for production and we need to provide the sources for the parts for machines that might be [x] or [y] or even [z] years old. So, a lot of parts that are no longer used at production, but they are still active for services.” (C5)

“Then of course the IPR, intellectual property rights. If we are not owning them and the part is becoming obsolete, then we are just not able to buy it.” (C5)

Again, the spare parts PLC is very much related to the spare parts category, as the supplier bargaining power is higher for commercial items. The head of services sourcing explained:

“But if the design is not [by the case company] ... then the bargain power is quite high for the suppliers. They can dictate the last-time-buy prices. They can dictate the prices for the spare parts and in many cases, we are not able to do anything else than just agree on those prices.” (C5)

Other sourcing related factors were focused on supplier relationships. Having good relationships with the suppliers is important, as it can help to gain some benefits both ways. For example, it can be possible to have a better delivery time or have some

visibility in the spare parts PLC from the supplier's side. The head of services sourcing explained as follows:

“Generally speaking, having a good relationship with the suppliers is a value that cannot be quantified because if you have a good relationship, then you can always give a call and speed up delivery. You will always get the information about the end-of-life because it's not always that we are getting that. We don't have contracts with every supplier. It's not mandatory for them to tell us. So, if you have a good relationship then you can know up front, then you can do a last-time-buy then maybe you can work also on the substitute or maybe a new generation.” (C5)

Overall, it was found out that spare parts PLC is heavily related to the installed base of the machinery, and the type of spare part. Various spare parts PLC characteristics were drawn from the interview data bringing new information. The spare parts PLC characteristics conducted from the interviews are summarized in Figure 22. Beginning, middle, and end of PLC were used to describe the PLC as clear introduction, growth, maturity, and decline phases were not used in the interviews.

Beginning of PLC	Middle of PLC	End of PLC
<ul style="list-style-type: none"> • Competition grows with a slight delay • Hard to forecast demand 	<ul style="list-style-type: none"> • High competition • Regular demand 	<ul style="list-style-type: none"> • Increasing costs • Some competition if enough demand on the market • Uncertain demand • Challenges in availability

Figure 22. Spare parts PLC characteristics conducted from the interviews

In the beginning of PLC, competition grows with a slight delay, and it is difficult to forecast demand. In the middle of PLC, it is easier to forecast the demand, but high competition makes it difficult to differentiate. In the end of PLC, there might be increasing costs, uncertain demand, and challenges in availability. Competition starts to leave the market.

5.3.7 Spare parts life cycle pricing

To better understand life cycle pricing of spare parts, the general spare parts pricing strategies mentioned by the interviewees will be first described. This is to help understand the general attributes that the interviewees think should be considered in spare parts pricing. After that, life cycle pricing strategies drawn from the interviews will be discussed.

General pricing strategies

The most mentioned factor related to spare parts pricing was competition. The interviewees agreed that the pricing should be aligned with the market prices, if customers can easily get the spare part from the market. Therefore, competition is something that should be considered based on the spare part category and the PLC phase. Here is a comment from one of the interviewees:

“I think at the end of the day, the market kind of dictates where pricing ultimately will be. I mean, we can increase prices every year, but at the end of the day, if the rest of the competitors in the market are selling it for \$50 less, we’re basically walking away from that business. So, from my standpoint, the market truly dictates what the pricing is ... If you have the availability and nobody else does, you can probably take higher margins. Absolutely. But, if everybody has it available, the market’s going to drive the pricing.” (S2)

The competition is of course related to the category of the spare part. If the spare part is something that only the case company can provide, the competition is low, and there is an opportunity to charge a premium. This can be either, when competitors have already exited from the market if the item is old, or if there is no competition as the spare part is complex and requires such expertise that there is no reason to compete. The interviewees commented the topic as follows:

“I would say that (the objective should be to) always to have healthy margins but also to identify the components that are [case company] key parts. We can earn a bit more money due to the fact that nobody else can provide those components.” (C5)

“It comes down to what is readily available somewhere else, or have we made it hard for them to find it somewhere else? And that really dictates what the pricing will or should be.” (S2)

“The more specialist the component the more they see the value in working with [the case company] whereas if it’s an easily available filter that you can buy the same parts from multiple vendors then that value starts to erode. So, the value is proportional to the type of spare part that they’re procuring when it’s a specialist (spare part).” (S4)

The interviewees also thought that spare parts pricing should be aligned with demand. This is also very much related to the PLC phase and the category of the spare part. If the spare part is facing great demand, and the spare part is a key part, a premium could be charged. However, if there is much competition, the price must be competitive, even if there is great demand. One of the interviewees commented:

“I would say (the objective for pricing should be) to meet the price to demand. So, to be able to shape the price and at the same time see the result coming from the sales.” (C4)

In addition, spare parts pricing should be connected to the level of customer relationship as well as the type of customer. This means that for the key customers the case company should not increase pricing too rapidly, to maintain a good relationship. With smaller customers, the case company can increase the pricing to compensate for the low volume from a certain customer. One of the interviewees explained:

“I think it's good to differentiate between different customers, not only customer segments in terms of opportunity and volume and how big the operations are, but also what are the different personas that we are selling to.” (C6)

Value-based pricing was only mentioned a few times in the interview data. This is probably because the customer value of a spare part can be hard to assess and it can vary depending on the customer and the context, and because competition is found to be the most dominant factor in spare parts business. However, the factors that create customer value over the machine's life cycle, can possibly be utilized in considering how the customer value acts throughout the spare parts PLC.

In conclusion, all these factors (competition, category, demand, customer relationship, and customer value) are somewhat connected to each other, and all should be considered in spare parts pricing, while still making sure to be profitable. However, the relationship between these items will most likely vary during the spare parts PLC, why spare parts life cycle pricing is needed.

Life cycle pricing strategies

The codes related to the life cycle pricing strategies could be divided into three parts already used with the spare parts PLC: beginning, middle, and end of PLC. In the beginning of PLC, spare parts pricing can be either higher or lower according to one interviewee:

“In this early stage, from one side the price could be higher to also kind of recover development of the part but from the other side the lower price can encourage this early adoption when the part appears at the market.” (C4)

If combined with the idea that competition grows with a slight delay at least for the parts that are categorized as key parts, the pricing could indeed be higher at first. On the other hand, lower pricing could encourage customers to buy. However, the spare parts are usually bought for need, so it's unclear how much this would affect sales. Setting a higher

price at first is also supported by the fact that the interviewees thought that usually the first owner of the machine is less price sensitive, and quality is valued with new machines.

During the middle period of PLC, the interviewees mentioned that pricing should be based on competition. This is in line with the assumption that competition is highest around the middle of PLC. Also, the demand is most likely the highest, based on the general concept of PLC, which means that the price should meet the supply and demand on the market. During this time, customers can most likely find alternatives easily, so pricing might need to be decreased from the beginning of PLC. However, pricing can still reflect customer value compared to the alternatives. One interviewee explained:

“In this middle stage, we should be competitive. So, then the price should be monitored and to keep this balance between the profitability and the demand.”
(C4)

When starting up the thesis, the case company thought that the end of PLC is the part where they are lacking knowledge. This is why the study was more focused on the end of PLC pricing options, and most codes were related to that part. Most interviewees thought that the pricing can be increased towards the end of PLC as the parts start to be more challenging to obtain from the market for the customer. One of the interviewees commented:

“When we have a lot of competition for the part, then I think we need to be more in line over the life cycle, and at the end of the life cycle we can definitely add more to that.” (C3)

This is supported by the idea that customers accept a higher price level as their machine starts to be that old that there are few options available. One of the interviewees explained:

“Maybe even yourself, if you think ‘I have an old car and I have to buy a part for that car, maybe I expect to pay more because it's older.’” (C7)

However, the appropriate level should be considered by each market as the competition and customer price sensitivity can vary. One of the interviewees explained:

“I think we have to look at each segment of business that we service today and figure out what the market will bear pricing standpoint. I think as the spare part gets older, if it's not readily available, we should be able to demand a premium for those parts.” (S2)

One interviewee thought that life cycle pricing should follow the demand of the spare part. This could be determined by following the age of the item. Basically, the demand should be matched with the supply on the market. One can assume that the supply decreases as the item ages. The interviewee explained:

“It might be that we can categorize based on a certain age of those parts and see ‘okay now we should be able to do something’. I do think that based on demand more or less.” (C3)

Considering the possible cost increases towards the end of spare parts PLC, the profitability should not be forgotten just to serve the customers. One interviewee noted that if the case company faces cost increases, competitors will as well. This enables the case company to increase pricing and still not fall out of the competition with older spare parts. The interviewee discussed as follows:

“But if they’re parts that sourcing costs have actually got higher. So, our cost is higher as a result of its age and those factors affect our competitors as well. We shouldn’t sacrifice margin because the part is getting more expensive to source.” (S4)

In certain situations, companies use pricing to stimulate demand and reduce their inventory before there is no more demand for the part. On the other hand, the inventory can be an advantage when there are no other suppliers that can provide that spare part. Also, if there is no stock, but the company can source the spare part, the price can be increased. Therefore, companies should also consider if they want to reduce the inventory by lowering pricing, or if they want to increase pricing when being one of the few suppliers in the market. One of the interviewees discussed the topic as follows:

“I think at the end of life we could consider that if we would like to reduce the inventory, the price could be lower. But as I said, then from the other side, maybe this part is exclusive, maybe we are the only ones who are still offering that part, so then from the other side the price could go up. So, I think it should be connected, and it should be considered, but it’s pretty individual and dynamic.” (C4)

The type or category of spare part came up in the life cycle pricing topic as well. It is most likely that same life cycle pricing strategies cannot be used for all spare parts categories. The pricing director considered:

“Can life cycle pricing be applied in the same way to all spare parts, or should there be different approaches depending on factors such as the spare parts category?” (C1)

The category can be, again, linked to the competition that the spare part faces. The commercial parts might face competition until the very end of the PLC, whereas key parts might be less competed. Hence, the category can be used to guide life cycle pricing strategies. Most likely, it would be more logical to implement higher increases for key parts. One of the interviewees discussed:

“So, if it was [A3] items and maybe not off-the-shelf items like on [an OEM supplier] then of course anyone can buy that. But in-house design, for example with steel parts, why not add [x]%. Just why not? Maybe because we're not selling. So, even from our supplier, we have to probably pay higher as well, but why not then charge a premium for that?” (C7)

Another interviewee agreed that for commercial parts the price should not change, but for the key parts the price could change depending on the situation. They suggested a more reactive approach, rather than adding a premium for a certain age of items. The interviewee explained:

“I believe ... for commoditized parts that are easily sourcable, price shouldn't change. But if it's a specialist part that we have to buy in because that machine is older, it's not in our normal stocking price profile, it's obsolete or it's made to order, then the price should be higher. But I wouldn't necessarily apply it to the general rule that any parts over the age of x suddenly become y amount more expensive.” (S4)

Another approach was to consider the age of the machine that a specific customer has rather than the PLC categorization of the spare part as one customer might need the same part for a new machine and another customer for an end-of-life machine. However, this can get complicated and would require different analyses and tender-based sales rather than list prices that are visible for all customers. Therefore, this solution might not work in the case company but might work for other organizations. The interviewee discussed:

“But of course, the thing is that the same part may have been used for a really long time, so someone with a [x]-year-old machine may want that same part, and someone with a machine that is only a couple of years old may want it too. It may require quite precise adjustments.” (C2)

In addition, it was suggested that the type of customer would be considered in life cycle pricing. This means that key customers would not have as high increases as other customers. This can also require specific price adjustments and analyses of the customer base for that spare part. However, this should be considered in the more

reactive price adjustments, for example when there is a sudden increase in cost. The interviewee explained as follows:

“If it is a super important customer then perhaps, we should be a bit more hesitant to increase too much. But if the customer base for that product is small customers, why should we care more or less.” (C3)

In conclusion, life cycle pricing can be made very complex, and there are multiple factors that can be considered. However, considering the complexity of the spare parts portfolio in the case company, some simplifications should be made to be able to implement logical and manageable pricing strategies. For example, it is not possible to follow the competitive situation by each market, not to mention by each spare part. Thus, some general guidelines are needed to navigate life cycle pricing by a spare part category.

The results of the life cycle pricing related topics from the interviews are summarized in Figure 23. At the top, there are the general factors that the interviewees thought should be considered in spare parts pricing. Thus, the pricing should be based on the relationship of all these factors in each PLC phase. The bottom of the figure presents the generalized pricing strategies for key parts and commercial parts in beginning, middle, and end of spare parts PLC conducted from the interview data.

GENERAL FACTORS OF SPARE PARTS PRICING		
Competition	Category	Cost
Customer value	Demand	Inventory
Customer relationship		
BEGINNING OF PLC	MIDDLE OF PLC	END OF PLC
Key parts: Initial price can be set slightly higher due to low competition, uncertain demand, and less price sensitive customers	Key parts: Pricing should be based on competition and the customer value for reasonable pricing	Key parts: Pricing can be increased as competition decreases while considering demand, costs, inventory, and category
Commercial parts: Pricing should be based on competition	Commercial parts: Pricing should be based on competition	Commercial parts: Pricing should be based on competition and costs

Figure 23. Generalized life cycle pricing strategies for key parts and commercial parts

The initial price for key parts can be set slightly higher as there is little or no competition, and the customers are less price sensitive with their new machines. For commercial parts, there is likely to be some competition from the beginning, hence the price should be according to the competition, while still considering other factors, such as costs.

During the middle of PLC, both key parts and commercial parts should be priced based on competition, as alternatives start to enter the market for key parts as well. However, pricing can still reflect the quality and other customer value factors compared to competing products. Towards the end of PLC, the key parts pricing can be increased as competition is likely to drop out of the market when demand decreases. In addition, costs are likely to increase, and pricing should reflect that. In some cases, pricing can be decreased to generate demand for remaining inventory. For commercial parts, pricing should not generally be increased as they are most likely available from the market even during the end of PLC.

6. DISCUSSION

In this chapter, the empirical results will be combined with existing theory creating new knowledge and recommendations for the case company. Based on all the results combined, the answers for the research questions are discussed. This chapter will form a comprehensive view of ways to assess spare parts PLC and strategies for spare parts life cycle pricing. In the first subchapter, methods to assess spare parts PLC will be discussed. In the second subchapter, it will be discussed what are the main attributes in spare parts pricing and how they behave over spare parts PLC. The third subchapter will discuss how the spare parts life cycle pricing strategy should be implemented and how the strategy should be formed based on the results. Lastly, based on these results, recommended actions in the case company are presented.

6.1 Assessing spare parts PLC

This chapter will discuss assessing spare parts PLC in the case company and in general. The aim is to answer the first research question about what kind of methods can be used to assess spare parts PLC. First, methods to assess spare parts PLC phase are conducted by combining the literature analysis and empirical results. Second, the current PLC categorization in the case company will be evaluated.

It was agreed both in the qualitative data and literature (Kennedy et al., 2002; Van der Auweraer et al., 2019) that spare parts demand is heavily related to the primary equipment and based on the customer need for maintenance. In addition, it was noted that spare parts may have intermittent and sporadic demand which is difficult to predict (Chien et al., 2023; Jouni et al., 2011). This was also agreed among the interviewees. It was noted in the interviews that spare parts are subject to becoming obsolete as the primary machines leave the production, which was also suggested by Kennedy et al. (2002). This creates challenges in availability. According to the interviewees, competition on the spare parts markets is high. This is why OEMs often lose sales to third-party competitors (Cohen et al., 2006). However, availability of spare parts is considered a significant competitive advantage in the market (Inderfurth & Mukherjee, 2008), as the machines are often critical for the customers' operations. With all these challenging characteristics, the spare parts PLC has yet not been clearly assessed.

Literature indicates that spare parts categorization (Jouni et al., 2011; Nnamdi, 2018), customer maintenance strategy (Kennedy et al., 2002; Takata et al., 2004), and demand

forecasting using installed base data (Van der Auweraer et al., 2019) should be considered when assessing the PLC phase that the spare part might be in. All these factors were also mentioned in the interviews. Perhaps the most highlighted topic in the case company was the need to categorize spare parts based on whether the spare part is a key part or not. This idea is similar to what Jouni et al. (2011) suggest in their spare parts categorization matrix on the supply category, which is based on the risk of becoming obsolete. According to Jouni et al. (2011), commercial and industry specific items are then less at risk to become obsolete. However, it was noted by the case company that suppliers have more power with these items, that are not key parts to the case company, and there might be challenges in availability. This is more likely to relate to the industry specific OEM parts, as commercial parts are likely to be available from the market until the very end of PLC. The risk can be minimized by having good relationships with the suppliers. With key parts, the risk of becoming obsolete is more related to the situation where costs increase so much that the spare part is no longer worth producing.

The maintenance strategies of the case company's customers are roughly divided into planned and breakdown maintenance. The interviews did not provide a clear picture of how many customers use the planned maintenance and how many the breakdown maintenance. According to Kennedy et al (2002), maintenance strategies of the primary machines largely shape the demand for spare parts. However, due to the complex portfolio of spare parts and customers in the case company, it would be challenging to analyse which spare parts are used in which kind of maintenance strategies. Therefore, maintenance strategy is perhaps not a feasible factor to consider in assessing spare parts PLC in most companies, but it should be kept in mind when considering the situation where the customer needs the spare part, like Kennedy et al. (2002) suggest.

Lastly, literature suggested that spare parts PLC could be determined by forecasting long-term demand. The demand could be forecasted either by historical demand, as suggested by Nnamdi (2018), or with installed base data, as suggested by Van der Auweraer et al. (2019). Forecasting based on installed base is argued to be more accurate, as the demand of spare parts generates from the need of spare parts in the primary machines (Van der Auweraer et al., 2019). Making detailed analysis of the installed base was also suggested by the interviewees. In the case company, demand forecasts are created utilizing both historical demand and installed base data combined with other factors, but the forecasts are not utilized in pricing.

With all the methods for assessing spare parts PLC conducted from literature and the empirical research combined with the general concept of PLC, there is a need to evaluate

the current PLC categorization in the case company. As described earlier, the PLC phase of a spare part can be indicated by the PLC category. The PLC categorization considers the installed base data as the category is defined by the latest year that the spare part has been delivered in a new machine. Therefore, this is somewhat according to the installed base method described by Van der Auweraer et al. (2019) as it considers the age of the latest machine. However, it does not consider other characteristics of the installed base, such as the usage. In addition, the PLC categorization does not consider the installed base as a whole but only considers the latest machine. This could mean that most of the machines have been delivered much earlier than the latest machine, as described in the interview data, which might distort the view of the PLC phase. Van der Auweraer et al. (2019) recommend utilizing new product sales and installed base size as a forecast for spare parts demand. Therefore, the current method in the case company may not be the optimal when forecasting spare parts long-term demand. In addition, the PLC categorization alone does not consider the category of the product as recommended by Jouni et al. (2011).

During the empirical results, it was already noted that A1 is the largest category in number of items and in sales, meaning that the demand is most likely reaching maturity by the end of A1 category. This was also supported by the comments from interviewees that the optimal window to sell spare parts is between years Z and X in the machine's life cycle, at least for the case company. For companies offering cheaper alternatives it might be that the maturity phase is later when customers start to switch to alternatives. Hence, it can be assumed that the A1 category would cover the PLC curve at least until it reaches its highest point. In the case company this would be around X years. A2 would then cover the other half or the maturity phase and beginning of the decline phase. Then, around Y years, spare parts would move to A3 category. A3 would then focus on the end of the decline phase of the demand curve. The PLC categorization in the case company is illustrated in Figure 24 with the help of the general concept of the PLC demand curve. It is noted that spare parts may not follow the general PLC curve precisely. However, a similar bell-shaped curve for spare parts demand was illustrated by Van der Auweraer et al. (2019), why this concept can be used for illustration. In addition, it is noted that the PLC categories may not follow this illustration if the latest new machine is delivered much later than the mass of the machines. In Figure 24, the decline phase will continue until the demand reaches zero or until the spare part becomes obsolete from the markets and therefore the demand cannot be met.

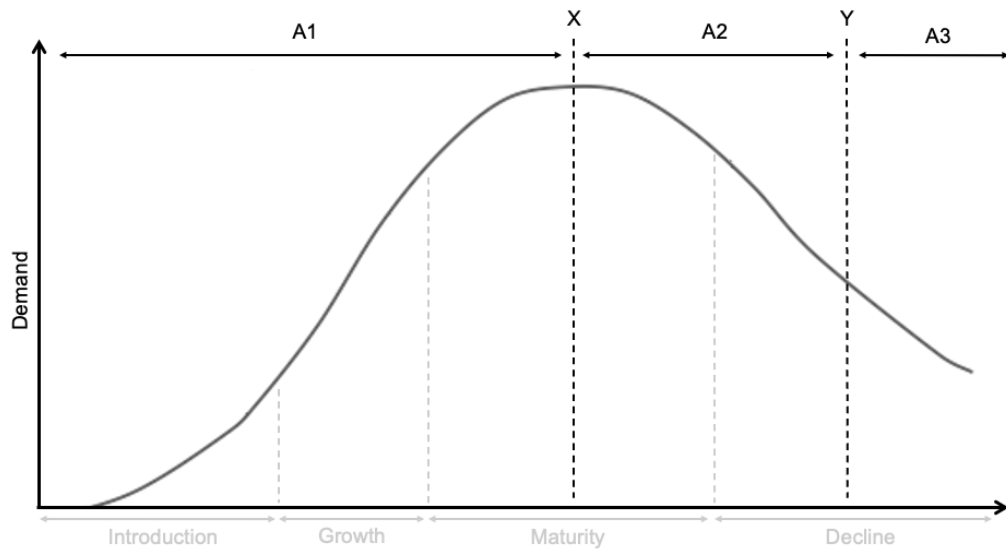


Figure 24. PLC categorization in the case company compared to the PLC phases

The A2 and A3 categories presenting the end of maturity and decline phases is also supported by the analysis on share of items with sales. In the analysis, it was found out that A1 has the highest share of items with sales, whereas this starts to decrease when moving on to A2 and further down to A3. This could indicate that the overall demand starts to decrease for these items. However, it is also noted that this can be a result of customers switching to competitors' offerings as the machines become older, as described by the interviewees.

As discussed in the literature review, the categorization of the spare part should be considered when assessing the PLC phase of the spare part. This is something that the current PLC categorization lacks. At least the supply category could be considered, but also a demand element could benefit the categorization. As the commercial and industry specific items face more competition, the PLC of these spare parts is most likely more stable and predictable compared to the key parts. It was also agreed by Smith et al. (1999) that the PLC is more consistent for low-technology products, which are often the commercial parts in the case company.

In conclusion, the PLC categorization in the case company gives one example of how the PLC phase of a spare part can be roughly estimated by using the latest delivery year of the new machines. In addition, the results suggest that the spare parts PLC can be estimated by making a detailed analysis of the installed base characteristics, such as age and usage, while still considering the category and type of spare part.

6.2 Spare parts PLC characteristics from a pricing perspective

This chapter will discuss the factors that should be considered in spare parts life cycle pricing. The aim of this chapter is to answer the first sub-question of the second research question about how different factors affect pricing in each PLC phase. Spare parts PLC characteristics gathered from literature and the empirical results will be presented to understand how the pricing attributes behave during PLC.

A pricing strategy that considers only the PLC phase is not optimal (Bahrami & Yaghoubi, 2024). Therefore, companies should rather focus on the characteristics that each PLC phase has while also considering other situation-specific factors. In the literature review, costs, competition, demand, customer value, and category were identified as the main determinants for spare parts pricing. The empirical studies added customer relationship and inventory value. There is a need to understand how these attributes behave in each PLC phase before life cycle pricing can be implemented. Therefore, a model for spare parts PLC characteristics should be created. No clear PLC characteristics of spare parts were found in the existing research. Hence, the empirical results will be combined with the general PLC concept. The results are presented in Table 9. Market growth and installed base size were used as factors to describe demand. In addition, costs, competition, and customer value were found pricing attributes that could be generalized into spare parts PLC characteristics. Category, customer relationship, and inventory value are believed to be more situation specific. In addition, profits and challenges were found a useful characteristic to consider.

Table 9. Spare parts PLC characteristics

	Market growth	Installed base	Competition	Costs	Profits	Customer value	Challenges
Introduction	Slight	Growing	Few	?	?	Availability, quality	Forecasting demand, unknown costs
Growth	High	High	Growing	Average	High	Availability, quality, price	High competition
Maturity	Moderate	Declining	High	Average to high	Declining	Price	High price competition
Decline	Negative	Small	Declining	Average to high	Low	Availability	Availability, uncertain demand and costs

The market growth was adapted from Bahrami and Yaghoubi (2024) and size of installed base was adapted from Van der Auweraer et al. (2019). The initial costs and profitability were found unclear as it might depend on the nature of the spare part, for example, some spare parts can be designed in-house which increases the initial costs. In addition, it was noted that some interviewees had experienced uncertain costs and steep cost increases

in the end of PLC, but that was not unambiguously detected in the quantitative analysis. It is also noteworthy that the profit development is based on the current situation in the case company and may not be generalizable.

The results suggest that in the introduction phase, the market growth is slight as the installed base is only growing. Competition is low, and customers value availability and quality. Forecasting demand and costs can be challenging. In the growth phase, the market is growing at a fast phase, and so is competition. Costs are most likely to be moderate, while most customers still value availability and quality. This allows good profitability for OEM suppliers. In the maturity phase, price competition starts to intensify, as some customers start looking for alternative solutions for their older machines. In the decline phase, competitors start leaving the market, but demand and costs become uncertain. Customers value suppliers that can provide spare parts for their old machinery.

These spare parts PLC characteristics should be considered when planning the life cycle pricing strategies for each phase. Competitor prices, costs, and demand were already acknowledged by Shipley and Jobber (2001) as the most prominent determinants for pricing in general. These factors were also emphasized in the interview data. In addition, the spare parts category should be considered, as Smith et al. (1999) have noted that the pricing strategies can differ for low and high technology products. The empirical data also suggested that pricing strategy for commercial items should be more consistent and mostly based on competition. Customer value can be hard to define accurately as it can vary largely between customers based on, for example, the age of the machinery and the maintenance strategy. It was not previously studied how the customer value of spare parts develops during PLC. Through the empirical results, it was found out that customer value is largely dependent on the age of the machine. Therefore, spare parts PLC can be used as a rough estimate of how old the machines might be. According to the interviewees, customer relationship should also be considered when deciding prices. In theory, monitoring the above-mentioned attributes in real time would always allow to set the optimal price. However, the benefit of the PLC concept is that it enables forecasting and therefore helps to implement more effective pricing strategies (Rink, 2017).

6.3 Framework for life cycle pricing

This chapter will summarize the results by creating two frameworks related to life cycle pricing. First, a framework is created for the case company and other spare parts suppliers to utilize in implementing spare parts life cycle pricing. Second, a framework for spare parts life cycle pricing strategy is created. This will answer the second research

question about what kind of framework can be used in spare parts life cycle pricing. After that, different life cycle pricing approaches and their impact on demand and profitability will be evaluated in spare parts context. This will answer the second sub-question about how different life cycle pricing strategies affect demand and profitability of spare parts.

The framework for implementing life cycle pricing strategy was created with the help of literature review and empirical results. The framework is designed for implementing life cycle pricing to support existing spare parts pricing strategy. The framework is illustrated in Figure 25. First, it is suggested to review the existing pricing strategy and pricing methods to fully understand the current situation. The importance of setting a clear strategy for pricing was emphasized both in literature and in empirical results. Shipley and Jobber's (2001) pricing wheel can be used to review and build the strategy. It is important to define the overall pricing strategy which defines where the company wants to have premium pricing and where more competitive pricing. As the case company acts as an OEM supplier, they do not have to have lowest prices on the market, but low enough to stay in the competition. It was noted by Gallagher et al. (2005) that OEMs cannot compete with only price, otherwise profits will fall on the market as competitors will follow price reductions. In addition, there should be a good understanding of the spare parts business and its characteristics as well as customer behaviour during the life cycle of the machinery. These set the premises for life cycle pricing.

Second, pricing objectives should be assessed. One of the objectives for life cycle pricing in the case company based on the interview data should be profitability over the whole PLC. The case company should focus especially ensuring profitability of spare parts heading towards the end of PLC. Another objective drawn from the interviews was about improving competitiveness and market position of spare parts business in older machines. According to Nnamdi (2018), one of the objectives could be avoiding excess inventory towards the end of PLC. Life cycle pricing is also found to be a way to improve overall demand and profitability (Bahrami & Yaghoubi, 2024), which could be one objective. In addition, companies should determine if they want to compete in spare parts in their end of PLC and integrate that in their strategy. Companies might see a business opportunity in being the only supplier with these older spare parts, which would allow them to charge a premium price.

Third, the framework suggests that companies should create a method for assessing and forecasting spare parts PLC phases. If the spare parts PLC is unknown, it is not possible to implement price adjustments in accordance with the PLC. As the case company already has a method for indicating the PLC phase, the case company should then evaluate if the current PLC categorization is suitable for achieving the objectives.

For example, the current PLC categorization does not allow to guide pricing in the first phases, which could be a challenge.

The fourth step of the framework is to define the pricing determinants and how they behave during PLC. This study suggests that the main pricing determinants for spare parts are competition, costs, demand, customer value, spare part category, customer relationship, and inventory. All these factors are most likely to vary during PLC. Hence, the spare parts PLC characteristics were assessed earlier in Table 9. These characteristics can be used as a rough estimate of how the pricing determinants may affect in each PLC phase.

Fifth, the life cycle pricing strategy can be created considering the objectives, ability to assess and forecast PLC phases, and different pricing determinants in each PLC phase. Combining results from the literature review and empirical parts, several different life cycle pricing strategies were found in terms of timing and logic. Companies must decide whether they would like dynamic pricing over PLC, where the price would be updated regularly based on changes in the market conditions, even in between PLC phase changes. Alternatively, companies can choose to adjust pricing only around PLC phase changes. The method of adjusting price can be approached by a coefficient, as in the study by Bahrami and Yaghoubi (2024), or with different functions, as in models by Asl-Najafi and Yaghoubi (2021) and Sun et al. (2024). At the time of the study, the case company uses coefficients to adjust pricing when the PLC category changes.

Lastly, the life cycle pricing strategy can be implemented. It is recommended that the strategy is first implemented for a smaller group of spare parts to see whether the strategy produces desired results. The results should be closely observed and analysed to see if the objectives are met and what is the response from the markets regarding profitability, demand and customer feedback of the spare parts. Based on the results, the life cycle pricing strategy can be further developed. By following this framework, the case company can review its current life cycle pricing strategy and implement further strategies that are not only based on expected cost increases towards the end of PLC. Developing the PLC categorization allows the case company to utilize more dynamic pricing over PLC, not only focusing on the end.

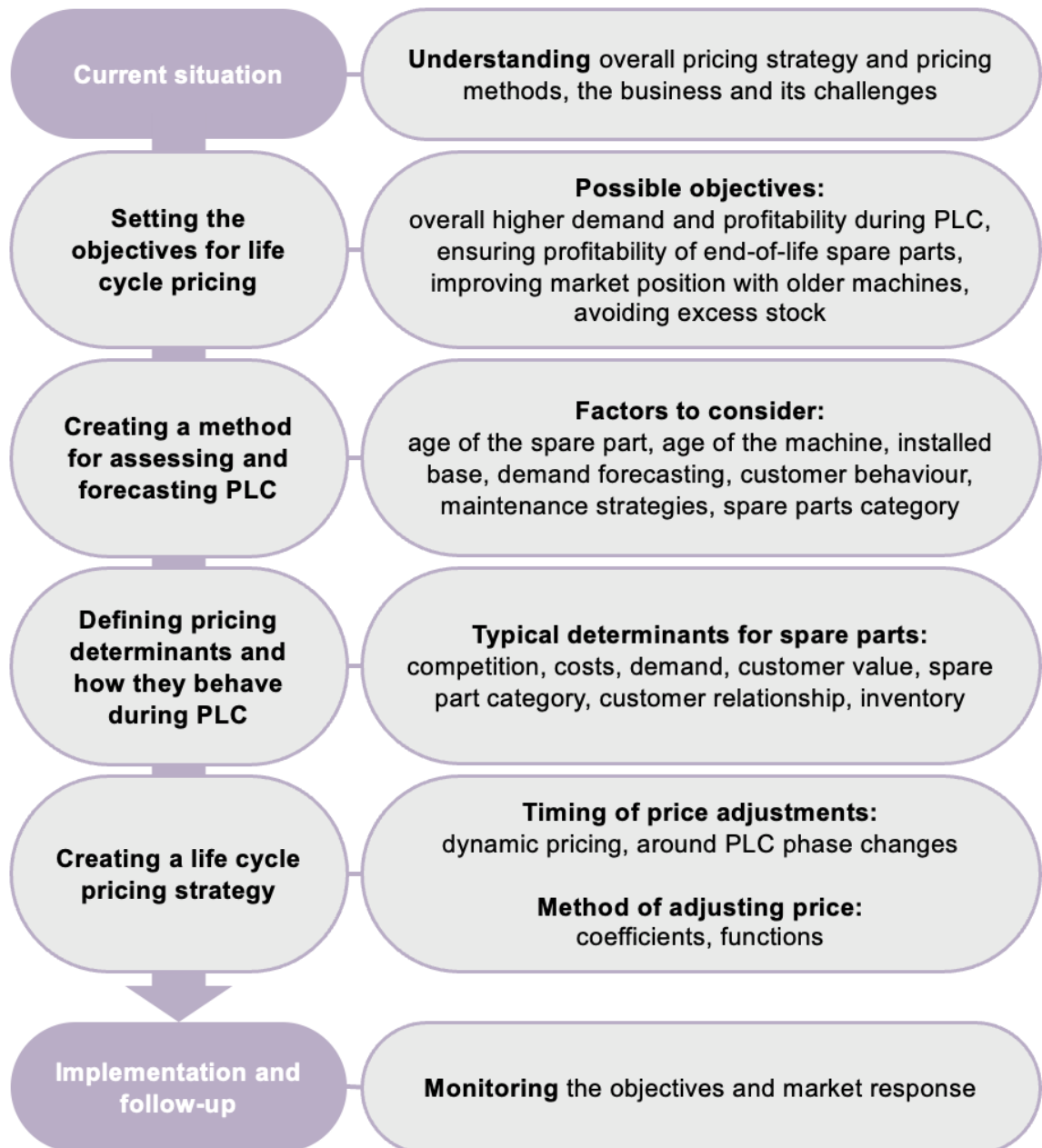


Figure 25. Framework for implementing spare parts life cycle pricing strategy

Another framework was created for the actual spare parts life cycle pricing strategy. The framework is presented in Figure 26. The framework can be used when considering which factors are the most relevant in each PLC phase for key parts and commercial parts, and how they affect pricing. In addition, the framework suggests a pricing strategy for each PLC phase. The framework reminds us to consider the current situation, objectives for life cycle pricing, and the method for assessing PLC. The trend that the determinants face is illustrated by arrows and the colour illustrates the impact that the trend has on price. By considering all these factors, possible pricing strategies for each PLC phase were formed. The framework illustrates key parts and commercial parts as

they have clear differences in life cycle pricing. Life cycle pricing strategies for industry specific spare parts should be considered from somewhere in between these categories.

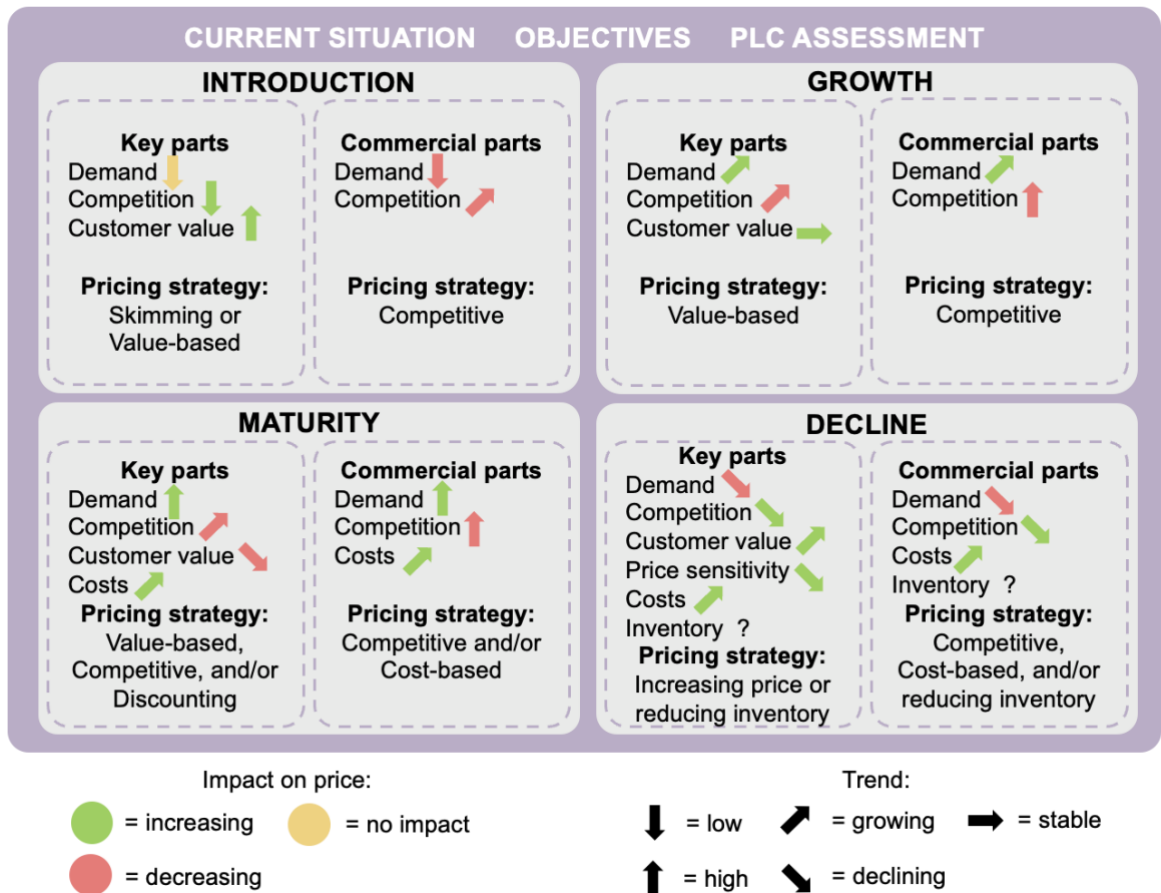


Figure 26. Framework for spare parts life cycle pricing

Summarizing the empirical results, whether to increase or decrease the price over PLC, the decision depends on the category, inventory and competition. Hence, these factors were included in the framework. For commercial parts, pricing strategy can be more stable and mostly based on competition. For key parts, most interviewees agreed that pricing in the introduction phase should be slightly higher as customers are willing to pay, if there is no competition. However, the meaning of price in the introduction phase remains unclear as most of the machines are most likely under warranty. When competition appears during the growth phase, pricing may need to be reduced, although customers still most likely value quality and availability. During the maturity phase, pricing should consider competition, which most likely requires further price reductions. In the decline phase, pricing starts to become complicated. In the end of PLC, the primary machine is most likely operating at a smaller customer, who is not ready to pay as much. However, if there are no other suppliers, customers might have to pay more to get the part. There might be increasing costs due to decreasing volume which should be considered. If there is a need to reduce the inventory, pricing could be reduced to

stimulate demand. According to Nnamdi (2018), life cycle pricing is an effective method to proactively reduce spare parts inventory. However, if the company would wait a few years, they could charge a premium for the spare parts that are no longer available anywhere else and customers start to value availability again.

According to Nnamdi (2018), companies can price themselves out of the market if not considering the PLC phase. However, price should still reflect customer value in key parts. If competitors exit the market in the decline phase, the price can then be increased, like Rink (2017) also suggests. In literature, most studies recommend gradually decreasing the price after the introduction phase, whereas Rink (2017) suggested that the price could be increased in the end if demand becomes less dependent on pricing. This was estimated to be an appropriate method for key parts as, according to Shipley and Jobber (2001), price sensitivity tends to be low for items that customers need urgently and that compete against few alternative solutions. These results support the framework created. Spare parts category can be used to estimate the amount of competition in the end of PLC. Hence, the pricing cannot most likely be increased for commercial parts.

One of the research objectives was to study how life cycle pricing strategies affect the demand and profitability of spare parts. According to Sun et al. (2024) pricing models based on PLC concept are overall more profitable than strategies based on linear demand. In addition, Bahrami and Yaghoubi (2024) argue that strategic timing of price adjustments during PLC lead to higher demand and profitability. It was also found out that price optimization utilizing PLC could help to lengthen the PLC and therefore allow higher overall demand (Asl-Najafi & Yaghoubi, 2021). However, this may not be applicable to spare parts as the demand for spare parts can only grow to a certain point, which is related to the need to maintain the machines. In the empirical results, it was found that the spare parts for which the PLC category is not known have lower profitability than those for which the category is known. This suggests that understanding the PLC allows companies to guide pricing more effectively leading to higher profitability. The impact of life cycle pricing on spare parts demand and profitability is summarized in table 10 with literature that supports the findings.

Table 10. The impact of life cycle pricing on spare parts demand and profitability

Demand	Profitability
<p>Life cycle pricing can lead to overall higher demand over PLC (Asl-Najafi & Yaghoubi, 2021; Bahrami & Yaghoubi, 2024), but it can only reach a certain level depending on the population fleet.</p> <p>PLC concept allows to forecast demand, competition, customer value factors, and other market conditions (Rink, 2017), which enables companies to match pricing with demand.</p> <p>Life cycle pricing can act as a proactive method to stimulate demand and to reduce inventories and minimize obsolescence risk (Nnamdi, 2018).</p>	<p>Life cycle pricing can lead to an overall higher profitability over PLC (Bahrami & Yaghoubi, 2024; Sun et al., 2024) with more effective pricing strategies.</p> <p>Better understanding of spare parts PLC allows companies to create more effective pricing strategies (Rink, 2017). Companies can better understand when they can charge a premium and when the pricing should be lower to stay in the competition.</p> <p>Assessing the PLC phase of the spare part allows better profitability and opportunity to guide margins.</p>

Through the empirical results, it was found out that there is a need to further develop life cycle pricing in the case company. It was noted that the demand and profitability of spare parts decreases as the spare part moves down the PLC categories. The decreasing demand is of course natural after reaching maturity. However, it was unclear whether the overall demand on the market decreases, or if the case company starts to lose more sales to competitors after a certain point. In addition, the results show that the profitability of spare parts decreases after maturity. This shows that the current proactive life cycle pricing methods and reactive methods to adjust pricing based on changing costs or other market conditions are not optimal to secure the profitability over PLC. Focusing on the maturity and decline phases, it is most likely that the demand could be increased by compromising profitability, as competitors are likely to offer cheaper prices. On the other hand, for some spare parts profitability could be increased by increasing pricing as competitors exit the market, but customers still want service for their machines. However, this may eat into demand. Companies should set clear targets and define the optimal strategy to balance demand and profitability.

In conclusion, this study suggests that understanding and assessing spare parts PLC allows companies to develop more effective pricing strategies, namely life cycle pricing strategies. Life cycle pricing allows companies to guide pricing according to the market conditions in each PLC phase to optimize demand and profitability. Without life cycle pricing companies can price themselves out of the market, or on the other hand, miss the opportunity to charge a premium. Life cycle pricing can act as a proactive method to reduce inventory when needed. In spare parts, it is crucial to consider the category and type of the part to be able to implement life cycle pricing.

6.4 Recommended actions in the case company

The need for spare parts life cycle pricing has been identified in the case company. According to the results, the current life cycle pricing logic where price is increased towards the end is suitable for spare parts life cycle pricing in the case company. However, the current methods are not optimal in terms of overall demand and profitability during spare parts PLC. In this chapter, recommendations for future actions in the case company are made.

As mentioned, it is suggested that the case company further evaluates the accuracy of the PLC categorization as well as if the categorization meets the need of pricing. It is recommended that a more detailed analysis of the installed base and the machines' PLC is made to understand whether the current PLC categorization is in line with the illustration in Figure 24. In addition, the PLC categorization could benefit from a demand forecast element to better understand the demand that a single spare part faces allowing more informed pricing strategies. Regarding pricing, the first price adjustment based on PLC is now made roughly in the middle of the maturity phase, and second in the middle of the decline phase. This could be beneficial according to Bahrami and Yaghoubi's (2024) approach, where adjusting pricing earlier for the decline phase improved overall demand and profitability. However, the current method gives no opportunity to guide pricing for the introduction, growth, and maturity phases. Hence, it is recommended that the PLC categorization is further developed to allow full potential of life cycle pricing.

In addition, it is recommended that competitor and supplier behaviour during PLC should be further studied to better understand spare parts PLC. One of the topics that require more attention would be studying how the direct material costs develop during PLC, and what kind of suppliers possibly utilize life cycle pricing. The quantitative results initiate that the biggest increases in cost would happen around the maturity phase, but this can vary. The case company should be able to forecast the supplier behaviour to proactively avoid any losses related to uncertain costs towards the end of PLC. Cooperation with sourcing should be increased to learn how the suppliers behave over PLC and to ensure that all needed spare parts can be delivered over the machine's life cycle. On the other hand, sourcing may also have more information about the availability of spare parts in the market allowing effective competitor-based pricing. Competitor behaviour should be studied in each spare parts category to be able to define which spare parts have competition in the end of PLC. This way the case company could define for which spare parts the price can be increased towards the end of PLC. In addition, the case company should consider cooperation with demand planning as they could provide more detailed analyses of the future demand as well as inventory analyses to utilize in pricing.

Furthermore, the case company could benefit from customer behaviour and market analyses that would explain at which point of the machine's life cycle the case company loses sales.

As mentioned, the case company has already implemented some life cycle pricing methods, mainly as a reaction to surprising cost increases that the company has experienced. The life cycle pricing strategy should now be evaluated based on the framework presented earlier and implemented more widely. The recommended actions are summarized as an action plan in Figure 27.

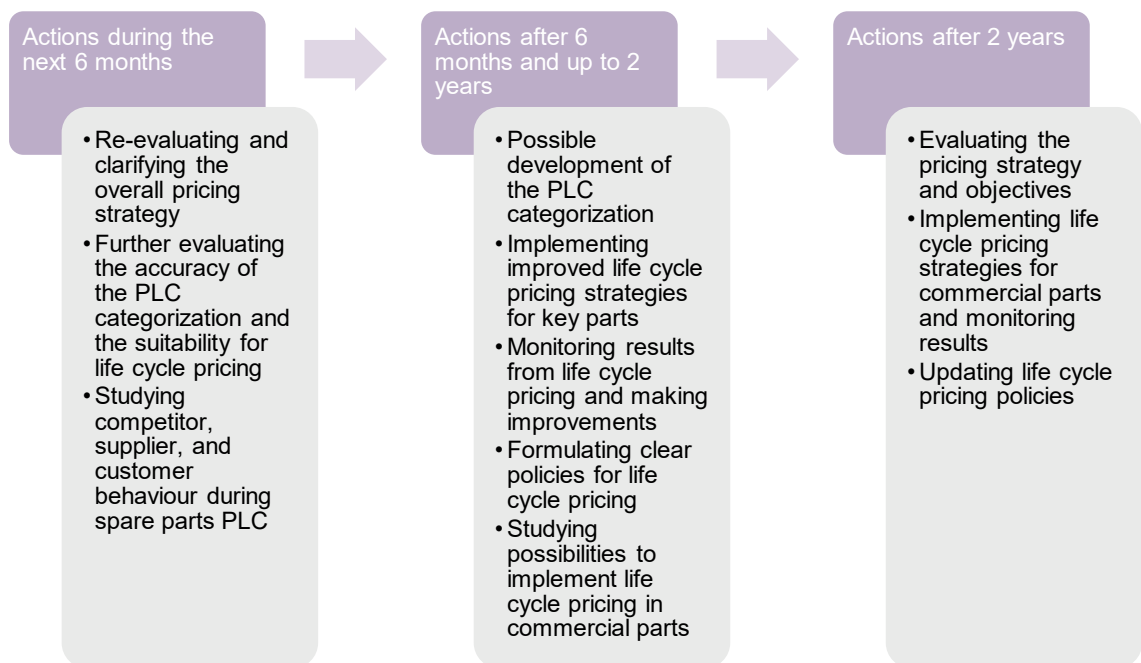


Figure 27. Recommended action plan

During the next 6 months, the case company should re-evaluate the PLC categorization and the overall pricing strategy. In addition, further studies on competitor, supplier, and customer behaviour during PLC should be made. Warranties of the machines should also be studied to estimate the number of machines under warranty in each PLC phase. This can also determine whether there is a need to implement life cycle pricing strategies in the very beginning of PLC.

After 6 months and up to 2 years, the case company should implement the possible developments to the PLC categorization. After that, it is recommended that the case company goes through the implementation framework and creates a suitable life cycle pricing strategy for key parts. Life cycle pricing should first be implemented to key parts as the life cycle pricing strategy was found the clearest and most likely the most beneficial for this category. After implementing the strategies for some spare parts, the results about profitability and demand should be evaluated. If the demand has remained and

profitability has improved, the strategies can be applied further. Clear policies should be created so that life cycle pricing is in line with the overall pricing strategy. During this period, the case company should also evaluate if they would like to further compete with price in the commercial items as the results indicate that the price level for these items may have to be lowered in the maturity and decline phases to stay in competition.

After 2 years, the case company should re-evaluate the life cycle pricing strategy and its objectives in the light of the situation at that time. Possible implementations for commercial items should be made. Life cycle pricing policies should further be clarified and updated accordingly.

7. CONCLUSIONS

This chapter examines the results of the thesis in terms of objectives and contribution to academic and managerial knowledge. First, reaching the research objectives is addressed. The second subchapter will discuss academic contribution. Third, managerial implications are presented. Fourth, limitations of the study will be discussed. Lastly, the fifth subchapter will consider the needs for future research.

7.1 Reaching the objectives

The objective of this research was to study PLC and life cycle pricing in heavy machinery spare parts, focusing especially on middle and end of PLC. The aim was to develop a comprehensive framework to use for implementing spare parts life cycle pricing. The need for the research emerged from the case company, where the need for spare parts life cycle pricing was identified, but there were no clear policies and lack of knowledge related to the topic. Next, the achievement of objectives is assessed one research question at a time.

The aim of the first research question was to search for methods that can be used to assess PLC of a spare part. This research question was answered by combining findings from different previous research with ideas collected from the qualitative studies. In addition, the case company's PLC categorization gave one example of the methods that can be used. The current literature suggests that spare parts PLC could be assessed by considering the spare parts category, maintenance strategy, and demand forecasts by either historical demand or installed base data. The empirical results also suggested considering the spare parts category as well as installed base data. The results were utilized in building the framework for implementing life cycle pricing. A comprehensive summary of the findings was conducted in chapter 6.1. One of the objectives raised by the case company was also to evaluate the case company's current PLC categorization. The results prove that the categorization should benefit from a demand forecast element as well as considering the category of the spare part. A more comprehensive analysis of the PLC categorization was also done in chapter 6.1.

The second research question and its sub-questions aimed to research how the PLC phase should affect the pricing strategy of a spare part. The first sub-question aimed to answer what factors affect the pricing of spare parts in different PLC phases. First, it was cleared out, which factors are the most prominent overall in spare parts pricing.

Combining results from literature and empirical studies, the most important factors in spare parts pricing are costs, competition, demand, customer value, spare parts category, customer relationship, and inventory value. Second, it was studied how these attributes behave during spare parts PLC. The behaviour of demand, costs, competition, and customer value were presented in chapter 6.2. The rest of the factors, that are spare parts category, customer relationship, and inventory value, were found more case-specific. Third, these factors were utilized in building the framework for the second research question.

The objective of the second sub-question was to clarify how life cycle pricing affects the demand and profitability of spare parts. The literature gave indication that life cycle pricing would allow higher overall demand and profitability. The empirical studies proved that the spare parts, for which the PLC was totally unknown, had lower profitability compared to the spare parts where pricing could be adjusted based on the PLC category. Combining results from the literature review and empirical analyses, understanding the PLC allows companies to better understand the market conditions in each PLC phase, and therefore enables more deliberate and effective pricing strategies. A summary of the results was presented at the end of chapter 6.3.

The framework was divided into two as one framework was needed to guide the implementation of spare parts life cycle pricing and another one was needed to guide the pricing strategies in each PLC phase. The implementation framework was built by combining different factors that should be considered in the implementation process. The framework suggests that the implementation process should start by understanding the current situation. Then, companies should set objectives for life cycle pricing and develop a method for assessing spare parts PLC phase. Next, pricing determinants should be assessed and their behaviour during PLC should be studied. After that, the life cycle pricing strategy and its practices can be created. The last step is to implement the strategy with a small group of spare parts first and follow-up by monitoring the objectives. The framework for life cycle pricing was built by considering the most prominent factors that affect pricing for key parts and commercial parts in each PLC phase. Based on these, the framework suggests a pricing strategy for each PLC phase. The results show that the price can be increased in the decline phase if there is little or no competition, but customers still have the need for the spare part. Both the frameworks were thoroughly presented in chapter 6.3.

7.2 Academic contribution

One of the objectives of this study was to fill a gap in research by combining the PLC concept with spare parts pricing forming the topic of spare parts life cycle pricing. Although the PLC concept has been a popular topic in research, the current literature only holds a few previous studies that suggest models for adapting the price over PLC. Moreover, no studies for spare parts life cycle pricing strategies were found. However, the need for life cycle pricing had been identified by Nnamdi (2018) as a proactive method to reduce spare parts inventory.

Van der Auweraer et al. (2019) presented a model for forecasting spare parts demand with installed base data. This research contributes to the study by combining its results with Nnamdi's (2018) and Jouni et al.'s (2011) findings that the spare parts category should be considered in forecasting PLC. In addition, spare parts PLC characteristics presented in this study complete the spare parts PLC concept. It was not previously studied what are the main pricing determinants for spare parts and how they behave during PLC. For example, the customer value of spare parts during PLC had not yet been studied. This is necessary knowledge as spare parts are known to have unique characteristics and relation to the primary equipment different to usual goods. This study contributes to current academic knowledge by providing the heavy machinery spare parts characteristics and a generalized framework that considers their behaviour in different PLC phases.

The frameworks presented in chapter 6.3 also bring up new academic knowledge. The implementation of spare parts life cycle pricing had not yet been studied. This framework builds on Shipley and Jobber's (2011) pricing wheel, while bringing it to a spare parts life cycle pricing context. The life cycle pricing framework is also considered unique as there is no previous research on life cycle pricing strategies for spare parts. The previous research on life cycle pricing has focused on mathematical models. The framework presented in this study is considered more practical and suitable for spare parts as it considers all the main pricing attributes in different PLC phases for commercial and key parts. The framework applies Rink's (2017) model in spare parts context.

The demand and profitability of spare parts under life cycle pricing had not yet been studied. Research shows that life cycle pricing allows overall higher demand and profitability (Asl-Najafi & Yaghoubi, 2021; Bahrami & Yaghoubi, 2024; Sun et al., 2024). The results show that this can also be applicable to spare parts. However, the demand for spare parts is limited by the population fleet. In addition, the results show that the

PLC concept enables forecasting, which helps to create more effective pricing strategies, which was also suggested by Rink (2017).

Exact numerical values could not be shown in this thesis due to confidentiality towards the case company. However, spare parts are often industry-specific (Nnamdi, 2018), meaning that the results should still be considered in each context separately. Therefore, this does not limit the contribution.

7.3 Managerial implications

This research provides multiple implications for spare parts business managers. It is believed that spare parts suppliers have a high interest in pricing as there is a possibility to gain high profits in the spare parts business. The study suggests that understanding the PLC allows companies to guide pricing more effectively generating higher profitability. Also, the study can help managers to understand the whole spare parts business and its challenges better. The frameworks provided in this study can be utilized as a guide for creating, implementing, and reviewing life cycle pricing strategies.

It is believed that this study is generalizable in other heavy machinery spare parts companies with certain adjustments and considerations for each context. The study is especially applicable in OEM businesses as the results show that life cycle pricing strategies are especially useful in OEMs' key parts. Based on the results, three suggestions are made for managers:

1. Switch from static pricing to life cycle pricing

This study suggests that managers should switch from static and reactive pricing to more proactive and data-based pricing strategies that consider the PLC. Research has proven that life cycle pricing strategies allow higher overall profitability and demand compared to strategies based on linear demand. Managers should understand that one price does not fit all phases of PLC as the market conditions vary. Therefore, different pricing strategies should be applied for each phase.

2. Understand the PLC

The study suggests that managers should first fully understand the spare parts PLC before applying life cycle pricing. Managers should consider what are the main characteristics in each PLC phase in their own business context. The spare part's relation to the machine's life cycle could be utilized as a basis. In addition, companies should understand how their customers, suppliers, and competitors behave throughout the PLC.

This study provides ideas for spare parts PLC assessment as well as PLC characteristics which enable managers to forecast the spare parts PLC. Understanding the PLC allows managers to apply more effective and justified pricing strategies. Data should be utilized to create accurate understanding, and spare parts category should be considered in the process.

3. Consider the practicalities

As said, spare parts suppliers can have large portfolios. Hence, managers should consider the practicalities related to PLC assessment and life cycle pricing. Managers should create a way to assess spare parts PLC effectively as the PLC assessment cannot be done manually for each spare part. The pricing strategies should be easy to manage. In addition, there should be clear policies and owners for life cycle pricing.

7.4 Limitations of the study

There are limitations that should be considered when examining the findings in this study. This research was conducted as a case study, and it is placed in a specific context making it highly case specific. All the interviewees were internal employees of the case company, which can cause subjective perspective and bias on the topic. The risk was minimized by aiming for an objective outlook when interpreting the results. Also, the empirical results were combined with literature, which improves applicability. It is believed that the findings can be utilized in other similar heavy machinery spare parts businesses. However, the context can vary widely, for example regarding competition and customer base on the market. Hence, there are limits to where the results can be used and the examiner should consider the context in relation to this study.

Some limitations related to the literature review were found. Most of the pricing related research was not based in spare parts context. Moreover, some studies were from B2C (business-to-consumer) context rather than B2B which was the focus on this study. This means that some of the results from B2C context have limited generalizability in B2B spare parts business. However, the risk was minimized by observing the results from spare parts context and further studying the topics in the empirical parts.

Semi-structured interviews were used in this study as a qualitative data collection method. Semi-structured interviews can limit the generalizability when there is only a small sample (Saunders et al., 2019, p. 447). As there were only 8 interviewees from the corporation and 4 interviewees from the subsidiaries this might limit the generalizability in other contexts. However, interviewees were chosen from different departments and backgrounds to increase variety in the interviewee group. Another limitation related to

the interview data is that few of the interviewees had experience or knowledge about pricing why the pricing related answers had to be interpreted carefully. In addition, it is necessary to note that the findings related to competitor, supplier, and customer behaviour during PLC were mostly conducted from the interviews and therefore might have limited generalizability. However, literature was used to support arguments where applicable.

The frameworks presented in this study have not yet been tested in practice why their viability and generalizability are yet to be proven. The frameworks were conducted based on the existing theory and empirical results. However, as there is a very limited amount of research considering spare parts PLC and life cycle pricing, it was not possible to compare the results to existing knowledge. The idea is to test the viability of the findings in the case company after finishing the thesis.

7.5 Implications for future research

This study leaves many implications for future research. As this study has limited generalizability, more research on spare parts PLC and life cycle pricing should be done in various contexts. It is recommended that future research concerns further and more detailed analysis on spare parts PLC assessment, PLC characteristics, and the viability of different life cycle pricing strategies in different contexts. Regarding PLC assessment, it is believed that the most accurate and convenient way to assess spare parts PLC is through installed base data. However, further studies are needed to define the best methods. In addition, it is implied that further research on life cycle pricing in the B2B environment is needed as the current research is mostly considering the B2C context.

As it was already stated, further research is needed on supplier and competitor behaviour during PLC. In this study, the results on these topics are mostly based on interview data or literature from other than spare parts context. Hence, there is an opportunity to further study the spare parts PLC on supplier and competitor behaviour. In addition, it could also be further studied how the cooperation with suppliers can help to forecast PLC. Further studies would allow more informed pricing decisions and spare parts management. In addition, spare parts demand and profitability should be further studied in different PLC phases. The methods used in this study did not allow to study the different phases, but only to consider overall demand and profitability.

This study was conducted as a cross-sectional study as there was limited time to conduct the thesis. Future research could be conducted as a longitudinal study to examine the long-term effects of different life cycle pricing strategies in spare parts. This kind of study

would clarify which strategies enable best profitability and demand. In addition, longitudinal study could examine a certain group of spare parts throughout their PLC which could produce further knowledge of the spare parts PLC characteristics.

As mentioned, the viability of the frameworks has not been tested in practice. Hence, future studies could focus on testing them in different contexts to see if they are applicable. Another interesting topic for future research could be the use of AI in life cycle pricing. AI could help to forecast PLC characteristics by gathering information about competitors or customers. The future research could also consider if the use of AI in pricing would allow more informed and effective pricing strategies during PLC.

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APPENDIX A. INTERVIEW QUESTIONS / PRICING

Background questions

1. Is it okay if I record and transcribe this interview?
2. Could you please tell me who you are and how your job is related to spare parts life cycle pricing?

Life cycle pricing

3. Could you please describe what the objectives are for spare parts life cycle pricing in your opinion?
4. What are the main drivers that are used to set the prices for spare parts currently?
 - a. How do you think these drivers behave during PLC?
5. How are fixed costs considered in spare parts pricing?
6. How often is a spare part's price adjusted?
7. What are the margin targets for each spare parts category?
8. How is spare parts PLC considered in pricing currently?
9. How does the profitability of spare parts change during PLC?
10. What factors should be considered in spare parts life cycle pricing?
11. What do you see as the challenges in implementing life cycle pricing for spare parts?
12. How do you see our competitive position throughout the PLC?
13. How do you think competitors handle life cycle pricing of spare parts?
14. Why do you think that realised margin might go down as the item ages?
15. Why do you think that realised margin is lower for A5 items and for items that the age is not known?
16. Are there some margin targets for the PLC categories?
17. Is there some feedback from the markets related to life cycle pricing of spare parts?

Outlet items

18. What criteria are used to select the outlet items?

19. How much is the price reduced on average?
20. How has the outlet affected sales and customer behaviour?
 - a. Additional question: Has sales increased?
21. Are there some spare parts categories that end up in the outlet more often than others?
22. Could life cycle pricing be utilized for outlet items?

Lastly

23. Is there anything else you would like to add considering life cycle pricing of spare parts?

APPENDIX B. INTERVIEW QUESTIONS / SOURCING

Background questions

1. Is it okay if I record and transcribe this interview?
2. Could you please tell me who you are and what does your team do?
3. What kind of opportunities and challenges do you see in spare parts business?
4. How is your job related to spare parts life cycle pricing?

Sourcing

5. Could you briefly describe the sourcing process?
6. How often is purchase data typically updated?
7. Until which point of the machine's life cycle are spare parts acquired?
8. Are you able to recognize any trends related to sourcing that appear during spare parts PLC (e.g. changes in cost or availability)?
9. How does supplier bargaining power change towards the end of PLC?
10. Are you familiar with the PLC categorization?
 - a. Do you utilize the PLC category data in sourcing activities? How?
 - b. Do you think the PLC categorization is suitable for your needs?
 - c. How do you deal with items where the PLC category is not known?
11. Are there additional risks related to sourcing end-of-life spare parts?
12. How do relationships with suppliers affect our ability to source end-of-life spare parts?
13. Do suppliers give us visibility in their own PLC (to inform when a spare part might become unavailable)?
14. In which cases it is decided that a spare part will no longer be purchased?
15. Do suppliers discontinue critical spare parts before we do? What happens then?
16. Do we source end-of-life spare parts even if it is unprofitable?

Life cycle pricing

17. What would you think the objectives should be for spare parts life cycle pricing?
18. How do you think PLC should affect pricing?
19. Why do you think that margin might go down as the item ages?
20. Why do you think that margin is lower for A5 items and for items that the age is not known?

Additional questions (if enough time)

21. What are the factors that create the most value for the customer in our spare parts business?
 - a. How do you think the customer value of a spare part changes as the machine gets older?

Lastly

22. Is there anything else you would like to add considering life cycle pricing of spare parts?

APPENDIX C. INTERVIEW QUESTIONS / PARTS PRODUCT MANAGEMENT

Background questions

1. Is it okay if I record and transcribe this interview?
2. Could you please tell me who you are and what does your team do?
3. What kind of opportunities and challenges do you see in spare parts business?
4. How is your job related to spare parts life cycle pricing?

Master data management

5. What does the PLC categorization mean? What are the different categories?
6. Where is the PLC category data utilized?
7. How much resources does the PLC categorization and its management require at the moment?
8. How accurately do you think our PLC categories describe the actual PLC of spare parts?
9. Are there other options to assess a spare part's PLC phase?
10. There are items that are categorized as unknown age and items that do not have a PLC category. What kind of items fall into these categories?
 - a. Are there some items for which the PLC category cannot be determined?
11. Is the goal to have PLC categorization for all items?
12. Do you think the PLC categorization is suitable for the need of master data and life cycle management?

PLC of spare parts and the equipment

13. How long is the equipment's useful life?
14. How long is the equipment's PLC (how long is one model sold for from launching)?
15. Until which point of the equipment's life cycle are spare parts offered?
16. How long is the PLC of spare parts generally (how long are spare parts sold for from launching)?

a. Does this vary between different spare parts?

17. How often are new equipment models launched?

a. How much of the spare parts remain the same in the next models?

18. What do you think are the factors that create the most value for the customer in our spare parts business?

a. How do you think the customer value of a spare part changes as the machine gets older?

19. At what point do customers stop maintaining the old equipment and decide to replace the equipment?

Life cycle pricing

20. What would you think the objectives should be for spare parts life cycle pricing?

21. How do you think PLC should affect pricing?

22. Why do you think that margin might go down as the item ages?

23. Why do you think that margin is lower for A5 items and for items that the age is not known?

Additional questions (if enough time)

24. What kind of maintenance strategies do customers have?

a. How does it affect the buying behaviour?

Lastly

25. Is there anything else you would like to add considering life cycle pricing of spare parts?

APPENDIX D. INTERVIEW QUESTIONS / DEMAND PLANNING

Background questions

1. Is it okay if I record and transcribe this interview?
2. Could you please tell me who you are and what does the demand planning team do?
3. What kind of opportunities and challenges do you see in spare parts business?
4. How is your job related to spare parts life cycle pricing?

Demand Planning

5. Could you briefly describe the demand planning process?
6. How far ahead is the demand forecast planned?
7. What kind of demand patterns are identified for spare parts?
8. How often is a demand forecast typically updated?
9. How do you consider the PLC phase of a spare part in demand planning?
10. Are you familiar with the PLC categorization?
 - a. Do you utilize PLC category data in demand planning activities? How?
 - b. Do you think the PLC categorization is suitable for the needs of demand planning? Why so?
 - c. How accurate are the demand forecasts for different PLC categories?
 - d. Do you think that our PLC categorization can be used to assess the PLC phase of a spare part? Why so?
11. How do you decide which spare parts should be kept in stock and which not?
12. How does demand planning differ for early-, mid- and end-of-life spare parts?
 - a. What challenges do you see in planning the demand for end-of-life spare parts?
13. How do you recognize when a part is reaching end-of-life from a demand planning perspective?
14. How do you balance demand planning with inventory management?

15. Do you collaborate with suppliers in demand planning? How?
16. Are there some spare parts that are harder to forecast than others? What spare parts?
17. How do you handle demand planning for spare parts with very low but critical demand?

Life cycle pricing

18. How do you see price affecting demand in the spare parts business?
19. What would you think the objectives should be for spare parts life cycle pricing?
20. How do you think PLC should affect pricing?
21. Why do you think that margin might go down as the item ages?
22. Why do you think that margin is lower for A5 items and for items that the age is not known?

Lastly

23. Is there anything else you would like to add considering life cycle pricing of spare parts?

APPENDIX E. INTERVIEW QUESTIONS / SUBSIDIARIES

Background questions

1. Is it okay if I record and transcribe this interview?
2. Could you please tell me who you are and what you do?
3. What kind of opportunities and challenges do you see in spare parts business?

Main questions

4. What do you think are the most important factors when a customer is choosing their spare parts supplier?
5. What kind of maintenance strategies do customers have?
 - a. How does it affect the buying behaviour for spare parts?
6. What do you think are the factors that create the most value for the customer in our spare parts business?
7. How do customer expectations change when the equipment gets older?
8. How do customers perceive our spare parts pricing?
 - a. What kind of feedback do you receive from customers regarding our pricing of older spare parts?
9. Do you think that it is important that we can offer end-of-life spare parts that are expensive or hard to acquire? Why so?
10. What do you think about our availability of older spare parts?
 - a. What kind of feedback do you receive from customers regarding the availability of older spare parts?
11. How do you see our competitive position in spare parts throughout the PLC?
12. Do you think customers perceive original [case company] spare parts as more valuable than alternatives?
 - a. How does this change when the machine gets older?
13. Do you think customers understand why prices change during PLC?

14. At what point do customers stop maintaining the old equipment and decide to replace the equipment?

Life cycle pricing

15. What would you think the objectives should be for spare parts life cycle pricing?
16. How do you think PLC should affect pricing?
17. Why do you think that margin might go down as the item ages?

Lastly

18. Is there anything else you would like to add considering life cycle pricing of spare parts?

APPENDIX F. THREE HIGHEST LEVELS OF THE CODING

Theme or code	References
Current state	64
Case company strengths	10
service for all the ages of the machines	8
strong webstore	1
can supply all necessary spare parts	1
Case company challenges	42
complex portfolio	13
availability	8
key parts	16
other challenges	5
Current state of pricing	5
factors and principles affecting pricing	5
Current state of life cycle pricing	7
reactive approach	2
lack of knowledge	1
current life cycle pricing methods	4
Objectives	25
General business objectives	18
commitment to support spare parts for Y years	9
capture rate	5
other objectives	4
Life cycle pricing objectives	7
healthy margins	2
improving competitiveness with old machines	2
ensuring profitability of end-of-life spare parts	2
clear strategy	1
Spare parts business characteristics	28
General characteristics of the market	7
profitability	2
legal requirements to support spare parts	2
demand is based on need	2
demand shifting to electric equipment	1
Competition	16
various competitors	11

hard to differentiate	5
<u>General challenges in the market</u>	5
long lead times	3
other challenges	2
<u>Understanding customer value and behaviour</u>	109
<u>Customer value</u>	45
availability of spare parts	11
data / web store related factors	10
quality related factors	10
customer service related factors	5
uptime of the fleet	4
other factors	5
<u>Customer relationships & maintenance strategies</u>	10
different types of customer relationships	6
planned maintenance	2
breakdown maintenance	2
<u>Customer behaviour in spare parts business</u>	22
price in choosing a spare parts supplier	12
other factors	10
<u>Customer behaviour through the life cycle of the machine</u>	32
attitude towards price	21
differences between types of customers	4
customers expect service until the end of life cycle	4
other factors that affect buying behaviour	3
<u>Spare parts PLC</u>	106
<u>Assessing spare parts PLC</u>	10
PLC categorization data	8
other possibilities	2
<u>Uses of the PLC categorization in the case company</u>	9
demand planning	5
prioritisation	4
<u>Challenges related to the PLC categorization</u>	11
lack of data	8
other challenges	3
<u>Life cycle of the machinery</u>	19
useful life of the machinery	12
optimal window to sell spare parts	5
PLC of the machinery	2
<u>Spare parts PLC characteristics</u>	57
development of cost	12

development of competition	3
other characteristics	2
demand planning through PLC	15
sourcing through PLC	25
<u>Life cycle pricing</u>	<u>65</u>
<u>General pricing strategies</u>	<u>34</u>
pricing based on competition	14
pricing based on category	13
other strategies	7
<u>Life cycle pricing strategies</u>	<u>31</u>
codes related to beginning of PLC	2
codes related to middle of PLC	2
codes related to end of PLC	18
spare parts category should be considered	4
other codes related to life cycle pricing	5