SCHOOL OF ECONOMICS AND MANAGEMENT

Adopting additional product-life extension strategies

- A study of reuse and remanufacturing in the maritime industry

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Abstract

The purpose of this paper is to investigate the potential barriers of adopting additional product-life extension strategies and therefore increase the understanding of this phenomenon. Just as the name implies, product-life extension entails keeping resources in use for as long as possible in order to extract maximum value from them. Specifically, the strategies investigated in this research are reuse and remanufacturing, regarded by the circular economy community as more value-capturing activities than other more widespread and for long preferred strategies such as recycling.

Inquiry is made into the under-researched empirical context of the maritime industry, as existing studies are focusing more on other capital-intensive industries. This research employs a qualitative approach to ascertain the opinions of maritime industry experts identified in managing directors and technical managers across five industrial stakeholder groups by means of interviews and questionnaires. The paper at hand makes enquiries into substantive and formal theories, as theoretical inferences are drawn from well-received product-life extension literature, established strategic renewal and inertia literature, as well as stakeholder theory, culminating into a framework outlining potential barriers that serves as the guiding element for the empirical data collection.

The main findings of this research point towards three main barriers that prohibits the industry from adopting additional product-life extension strategies; (1) reliance on the utilization and continuous optimization of current strategies i.e. recycling (2) absence of policy and regulation that promotes reuse and remanufacturing, and (3) stakeholder misalignment in articulating the potential that adopting additional PLE strategies hold. The study furthers understanding of the industrial stakeholder influence to be dispersed however paramount in leveraging existing resources and competencies to overcome the barriers in adopting additional product-life extension strategies such as reuse and remanufacturing.

Keywords: *product-life extension, circular economy, repair, reuse, remanufacturing, recycling, maritime*

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List of Abbreviations

PLE Product life-extension
CE Circular economy
OEM Original equipment manufacturers
B2B Business-to-business
B2C Business-to-consumer

1 Introduction

This chapter serves as brief account of the overarching topic of the thesis, including the problem formulation, the corresponding purpose, the overarching research question and the objectives to guide the research.

1.1 Background

In the current business landscape, recycling is regarded as the most widely implemented and globally accepted end-of-life management strategy (Cooper, 2016). The key motives for the utilization of recycling practices in regard to products and materials center around the instrumental claim for cost-efficiency and resource preservation. From an economical aspect, previous literature has highlighted the cost of recycled materials to be generally lower than those of virgin materials (Bringezu, 2002). This, in turn, has led to recycling becoming a mandatory practice in major parts of the world economy, especially evident in European countries (European Commission, 2008).

In line with recent developments, several product-life extension strategies (henceforth referred to as PLE strategies) have surfaced as appealing alternatives to conventional recycling. These strategies have particularly been pinpointed to be effective in B2B industries, where high-value equipment is required (Lacy & Rutquist, 2015). The instrumental claim for cost-efficiency in relation to these PLE strategies has attracted considerable attention across a broad spectrum of capital-intensive industries such as automotive, aviation and heavy equipment in terms of business (Shafiee & Animah, 2017), policy-making (European Commission, 2018) and academia (Bocken et al., 2016). The decision to extend product-life is motivated by the benefits to be achieved from continuing the operation of assets beyond original design life. The prolongation of the life of industrial assets is ought to provide significant added-value benefits to assets owners, asset managers, service providers and public policy-makers, environment protection authorities and regulatory bodies, etc. (Seitz, 2007). Products and components are traditionally designed for a specific life span and when the end of their useful life approaches, stakeholders must decide whether to extend the operating life of existing components or to decommission and replace them with new ones (Shafiee & Animah, 2017). However, in such decision-making, many organizations are not aware of the considerations and challenges associated with PLE strategies that provide more value-capturing opportunities.

1.2 Research problem

Recycling is argued to illustrate the least value-capturing activity among PLE strategies, although attracting significant attention in previous research (Stahel, 2014). As recycling only retains value of materials, the properties of products and components is argued to be minimal (Braungart & McDonough, 2009). Linton and Jayaravan (2005) highlight the over-emphasis on recycling to exhibit a misrepresentation of how much value that can be extracted from a single PLE strategy. Previous research credits legislation for this matter, as recycling for long has been preferred as a strategy that provides organizations with a simple procedure in order to adhere with environmental compliance (Folz, 1999; Honeywill; 2002, Tiemstra; 2002 as cited in Linton & Jayaravan, 2005). However, recycling might not yield the optimal benefits in relation to the instrumental claim for cost-efficiency, as previous literature highlights additional value-capturing PLE strategies (Linton & Jayaravan, 2005).

Value-capturing activities more effective than recycling are argued to be repair, reuse and remanufacturing, as presented by circular economy advocates (MacArthur, 2013; Stahel, 2014). A circular economy (CE) is defined as an economic system whereby resource input and output are minimized by slowing, closing and narrowing energy and material loops. It aims to redefine product and services and is achieved by long-lasting design and product-life extension strategies. In order to move beyond the dependency on recycling, Goyal et al. (2016) point out the significance of optimizing the gains from other PLE strategies. This notion is later also argued by Sousa-Zomer et al. (2017), who state that in order to maximize the value-capturing potential of PLE strategies, research might consider the viability of combining several PLE strategies instead of relying on one strategy. Truttmann and Rechberger (2006) especially argues for reuse to be coupled with remanufacturing in order to provide operational and financial viability. However, with commonalities and differences between them, the alternative PLE strategies require certain resources, infrastructure, skills and competencies, which potentially might pose a diverse set of barriers of adoption in the case of these factors being absent. On the other hand, alternative strategies of product-life extension might also allow organizations to leverage existing resources and competencies. As argued by Linton and Jayaravan (2005), pursuing such strategies might require less investment or business development than anticipated, however, the navigation could entail a dependency on specific resource requirements and managerial competencies, proposing a

prospect to be researched. In order to interpret such circumstances and confer input into this area, strategic renewal and inertia literature could be helpful in order to identify common elements that either make or break organizations on the verge of adopting new ventures that deviate from current strategies. Following this line of thought, these theoretical inferences could be insightful when illuminating related strategic implications of resource requirements and management competencies in pursuing the adoption of additional PLE strategies.

In addition to this, Diallo et al. (2017) argue that further research efforts are needed in exploring the linkages among industrial stakeholders, which might problematize the adoption of additional PLE strategies. Organizations or whole industries might have varying perceptions regarding the potential barriers in adopting additional PLE strategies (Linton & Jayaraman, 2005). In this light, there is scarce empirical evidence in assessing the stakeholder influence in adopting additional PLE strategies in an industry-wide context. Zhu et al. (2010) argues that the needs of stakeholders and the collaboration between internal and external partners with supply chain members to properly adopt circular economy practice, is a broader perspective on what remains a gap to be addressed. This is deemed to be a necessity for academic research rather than tools and best practices to circular economy, which long have received attention in form of single-case studies (Zhu et al., 2010). Pan et al. (2015) echo this notion, stating that the preconditions for an industry must be made more explicit in order to understand the implications for a circular economy transition. As such, in line with Freeman and McVea (2001), this research takes a pragmatic approach in terms of stakeholder theory, as it is deemed a fruitful apparatus to address the research gaps identified for this study, pointing out the industry-wide implications for product-life extension in a circular economy.

Existing literature has focused on PLE strategies in industries such as textile, electronics and transport, amongst others (Fischer & Pascucci, 2017; Whalen et al., 2017; Subramoniam et al., 2009). Within the domain of transport, it is automotive and aviation that have received considerable attention in PLE research. However, a similar capital-intensive industry, maritime, has been neglected by this stream of research, argued to be an interesting prospect of exploring additional PLE strategies (Jansson, 2016; Shaffie & Animah, 2017). The context of maritime is in harmony with the aforementioned argument by Lacy and Rutqvist (2015), who argue that B2B

industries where high-value equipment is required hold most potential for adopting product-life extension. Furthermore, recycling is the dominant and most preferred PLE strategy in maritime, which has been executed since vessels were built out of wood (Jansson, 2016). In this light, maritime could provide an insightful context to understand the potential barriers industries face when evaluating the potential of additional PLE strategies.

1.3 Research purpose

Linked to the research problematization, the purpose of the paper at hand is to increase the understanding of potential barriers in adopting additional PLE strategies. Unambiguously, the overarching research question is formulated as:

RQ: *What are the barriers affecting the adoption of additional product-life extension strategies?*

Specifically, this paper investigates the conditions under which entities are inclined to adopt additional PLE strategies, as well as the related resource requirements and managerial competencies necessary for such line of action. Furthermore, an important empirical contribution is identified in examining the barriers and opportunities experienced by stakeholders in an industry-wide context, namely maritime. Thus, the following research objectives are deemed to facilitate the achievement of the above-mentioned purpose and overarching research question:

1. *Identify and analyze the potential resource requirements and gaps to adopt reuse and remanufacturing in addition to recycling,*

2. *Identify the managerial competencies necessary to facilitate the adoption of reuse and remanufacturing in addition to recycling,*

3. *Investigate the influence of different stakeholders in the process of adopting reuse and remanufacturing in addition to recycling.*

1.4 Delimitations

As the focus is on the merchant maritime, characterized as a business-to-business industry, the inherent global business operations cannot be limited to a regional or country-specific compartment. Thus, although the sample utilized Swedish and Danish companies, this was deemed to be an appropriate representation of the global population of maritime. As such, entities outside this geographical region have not been pursued for contact. Moreover, the unit of analysis is based on stakeholders in the form of business entities with a higher levels of decision power, and how these influence the industry dynamics. Thus, the relations and processes among internal stakeholders (e.g. employees) are therefore not subject to this research. Further, recreational boats are acknowledged as an interesting aspect of the maritime industry. However, this industry is out of the scope of this report which focuses on commercial vessels, which consists of the largest amount of asset value in the maritime industry. The global fleet of vessels are made up of a range of categories such as container, oil and bulk vessels which comes in different sizes. However, this thesis will not make a distinction between these different categories owing to the strategic and less technical focus of the research. Henceforth, vessel is used as an encompassing term.

1.5 Disposition of paper

In line with the American Psychological Association (2009) guidelines for the structure of a research paper, the disposition of the ensuing sections is summarized in figure 1.

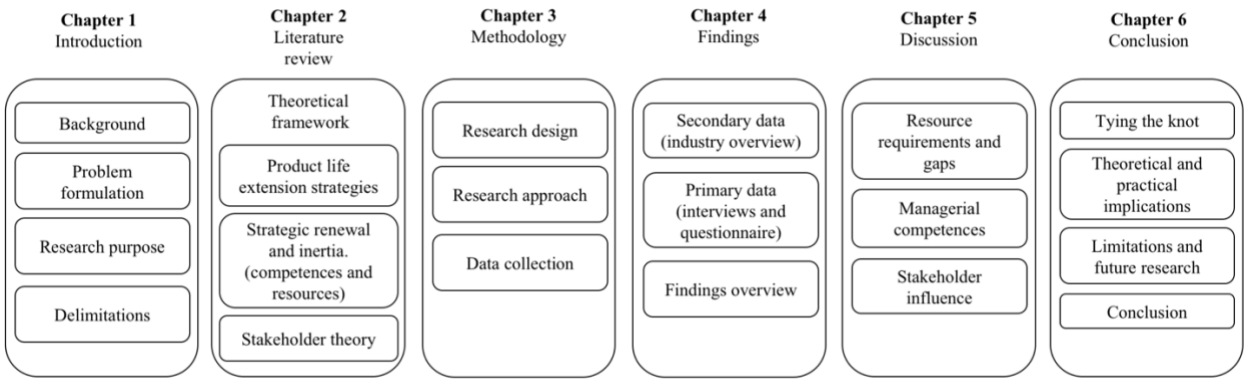

Figure 1 – *Disposition of paper overview.*

2 Literature review

This chapter provides a careful review of both substantive and formal theories in order to grasp the theoretical developments and recent academic contributions in the interest of the research topic. The literature is critically reviewed in order to identify areas of contribution. Lastly, a theoretical framework based on the literature review is presented to aid the research.

2.1 Product-life extension in a circular economy

Numerous authors have recently suggested the need for new economic models whereby material inputs and waste generation can be minimized (Lovins et al., 2013; Tukker, 2015; Ghisellini et al., 2016; Geissdoerfer, 2017; Murray et al., 2017). In a series of subtle arguments, Lovins et al. (2013) indicate that the reason for this suggestion is that the presiding linear economic model, which industry has squeezed a significant amount of efficiency out of over the past hundred years yet contains a seemingly large amount of waste. The authors view the linear economic model as complicated due to its propensity to destroy nearly all of the value that is inherent in products during the inceptive period of their life time (Lovins et al., 2013). Product life time, as Van Nes and Cramer (2016) point out, can be regarded to start at the moment of acquisition and end when the product either is disposed or replaced by another product that covers the particular application of the preceding product. However, as most products according to Lovins et al. (2013) are either disposed to landfills or incinerated at the end of life, the authors highlight circular models to be a viable option for value capture. Circular models' intent is to produce no waste or pollution by means of practices aiming to keep products, components and materials at their highest utility and value (Lovins et al., 2013). Accordingly, Webster (2017) fittingly complements this discussion by stating that circular models answer a simple fundamental question, namely how more economic value, that usually is lost in the traditional linear system, can be retained and recaptured.

As a leading author in the field of product-life extension, Stahel (1994) points out that extending the duration of product lifetime is a crucial component in circular models. Just as the name implies, product-life extension entails keeping resources in use for as long as possible in order to extract maximum value from them, ultimately considering recovery and regeneration of products and materials at the end of each service life (Stahel, 2013; MacArthur, 2013). However, the term "product-life extension", as it seems, is not properly defined in articles published in academic

journals, with multiple scholars referring to slightly different definitions. To compensate for this shortcoming, a recent publication entitled "Longer lasting products: alternatives to the throwaway society" by Cooper (2016) contributes with a revitalized definition of product-life extension. Accordingly, product life extension is defined as "attempts to lengthen product life-spans, whether by improving intrinsic durability, influencing user behavior or promoting wider socio-cultural change" (Cooper, 2016, p.8). In a circular economic context, Stahel (2013) as well as Hopkinson and Spicer (2013) share the idea that product-life extension translates into maximizing the number of consecutive product and component cycles in terms of repair, reuse and remanufacturing, differentiating product-life extension from less value-capturing activities such as recycling or other standard approaches to resource efficiency. As Stahel (2014) later accentuates, however, it seems to be necessary for industry to employ PLE strategies to seize long term resource and cost benefits. Ultimately, according to Planing (2015), product-life extension is ought to provide value-capturing opportunities for businesses, customers and the economy at large compared to linear product and material flows. However, perceptions around product-life extension vary, which the ensuing section addresses.

2.1.1 Equivocal perceptions on product-life extension

Numerous authors have recently suggested that there exists a perceived reluctance of adopting product-life extension. According to Stahel (2010), product-life extension is perceived to negatively affect growth in production and sales volume, as planned obsolescence (designing a product with an artificially limited lifespan) allows for a quick return on investments. Thus, as the author points out, product-life extension can be viewed as an obstacle to mass consumption, which the industrialized world benefits of as apparent in recurrent profits. Ultimately, critics point to the possibility for product-life extension strategies to induce cannibalization of new sales. Mont (2008) further adds that the reluctance to adopting product-life extension lies in the general perception of such activities to discourage the development of new technologies. Early research by Fishman et al. (1993) emphasized short lifespans of products to drive technological advancement and thus prove to be advantageous for industrial development. Nonetheless, Heiskanen (1996) and recently Mont (2008) and Bocken et al. (2016) contradict this assumption, as such a perspective on product-life extension might inadvertently misguide theory and practice. These scholars share the idea that substituting products only compromises on long-term resource- and energy-efficiency, as

innovation tends to continue irrespective of planned obsolescence. Additional scholarship mentions other factors that have led to the reluctant impression on product-life extension, such as time-effectiveness of PLE activities (Parida & Kumar, 2006) and cost-effectiveness evaluated in cost of components replaced and cost of labor (Barbiroli, 2008). This is connected to the notion that capabilities, in terms of equipment, experience and technical skills imperative to product-life extension strategies differ from those apparent in traditional manufacturing. Therefore, as Stahel (2010) rightly points out, it seems to be necessary to look at new procedures when adopting product-life extension in order to maintain steady revenue streams. Stahel (1998) suggested that selling the function of products might assist companies in exploiting the opportunity for earning higher profits. This has developed in a prominent stream of research denoted "product-service systems" (Mont, 2001; 2002; Tukker, 2004; Baines et al., 2007; Piscicelli et al., 2015), making product life-extension an interesting prospect for the business world of the 21st century.

2.1.2 Preconditions for product-life extension

Previous research highlights product-life extension to require strategic management preparedness as its feasibility is dependent on several circumstances. As product-life extension considers prolonged utilization of a product beyond the point of sale, according to Stahel (1997), a key concern for companies is to find ways to connect revenue generation to longevity instead of volume. For this, prices need to be substantially low enough to drive sales of such products whilst simultaneously being profitable. However, as previous literature indicates, there might be challenges with such a position. Van Nes and Cramer (2006) note that the adoption of product-life extension must be pursued as a proactive endeavor in altering customer behavior. The authors rightly conclude that normalizing modified procurement patterns remain vital if product-life extension is ought to become commonplace. Aligning himself with this line of reasoning, Stahel (2013) points out a focus on consumer dialogue to denote a favorable point of departure. The author makes a modest claim in stating that customers should be persuaded as product owners rather than consumers. This approach, argued by Stahel (2013), provides the opportunity to encourage customers to repair products rather than inflicting significant disbursements associated with new product acquisitions.

Lacy and Rutqvist (2015) contribute to this discussion by stating that customers need additional incentives to engage with suppliers throughout the lifecycle of specific products, such as that repairs can be performed cost-efficiently through a service or partner network (Lacy & Rutquist, 2015). Conducive to enabling such plan of action, products need to be optimized for a cycle of disassembly and reuse, although not necessarily in their original form or product cycle (Lacy & Rutquist, 2015). In order to further seize opportunities for longer product utilization, Niinimäki and Hassi (2011) complement the preceding literature by stating that products and components should not compromise on quality. Adjacent product characteristics as durability and functionality are highly valued, as more intense use of products and components provides significant potential to decouple from dependency on constrained resources (Niinimäki & Hassi, 2011).

These arguments around product-life extension give an indication of the preconditions necessary to pursue enabling strategies, which within business are quite often overlooked. To facilitate product-life extension, reiterating the arguments presented by Cooper (2016), rapid replacement cycles are avoided, and products are developed to endure, using components which can be repaired, reused, remanufactured and resold. These strategies, referred henceforth PLE strategies, are reviewed more rigorously in the ensuing section in order to investigate and juxtapose scholarly contribution to the opportunities and barriers with pursuing such strategies for value capture.

2.2 Strategizing for product-life extension

Product-life extension has yet to attract significant research interest within strategic management. Other disciplines, however, especially those within production and operations research, have made attempts to explore critical success factors of longer lasting products in varying context. Drawing parallels to these disciplines aids to grasp the fundamental elements of product-life extension that might be needed for further research in strategic management.

Focusing on value-capturing activities aiming to prolong the profitable life of a product, as Stahel (2013) points out, is imperative to facilitate a PLE strategy. As it stands, this assumption is well-supported by other research, as Lovins et al. (2013) state that service loops aiming to extend the life of a product ensure economic usefulness and increased utility. Other scholarship complements this assertion by providing examples of activities that maximize the number of consecutive cycles

intended to prolong a products life (McDonough & Braungart, 2010; MacArthur, 2013; Lovins et al., 2013; Stahel, 2014). The most significant activities in terms of value-capture are here introduced as the four Rs of product-life extension and include repair, reuse, remanufacturing (including technological updating) and recycling. In simple terms, according to these scholars, small loop activities should be prioritized according to their efficiency and value-capturing ability, as illustrated below:

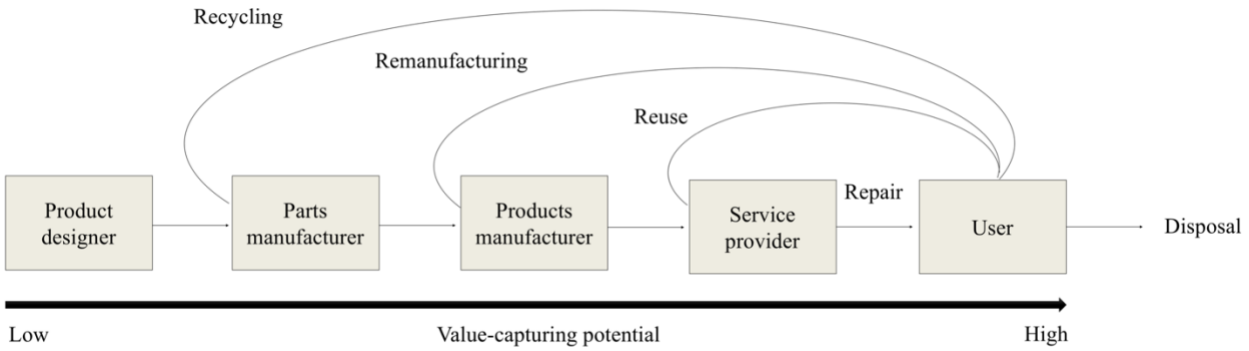

Figure 2 – *Product-life extension strategies (authors' own illustration).*

As illustrated in figure 2, the tighter the circle of activity is, the less a product has to undergo change. In the same light, the faster a product returns to use, the greater the profitability of the activity performed (Lovins et al., 2013). Such a broad-sweeping generalization among these publications might however cloud the inherent challenges in pursuing such strategies. Apart from the customer encouragement mentioned earlier, where the customer repairs, reuses or remanufactured the product in question instead of discarding it, the potential of PLE strategies depends on providers' ability to perform such activities with a confidently high level of quality, as argued by Mont (2008). Nonetheless, the former contributions are proven to be timely and especially significant to recent European legislative proposals, such as the circular economy action plan adopted in 2018[1], among which product-life extension has been highlighted as an important frontier to pursue. As argued by Linder and Williander (2017), exploiting these activities could incentivize the private sector to unearth potential business opportunities while simultaneously reducing the dependence on strategic materials. In order to realize this potential however, according to Stahel (2013), two integral elements are highlighted in activities for product life

[1] The Circular Economy Strategy is part of the continuous efforts to transform Europe's economy into a sustainable one, retreived from http://ec.europa.eu/environment/circular-economy/index_en.htm

extension, namely maintaining value (in terms of quality and performance) and utilizing value (in terms of usage and replacement). These two elements enable these activities to be transparent throughout, simultaneously allowing new economic actors to enter at any transaction point (Stahel, 2013). Therefore, renewed processes and reverse logistics streams are imperative to introduce and support the viability of pursuing such strategies. However, as highlighted by literature, establishing efficient product-life extension markets does not come without a price, as the correct application of such activities depends on several circumstances depending on the strategy pursued.

2.2.1 The four Rs of product life extension

As mentioned earlier, the initial idea of PLE strategies is to keep a given resource, component or product, in circulation for as long as possible through repair, reuse or remanufacturing and lastly recycling in order to seize long term resource- and cost-efficiency (Stahel, 2014). However, previous research pinpoints the divergence of these strategies in their value-capturing abilities. Table 1, illustrated below, provides a brief overview of each strategy, including the definition, focus and examples of application. Consequently, the ensuing sections dissect each of the strategies separately to gain more insight into the considerations organizations might need to get hold of when opting for one or a combination of these strategies.

Table 1. *The 4Rs of product-life extension and their definitions.*

PLE strategy	Definition	Focus
Repair	"Repair refers to the process of restoring a product to a sound or adequate condition after decay or damage." Flexner (1987)	Life extension
Reuse	"Reuse refers to direct and part reuse, with or without out repair" Parker and Butler (2007)	Life extension /Reduction of materials
Remanufacturing	"Remanufacturing refers to the process were products are disassembled into components, and those components are brought back to the original quality, and then used to manufacture new product that are identical to the original products." Parker and Butler (2007)	Life extension
Recycling	"Recycling refers to the process by which materials that have achieved their end of life are collected, processed into common material types and further utilized as feedstock in the manufacturing process of new products." (Kopicki et al., 1993; Linton & Jayaraman, 2005; Stahel, 2013).	Reduce material and energy inputs

2.2.1.1 Repair

Flexner (1987) defines repair as the process of restoring a product to a sound or adequate condition after decay or damage. Numerous authors have recently reinstituted repair as the most efficient process of retaining or restoring equipment to the desired level of performance (Ajukumar & Gandhi, 2013; Stahel, 2014). An earlier study by Linton and Jayaravan (2005) specifically highlights repair as favorable due to the functionality of a unit in question to be restored with only small inputs of labor and materials. Thus, as Feuchter et al. (1991) point out, repair is especially customary in products where cost of replacement exceeds the cost or repair. As a PLE strategy, repair is argued to be carried out by customers, manufacturers or third parties during the usage phase of a product (Linton & Jayaravan, 2005). Areas of application have been highlighted in an early study by Ashayeri et al. (1996), who identified industrial repair to be commonplace in in airframes, automobiles, heavy equipment and consumer appliances. Ultimately, as argued by Wise & Baumgartner (1999), during the product life cycle, after-sales services and spare parts may generate more than three times the turnover of the original purchase, making it a viable business case in an industrial context.

Nonetheless, to only rely on the favorable assumptions of repair could inadvertently misguide the discussion around the process, as repair also poses challenges. Mont (2008) highlights a practical reason for the limited adoption of repair to lie on the insufficient compatibility between new and old product models in terms of available spare parts. The difficulties are previously highlighted by Linton and Jayaravan (2005) who pinpoint products with varying life expectations and a complex composition of components to frequently require repair.

2.2.1.2 Reuse

Reuse is defined by Parker and Butler (2007) as a generic term covering all operations where a product is put back into service, essentially in the same form, with or without repair or remediation. Previous research points out subjects for reuse to be either complete products or components of the product which then are sold (Amelia et al., 2009). In related terms, Quella and Belli (2013) reference to Kopicki et al. (1993) to complement this assertion by defining two particular instances for reuse activities; direct product reuse and part reuse. "Direct product reuse" refers to the use of a product in its same form for the same use without remanufacturing (Kopicki et al., 1993). Relevant contributions to the notion of direct product reuse has been made by Stahel (2013), who

states that electronic marketplaces have enabled direct product reuse of consumer and industrial products for both the B2C and B2B market. “Part reuse”, on the other hand, refers to the use of only a part in its same form for the same use without remanufacturing (Kopicki et al., 1993). Prerequisites for the consideration of reusing parts include quality and functionality, as components should offer the correct material composition and the desired performance (Linton & Jayaraman, 2005).

From a circular economic perspective, previous research argues that reusing products or components entails benefits that are manifold. Amelia et al. (2009) state that one such benefit is embodied in reuse preventing the need for further materials to be used for new products or components, as it consequently reduces impact on the environment and dependency on new resources. This is echoed by Truttmann and Rechberger (2009), who argue that employing reuse practices can be considered a cost-effective way to contribute to resource conservation. Consequently, apart from benefits for resource conservation, reuse of components and products offers attractive economic advantages, provided that components are “qualified as good as new” (Quella & Belli, 2013). Financial benefits can be seized in increased profits by reducing materials and energy costs (Truttmann & Rechberger, 2006). Furthermore, the cost of collecting and testing the parts is much less than the cost of manufacturing new parts (Linton & Jayaraman, 2005).

However, an immensely important argument is provided by Truttmann and Rechberger (2006), who point out reuse could be considered as one measure in a multi-criteria approach towards resource conservation, meaning that in certain areas, it should be coupled with other PLE strategies such as remanufacturing to provide operational and financial viability. As a reminder, this research employs this assertion, referring to the viability of reuse to be enhanced only in conjunction with remanufacturing. This is deemed necessary as the analysis around reuse as a sole process might fall a little short without the linkage to remanufacturing.

2.2.1.3 Remanufacturing

Remanufacturing is defined by Parker & Butler (2007) as the process of recovering an end-of-life product and carrying out required restoration to return it to at least Original Equipment Manufacturing (OEM) performance condition with a product warranty that at least equals that of

a comparative product. Previous research characterizes remanufacturing as an industrial process whereby used products, referred to as "cores" are restored and value-added to the material when the product was first manufactured is recaptured (Lacy & Rutqvist, 2015). The process can be performed on either entire products or the components that constitute the product, whereby substandard components are replaced, feature upgrades are incorporated, and the product is reassembled (Nasr, 2015).

Stahel (2013) differentiates remanufacturing from standard manufacturing due to additional procedures such as dismantling, cleaning and quality control to employed. Nasr (2015) singles out quality control as an essential function to check if functionality of a remanufactured product is equivalent to original specifications. This, as argued by Hopkinson and Spicer (2013) requires modified methods using higher skilled labor and technology in order to ensure the quality of the product. Ultimately, from a customer viewpoint, the remanufactured product should be considered to be the same as a new product (Hopkinson & Spicer, 2013).

The potential benefits of remanufacturing are argued to be significant; Giutini and Guadette (2003) report that remanufactured products could cost 40-60% less to produce and could typically be 30-40% cheaper for the customer. Remanufacturing becomes financially attractive for price-sensitive firms especially, as Steinhilper et al. (2006) observe remanufacturing to have the possibility of being twice as profitable as manufacturing. Subramoniam et al. (2009) further express remanufacturing to entail inherent progression towards a sustainable company, as energy, materials and other negative environmental impact of production waste are minimized. Matsumoto et al. (2016) discuss the complexity of the remanufacturing process as it consists of excess stages in comparison with manufacturing, stages such as disassembly, cleansing, inspection, repairing, replacing and reassembling the components of a product to restore it to "as new" conditions.

Remanufacturing is often compared to reconditioning, even though the two processes differ significantly (Nasr, 2015). Reconditioning is the process of restoring a product or a component to "like-new", however, the process is not as thorough as remanufacturing. Gray and Charter (2007) state that reconditioning could simply center around the improvement of the aesthetics of a product. Remanufacturing, on the other hand, retains the geometrical shape of the product and

captures materials and value-added (e.g. labor and energy) that were embedded in the product during initial manufacturing (Nasr, 2015). In sum, previous researches show that implementing remanufacturing in business operations can contribute to avoid disposal costs, capture value embedded in the product and utilize resources more efficiently. Hopkinson and Spicer (2013) highlight policy-making as a crucial element for this endeavor, as widespread regulatory barriers affect remanufacturing activities and trade in remanufactured goods.

2.2.1.4 Recycling

Previous research characterizes recycling as the process by which materials that have achieved their end of life are collected, processed into common material types and further utilized as feedstock in the manufacturing process of new products (Kopicki et al., 1993; Linton & Jayaraman, 2005; Stahel, 2013). Braungart and McDonough (2009) discuss recycling to generally be conducted in means of downcycling, meaning recycling of materials into lesser quality, and state that most recycled materials lose their purity or value in the recycling process, meaning that the material is degraded and cannot be used for their original purpose. In contrast, Braungart and McDonough (2009) further discuss upcycling, entailing increasing the value of a product through using it for a different purpose. An early study by Bor (1994) pointed to recycling being commonly conducted in the metal, paper, glass, plastics, textiles and electronics industries.

Previous research has commonly highlighted the recycling process to assist organizations in avoiding waste to go to landfill, while simultaneously reducing energy usage by avoiding primary extraction and consequential impact on the environment by reducing the need for virgin materials (Bringezu, 2002). Literature also argues recycling to be a common practice favored by policy-makers (Folz; 1999, Honeywill; 2002, Tiemstra, 2002 as cited in Linton & Jayaravan, 2005). Nevertheless, recycling has become a mandatory practice in major parts of the world economy and thus assists organizations in compliance with legislation (Bringezu & Moriguchi, 2002). From an economical aspect, previous literature also highlights the cost of recycled materials to be generally lower than those of virgin materials (Bringezu, 2002).

As recycling entails the separation and granulation of all materials in order to recapture any residual value from them, Linton and Jayaravan (2005) argue that the ultimate value of recovered

materials is significantly lower than the value of virgin materials. In the aforementioned PLE strategies, the value of the shape or assembly of components is partially or completely retained. Thus, Linton and Jayaravan (2005) argue that recycling only retains value of materials, and consequently degrades the properties and the identify of products and parts. However, Linton and Jayaravan (2005) find the popularity of recycling in academe and practice to be puzzling, as it appears to be the process with the lowest economic value of any of the aforementioned PLE strategies. The intent of this research is therefore to be timely, as looking beyond recycling to additional product-life extension strategies might be appealing for both academia and practice.

2.2.2 Applications of product-life extension strategies

Stahel (2013) states that local and regional operations are argued to avoid substantial transportation and transaction costs, with Lacy and Rutqvist (2015) adding that geographical proximity allows field-service providers to achieve certain degrees of economies of scale. Mainly, the significance of "Field service" companies is demonstrated by their ability to provide repair, upgrade, remanufacturing and maintenance services (Lacy & Rutquist, 2015). Nonetheless, other research slightly tones down the notion of economies of scale in pursuing PLE strategies due to stochastic and limited intensity of supply and demand in such components and products (Guide et al., 2003; Zhao & Zhu, 2017). However, Stahel (2013) on the other hand also indicated that economies of scale is not an overriding objective in the inauguration of PLE strategies, although it should receive ample consideration subsequent to its adoption, hence, the need for functioning markets. Further, it is argued by Stahel (2013) that creating an environment conducive to local and regional proximity incentives cost-effective services, further evoking collaboration opportunities with local entities to suit local needs. This argument is complemented by Lacy and Rutqvist (2015) who state that "Field service" companies tend to build strong relationships with customers due to increased interaction points, meaning that companies who leverage product-life extension deepen customer relationships to understand needs in terms of performance requirements, as well as time- and cost efficiency targets.

2.3 Adopting additional product-life extension strategies

The PLE strategies introduced in the previous sections seem to share similarities, but simultaneously diverge in their differences. Perhaps, the most relevant contribution to the

distinction of PLE strategies has been made by Linton and Jayaravan (2005), although inevitably, several crucial questions are left unanswered by this insightful article. Notwithstanding that the authors note organizations in general to be active in at least a few PLE strategies, these are not explicitly discussed in the context of adopting additional PLE strategies in an industry-wide context. However, Linton and Jayaravan (2005) go on to say that by considering the strategies where organizations currently are involved in, the assessment of the resource requirements and managerial competencies needed to adopt additional ones might become easier. The article intends to be propitious for practice and academia but falls a little short as no empirical examination has been performed in regard to its promise. Despite its confined contribution, however, the article offers valuable theoretical insights, interesting examples and thus a starting point for further investigation for researchers with an interest in product-life extension.

From a strategic management perspective, Sanchez (2006) argues that organizations strive to achieve and distribute sustainable value creation by deciding on resources to effectuate such operations and competencies to motivate resources. However, as Stahel (1997; 2013) suggests, adoption of product life extension strategies might induce modest economic and organizational change. In order to shed light on such circumstances and confer input into this area, the ensuing sections (2.4 and 2.5) briefly review strategic renewal and inertia literature in order to identify common elements that either make or break organizations on the verge of implementing renewed strategies. Particularly, strategic renewal literature is deemed relevant as it aids with insights on managerial competencies and resource allocation in order to explore the potential barriers managers face in pursuing new strategies.

2.4 Strategic renewal

According to Floyd and Lane (2000) strategic renewal can be defined as “an evolutionary process associated with promoting, accommodating, and utilizing new knowledge and innovative behavior in order to bring about change in an organization's core competencies and/or a change in its product market domain” (Floyd & Lane, 2000, p. 155). The term strategic renewal has its origin within the evolutionary models of strategic change (Nelson & Winter, 2002; Floyd & Lane, 2000; Barnett & Burgelman, 1996; Huff et al., 1992; Burgelman, 1983a), which conceive renewal as an iterative process affecting beliefs, actions and learning in order to align the strategy of the organization with

changes in environmental circumstances (Floyd & Lane, 2000). Simply put, the theory of strategic renewal recognizes the importance of maintaining adaptiveness, by the means of exploiting new and existing competences (Floyd & Lane, 2000). These competences can be referred to as complex combinations of assets, skills and knowledge, which are the foundation of an organization's ability to deliver value through its activities (Floyd & Lane, 2000; Barney, 1991). Strategic renewal is thus concerned with the successful implementation of new management strategies, by ensuring a strategic fit with the current business environment (Zand, 2009).

2.4.1 Managerial competencies

Building on previous literature, Floyd and Lane (2000) suggests strategic renewal to be broken down into three subprocess that are all sequentially linked to events behaviors in strategy literature. The first subprocesses is *competence deployment*, which refers to the process of allocating resources into new products and market developments or for the purpose of reinforcing a current market positioning (Hamel & Prahalad, 1989; Levinthal & March, 1993; Mehra & Floyd, 1998). With that in mind, the management must adjust the organizational structure, systems, human resources and necessary competences (Nelson, 1991) to fit with the overall strategy (Floyd & Lane, 2000), and thereby avoid an attempt to execute a strategy without the necessary resources (Cool & Schendel, 1988).

The second process is *competence modification* and refers to the process in which managers recognize the need for change, questions the organization’s current strategy and competences and finally encourages adaptability (Huff et al., 1992). This type of questioning might lead to a shift in perception of how well-established routines fit with the conditions of the external environment (Floyd & Lane, 2000). The competence modification process is however only perceived to produce flexibility in a period of strategy transition, as the purpose is to have managers to relax control systems and encourage mutual adjustment (Floyd & Lane, 2000). The consequence of lacking a clear strategy and resource commitment would in the long-term lead to the organization falling behind competition in terms of learning and efficiency (Floyd & Lane, 2000).

The last process is *competence definition* which covers the process in which managers are encouraged to explore new capabilities and market opportunities in order to be able to contest the

formal business definition and how the organization competes (Floyd & Lane, 2000). A few strategic alternatives are expected to come out of this, from which one or more alternatives are formally selected. This selection process is typically more incremental and less rational (Huff et al., 1992), as managers can first accept change, after they understand the need for change in the organization or the urgency of a change in the environment (Floyd & Lane, 2000). Hence, managers should devote to change in old routines and make the necessary commitments to new future horizons (Wooldridge & Floyd, 1989). However, it is worth keeping in mind that managers can be reluctant to decisive change before uncertainties of political and market shifts are clarified (Burgelman, 1994).

Identifying resource gaps, through element of the resource-based approach, is deemed relevant to complement the strategic renewal literature in order to understand what resources makes companies stick with current strategies and what is necessary to move beyond the current strategic practice. However, while the resource-based approach is regarded useful to identify internal sources of value, this research finds a wider applicability of the theory to establish the depencies valuable and grounded resources among a several stakeholders to identify a holistic picture of the existing resources in an industrial setting.

2.4.2 Resources and resource allocation

The resource-based approach to strategic management, as described by Barney (1991) and Grant (1991), is deemed useful to systematically identify and classify critical resources of the firms within the industry. Resources, according to Daft (1983) as cited in Barney (1991) "include all assets, capabilities, organizational process, firm attributes, information and knowledge, controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness". The resource-based approach further illuminates how a selected strategy can effectively exploit existing resources as well as identify resource gaps to be filled in order to achieve full performance potential (Grant, 1991). As such, Barney (1991) further states that resources can be deemed valuable if they equip an organization to advance its efficiency and effectiveness. However, the notion of value and valuable resources has received scholarly critique based on its unrestricted definition of value (Priem & Butler, 2001). As a reaction, Bowman and Ambrosini (2000) presented two concepts of value: perceived use value (a customer's perception

of value and the total money value they are prepared to pay) and exchange value (the actual amount paid). Accordingly, this research deploys the resource-based approach to identify the value of resources that is either possessed industry wide or by single firms for thereby to understand if the perceived value of reused and remanufactured products constitutes a barrier. On that note, resources that leads to market power can be possessed exclusively by a single firm or owned collectively by industry members (Grant, 1991). This notion of resources and market power further enables a discussion of how resources can be allocated differently to develop necessary capabilities (Christensen & Bower, 1996).

There exist several distinct resource categories, from which this paper takes the view of Barney (1991) who divides resources into three main categories: Physical capital, human capital and organizational capital. Physical capital refers to the physical technology available to the firm such as the facilities, equipment, geographical location and access to raw materials (Barney, 1991). Human capital includes the "training, experience, judgment, intelligence, relationships, and insights of individual managers and workers in a firm" (Barney, 1991, p.101). Finally, organizational capital includes the "firm's formal structure, formal and informal planning, coordinating systems (and) informal relations (...) between a firm and those in its environment" (Barney, 1991, p.101).

On the other hand, Amit and Schoemaker (1993) define resources as "stocks of factors that a firm controls and capabilities as the firm's capacity to deploy resources for a desired end result" (p. 35). The notion of deploying resources was highlighted by Bower (1970), and later developed by Burgelman (1983a, 1983b) who described resources allocation as an internal function of the firm. These authors proposed that the majority of strategic proposals - whether aimed at adding capacity or developing new products or process - are formed at the operational and lower levels of an organization (Christensen & Bower, 1996). Further, because risk management are linked to resources allocation, projects with assured customer demand are most likely to receive funding (Bower, 1970).

Differently oriented, Christensen and Bower (1996) suggested that patterns of resource allocation are largely determined by demand or lack thereof from the current customer base and how

customers communicate their need for innovative solutions. Christensen and Bower (1996) further concluded that when impetus from customers were high enough, the established firms were able to take the lead in the industry and develop the competences and capabilities needed for sustaining a technological change. In relation to that, it was interestingly found that strategic change was not a prerequisite for achieving technological change, because sustaining technologies cater to the already existing customers of the established firms (Christensen & Bower, 1996). On the other hand, if an established firm has obtained the technological competence but lacks the impetus of customers, it is often hard to commercialize and thereby makes the technology unattractive to established firms (Christensen & Bower, 1996). To commercialize a new disruptive technology would therefore require a change in strategy in order to address a different market (Christensen & Bower, 1996). Even though companies seem to be challenged by technological change, the key issue does not seem to be within changing technology, but rather a lacking the competence to change strategy (Christensen & Bower, 1996).

In sum, theory of resource allocation provides to useful viewpoints: (1) the funding and support of projects are mainly influenced by risk management and (2) the dependence on customer demand or the absence of it. In in the end, this is explained by how firms are capable of changing their strategy accordingly. However, resource allocation faces further obstacles in line with patterns of strategic decisions made by organizations. With this in mind, the following subsection draw inferences from strategic inertia literature to address how individual firms might be prohibited in committing to the allocation of resources to new strategies.

2.5 Strategic inertia

Numerous authors have suggested that, although strategic renewal is gaining increased momentousness, organizations often find themselves in a state of extending inertia. In an early contribution, Huff et al. (1992) define strategic inertia as "the level of commitment to current strategy, reflecting individual support for a given way of operating, institutional mechanisms used to implement strategy, monetary investments and social expectations" (p.56). In a more recent contribution, Hopkins et al. (2013) critically assess the developments in strategic renewal literature and argue that inertia indeed occurs due to perception of prevalent satisfactory performance. In simple terms, the authors' prose pinpoints the tendency of organizations to remain with the status

quo, as even in cases of conspicuous desire for renewal, organizations are challenged by numerous internal and external factors that inhibit such aspirations. Zand (2009), on the other hand, tries to make more modest claims and argues that organizations that effectively recognize changes in the external environment identify threats and opportunities to establish a strategic fit between these and their internal structure and capabilities. Thus, as the interplay between internal and external factors is regarded to repress attempts for strategic renewal (Malette & Hopkins, 2013), the following subsections aim to provide further theoretical insights.

2.5.1 Internal factors for strategic inertia

As noted, previous research argues for strategic inertia to be prevalent in organizations with strong commitment to current strategy (Huff et al., 1992). The authors provide an informative overview into organizations' tendency to foster an approach to avail themselves on current systems, structures and principles in an attempt to maintain stable organizational performance. Malette and Hopkins (2013) contribute to this expression of views and complement Huff et al. (1992) by adding that reliability on current strategic operations is reflected in the propensity of over-investing in current business areas. Rusetski and Lim (2011) rightly conclude that as organizations find approaches to accomplish their sought objectives, they remain averse to renewing their strategies.

However, as the aforementioned research investigates strategic inertia as a reactive endeavor, such line of reasoning might have a few weaknesses that Christensen and Bower (1996) point out in their investigation of strategic inertia from a proactive perspective. Here, the authors point out the failure to appropriately navigate the allocation of resources is considered a critical component in causing strategic inertia. The authors argue that decision-making on strategically appealing activities becomes vital when considering new prospects, as actualizing all organizational targets simultaneously is deemed impossible. Nonetheless, other research conducted earlier by Johnson (1988) tends to present another view, as the author points out insufficient awareness and communication to primarily influence strategic inertia, as unclear information negatively impacts the willingness for change among managers (Johnson, 1988). This argument enlightens the need for strategic renewal to therefore depend on minimizing ambiguity around the necessity of change and its consequential benefits.

2.5.2 External factors for strategic inertia

Apart from internal factors argued for in previous research, Pfeffer and Salancik (2003) argue that a comprehensive understanding of the external environment becomes vital in the allocation of resources, mainly due to organizational environment being in a constant flux of change. Marinova (2004) echoes this notion and points out the varying ability of organizations to respond external changes and its subsequent effect on their capacity to scan the environment for new business opportunities. However, in an earlier study, Schoemaker and Marais (1996) propose that strategic inertia is connected to legal, fiscal and national barriers such as price controls and new laws and regulations that discourages exploration beyond these boundaries. The situation becomes more complex, according to Pfeffer and Salancik (2003), when considering various stakeholders and their continually changing preferences that consequently influence a manager's choice of resource allocation. As stakeholder potency might impact the pursuance of new strategies, the succeeding subsection provides insights into to identify industrial stakeholder and how they might facilitate or prohibit the adoption industry-wide strategies.

2.6 Stakeholder influence

Stakeholder theory and its linkage to strategy was initially described in the mid 1980's with Freeman's (1984) 'Strategic Management: A Stakeholder Approach' being one of the central papers of the movement. Derived from the work of Emshoff (1978) and Mason and Mitroff (1982) the stakeholder theory came as a response to managers who were faced with the challenge of value creation in changing business environment. As such, Freeman (1984) outlined the stakeholder theory, or stakeholder approach as it is also referred to, as a concern for value creation, trade and how to manage a business effectively (Freeman et. al, 2010).

However, the stakeholder theory can arguably be said to lack a consistent definition and usage despite its wide range of application since its first introduction (Freeman et al., 2010). Related to that, Donaldson (1995) emphasize one definitive definition of 'stake' to constitute one of the biggest challenges of stakeholder analysis. Freeman (1984) himself define a stakeholder as "any group or individual who can affect or is affected by the achievement of the firm's objective" (p. 25). Additionally, the main idea of the stakeholder approach is that organizations and management choices are dependent on stakeholder *influence* (Brenner & Cochran, 1991). Related to this, the

approach recognizes that organizations are required to comply with and address a set of *expectations* that ultimately has influence on strategic decision making (Rowley, 1997). The concerns and expectations from stakeholders are further deemed to influence performance goals and encourage firms to strategize for the opportunities that do have the backing op stakeholders (Preble, 2005). Thus, one of the main objectives of stakeholder analysis can be said to map the stakeholders of a firm and categorize the level influence each one of them possess (Rowley, 1997). A typical stakeholder map is suggested to include a myriad of groups such as customers, suppliers, competitors, governments and local communities etc. (Freeman, 1984). However, as Freeman et. al (2010) points out in this network theory on stakeholder influence, the process of value creation happens through the multifaceted set of relationships among all groups with a stake in the business' activities. It is therefore necessary to understand how an organisation responds to the entire set of influential stakeholders and their common attributes, and thereby not just each individual stakeholder (Rowley, 1997). Contrary to Rowley's (1997) network theory centering around one organization at a time, Roloff (2008) suggests a stronger focus on how companies collaborate in a multi-stakeholder network and execute their stakeholder management accordingly. As such, it is suggested that organizations should collaborate in a multi-stakeholder network to be able to address complex challenges and manage occasional contradictory demands of stakeholders (Roloff, 2008).

Initial research stakeholder research identified how support from stakeholders was critical for long-term success and that management should explore the relationships with all groups of stakeholders in order to develop and execute new business objectives and strategies (Freeman & McVea, 2001; Freeman et al., 2010). Hence, the original stakeholder approach called SRI seeks to integrate all stakeholder interests in the process of strategy development. Contrasting to this, stakeholder theory has received scholarly critique by Ansoff (1965) who rejected the part of the theory that claimed stakeholders' support as a necessity of survival. Although dependent on a situational variable, Ansoff (1965) widely considered stakeholders as constraints and barriers for the corporate objectives of a firm. This line of thinking sparked several applications in the field of *corporate planning* which generally see stakeholders as limits to the firm's operations, thereby defining the boundaries from which a corporation can develop a strategy to optimize benefits to the stakeholders (Freeman et al., 2010). The corporate planning theory was however expanded by

Dill (1975) who suggested that *open communication* and increased *stakeholder participation* could be used in strategic decision making. This open communication and stakeholder participation is seen as contributions to understand to the ability of stakeholder to influence the firm, considering the source of their power (Dill, 1975; Freeman & Reed, 1983). Adding to that, continual communication between powerful stakeholders can be a useful tool or even a necessity to influence the common perceptions (D'Aveni & MacMillan, 1990). More intensely oriented, Pajunen (2006) states that communication with stakeholders plays a vital role in the survival for organizations, while intergroup competitiveness can be threatened through a lack of understanding of the common goals between stakeholders. Finally, this view of stakeholder participation indicated the importance of interorganizational relationships with reference to strategic alliances in strategic management (Barringer & Harrison, 2000). Strategic alliance as such can be referred to as "collaborative efforts between two or more firms in which the firms pool their resources in an effort to achieve mutually compatible goals that they could not achieve easily alone" (Lambe et al., 2002, p.141). Such endeavor could be further explored by the means of systems theory, that consider stakeholders as interconnected entities holding the potential to collectively address industry-wide strategic change.

2.6.1 Systems theory

The stakeholder approach has further branched out in what is referred to as *systems theory*, which was originally linked to stakeholder theory by Churchman and Ackoff (1947) and later on applied to organizational systems (Ackoff, 1970). Systems theory refers to the external links that are present in every organization (Freeman & McVea, 2001). In that way, organizations should be seen as 'open systems' in a larger network and not just as independent entities (Freeman & McVea, 2001). The systems theory differs from strategy theory in the way that a problem, should be solved as a system-wide problem, and not as a problem for a single firm (Ackoff, 1970, as cited in Freeman et al., 2010). It is addressed in the context of the entire stakeholder system, as opposed to seeing the problem at an organizational level of analysis (Freeman et al., 2010). System theory is therefore centered around identifying the stakeholders and the associated interconnection between them (Freeman & McVea, 2001). Problems can thus only be solved with the backing of all stakeholders which in turn also emphasizes the development of *collective strategies.* This differs from the corporate planning theory that rather focus on individual optimization through the

network as the unit of analysis (Freeman & McVea, 2001). As part of the concept of a collective strategy, the systems model of stakeholders looks a planning from the aspects of all organizations in the system, in order to avoid optimizing on a sub-system that works against system wide goals and objectives (Freeman et al., 2010).

2.7 Summary of theoretical framework

Based on the performed literature review in the areas of product-life extension, strategic renewal and inertia and stakeholder theory, a number of factors have been identified that could potentially represent barriers for the adoption of additional PLE strategies. Figure 3, illustrated below, presents the suggested theoretical framework that aids the further investigation of the empirical context of this research. The suggested framework allows for the interpretation of gathered data in terms of resource requirements, managerial competencies and stakeholder influence, thereby providing a pragmatic approach on the evaluation of adopting additional PLE strategies.

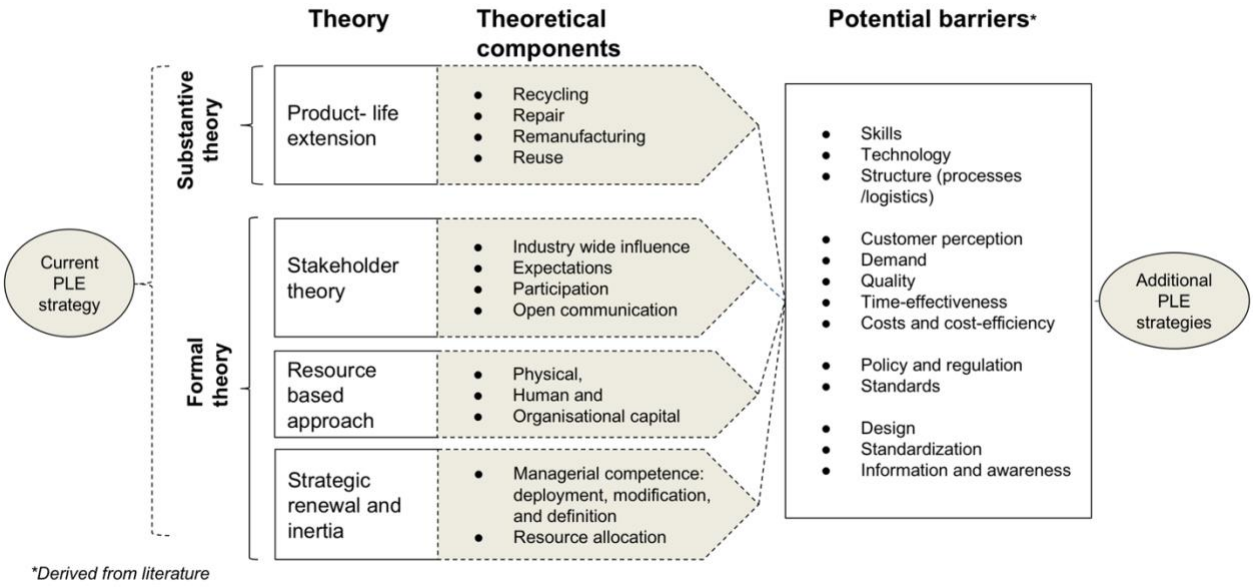

Figure 3 – *Theoretical framework (authors' own illustration).*

2.8 Chapter summary

The literature on product-life extension provided significant insight into the characteristics on motives for pursuing more value-capturing activities. It further highlighted the strategies of repair, reuse, remanufacturing and recycling to share similarities, but simultaneously diverge in their differences. The strategic renewal literature aided with insights on necessary managerial competencies and resource allocation in order to understand the potential barriers in the adopting of additional PLE strategies. Further inferences drawn from strategic inertia literature provided comprehension on how individual firms might be prohibited in committing to the allocation of resources to new strategies. Finally, the literature review resorted to stakeholder theory, to identify industrial stakeholders and how their influence facilitates or prohibits the adoption industry-wide strategies.

3 Methodology

This chapter provides comprehensive insight in the methods employed for conducting this research. Accordingly, perspicuous explanations are provided in order to ensure apprehension of the methodological choices and their relevance to the overall purpose of this research.

As the purpose of this research is to increase the understanding of potential barriers in adopting additional PLE strategies by means of managerial inquiry, an interpretative philosophical stance has been employed. This decision was made, as in accordance with Saunders et al. (2009), interpretivism is most suited for conducting people-focused research and inquire into business as unique and complex situations. Furthermore, in line with Easterby-Smith et al. (2015), as the philosophical stance taken dictates the strategy, design and overall approach, deliberate efforts are made to explain the steps taken and are therefore individually motivated for below.

3.1 Research design

This research employed a *qualitative method* in order to correspond to the requirements dictated by the overarching research question, which tackles the potential barriers for the adoption of additional PLE strategies. A qualitative method was deemed more appropriate than a quantitative method on account of the inherent interest of the research to be in non-numeric issues. Rather, the motivation for employing a qualitative method rested in the vicinity of the specific resource requirements, managerial competencies and stakeholder influence in adopting additional PLE strategies. In line with Bryman and Bell (2015), the qualitative method was the most suitable prospect as it allowed to understand and interpret the research topic in the eyes of the research respondents.

While the scarce amount of studies on the particular research problem motivated the choice of a qualitative design, it further manifested in the corresponding decision for *an exploratory research design.* In line with Easterby-Smith et al. (2015), the explorative notion in the chosen design was employed due to the purpose of the research being to seek insights, clarifications and understand a phenomenon that have not yet been explored extensively. Thus, employing an exploratory design assisted the research in achieving the purpose of the study, which was to increase the understanding of the area of the research topic, namely the potential barriers in adopting additional PLE strategies.

For this reason, this research relied on interviews to achieve this purpose, as such a technique allowed to gain further insight in the research topic. Finally, as Saunders et al. (2009) point out, it is important to note that an exploratory research design intends merely to explore the research questions and not offer final and conclusive solutions to existing problems, but rather a presumptive and credible conclusion.

3.2 Research approach

The choice of a qualitative design with an exploratory stance precipitated an abductive approach to be most suitable to gain enriched insight from this research. In accordance with Alvesson and Sköldberg (2008) and Saunders et al. (2009), abductive reasoning provided room to maneuver between theory and reality, further culminating in the combination of observations from data with theory to perform plausible interpretation of the findings. As the purpose of the study was to increase understanding of the phenomenon at hand, in line with Dey (2004), conclusions by means of an abductive reasoning provided the appropriate procedure to achieve such intention. This holds true especially in the empirical context of the maritime industry, as the abductive stance allowed to seek insight into the potential barriers of adopting such strategies, and consequently increase the general understanding of this phenomenon. In order to perform proper and valuable interpretation of the data gathered, the data analysis draws particular inferences from the theoretical framework presented in section 2.7. Consequently, the discussion utilized theoretical contributions from previous research to explicate the studied phenomenon and ultimately allowed for the credible conclusions to be drawn.

3.3 Data collection

In order to answer the research question in the light of the purpose, the data collected for this research consists of primary and secondary data. The gathered data was utilized to increase the understanding the barriers of implementing additional PLE strategies considering resource requirements, managerial competencies and stakeholder influence. Following, primary and secondary data are discussed separately to elucidate the steps taken.

3.3.1 Primary data collection

This research took a respondent approach utilizing a mix of semi-structured interviews and a questionnaire-based survey as qualitative research methods to gather primary data. These are described in the subsections below.

3.3.1.1 Respondent selection

In the selection of respondents, it was deemed necessary to identify a sample of interviewees that potentially represent the larger target population of the maritime industry. For this reason, random sampling was utilized as a tool to realize this decision (Easterby-Smith et al., 2015). Random sampling was deemed appropriate for this study since there was a clear motive to contact companies that have adequate insight and an appropriate insight on the matter of drivers and barriers in product life-extension strategies, in order to reach reliable answers in line with the objectives, and ultimately, the overarching research question. The respondents chosen were based on specific criteria, namely; origin, stakeholder identity and position. In order to increase the prospect for gaining accurate data from organizations, it was decided to establish contact with managers, as they are deemed to have adequate knowledge of strategy. Meaning, although the sample encompasses managing directors and technical directors in Swedish and Danish maritime companies, this sample could represent maritime in general to the inherent global operations connected to it. In line with Saunders et al. (2009), the research took a respondent approach since the empirical evidence depended on multiple perspectives in order to come to a viable conclusion. Assuming that each respondent possessed vital insights and shared a certain degree of them by means of the data collection process, in line with Saunders et al. (2009), these inferences strengthen the empirical evidence. By the above-mentioned criteria, the following respondents participated in the provision of information:

Table 2. *List of respondents and interviews conducted.*

Interview	Company type	Interviewee role	Date
1	Shipyard	Managing director	Mar. 2018
2	Shipyard	Managing director	Mar. 2018
3	Shipyard	Managing director	Apr. 2018
4	Shipyard	Managing director	Apr. 2018
5	Shipping company	Head of Strategic Purchasing	Mar. 2018
6	Shipping company	Technical manager	Apr. 2018
7	Shipping company	Senior sustainability advisor	Apr. 2018
8	Original equipment manufacturer (OEM)	Global parts manager	Apr. 2018
9	Original equipment manufacturer (OEM)	General manager (field service)	May 2018
10	Classification society	Technical performance manager	Apr. 2018
11	Classification society	Managing director	May 2018
12	Maritime insurer	Head of broking	Apr. 2018
13	Regulation	EU policy advisor	May 2018

3.3.1.2 Interviews

This research utilized in-depth interviewing as a qualitative research method in order to gather primary data. Semi-structured interviews were deemed the interview structure of choice as it allowed for in-depth exploration of the subject of interest (Saunders et al., 2009), the adoption of additional PLE strategies, and to seek new insight (Robson, 2002). Although this method of data collection was deemed the most beneficial, it was not without its minor challenges. As the interviews in the majority of cases were conducted by phone, in order for the method to be effective and deliver reliable information, the interviewers had to complement each other in order to prevent data loss. This was however solved as the interviews utilized a list of topic areas and questions to cover, as the intention was for the interviewees to talk in their own terms.

The thirteen interviews were conducted with a target group of managing directors and technical managers in general, thus, with higher management with a knowledge about PLE strategies in

particular. It was deemed crucial to contact this specific target group due to the importance these managers have on the potential adoption of additional PLE strategies and to obtain the insights necessary to shed light on the objectives of the research at hand. Further, their potential involvement in such undertakings would provide information that could be juxtaposed against potential barriers outlined in previous research, thus validating or disproving arguments presented in existing literature.

Consideration was given to the accessibility of the selected respondents, and an inquiry via an introductory phone call and email was sent prior to the scheduled interviews. Although time-consuming, the majority of the respondents (8) agreed to the selected interview method (semi-structured interviews). Semi-structured interviews as a method proved to be appropriate as it provided flexible interactions with the respondents by using the tools of laddering and probing (Easterby-Smith et al., 2015), in order to dig deeper into a specific question and minimize bias respectively. By requesting more information regarding specific answers by aid of these tools, more complete answers and authentic information were acquired and kept the discussion going. This was imperative as the complex nature of the research topic would not allow for short answers in order to evaluate the barriers of implementing additional PLE strategies taking into account resource requirements, managerial competencies and stakeholder influence. Thus, the respondents answered open-ended question and were therefore asked to elaborate, providing more rich information benefiting and strengthening the findings. Ultimately, "why" and "how" questions during the conduct of interviews, which are the foundation of a qualitative study (Easterby-Smith et al., 2015), allowed for a more thorough understanding of the information gathered.

Semi-structured interviews were also suitable in order to obtain answers that relate to the research question, allowing for the comparison between respondent's answers in line with the chosen theoretical framework, argued by Saunders et al. (2009) to strengthen the overall quality of the research. As the questions set for obtaining the empirical evidence were designed in line with the proposed theoretical framework, emphasis was placed on the formulation of the interview question in order for all respondents to feel comfortable and understand the questions to the same degree. In addition, the research topic and key concepts were operationalized before the interview in order for respondents to be completely on sure about the fundamentals of the chosen research. Audio-

recording was utilized, in agreement with respondents, in order to analyze the empirical evidence after the conducted interview. This provided flexibility for both parties, interviewers and interviewees, as it allowed the subject to speak more freely, without pause or interruption, and allowed for both parties to be present and involved in keeping the discussion going, rather than focusing on annotating the information.

3.3.1.3 Questionnaire

In-depth interviews are similar to a questionnaire-based surveys but tends to dig deeper into the topic, encouraging respondents to talk and explain their answers (Saunders et al., 2009). However, a questionnaire was also utilized as backup solutions in case of potential time-constraints of selected respondents, as a tactic to address the busy schedules of the interviewee sample consisting of managing directors and technical managers. The questionnaire, consisting of 33 questions (found in Appendix B) was originally constructed in English, consequently translated in the native languages of the interviewee sample, namely Swedish and Danish, in order to provide comfort and ease of expression to gain more reliable information. Taking two perspectives under consideration, those of business and policy barriers of adopting additional product-life extension strategies, the questionnaire allowed for a holistic comparative review of answers and finding connections between different interviewees. As the questionnaire was developed in accordance with literature, it allowed for the identification of perceived importance of barriers and the weight of different strategic factors that prohibit or elicit the studied phenomenon. Emphasis was therefore placed on simplifying and explaining the definitions of key concepts either by means of a short phone call or email. This proved to be of benefit, as five (5) interviewees indeed could not schedule interviews but found time for completing the questionnaire.

3.3.2 Secondary data collection

Numerous secondary sources were deemed important to explain and quantify key concepts related to substantive theory of product-life extension. In the same light, secondary sources aided in obtaining a deeper understanding about the empirical context, which clarified the research problem and consequently strengthened the findings.

3.3.2.1 Theoretical data collection and source criticism

Scholarly literature from academic journals, books and other publications provided information forming the theoretical framework of the study, which helped form appropriate interview questions. More specifically, increased understanding was obtained from the integration of product-life extension as a substantive theory in the light of strategic management provided by well-grounded theories such as the stakeholder theory and connected theoretical contributions from strategic renewal and inertia literature. There were consequently acquired through Google Scholar as the primary search engine. The keywords *product-life extension, repair, reuse, remanufacturing, recycling, maritime, strategic renewal and inertia, stakeholder,* in different combinations aided the proper search for necessary information. Deliberate efforts were taken to employ source criticism by means of critical review and comparability between studies for enhanced understanding. However, the most relevant of this research might derive from the methodologies employed for the literature review. The content analysis, despite being performed by two researchers, might be afflicted by interpretation biases. However, the thematic analysis of the literature performed might help to mitigate these limitations, as the literature derived from a multitude of relevant academic disciplines in order to address the differences and similarities between publications. Furthermore, contributions from reports and other documents not published in academic journals have been taken under considerations to identify any deviations or contradictions to gain more insight into potential academic bias of the phenomenon researched.

3.4 Data analysis

According to Yin (2013), there are mainly two avenues to commence on for the analysis of data; developing a case description or relying on theoretical propositions. The latter is employed in this research as the gathered empirical evidence was analyzed with the aid of the theoretical framework presented in chapter 2 (subsection 2.3). The theoretical postulations guided the analysis, as previous research created a foundation to evaluate the challenges and opportunities with the adoption of additional PLE strategies, as this research aimed to increase the understanding of such strategies in the empirical context illustrated by the maritime industry. Furthermore, as proposed by Yin (2013), pattern-matching was utilized as an analytical tool in order to compare the gathered empirical data to the theories used in this research. This was deemed appropriate for this research,

as the interest in the data was to juxtapose the gathered data against conventional theory. Qualitative synthesis was deemed appropriate to perform on the empirical evidence in order to reaffirm the most important barriers. The data was analyzed collectively, regardless of specific characteristics of each stakeholder. Rather, it was important to highlight the resource requirements, managerial competencies and stakeholder influence, as outlined by the objectives of the research. Ultimately, by means of this line of reasoning, the analysis of the data concentrated on contributing to the overarching research question.

3.5 Quality standards

According to Neuman (2013), the concepts of reliability and validity in qualitative research are argued to be connected with the logic and reasoning through words. Validity refers to the authenticity and truthfulness of the gathered data, and thus evaluated by means of internal and external validity in accordance with Easterby-Smith et al. (2015). On the other hand, reliability is based on observations, and therefore on the interviews in the context of this research as importance was weighed on the consistency of the information gathered (Neuman, 2013).

3.5.1 Concerns about validity

In qualitative research, *internal validity* draws attention to the assurance that results are true, and conclusions are correct through elimination of systematic sources and potential bias (Easterby-Smith et al., 2015). According to this definition, the research has made an earnest attempt to assure a consistent and transparent approach to the trustworthiness of the findings. For this reason, as suggested by Patton (2005), different triangulation techniques were employed to increase the confidence in the accuracy of observations and thus internal validity of this research:

1. *Data triangulation* – in accordance with the research purpose, information was gathered from different stakeholders in order to gain insight into their perspectives on potential barriers of adopting additional PLE strategies. In the discussion, the information was compared in order to determine areas of agreement as well as areas of divergence.
2. *Theory triangulation* – as mentioned earlier, inferences from different theoretical realms were drawn in order to contrast the findings against them in the discussion. Moreover, a mix of distinct and well-cited scholarly contributions were contrasted against more recent

and timely contributions from various formal and substantive theoretical domains in order to cover a wide spectrum of publications.

3. *Investigator triangulation* – as the research was conducted in a team of two researchers, critical discussion was employed during the analysis process in order to minimize bias in the interpretation of gathered information. Furthermore, dialogues with other professionals were conducted in order to gain multiple perspectives on how to interpret the set of data gathered for the purpose of this research. Outside professionals consulted were PhD colleagues from the field of environmental and marine engineering, but also within the management discipline with professionals occupying different status positions such as professors and supervisors.

In addition, *external validity* emphasizes whether the patterns observed from the sample data are transferable other contexts and settings, and thus if the empirical evidence can be generalized (Easterby-Smith et al., 2015). According to this definition, the transferability of the empirical evidence gathered in this research can be considered rather low. This is due to limited generalizations that can be made as the potential barriers perceived might be inherently different between different industries. However, the fruitful discussion based on theoretical grounding assumes a certain degree of findings to be applicable to other settings, such as organizations in other capital-intensive industries. A theoretical framework has been developed to achieve a higher relative explanatory power and thereby strengthen the external validity, as according to Glaser and Strauss (2017) this is necessary to provide a new approach, which existing theory does not yet cover. This new approach incorporates stakeholder theory in the evaluation of potential barriers in adopting PLE strategies.

3.5.2 Concerns about reliability

In qualitative research, reliability assures the minimization of errors and bias (Saunders et al., 2009) and refers to how well a research process is explained and whether the results are repeatable (Bryman & Bell, 2015). In line with these definitions, the methodology section has spared no effort in disclosing all the information regarding the research process, while simultaneously ensuring consistent referencing throughout the progress of the research. Again, the methods utilized for the collection of empirical evidence were not affected by personal frames of reference, but rather

formulated by means of the research purpose in relation the theoretical framework constructed. In order to increase the overall degree of reliability in this research, the gathered information was sent to the respondent's post-interview in order to reduce the risk of misinterpretations and to make sure that the information gathered was interpreted corresponding to the entered meaning. As data interpretation can be regarded somewhat subjective in qualitative research, it was deemed necessary to bring a measure of objectivity in the evaluation of the gathered data. Thus, peer-reviewers ratified the examination of the data, leading to a minimization of inappropriate biases that could have impacted the data analysis.

3.6 Ethical considerations

As argued by Easterby-Smith et al. (2015), the right to confidentiality can be of great importance in management research. For this reason, ethical issues were taken into account in the process of conducting this qualitative research. Especially due to the method of choice regarding data collection in this research, namely interviews, Bryman and Bell (2015) argue ethics to be imperative. Accordingly, the respondents were made aware of their right to anonymity and by mutual agreement, the names of the companies were anonymized. However, this was also an intentional choice as it allowed respondents to speak freely and point to the barriers and their intentions to implement additional product life extension strategies, instead of speaking positively about sustainability and tone down actual perceptions.

Furthermore, reaffirmation that the implications of the study were explicit to the respondents was performed, and assurance was provided regarding the information gathered to be used in the same context as discussed with the respondents, not in any other manipulated form. Accordingly, a deliberate briefing was performed in the initial e-mail, phone calls and personal meetings to ensure the respondents of the purpose of the study and why interviews were deemed to be most valuable method for data collection. For future reference, the consent of respondents to record the interviews was sought, and therefore by mutual agreement, also performed. Finally, as Easterby-Smith et al. (2015) argue, it can be hard to maintain confidentiality of what one interviewee has said if it would be of interest to follow that up with another interviewee. With this in mind, during the data collection process, responsibility was taken in order to not disclose any information gathered from one interview to another, thus, respecting the dignity of the respondents.

3.7 Chapter summary

The methodological approach in this research has been tailored for the adequate contribution to the research purpose. The illustration below presents an overview of the essential parts if its application during the span of this research:

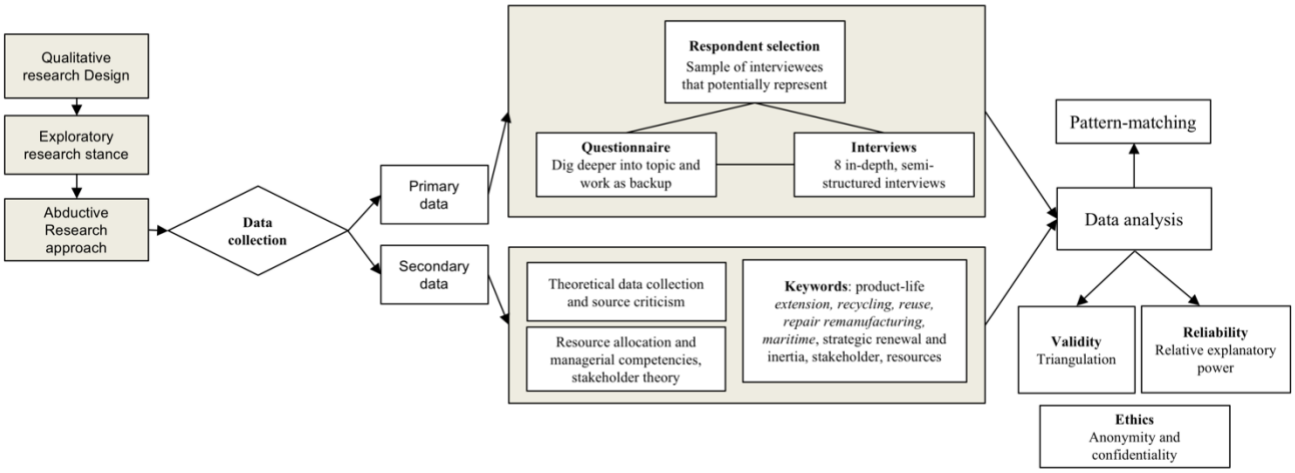

Figure 4 – *Methodological approach (authors' own illustration).*

4 Findings

This chapter provides the findings from the secondary and primary data collection. It is structured in a way that provides an overview of the industry that is relevant to the research at hand and is followed by a presentation of the insights gained from interviews and questionnaires. The findings serve as the basis from which the discussion in chapter 5 is anchored.

The first part of the following chapter presents an overview of the maritime industry based on maritime scholars and comments from industry experts and practitioners. As such, the industry overview provides insights of the general characteristics in terms of size and dynamics, the attributes and activities of the industrial stakeholders in maritime, and finally an assessment of current state of the maritime industry. The second part of the results chapter presents relevant findings from the conducted interviews and questionnaires with the stakeholders outlined in table 2 in the methodology. The structure of the findings follows the stakeholders and activities identified in the first part of the maritime overview. In turn, the findings present the perceptions of each industrial stakeholder in the relation to the potential barriers outlined in the framework presented in figure 3.

4.1 Industry overview

The following paragraph presents findings of the characteristics of the maritime industry in terms of size, dynamics and the maritime industrial stakeholders and their associated activities. Finally, the industry overview provides insights into the preferred PLE strategies of the maritime industry.

4.1.1 Characteristics of the merchant maritime industry

The maritime industry can be defined as "all businesses that own, operate, design, build, supply equipment or specialist services to all types of vessels and other floating entities" (Jakobsen, 2011, p. 9). It is an established and capital-intensive industry (Tillväxtanalys, 2010), as illustrated by the fact that in 2007, $187.5 billion worth of new vessels were ordered globally to increase cargo capacity (Stopford, 2009). The world fleet of consists of over 89.000 commercial vessels (Equasis Statistics, 2016), with vessels constituting the largest asset of the maritime industry, owing to its central role of operations in merchant shipping (Stopford, 2009). As indicated by a respondent shipping company, the maritime industry is characterized as inherently global and anchored in conservatism which can be linked to its repetitive patterns of shipping- and shipbuilding cycles.

The maritime industry is further characterized by clusters and inter-firm collaborations (Solesvik and Westhead, 2010). These clusters are especially utilized for pooling resources and distributing costs for the design of new ship, between different stakeholders of industry and their respective supply chains (OECD, 2018)

4.1.2 Industrial stakeholders in maritime and activities

Derived from Tillväxstanalys (2010) and interviews with industry experts, the merchant maritime industry can structurally be divided into five industrial stakeholders and associated activities: (1) shipping companies (2) shipyards (3) maritime equipment manufacturers (4) maritime service suppliers and (5) regulatory agencies. All five stakeholders are interlinked and mutually dependent on each other from the standpoint of the market's supply and demand mentioned before (Stopford, 2009). Figure 5 depicts an overview of the different industrial stakeholders in maritime.

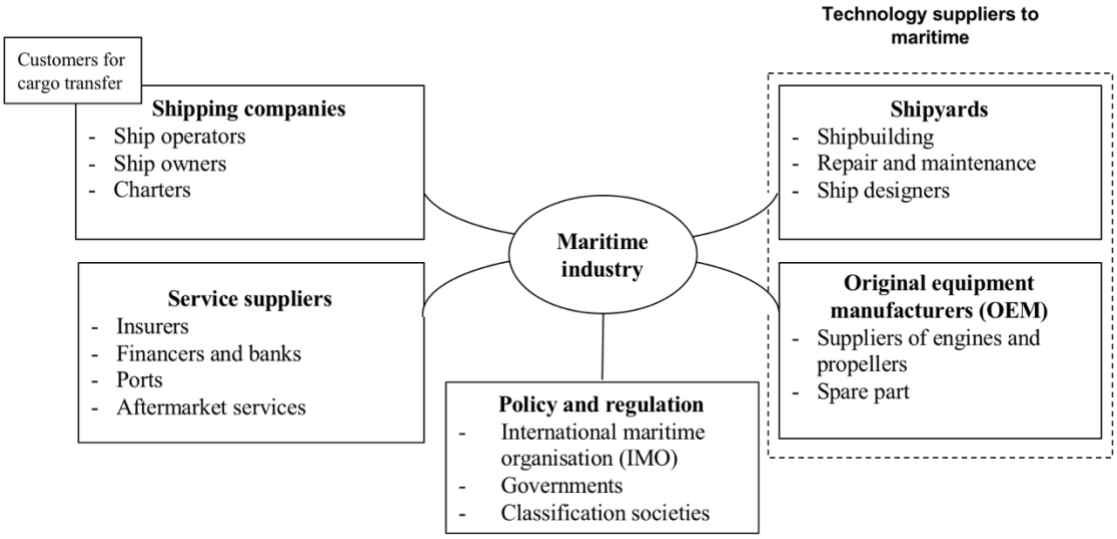

Figure 5 – *Industrial stakeholders in maritime and activities (adapted from Tillväxtanalys (2010) and interviews)*

Firstly, shipping companies are by industry stakeholders regarded as the main agent of the industry. This is backed by the arguments that shipping companies are the group of industrial stakeholders to initiate demand for new vessels and to manage both short-term operational and long-term strategic goals (TPR, 2015). Shipping companies are either categorized as shipowners, ship operators (through chartering etc.) or both of the two options (Jakobsen, 2011). Additionally, shipping operators act as decision makers to purchase services like maintenance, repairs and

improvement of existing vessels through the shipyards, ordering and selling vessels on the second-hand market and ultimately sell ships to a demolition yard (Stopford, 2009).

Secondly, shipyards constitute another important function of the industry. Most shipyard companies are conducting maintenance, repairs and remodeling of vessels, while a smaller share, at least in Sweden, is actually designing and building new vessels (Tillväxtanalys, 2010). In addition to that, shipyards can act as shipbreakers (also called recyclers) and thus serve as the end destination for vessels that no longer adhere to regulations or can be profitable operated (Stopford, 2009). As noted by a respondent from a shipping company, this means that shipyards are present at each stage of the product life cycle of the ship, although not all shipyard companies have the necessary capabilities to address every stage of the product life cycle. Additionally, shipyards who maintain and repair the complex structures of vessels, commonly work together in a network with manufacturers of marine equipment, including original equipment manufacturers (OEM) (Stopford, 2009).

Thirdly, in order for the shipyards to conduct the repairs and maintenance, the original equipment manufacturers to the maritime industry, commonly referred to as OEMs, are responsible for facilitating access to a wide range of technical inputs and services. These OEMs specialize in a certain type of maritime equipment like propulsion and engines (Tillväxtanalys, 2010). The maritime industry is however not the sole customer group for these companies, meaning that the technology used in the maritime equipment is also likely to be utilized across a wider range of industry clusters (Tillväxtanalys, 2010).

Fourthly, a number of other activities are taking place around the sea and ports. These activities are performed by stakeholders other than shipping operators and can be categorized as maritime service suppliers. Service suppliers include a wide range of sub-categories with the largest being brokers, financers and ship insurers (Tillväxtanalys, 2010). As earlier mentioned, the shipping industry represents large amounts and consequences from accidents can have significant financial impact. As such, a maritime insurance company is required to possess an extensive level of expertise in order to cope with these high risks in a global and complex industry (Tillväxtanalys, 2010).

Finally, policy and regulatory bodies constitute an overarching category of actors which through regulatory development manages the work for safer, secure and cleaner waters (Tillväxtanalys, 2010). The International Maritime Organization (IMO), a UN agency, is regarded as the most influential regulator owing to its global reach and influence (Stopford, 2009). IMO specifically works to solve the complex assignment of aligning interests and reaching agreements through conventions that might eventually become international law if accepted by all 166 members (UN, (n.d); Tillväxtanalys, 2010). However, as noted by a classification society during the interviews, obtaining agreement among all members provide substantial difficulties, often resulting in vague formulations and few concrete measures. As further explained, these vague formulations can partially be explained by the fact that the maritime industry has its own regulatory system in the form of classification societies. The role of the classification societies is to work as technical advisors to the shipowners and establish an industry standard to certify whether a ship lives up to certain technical standards in terms of design, construction and maintenance (Stopford, 2009).

4.1.3 Recycling of vessels - the preferred industry process

The maritime industry is under increasing political pressure to adhere to environmental issues and new regulatory frameworks for vessel recycling with end-of-life solutions in mind to improve on safety and environmental impact from scrapping vessels (Lloyd's register, 2011). As of 2018, the shipping industry signed what is called a historic climate deal, entailing a reduction of emissions by 50% by 2050, signaling a willingness to break out of the long-reigning conservatism, but also an indication for the industrial stakeholders in maritime that: "rapid innovation is needed" (BBC, 2018).

Related to the aspect of waste management, the industry is using recycling (also called scrapping) as the preferred business model for dealing with vessels that no longer live up to the either the requirements from regulation or clients (Lighthauz, 2015). The maritime industry has always incorporated recycling processes as vessels reach the end destination on their life cycle voyage. The material used for building vessels, in the old days wood, or nowadays steel and other metals has always been valuable. In recycling, the maritime industry is a forerunner in closing the lifecycle loop when compared to other industries (Jansson, 2016). In fact, 95-98% of ship weight gets recycled which is well ahead in comparison to similar industries such as automotive and

aviation (Jansson, 2016). As emphasized by a respondent shipping company, recycling is thus regarded as the best alternative for value extraction at the end of the vessel life-cycle, as the only other alternative is selling it as second-hand ship, which not always is a viable option.

Currently, the ship recycling process can be executed through four different practices with beaching, mainly practiced in India, Pakistan and Bangladesh, being the cheapest but also least sustainable practice from a worker safety and environmental perspective (Litehauz, 2015). The Hong Kong convention provide guidelines for the dismantling process to improve these conditions, although this convention are still only guidelines for the industry and lacks the adoption as an international standard (Equitas Statistics, 2016). The largest shipping company in the world, Maersk Line, has since 2009 implemented their own recycling standard as a strict interpretation of the Hong Kong convention. However, Maersk deems this to be an industry wide problem, and will require the onboarding of other stakeholders to change unsafe recycling practices, since they are all linked to other aspects beyond the vessels in the time before recycling (Maersk, 2017). By adhering to their own standard, Maersk is even losing money from every ship they send for recycling in the pursuit of spreading responsible practices (Maersk, 2017).

4.1.4 Industry overview summary

The maritime industry can be deemed conservative and slow moving as it has experienced only incremental changes, when taking into consideration its global footprint, size and range of stakeholders. It is a capital-intensive industry with vessels constituting the largest asset category. The industry consists of five main industrial stakeholders and activities; shipping companies, shipyards, OEMs, service suppliers and regulators. Stakeholders seem interdependent in different linkages and possess differing influential power on the strategic direction of the industry and its stakeholders.

4.2 Perceptions of maritime stakeholders

The following section presents the findings from interviews conducted within each stakeholder group as listed in table 4. The presentation of stakeholder perceptions is structured according to which end of the product-life extension strategy the individual stakeholder has influence within. Sequentially, the overarching stakeholder groups of regulators and service groups follows

sporadically. Hereafter, the findings present how each stakeholder perceived the potential barriers outlined in the framework presented in figure 5 (p. 47). This is motivated on the basis of stakeholders providing different perceptions, when asked about the potential barriers. Figure 6 below depicts each industrial stakeholder and associated activity relates to the different PLE strategies.

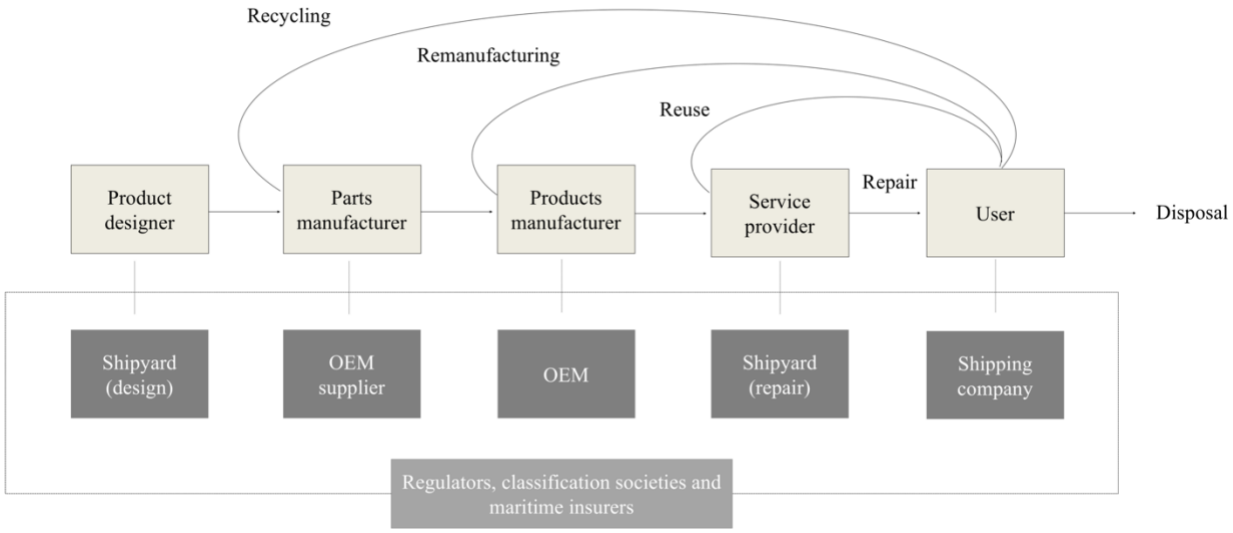

Figure 6 – *Stakeholders identified in maritime as part of PLE strategy transactions (authors' own illustration).*

4.2.1 Shipyards

Mixed views on necessary skills. Some respondents from the first stakeholder group shipyards, address explicitly the lack of local skills in pursuing new strategies such as reuse and remanufacturing. This lack of skills is caused by short-term guest workers from neighboring countries, prohibiting the shipyards to utilize their labor force in pursuing new strategies. One respondent describes this situation as shipyards becoming increasingly management-oriented, with not many skills and knowledge left on the shipyards. Thus, customers complain since they want knowledge and skills to be at the shipyard, but they also realize that it is difficult to keep staff and understand that overhead costs need to be held down with a flexible labor. Vessel systems are becoming ever more complicated and the lack of skills at the shipyards today could illustrate a risk for the future. Other respondents do not highlight a shortage of skills. Instead, it is argued that skills and opportunities for remanufacturing and repairing components already exist as there is a whole aftermarket that lives on just reconditioning.

Adequate logistics systems. Reverse logistics infrastructure raises another important resource-issue in adoption of reuse and remanufacturing. One respondent asserted that the maritime industry is more reliant on the large recycling industry, with not much effort put in preserving equipment for reuse. As it is cheaper and carefree to scrap, Swedish industrial stakeholders in maritime, in particular, tend to stay away from involving themselves into complicated transactions. Another respondent also mentioned recycling companies to frequently take care of waste as a result of maintenance and repairs and thus building a solid infrastructure to gain access to these components. Drawing upon their experience, another respondent, however, stated that: "reverse logistics infrastructure is already developed due to maritime being a business-to-business market. I can therefore not see a problem with the processes of taking back a product for reuse or remanufacturing".

Lacking demand for reused and remanufactured components. One of the Shipyards highlighted the fact that, customers in the shipping business are limited, and they know all of them, meaning that the challenge of the shipyard is to increase the work performed for existing customers in the market. The respondent also explained a case of how the industry of remanufactured components was a striving industry but died abruptly: "Before 2008, the shipping industry where in high demand of ship engines, and remanufacturing of engines was preferred, because the complete remanufacturing process of engines took only two months, which included the logistics and paperwork". As such, demand for remanufacturing was explained as being upheld by the aspect of time efficiency. In that regard, the time a vessel spend during a repair is described by most stakeholders as one of the most critical factors in the maritime industry. This is supported by another respondent pointing out that price and delivery time are the controlling parameters as to whether a component would be suitable to be repaired or remanufactured.

One of the shipyards addressed that is it not up to them to start the process of reuse and remanufacturing in ship repair. Rather, the demand should come from the ship owners, because shipyards do what the owners say, and shipyards can only suggest using remanufactured parts, not enforce it. Shipyards would have to wait for the request and then advance when that situation comes, but that is not on the agenda right now.

When asked about the global aspect of demand, the shipyard stated: "If the demand will rise beyond the few requests we have from China and India, then we will consider it a good opportunity to start a reconditioning yard". This was followed by a comment stating that they will need partnerships and a network of suppliers for making it work. Further, one responded stated that: "The industry tradition is to run equipment until it is completely worn out in order to extract as much value of possible". This in turn is claimed to unfortunately make remanufacturing unlikely as there practically is little to use at the end-of-life cycle.

Mixed customer preferences on reuse and remanufacturing. Shipyards stated that there were varying perceptions regarding customer perceptions of reused and remanufactured products. A shipyard stated that some of the shipowners they work with have specifications to only use OEM parts, and that no reused or reconditioned parts are allowed. "Some customers are indifferent as to what type of component they get while others are very picky about the technical parts". Another shipyard respondent experienced that the customers normally has no opinions but is rather controlled by costs as the main factor. Demand for reused and remanufactured products were currently not on the agenda. The focus is much more on avoiding downtime and getting the right quality at the right price. However, if the remanufacturing of a component would increase down-time, this would prove a major barrier. A respondent further stated that it is a challenge to convince ship owners that a remanufactured component is as good as a new in terms of quality and it will operate without problems. This was further backed by another shipyard who stated that finding a suitable customer for the remanufactured parts constituted a very high barrier. Following that, one shipyard mentioned that customer preferences regarding spare parts differs.

Global competition push prices down. A shipyard highlighted the role of price in transactions with customers. One respondent added that prices are not competitive as the maritime industry always pushes the prices down by means of tenders, consequently accepting the cheapest offer. An additional respondent noted the marine industry's global exposure to be the reason for seeking lower prices for any type of service, further adding that the global competition makes it fierce to obtain a service agreement. With the focus on price, shipyards recognize the necessity of adapting to the situation with flexible services and high availability at all times. One respondent put it

succinctly; “shipyards are increasingly resembling management-organizations basically focusing on the supply chain”.

Difficult to obtain economies of scale. In further discussion for this instrumental claim for cost-efficiency, one respondent highlighted engine parts to have the highest potential for reuse and remanufacturing. There is always a need for ship operators to replace engines, usually going through an assessment to decide on costing grounds. However, the need for shipowners to accept such components was deemed of utmost importance, especially because they were emphasized to be cheaper. Another respondent attested this notion: “cost is always a decisive factor in ship repair and in replacement of components such as engines”. According to one respondent, small shipyards do not have the optimal opportunity for the creation of economies of scale in this regard to make it a solid business case. Shipyards with larger volumes, on the other hand, were pointed out as better candidates to investigate business opportunities involving reuse of residues.

Lack of industrial consultation regarding design and standardization. Shipyards also highlight the importance of design and standardization of components in the encouragement for reuse and remanufacturing. Many components were highlighted to be heavy and complex to remanufacture because of technical impracticalities. There is a large variation from vessel to vessel and as one respondent stated: “There are a lot of individual vessel designs, which makes it difficult to find components suitable for many applications”. One respondent specifically mentions small components to lack standardization. From a perspective of repair, these relatively inexpensive components quickly can become costly to repair, due to hourly cost becoming too high, compared to buying a new component. It is further highlighted that: *“*...more rigorous and transparent documentation would allow vessels to be properly managed, as it would become more difficult to scrap vessels in the third world due to well-defined requirement specification and documented control”.

Insufficient information and awareness regarding reuse and remanufacturing. Shipyards further point out information as an important driver to influence sector-wide change. One respondent states that shipyards are in a convenient position to influence ship operators in their decisions. As ship operators have many other business issues to shift focus to, ample space for decision-making

is in the hands of shipyards. However, shipyards need to be prepared to discover sound solutions that address the instrumental claim for cost-efficiency. Another respondent asserts that shipyards are committed to keep up to date with information regarding their industry. Nevertheless, a shipyard reported: "There need to be more widespread information on the benefits of reused and remanufactured components. We will welcome an evaluation of further opportunities".

Lack of regulatory pressure. All shipyards identified several policy and regulatory barriers to reuse and remanufacturing in the maritime industry. Attention was called on government who currently not allow remanufactured equipment in retrofitting existing vessels, as new components are preferred instead, one respondent mentioned. One respondent added: "mandatory national targets by government for reuse and remanufacturing in the maritime industry can be useful if it does not distress the ship operator and conditions are given to the re-user". However, such policies are yet to be discussed, one respondent added and further explains: "Mandatory requirements for reuse and remanufacturing are absent and ship operators usually have their own business policies"

For target setting, however, one respondent states that there needs to be industrial consultation and agreement to make sure that required targets actually are possible to fulfil. At the moment, however, requirements from authorities are characterized by inadequate cooperation and solution orientation, with one respondent adding that a wider participatory approach is necessary to promote reuse and remanufacturing, in case it is a feasible business endeavor. Thus, one respondent concluded, a new economic system to apply in general might be needed for reuse and remanufacturing of components to become commonplace in the maritime industry.

4.2.2 Shipping companies

Mixed views on the matter of skills and technology. One respondent mentioned skills and technology for PLE strategies to exist, however, in their view, it is currently too expensive to purchase remanufactured products due to the costs of skills needed for it. Another respondent also mentioned that expanding the business within remanufacturing could mean less skilled manpower allocated to recycling. It was therefore a concern if these two skills technological processes were not developing on par with each other. However, one shipping companies stated that they have

started looking at the opportunities, together with other shipping companies as a strategic alliance, of using 'grey parts' which are spare parts from third parties and not OEMs.

Customer attention on recycling. As reported by a shipping company: "Today, approximately 98% of the vessel can be recycled, either by means of direct reuse or re-melting, which in some cases, however, provide lower quality steel". "The business case with moving to a cradle-to-cradle process would avoid mixing high-quality steel with lower-quality steel, and therefore, avoid the dilution of high-quality steel as a end result". However, the shipping company said, pursuing such processes to a larger extent also present challenges in the form of awareness and data, as there are many unknowns involved, ultimately weakening the business case.

Predominant time and cost-consciousness around assets. All shipping companies reaffirmed the notion of price and costs being critical at the negotiation table. Several respondents noted customary repairs to be conducted abroad, especially Asian countries (China, India and Korea) because of cost-effectiveness of labor. Consequently, dealings with shipyards in northern Europe (Sweden, Denmark) were mentioned to be minimal or insubstantial due to expensive offerings and operations. An important cost factor was highlighted by one respondent in importance of the key asset in the maritime industry; the vessel. They emphasized that: "There should be no stops on vessels, as even small stops will cost millions of dollars". Associated to this, time-effectives was deemed a critical factor, in order to avoid costly downtime. In order to open up for reused and remanufactured components, another respondent accentuated the intent of having "a spare parts deal with the OEMs for their vessels, since it is cheaper compared to getting spare parts from shipyards.

Information disparity between markets. Ship operators point the global nature of the maritime industry to pose difficulties in terms of awareness, which by one respondent is regarded to vary drastically between markets. Awareness levels around reuse and remanufacturing can be at completely different levels depending on what part of the world it is referred to. The information disparity holds the maritime industry back from applying circular economic principles, and only being circular in Europe makes no sense if you cannot be circular simultaneously in other parts of the world. Reuse and remanufacturing, therefore, has to be globally circular, and the maritime

industry is far away from it for the moment. The respondent did not state that it cannot occur, however, it will take a lot of effort. Ultimately, reuse and remanufacturing cannot be universally established in the maritime industry for the moment yet due to the information levels being insubstantial, the respondent concluded.

Lack of data and standardization in design. Further, it was highlighted that a shipping companies had experience in trying to create a standard showing all components of their vessels. However, they realized that the supply chain was too global and too big for them to create the standard themselves. Now, they are ready to create the demand for more data transparency in the industry of components and a change towards more circularity in maritime, but stress that it would require forging of wider alliances among stakeholders in the industry. Meanwhile, it was further emphasized that implementing circular principles in shipbuilding would require a global perspective: "In shipbuilding, you cannot make a solely European made vessel, because the suppliers will all over the world. Only being circular in Europe makes no sense - if you are not circular in Asia at the same time. It needs to globally circular and we are so far away from it".

In terms of reuse and remanufacturing, one respondent attested that there is no consensus among shipowners for the cost-benefit of reused and remanufactured components. As the maritime industry operates in a global market, shipowners from different markets are not recognizing any cost savings, but rather expenses, as reuse and remanufacturing is ought to entail significant upfront investment before it potentially pays off. It was commented that: "the sustainability profile would be boosted, but it is not enough to make the business case robust". Thus, the respondent added, because there is no pressure, ship operators are not discussing reuse and remanufacturing as a necessity at a bigger scale. Shipping companies further acknowledge the importance of component design. Depending on the component, as effortless access to documentation usually makes maintenance and repair of components unambiguous. One respondent emphasizes heavily on sister vessels, a standardized portfolio of vessels that utilize the same constellation of components. Standardization of this kind is deemed helpful in managing the fleet in line with reuse and remanufacturing.

Global regulation prohibits adoption of reuse and remanufacturing. A shipping company also mentioned how politicians set out the terms. However, one respondent stated that since shipping is a global endeavor, there is a multitude of countries and politicians involved, everyone with their particular interests. Another respondent echoed this notion, further stating that maritime is quite conservative, and from a regulatory point of view, the only industry in the world that is globally regulated. There are no disruptive transformations in the industry as it is "hidden", as one respondent put it, due to its business-to-business character. As not a lot of people are aware of the industry, awareness and pressure to change are low to move towards circularity in terms of reuse and remanufacturing. Further, parallels were drawn to the automotive industry and the proliferation of regulation favoring reuse and remanufacturing. As automotive is regionally regulated, one respondent highlighted EU regulation to have given rise to standards that promoted the automotive industry to establish reuse and remanufacturing as commonplace processes.

Expertise within logistics and planned maintenance. One of the respondents emphasized that the shipping industry is dependent on continuous forecasting, cost optimization and time effectiveness. With these competencies in place, it is deemed that it should not be difficulty to plan repair and maintenance to incorporate reuse and remanufacturing. This is due to repair being a frequent operation and it is seldom necessary to do repairs in specific locations, and as such, exchanging cores and spare parts for reuse and remanufacturing should not pose a barrier.

Difficult to impose new global standards by oneself. To optimize on value-capturing, one respondent mentioned the initiated cradle-to-cradle passport, which aimed to discover how vessels can be designed for better recycling by mapping out all data on a ship's components. However, the project could not fulfil its full potential, owing to a lack of backing from shipbuilders and customers and the fact that they could not do it single-handedly. In relation to the cradle-to-cradle passport, the shipping company further stated that they could not deploy such a such a project without industry-wide consensus on its benefits. The respondent states that it is not only about the details, but rather about politics and alliances with other parties, that can engender consideration for reuse and remanufacturing in maritime. Bringing stakeholders together, to set global standards on such practices positively affect the degree to which ship operators can reuse and remanufacture components in ship repair.

4.2.3 Original equipment manufacturers (OEMs)

Quality of remanufacturing on par with new production. The OEMs had already started their business units within reman and remanufacturing January 2018 and it had so far already exceeded sales expectations. They stated that dialogue has been initiated with their larger global customers, but the implementation is moving slowly. The OEM consider it a win-win situation for both parties, but there is some conservatism ruling the industry, which stops the demand on larger scale. Quality of the cores was not seen as barriers since the OEM can provide guaranties with the products. However, it should not be every shipyard that does it, since they risk damaging the product and trust in the quality. Time on the other hand was assessed as a potential issue, as the ease of bringing back a product and transporting it to the customer could be timely. Nevertheless, it was claimed by the OEM that they have the resources they need in terms of finance, skills and technology to scale it up.

Difficulty in convincing customers on cost- and time-efficiency. One of the OEMs reported that a challenge being: "the special and specific parts, which are not as common as an engine, where you have more similar components and product range. Then there are also the classification societies. Some products might be a problem for the classification societies to approve". Another challenge was highlighted as third-party actors, including shipyards, who are not capable of handling and fitting the reused and remanufactured components. It was reported saying: "We have a lot of problems with people that should not be touching our products and does more damage to the products. When asked what their concerns were in terms demand, they stated that they have much dialogue with their bigger global customers. However, the concern of the customers was if the process would entail more time consumption in relation to repairs. It was emphasized that it will take a long time to implement these new processes, due to conservatism ruling the industry. Nevertheless, the OEM stated that they had already exceeded expectations for the remanufactured parts this year, although it is still in the small numbers with 50 propellers being remanufactured.

Initiated dialogue with classification societies. In terms of information and communication, the OEM stated that: *"*We are working with classification societies to get procedures up and running. They have everything we need, so that they that can approve a product from day to day and give confirmation. The communication between us and the classification societies is up and running".

As such, the adoption of reuse and remanufacturing would not be possible without close collaboration with classifications societies. It was claimed that there should be better consensus among stakeholders, that these new initiatives of remanufacturing should only be seen as an option within spare parts, and it would therefore not risk cannibalizing on their existing business.

4.2.4 Regulators and classification societies

Trust issues regarding quality and time-effectiveness. It was stressed that taking back engines and bringing them back to OEM standard had been discussed before as well as the use second hand components. However, this reuse and remanufacturing practice is not something they advocate for due to trust issues on remanufactured and reused products to fulfil the requirement of the latest engine standards, in relation to vessels receiving major modifications. The respondent comments that they do not recommend other industrial stakeholders to refurbish parts, such as pumps, injectors etc. outside of the OEMs licensees. Further, the classification society notes that there are companies trying to make a business out of repaired components, which are advertised as just as good as genuine components, although they are not in their perception. Ultimately, there is a lack of trust in the quality they claim.

Lack of information and traceability. They further highlight that all things can be considered in the format of time, but in the likelihood that propriety of shipowners accept the remanufactured parts, the parts will still not necessarily pass those requirements of the classification society. The lack of confidence exists due to a lack of traceability, lack of understanding if the components match the OEM's manufactured parts, significant design changes whereby they will not recommend the use of old parts.

Putting responsibility on shipping companies. The classification society further discussed costs within product-life extension to depend on shipping companies. It is the call of ship operators to decide for reuse and remanufactured components in terms of cost-efficiency. This meant that if the benefits outweigh the costs of investments, then there could be opening for further discussions on the matter. However, this discussion was not expected by the respondent to come into place anytime soon, as he perceived that to have been discussed enough already in the last decade.

Planned obsolescence preferred. Classification societies are conflicted in the deliberation of a potential business case in product-life extension of vessels. One respondent asserts the life cycle of vessels to be decided at the design table, as all vessels are designed for a specific amount of utilization, meaning a finite life cycle. However, that does not mean that the lifecycle is limited by such; the age depends on the vessel type and ultimately its use. Although reassessments on vessels can be conducted, however, classification societies cannot assess vessels as younger than they actually are. Thus, in relation to contemporary reuse and remanufacturing it was reported that: "a component cannot be classified as younger than it actually is. Ultimately, when a component gets older, shipyards should disclose that the component's ability to absorb high uses and stresses has diminished". Designers therefore have to optimize the design for a specific number of life cycles and avoid residual design redundancies in this design. It was mentioned that it he saw it as possible to design components for remanufacturing, but that mean that designers will design themselves out of their profession if a vessel is designed for infinite use.

Policy imperative to drive reuse and remanufacturing. The classification society stated that they have various innovation streams and that they are open to the industry's ability to comply with the changing regulation imposed by the International Maritime Organization (IMO). However, the respondent stated that they are not advising the industry stakeholders to pursue longevity and material notation, but rather working together with the industry to achieve the end goal dictated by the IMO. They further added that classification societies are not influenced by political hand, but rather operate as an independent organ to reassure trust and safety within the industry.

Reuse and remanufacturing not on the agenda for legislation. One of the respondents noted that not discussions existed currently around reuse and remanufacturing on a higher legislative level. The agenda for maritime legislation was claimed to be focused climate and emission levels of vessels and incorporating improved measures within safety and regional practices of recycling processes.

4.2.5 Service suppliers (insurer)

*Acceptance if quality is assured***.** The insurer pinpoint quality to be prioritized in case of reuse and remanufacturing. Vessels must maintain quality due to requirements dictated by the classification

societies. Although spare parts and non-OEM components are acceptable, they have to conform with OEM-component quality. The insurer commented: "As long as the quality could be guaranteed, and it can be done in a timely manner, I cannot see why we should not accept shipping companies to use reused products". It was further emphasized that there should be no problem with reused and remanufactured products as long the other industrial stakeholders in maritime recognize a business opportunity in terms of significant cost savings. The insurer would be surprised if the ship owners were not reusing refurbished certain parts for the engine. However, the insurer also stated that the ship owners prefer new parts over refurbished parts. This preference was similarly based on the concerns on quality of spare parts as well as industry standards. They further stated that cheaper components are always strived for in order for shipping companies to maintain profitable operations. However, it was reinstated that those cheaper components, whether they are reused or remanufactured, should live up to "(...) as new standards".

Dependency on classification societies. The insurer recognized that the acceptance of reused parts will have to be decided by the classification societies. They also established that shipowners mainly prefer new instead of refurbished parts, but they had not heard about their customers considering it. From the insurance perspective, the most important factor was cost-efficiency, and if they could purchase a remanufactured component that lived up to the quality standards, then they would always do that. Nevertheless, at this time, they would have to obtain clearance from classification societies.

4.3 Synthesis of findings

Figure 7, presented below, synthesizes the critical and non-critical issues perceived from the empirical context in identifying the potential barriers of adopting additional PLE strategies. In order to simplify the review of the figure, the most important findings are divided into:

1. Factors perceived to constitute a barrier according to the respondents,
2. Factors perceived to not constitute a barrier according to the respondents, and
3. Factors that have received mixed perceptions in regard to constituting a barrier or not.

Furthermore, in order to ameliorate the traceability of the statements of particular respondent group, the stakeholders are listed to the left of the figure.

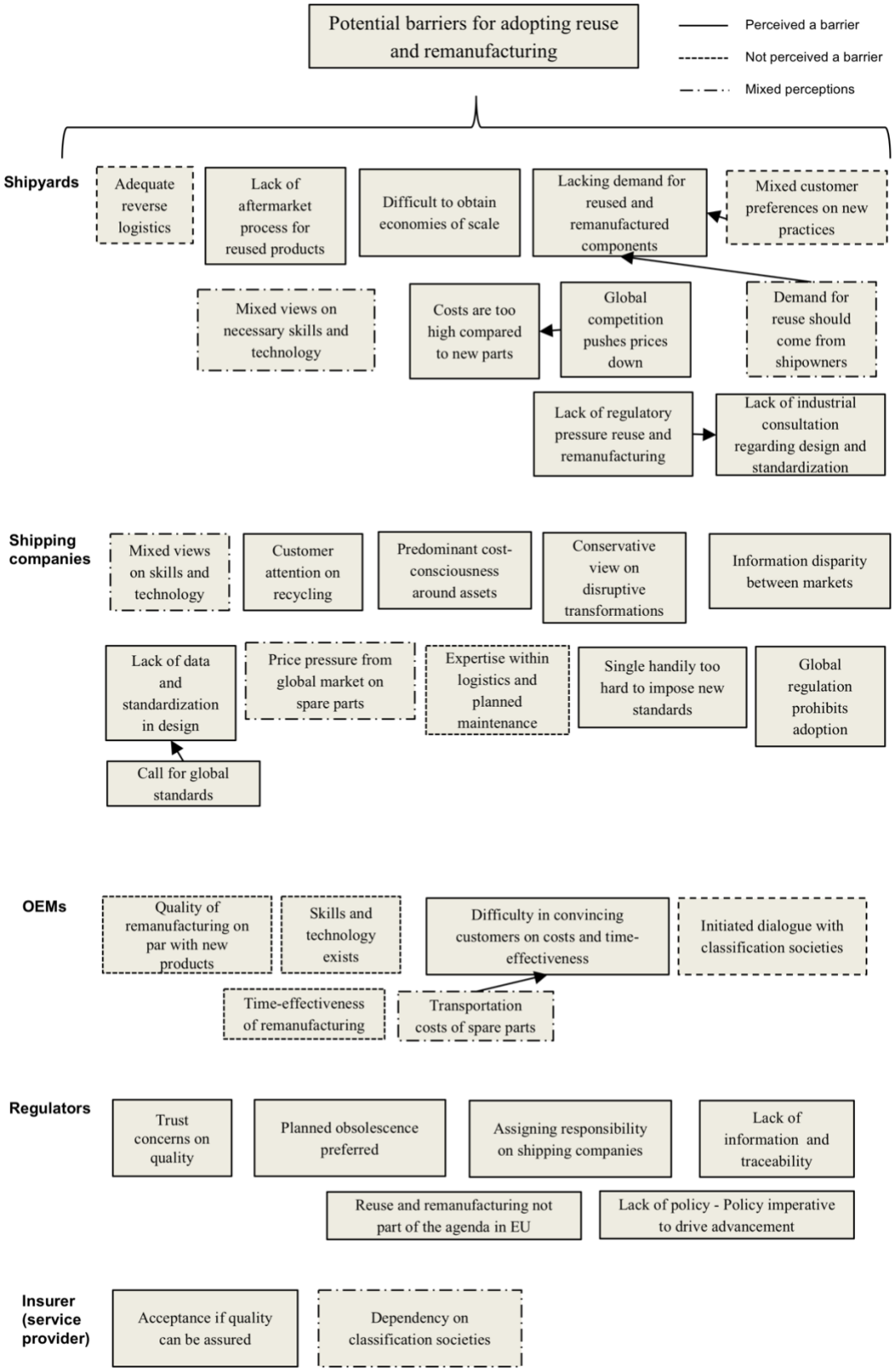

Figure 7 – *Overview of the research findings (authors' own illustration)*

4.4 Chapter summary

The generous number of findings obtained for this research paint an intricate picture for adopting reuse and remanufacturing practices. These findings indicate that certain perceptions of barriers are intertwined and are shared among numerous respondents, while others are ought to constitute a barrier for specific stakeholder groups. Nevertheless, the findings shed light on the holistic perspective of the maritime industry and provide compelling discussion points from each industry stakeholder, which the following chapter will examine in the light of the theoretical framework presented earlier.

5 Discussion

The discussion builds on the findings in the light of previous research and, thus, utilizes pattern-matching to place the theoretical realm and the observational realm in proximity in order to contribute to the purpose of this research.

The purpose of this research is to increase the understanding of the potential barriers inflicting the adoption of additional PLE strategies. The findings presented in the preceding chapter indicate that the adoption of such strategies might be subject to multifaceted impact from resource requirements, managerial competencies and stakeholder influence. Accordingly, the three objectives presented in the introduction help to guide the discussion around these three categories to answer the overarching research question.

5.1 Resource requirements

Reiterating previous literature, certain resources could be a requirement in order for an industry to adopt additional PLE strategies. Thus, specific resource factors were highlighted in the theoretical to determine the potential resource gaps to be filled in order to fulfill the resource requirements that might be required when adopting additional PLE strategies. The ensuing discussion of this section sheds light on the first objective of this research, that is:

Objective 1: *Identify and analyze the potential resource gaps and requirements to adopt reuse and remanufacturing.*

Technology. Theory suggests that physical capital in the form technology can provide a resource gap and that resource allocation is dependent on whether the technology is available or if demand already exists (Linton & Jayaraman, 2005). Findings show mixed views on whether technology constitute a resource gap in relation to adopting reuse and remanufacturing strategies. While classification societies are skeptical about the quality of reuse and remanufactured products, OEMs claim that the technology exists to offer the same quality as new products, pointing to technological resources not constituting a barrier. However, because risk management can be linked to resource allocation, projects with assured customer demand are most likely to receive funding (Christensen & Bower, 1996). Associated to this, a potential barrier might exist in the onboarding of industrial

stakeholders to allocate resource to additional technological standard, and adopt additional PLE strategies, due to the findings pointing at lacking customer demand.

Technology and recycling. Additionally, the findings might support previous research stating that a barrier for adopting of additional PLE strategies can be associated with a perception that adopting PLE strategies would discourage the development new technology (Heiskanen, 1996; Mont, 2008; Bocken et al., 2016). This is due to the fact that there were mixed views on new practices, although classification societies, being an impactful player in industry, saw remanufacturing as a negative impact on the development of new technology and optimization of recycling. As such, barriers are more perceived to exist in a loyalty toward developing on existing technology of recycling, rather than the actual technological behind reused and remanufactured products.

Quality and time-effectives. The aforementioned lack of demand could further be assigned to several factors such the lack of information and traceability, trust concerns on quality and time-effectives. This lack of trust in time-effectiveness supports previous literature (Parida & Kumar, 2006) stating that time might negatively affect remanufacturing processes, meaning that components are regarded to not be delivered on time. However, OEMs does not perceive time-effectiveness to be affected negatively for remanufactured components. Instead, they argue that remanufactured products is ideal for maximizing productivity while minimizing downtime. Hence, time-effectiveness is not found to be a resource barrier, although the awareness around it might provide a barrier.

Skill. Human capital aspects such as skills, training and experience are in literature identified as possible resource gaps (Barney, 1991) and potential resources gaps in adopting additional PLE strategies (Linton & Jayaraman, 2005). Shipyards had mixed perceptions as to whether the necessary skills to execute new PLE strategies were available. However, one of the OEMs pointed to the fact that shipyards and other third-party players were not supposed to perform the actual manufacturing, but rather purchase such products for usage in repair operations. Skills, training and experience at shipyards should thus not provide at barrier. From the perspective of classification societies, a challenge exists in OEMs risking designing themselves out of business, if they were to extend their skills to be able to build components for more long-term usage. In other

words, planned obsolescence is preferred. This supports the arguments of Stahel (2010) and Bocken et al. (2016), who state that the well-established practice in manufacturing supports planned obsolescence, prohibiting remanufacturing to accelerate. Relatedly, several stakeholders highlight the same notion that global regulation prohibits the adoption of reuse and remanufacturing, due to its sole focus on recycling. On the other hand, as implementing new standards single-handedly was deemed difficult, global policies and regulation is deemed necessary to impose mandatory policies on other than recycling. As such, these finding confirms the research of Hopkinson and Spicer (2013) claiming mandatory policies to be paramount for PLE strategies.

Design. Interestingly, findings showed that skills required to design and optimize for reuse and remanufacturing was not seen as a barrier and cannibalizing risk among OEMs, who already design such products and components. This reinstates that the full potential of reuse and remanufacturing could be held back by the classification societies' loyalty to existing practices, and not by the lack of skills. Further, empirics point in the direction that resources are not allocated towards developing and training skills at shipyards to support other practices than repair and recycling. Thus, a lack of skills in the aftermarket process for the instalment of reused and remanufactured products in repair might constitute a barrier.

Reverse logistics. Resonating with previous literature and research, organizational capital in the form of coordinating systems and reverse logistics may carry the potential as barrier for adopting PLE strategies (Linton & Jayaraman, 2005). According to the findings, reverse logistics received different views as to whether it represents a barrier. On the one hand, some shipping companies were skeptical as to whether the speed of logistics would be slowed and be more costly. On the other hand, other shipping companies and OEMs stated that existing recycling practices already are in place to bring back products and components in due time. Additionally, reception of all types of vessels and components is common practice, meaning that reuse and remanufacturing could proliferate through its use. Further, Lacy and Rutquist (2015) argued that B2B industries holds significant potential within PLE strategies. This argument was supported in discussions with shipping companies, characterizing maritime as a B2B market build around logistics and formal

systems. This notion ultimately points at logistic resources not being perceived as a barrier of resources, as is otherwise highlighted as a concern by Jansson (2006).

Cost-effectiveness. In line with previous studies on cost-effectiveness in terms of components and labor costs (Barbiroli, 2008), the current costs associated with reused and remanufactured products are too high to make financial sense, as perceived by some shipping companies. This is fueled by the fact that the industry is reliant on recycling, which currently is the cheapest and most carefree process. From a perspective of repair, these relatively inexpensive components quickly can become costly to repair, due to hourly cost becoming too high, compared to buying a new component. Additionally, related to the finding that the industrial stakeholders in maritime are deemed costs-conscious and particularly interested in labor costs, maintenance and repairs, the current costs of especially the smaller remanufactured products are considered a hindering barrier. It can thus be suggested that more complex and valuable components such as engines, are most suitable for capturing circular value, as costs of labor might limit the profitability of less valuable components.

5.1.1 Key takeaways

Drawing inferences from the discussion, resources in the form of available technology were overall not perceived as a resource gap owing to OEMs already possessing the technological requirements to perform reuse and remanufacturing. However, with planned obsolescence encouraged by classification societies and resource not being allocated towards adopting new technologies, loyalty toward the existing practice of recycling constitutes a barrier. Human capital in the form of skills and experience is not perceived a current resource gap, despite the fact that shipyards stated a lack aftermarket processes to support rescued and remanufactured products. This is because OEMs claim to have the skills required to design components for reuse and remanufacturing. However, the OEMs perceive a barrier to exist in creating demand by marketing the products as cost-effective and adequate in terms living up to ‘as new’ quality levels. Nevertheless, shipping companies highlighted that demand would have to be supported by global regulation to set new standards within PLE development. Interestingly, from the structural point of view, reverse logistics is not considered a resource gap because of the existing recycling practices in the B2B market that allow for more efficient take-back systems. In sum, existing

resources could be deployed adequately if mandatory policy favoring reuse and remanufacturing would become commonplace.

5.2 Managerial competencies

Building on previous literature, managerial competencies could be regarded as integral to the adoption of additional PLE strategies. As mentioned earlier, theoretical contributions from strategic renewal literature, namely the subprocesses of renewal argued by Floyd and Lane (2000), could be helpful in increasing the understanding of the managerial competencies needed to facilitate such strategies. Thus, the discussion in this section is conducted in view of the second objective of this research, namely;

Objective 2: *Identify the managerial competencies necessary to facilitate the adoption of additional product-life extension strategies.*

Allocation of resources. Theory refers to competence deployment as the managerial ability to allocate resources into new products and market developments (Hamel & Prahalad, 1989; Levinthal & March, 1993; Mehra & Floyd, 1998). Accordingly, the findings show that such abilities are imperative to evaluate the adoption of additional PLE strategies. Firstly, the allocation of resources to additional PLE activities is necessary in order to develop a market for such types of products. As inveterate consensus of reused and remanufactured components is not widespread among different stakeholders, a responsibility is identified in OEMs to market such products to a higher standard. This coincides with the notion that remarketing is needed in order to incentivize customer willingness as argued by Bocken et al. (2016). Suitably, the findings show that OEMs have started to allocate resources to the development of remanufactured components. Simultaneously, shipping companies are allocating resources to evaluate the value for such products and are becoming more open to effectuate such purchasing practices.

Commitment to current strategy. As argued by Huff et al. (1992), competence modification refers to the process in which managers recognize the need for change, questioning current strategy and encouraging adaptability to market developments. In line with this notion, the findings show that there is a lacking recognition for the adoption of additional PLE strategies in maritime, due to prevailing recycling practices being favored by the majority of the industrial stakeholders in

maritime. Recycling as a strategy is not questioned as the overall perception points to recycling illustrated a sufficient, accomplished process in the industry. The findings show that established routines are not a subject of change and adaptability to market development is not encouraged. Drawing parallels to strategic inertia literature, strong commitment to current strategy inhibits management from proactive responses in renewed strategies (Huff et al., 1992). Thus, the tendency to conform and remain with the status quo, in this case recycling, might prohibit management from adding more value-capturing PLE strategies such as reuse and remanufacturing to the mix, and therefore halt back the deliberate efforts to capture value, coinciding with the notion of durability as argued by Cooper (2016).

Instrumental claim for cost-efficiency. The predominant cost-consciousness around assets in the industry has been highlighted as a barrier for pursuing additional PLE strategies. Although, Stahel (2013) mentions cost-efficiency to be a natural result of pursuing reuse and remanufacturing, managers in shipping companies seem to be risk averse as there is no apparent need for pursuing reuse and remanufacturing. In contrary, in the current climate, it can become more expensive to reuse and remanufacture than to recycle, which would contradict the arguments presented by Stahel (2013). Findings point to mandatory policy to be favorable to break this barrier, validating the arguments presented by Hopkinson and Spicer (2013), highlighting policy-making as a crucial element for this endeavor.

Lack of recognition for change. Related to the notion of competence definition, argued by Floyd and Lane (2000) to cover the process in which managers are encouraged to explore new market opportunities, OEMs specifically are becoming encouraged to explore the market opportunities with remanufacturing, as it aids them to hedge against future risk, both in terms of scarce resources and competition creating revenue streams with the aid of such practices. The findings reiterate the argument by Floyd and Lane (2000), that the consequence of lacking encouragement can lead organizations to fall behind competition in terms of efficiency. OEMs specifically state that recognizing the need for remanufacturing is a matter of avoiding market cannibalization in reference to increased competition in so called “grey parts”, components from third parties, that shipping companies also are becoming more accepting of. The lack of recognition for change among other industrial stakeholders’ managers can be accredited to a myriad of reasons, with lack

of information flows and conservative views on transformation as prominent factors. The responsibility, again, seems to fall on OEMs ability to enlighten and convince customer about the instrumental claims for cost- and time-efficiency with the adoption of additional product-life strategies. Furthermore, in reiterating previous research, a sign of reluctance in adopting additional PLE strategies is in the general managerial perception of such activities to discourage the development of new technologies. However, in maritime this does not necessarily seem to be the case as products and components are built to last. A shipping company pointed out that the horizon of a vessel to be set for 25-30 down the road, and an OEM reinstated that products and components are ought to be remanufactured and, in many occasions, upgraded during the same process.

Strategic action by means of forecasting, purchasing and planning. As the findings indicate, managerial competencies for strategic action are central to accommodate the pursuance of additional PLE strategies. Such strategic action points to functions such as forecasting, purchasing and planning to be necessary in order to commence on reuse and remanufacturing, as respondents point to these being linked to the prevailing expertise within logistics and planned maintenance. *Forecasting competencies* are identified as important characteristics due to the stochastic supply and demand of components suitable for reuse and remanufacturing, where it seems that managers are required to coordinate the two elements, reaffirming arguments presented by Zhao and Zhu (2017). *Purchasing competencies*, and specifically strategic purchasing, are deemed beneficial as locating the best component at the cheapest price seems to be the norm, supporting arguments presented in previous literature (Stahel, 2014; Shafiee & Animah, 2017) in highlighting the instrumental claim for cost-efficiency. Drawing further inferences from the findings, as uncertainty around acceptable quality seems to indicate a critical barrier, strategic purchasing could also be leveraged counteract preconceived perceptions that reused and remanufactured components do not hold the same quality as new ones. *Planning competencies* are also deemed to assist as useful instruments to adopt reuse and remanufacturing as in the case of shipping companies, who schedule most of their repair services. Shipping companies can acquire reused or remanufactured spare parts as part of these operations or act as a mediator for bringing back components that can be reused and remanufactured through reverse logistics channels, supporting arguments brought forward by Linton and Jayaraman (2005).

Ultimately, findings highlight the perception of quality to be the primary concern in deciding for the addition of PLE strategies such as reuse and remanufacturing. The opposing views regarding reused and remanufactured products could potentially point to what the strategic inertia literature finds as the most prominent barrier, namely insufficient awareness and information regarding additional PLE strategies. Thus, it can be argued that *communication competencies* are desired in order to facilitate the dialogue around such products, that according to the OEMs hold the same or better quality and warranty than new components. This reinstates the argument presented by Johnson (1988), pointing out the lack of information as a constraint for seizing strategic opportunities. The ability to communicate is especially necessary when shifting focus to classification societies and regulatory bodies, who put a limit to the adoption of additional PLE strategies due to skepticism around the characteristics of reused and remanufactured components.

5.2.1 Key takeaways

In line with the objective of the research, the adoption of additional PLE strategies necessitates several managerial competencies. Part of the ethos of a competent manager in the empirical context regards exploring the potential benefits of reuse and remanufacturing while retaining a focus on the goals of the company. Strategic action by means of optimized forecasting, purchasing and planning elicits the prospect for increased reuse and remanufacturing and can to large extent be leveraged from existing practices evident in recycling. The findings reiterate theory in the notion that loyalty towards current strategies halts back further exploration of more value-capturing activities. Thus, communication competencies appear to be paramount in intensifying the ability to allocate resources, scan the external environment and to gather relevant information in order to overcome the barriers set by the loyalty to current PLE strategies. In closing, commitment from top management is ought to be paramount in adopting reuse and remanufacturing, as it is indicated to be a strategic business decision. However, managers seem to be in need of policy-making that could help to proliferate the process further.

5.3 Stakeholder influence

With reference to previous literature, stakeholder influence can be applied as a pragmatic approach for understanding how dynamics between stakeholder groups might affect company and industry

wide change. Specifically, stakeholder expectations, interdependency and open communication were identified as relevant concepts to illuminate the second objective, namely;

Objective 3: *Investigate the influence of different stakeholders in the process of adopting additional product-life extension strategies.*

Expectations. The empirical findings have provided insights on potential barriers from a stakeholder perspective. Theory implies that organizations should to comply and address a set of stakeholder *expectations* that consequently makes management decision dependent on stakeholder influence (Brenner & Cochran, 1991). With this in mind, findings show that classification societies do not expect reused and remanufactured products to be adopted further in the industry, due to concerns on quality standards. It is further indicated that classification societies carry influential weight in the industry, and thus, their reluctant expectations could cascade through to ship owners. Although some OEMs are confident in the quality of the reused and remanufactured products, these expectations from the classification societies seems to provide a barrier for the adoption of additional PLE strategies.

On the other hand, shipping companies are by other industrial stakeholders referred to as the main agent of the industry, owing to their influence on short-term operations such as repairs as well as long-term strategic planning on ship investments. However, findings show that adopting new PLE strategies is not expected to appear on the agenda for neither the shipping companies, nor the organizations that represent them in EU regulations. Rather, the expectations are to improve on the recycling methods as means of value extraction, which not unexpectedly supports previous research that highlights industries favoring the improvement of a single PLE strategy at a time (Linton & Jayaraman, 2005).

Conversely, from the perspective of OEMs, who consider PLE strategies as a win-win situation with potential to capture value for all parties, this lack of impetus and demand from shipping companies or regulators is perceived a barrier. This finding can be associated to the domain of *corporate planning* (Ansoff, 1965), which implies that stakeholders can be seen as constraints to the corporate objectives. Hence, from the perception of OEMs and insurers, stakeholders such as

classification societies are in certain instances considered more as constraints than a cooperative force.

Interdependency and collective strategies. Contrary to the view presented above, the original stakeholder domain of SRI (Freeman et al., 2010) encourage managers to integrate and explore relationships with all stakeholders, instead of approaching them as constraints. Previous research notes that the adoption of PLE extension must be pursued as a proactive endeavor in altering customer behavior (Van Nes & Creamer, 2006). However, findings show that challenges could be expected in bringing stakeholders together to jointly introduce an industry standard, even though a large industry leader has proactively sought out to change behavior. This further indicates that there exists a relatively high degree of interdependence between stakeholders since no industrial stakeholder presumably can impose industry standards single handedly, ultimately, indicating interdependence as a barrier.

Adoption of global standards. In conjunction with the latest regulatory goals set by IMO, it is expected that the industry will be faced with industry changes, in which stakeholders are forced adhere to and collectively strategize for. Backed up by comments of several stakeholders, findings show that a widespread adoption of standards should stem from regulatory enforcement in order to mobilize all influential stakeholders. Unsurprisingly, these findings support previous research crediting legislation for making a certain PLE strategy the industry-wide standards (Folz, 1999; Honeywill, 2002), eventually pointing towards the lack of policy and legislation as a barrier.

Geographical proximity not imperative. Reiterating previous research from Lacy and Rutqvist (2015), it is pointed out that geographical proximity is vital in the application of PLE strategies. Interestingly though, the findings from shipping companies and OEMs show that this proximity is not a prerequisite or a barrier, because of the global nature and interconnection of the industry stakeholders. However, resonating with literature stating that local regional operations assist to avoid transportation and transaction costs (Stahel, 2013), OEMs claim that transportation cost of reused and remanufactured might impose a barrier, as stated by customers. Converesely, shipping companies claim to possess an expertise in planning for ship repair and maintenance regardless of

the ship's location in the world, indicating that shipping companies can pick up spare parts without much dependency on regional operations.

Misalignment. Additionally, with regards to shipbuilding, it was claimed that it would not be possible to think on a regional context only, since the network of suppliers were globally interconnected. Thus, the case of maritime is therefore not supporting previous PLE literature in claiming that geographical proximity and regional operations are necessary to successfully adopt reuse and remanufacturing. Relatedly, following the notion of systems theory (Freeman & McVea, 2001), networks and clusters could also be leveraged to form collective strategies, in order to approach a problem as an industry wide problem such as the inertia identified in the conservatively oriented industry. As such cluster already seem to exist in maritime, these could be leveraged to create industry wide consensus of standards and align stakeholders' perceptions of PLE strategies. Nevertheless, findings show no such collective strategies to address the lack of standards and additional strategies apart from recycling. Eventually, this points toward lack of misalignment and collective strategies among industrial stakeholders as a barrier.

Ultimately, the interconnection and interdependence therefore interestingly point towards a paradox in relation to adoption of additional PLE strategies: Adoption of new strategies is constrained since decision-making power is distributed across a range of stakeholders. Simultaneously, it seems necessary to align all stakeholders, since the ones pushing for adopting new PLE strategies single are unable to execute the strategy single handedly. Stakeholder interconnection and interdependence can be therefore both constitute a barrier and potential opportunity depending on the management competence to include stakeholders as a decisive factor.

Open communication and participation. The notion of open communication (Dill, 1975) suggests that increased stakeholder participation could be used to improve the information and awareness of the value-capturing potential of reuse and remanufacturing. With reference to previous research, insufficient awareness and communication is also considered to influence strategic inertia, as unclear information negatively impacts the willingness for change among managers (Johnson, 1988). Findings support this notion, as challenges seem to exist for shipyards and OEMs to

communicate the benefits of the potential value capturing in the form of costs-savings. This can possibly be related to findings indicating loyalty towards the existing recycling process and the previously identified inertia inflicting the industry. Both representatives from shipyards and shipping companies point out that there is a general lack of awareness of the potential benefits of reuse and remanufacturing processes. This indicates an absence of stakeholder dialogue as many stakeholders have not balanced out the benefits and costs associated with adopting new PLE strategies. This supports Stahel's (2013) notion of consumer dialogue to denote a point of departure for adopting additional PLE strategies. Finally, the lack of awareness regarding remanufacturing specifically is embodied in the observation that as a term, remanufacturing is used interchangeably with reconditioning and refurbishing, although these point to three processes with inherently different procedures.

Interestingly though, several interviewees pointed to the fact that even though benefits would be better communicated, the adoption of new PLE strategies would mostly benefit from being discussed as a mandatory policy, and not on the level of individual organizations. Consequently, findings show no single specific industrial stakeholder to take the lead on marketing the options of reuse and remanufacturing. As such, it can be suggested that the lack of open communication among all stakeholders is a barrier to overcome, in order to get the boat sailing.

5.3.1 Key takeaways

As reinstated by the empirical context, the stakeholder influence indicates that expectations regarding factors of quality, time, costs, and open communication prohibits the wider spread of awareness of the potential of adopting additional PLE strategies. As such, stakeholder alignment concerning these factors is a prerequisite for pursuing reuse and remanufacturing on top of recycling. A critical factor might therefore exist within increased awareness and information to build a collective strategy aimed at capturing circular value for the benefit of the whole industry. Further, it should be taken into consideration that the majority of the stakeholders pointed to each other as responsible influencers in driving the adoption of additional PLE strategies. Thus, due to the dependency on other industrial stakeholders, the path towards circular economy and product life extension in maritime is not a one-stakeholder endeavor. In contrary, for such operations to

become customary, a barrier exists in the form establishing alignment among the multitude of globally dispersed stakeholders.

5.4 Chapter summary

The adoption of additional PLE strategies, when investigated from the perspective of resource requirements, managerial competencies and stakeholder influence, might represent a complex endeavor. However, existing recycling practices might provide a paradoxical barrier. On one hand, existing practices within recycling could facilitate the adoption of reuse and remanufacturing due several similarities in resource requirements and managerial competencies. On the other hand, the loyalty towards recycling practices seems to prohibit the allocation of resources towards exploring additional value-capturing activities. Accordingly, although existing managerial competencies can be leveraged to allocate necessary resources, mandatory policies are called for to counteract the current managerial inertia embodied in conforming with the status quo. Lastly, in an industry-context, the findings point to stakeholders exerting significant influence as the potential benefits of additional PLE strategies beyond the current practices of recycling are not articulated among the stakeholders. The following and final chapter will discuss the key takeaways from this chapter in a broader light in order to answer the overarching research question.

6. Conclusion

The closing chapter of this research returns to the research question set in the introduction and illuminates the contributions in line with the overarching purpose. It also highlights the theoretical and practical implications, simultaneously presenting avenues for future research.

The purpose of this research was to increase the understanding of the potential barriers of adopting additional PLE strategies. As indicated from the three aforementioned sections, certain barriers from resource requirements, managerial competencies and stakeholder influence are evident in this endeavor. As the three objectives of this research have been addressed in the preceding discussion chapter, the main takeaways are brought to the light of the overarching research question: *What are the barriers affecting the adoption of additional product-life extension strategies?*

The discussion of findings provided several theoretical and practical insights to answer the above research questions, which fall under the umbrella of three main barriers:

1. *Reliance on current strategies i.e. recycling.* Among most stakeholders, there is a perception that recycling is sufficient, and that currently, reuse and remanufacturing do not comply with the critical success factors of the industry argued to be time, quality and cost. However, reuse and remanufacturing hold greater potential in complementing repair processes, as spare parts present a gateway to increased adoption.
2. *Absence of policy and regulation in favor of reuse and remanufacturing*. Stakeholders perceived the adoption of new PLE strategies to mostly benefit from being discussed as a mandatory policy, and not on the level of individual organizations. Although geographical proximity is argued to provide more effective value capturing potential, a globally regulated industry might not take advantage of regional benefits as it calls for regulation be pursued in the global arena.
3. *Stakeholder misalignment in the prospect of reuse and remanufacturing.* Stakeholder influence in the industry is perceived to be dispersed, and coupled with the interdependency of the network, this influence embodies critical barriers to hold back the value-capturing potential of reuse and remanufacturing. The majority of stakeholders in adopting additional PLE strategies pointed to each other as responsible parties in driving the change. However, OEMs, identified to possess the required resources have embarked on the path of

remanufacturing components, potentially providing a starting point for increased awareness and information around such strategies. This could facilitate a stronger articulation and in the long-term encourage a collective strategy aimed at capturing circular value for the benefit of the whole industry.

In an increasingly interdependent and globalized business arena, it is striking how current research to large extent investigates individual organizations in the pursuance of additional PLE strategies. Addressing industry-wide barriers might pose a more fruitful avenue of research, as evidenced by this paper, as such barriers might prohibit organizations from reaping benefits of potential profitable practices. In this light, it is worth to mention that despite efforts from an impactful industry stakeholder initiating a value-capturing project, such efforts did not live up to their potential because the lacking industry-wide acceptance in the international community.

6.1 Theoretical implications

The paper at hand has taken an important step in increasing understanding in adopting additional PLE strategies, as it highlights the resource requirements, managerial competencies and stakeholder influence when attempting to adopt reuse and remanufacturing in addition to recycling. The contribution of this paper came as a reaction to previous researcher's calls for more industry-wide research on the matter of PLE strategies in order to explore the linkages among industrial stakeholders (Zhu et al., 2010). This paper addressed this gap by employing a pragmatic approach, as suggested by Freeman and McVea (2001), to study the interdependence and interconnection among industry stakeholders, as per the empirical context of maritime. As argued, Zhu et al. (2010) stated that this is a gap that remains to be more intensively addressed, rather than tools, best practices to circular economy theory and its supply deployments. The proposed theoretical framework contributed with relative explanatory power, as it helped clarifying the multi-stakeholder preconditions for the adoption of additional PLE strategies. In accordance with Glaser and Strauss (2017) view on external validity, this research aimed to contribute with a different approach not previously explored by theory, as observed through the use of stakeholder theory with PLE strategies. However, this framework has been crafted for capital-intensive industries in particular. Thus, it is encouraged that this framework receives contextual attention to strengthen its application in other settings and ensure its validity.

6.2 Practical implications

The findings of this research provide implications for the maritime industry but may also be applicable in other capital-intensive industries and particularly transport sectors, due to common characteristics. Stakeholders in the industry such as OEMs could utilize the findings to either understand the potential of reuse and remanufacturing processes and the barriers perceived by different industry stakeholders. The perceptions of these barriers differ between stakeholder groups, without responsibility being claimed solely by any specific industrial stakeholder. The implications of this research suggest dialogue to be facilitated in order to find common ground for accelerating reuse and remanufacturing practices. Further, demand could be driven by assuring quality in communication channels as evidenced by the dialogue between OEMs and classification societies. It is with the hope that other industries on the verge of adopting additional PLE strategies find inspiration in the findings of this research. As this research highlights the resource requirements, managerial competencies needed, and the influence stakeholder might exert when deciding to pursue reuse and remanufacturing, other companies could gain the insight necessary evaluate the adoption additional PLE strategies.

6.3 Limitations and future research

Shipbuilders, the industrial stakeholder responsible for designing a vessel from scratch, were not subject of this study, as they fall outside of the scope of product-life extension in terms of components, which was the focus of this study. However, the findings show that when switching to a focus of the product as a whole, shipbuilders might possess substantial influence of eliciting standardization for reuse and remanufacturing in a vessel. Thus, future research could inquire into the topic of design for remanufacturing (*DfRem*) from a shipbuilder's perspective, who might carry the responsibility to design vessels with remanufacturing in mind.

The findings of the paper might be solely limited to capital-intensive industries and might not be representative of the dynamics of all industries ought to adopt additional PLE strategies. However, the nature of B2B industries might reflect the same perceptions of barriers in doing so. In order to validate this, future research could inquire into capital-intensive industries and re-applying the theoretical framework presented in this paper.

6.4 Concluding remarks

Significant attention has been directed toward recycling in previous research regarding product-life extension. Simultaneously, recycling as a PLE strategy has also been preferred by industry stakeholders because of perceived cost-efficiency and resource preservation with recycling process becoming a mandatory practice in a lot of countries. A new wave of PLE strategies such as reuse and remanufacturing has started to wash up on shore and encompass more value-capturing activities in comparison with recycling. The adoption of these strategies on top of recycling has been researched and implemented extensively in capital-intensive industries, and specifically transport, such as auto and aviation. However, similar interest has been neglected in another significant industry, namely maritime, which continues to optimize recycling practices alone. This research commenced as an effort to uncover the potential barriers perceived in adopting reuse and remanufacturing.

This research has uncovered a lack of awareness among industry stakeholders and nominal understanding regarding the inherent challenges of adopting such strategies. The contributions made as part of this research point to three encapsulating barriers widen the scope of theoretical inquiry. Firstly, loyalty towards recycling has been pinpointed as one of the prohibiting factors, as it well-established and perceived to be a satisfactory practice. Secondly, lack of policy and regulation is perceived to discourage further exploration due to industry stakeholders recognizing this endeavor as a global legislative decision. Lastly, stakeholder misalignment points toward industrial stakeholders' dispersed awareness and lack of dialogue regarding more value-capturing alternatives to halt back further exploration.

Although there seem to be mixed perceptions on the potential barriers for adopting additional product-life extension strategies, resource requirements and managerial competencies do not seem to embody significant barriers. Instead, leveraging these might be even more uncomplicated than previous research indicates, as several elements of reuse and remanufacturing are shared with existing recycling practices. As industrial stakeholders exert significant influence when pursuing additional PLE strategies, the main contribution of this research points to stakeholder mobilization as key in such an endeavor.

References

Ackoff, R. L. 1970. A Concept of Corporate Planning. New York: John Wiley & Sons.

1974. Redesigning the Future. New York: John Wiley & Sons.

Ajukumar, V. N., & Gandhi, O. P. (2013). Evaluation of green maintenance initiatives in design and development of mechanical systems using an integrated approach. *Journal of cleaner production*, *51*, 34-46.

Alvesson, M., & Sköldberg, K. (2008). Tolkning och reflektion–Vetenskapsfilosofi och kvalitativ metod. *Lund: Studentlitteratur*.

Amelia, L., Wahab, D. A., Haron, C. C., Muhamad, N., & Azhari, C. H. (2009). Initiating automotive component reuse in Malaysia. Journal of Cleaner Production, 17(17), 1572-1579.

American Psychological Association. (2009). *Publication manual of the American Psychological Association* (6th ed.). Washington DC: Author.

Amit, R., & Schoemaker, P. J. (1993). Strategic assets and organizational rent. *Strategic management journal*, *14*(1), 33-46.

Ansoff, I. 1965. Corporate strategy. New York: McGraw Hill.

Ashayeri, J., Heuts, R., Jansen, A., & Szczerba, B. (1996). Inventory management of repairable service parts for personal computers: A case study. *International Journal of Operations & Production Management*, *16*(12), 74-97.

Baines, T. S., Lightfoot, H. W., Evans, S., Neely, A., Greenough, R., Peppard, J., ... & Alcock, J. R. (2007). State-of-the-art in product-service systems. *Proceedings of the Institution of Mechanical Engineers, Part B: journal of engineering manufacture*, *221*(10), 1543-1552.

Barbiroli, G. (2008). Profile of products enduring quality over long periods as strategic factor to increase their utilisation rate. *International Journal of Product Development*, *6*(3-4), 450-467.

Barnett, W. P., & Burgelman, R. A. (1996). Evolutionary perspectives on strategy. *Strategic Management Journal*, *17*(S1), 5-19.

Barney, J. B. (1991). Firm Resources and Sustained Competitive Advantage. Journal of Management. Vol. 17, No. 1, 1991, pp. 99–120

Barringer, B. R., & Harrison, J. S. (2000). Walking a tightrope: Creating value through

interorganizational relationships. *Journal of management*, *26*(3), 367-403.

BBC (2018). Global shipping in 'historic' climate deal. Retrieved April 22 2018 from http://www.bbc.com/news/science-environment-43759923

Bocken, N. M., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33(5), 308-320.

Bor, J. M. (1994). The influence of waste strategies on product design. *Materials & Design*, *15*(4), 219-224.

Bower, J. L. (1970). Managing the resource allocation process: A study of corporate planning and investment decision. *Harvard Business School, Boston*.

Braungart, M., & McDonough, W. (2009). Cradle to Cradle Building Charter: Cradle to Cradle.

Brenner, S. N., & Cochran, P. (1991, July). The stakeholder theory of the firm: Implications for business and society theory and research. In *Proceedings of the international association for business and society* (Vol. 2, pp. 897-933).

Bringezu, S. (2002). *Towards sustainable resource management in the European Union* (No. 121). Wuppertal papers.

Bringezu, S., & Moriguchi, Y. (2002). Material flow analysis. *A handbook of industrial ecology*, 79-90.

Bryman, A., & Bell, E. (2015). *Business research methods*. Oxford University Press, USA.

Burgelman, R. A. (1983a). A model of the interaction of strategic behavior, corporate context, and the concept of strategy. Academy of management Review, 8(1), 61-70.

Burgelman, R. A. (1983b). A process model of internal corporate venturing in the diversified major firm. Administrative science quarterly, 223-244.

Burgelman, R. A. (1984). Managing the internal corporate venturing process. Sloan Management Review, 25(2), 33-48.

Cooper, T. (2016). Longer lasting products: alternatives to the throwaway society. CRC Press.

Christensen, C. M., & Bower, J. L. (1996). Customer power, strategic investment, and the failure of leading firms. Strategic management journal, 197-218.

Churchman, C. W., & Ackoff, R. L. (1947). An experimental measure of personality. Philosophy of Science, 14(4), 304-332.

Cool, K., & Schendel, D. (1988). Performance differences among strategic group members.

Strategic Management Journal, *9*(3), 207-223.

D'Aveni, R. A., & MacMillan, I. C. (1990). Crisis and the content of managerial communications: A study of the focus of attention of top managers in surviving and failing firms. *Administrative science quarterly*, 634-657.

Daft, R. (1983). *Organization theory and design*. New York: West.

Dey, I. (2004). Grounded theory. *Qualitative research practice*, 80-93.

Diallo, C., Venkatadri, U., Khatab, A., & Bhakthavatchalam, S. (2017). State of the art review of quality, reliability and maintenance issues in closed-loop supply chains with remanufacturing. *International Journal of Production Research*, *55*(5), 1277-1296.

Dill, W.R. (1975). Public participation in corporate-planning: Strategic management in a kibitzer's world. Long Range Planning, 8(1), 57-63.

Donaldson, T., & Preston, L. E. (1995). The stakeholder theory of the corporation: Concepts, evidence, and implications. Academy of management Review, 20(1), 65-91.

Easterby-Smith, M., Thorpe, R., & Jackson, P. R. (2015). *Management and business research*. Sage.

Equasis Statistics (2016). The world merchant fleet 2014. Retrived April 01 2018 from http://www.emsa.europa.eu/equasis-statistics/items.html?cid=95&id=472

European Commission (2008). Directive 2008/98/EC of the European Parliament and of the council. Retrieved April 10, 2018 from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

European Commission (2018). Closing the loop - an EU action plan for the Circular Economy. Retrieved April 12, 2018 from http://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF

Feuchter, C. A., Van Meter, C. A., Neuman, K. M., & Sparrow, K. J. (1991, December). When is a satellite not a toaster?. In *Proceedings of the 23rd conference on Winter simulation* (pp. 499-508).

Fischer, A., & Pascucci, S. (2017). Institutional incentives in circular economy transition: The case of material use in the Dutch textile industry. *Journal of cleaner production*, *155*, 17-32.

Fishman, A., Gandal, N., & Shy, O. (1993). Planned obsolescence as an engine of technological progress. *The Journal of Industrial Economics*, 361-370.

Flexner, S. B. (1987). The random house dictionary of the English language, 2nd ed. New York: Random House

Floyd, S. W., & Lane, P. J. (2000). Strategizing throughout the organization: Managing role conflict in strategic renewal. *Academy of management review*, *25*(1), 154-177.

Freeman, R. E., & Reed, D. L. (1983). Stockholders and stakeholders: A new perspective on corporate governance. California management review, 25(3), 88-106

Freeman, R. E. (1984). Strategic Management: A Stakeholder Approach. Boston: Pitman. 1994. The politics of stakeholder theory: Some future directions. Business Ethics Quarterly 4 (4): 409 421.

Freeman, R. E., & McVea, J. (2001). A stakeholder approach to strategic management. *The Blackwell handbook of strategic management*, 183-201.

Freeman, R. E., Harrison, J. S., Wicks, A. C., Parmar, B. L., & De Colle, S. (2010). *Stakeholder theory: The state of the art*. Cambridge University Press.

Folz, D. (1999). Municipal Recycling Performance: A Public Sector Environmental Success Story. *Public Administration Review, 59*(4), 336-345.

Freeman, R. E. (2010). *Strategic management: A stakeholder approach*. Cambridge university press.

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm?. *Journal of Cleaner Production*, *143*, 757-768.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, *114*, 11-32.

Glaser, B. G., & Strauss, A. L. (2017). *Discovery of grounded theory: Strategies for qualitative research*. Routledge.

Grant, R. M. (1991). The resource-based theory of competitive advantage: implications for strategy formulation. In *Knowledge and strategy* (pp. 3-23).

Giutini, R., & Gaudette, K. (2003). Remanufacturing: The next great opportunity for boosting US productivity. Business Horizons, 46(6), 41-48.

Goyal, S., Esposito, M., & Kapoor, A. (2016). Circular Economy Business Models in Developing Economies: Lessons from India on Reduce, Recycle, and Reuse Paradigms. *Thunderbird International Business Review*.

Guide Jr, V. D. R., Teunter, R. H., & Van Wassenhove, L. N. (2003). Matching demand and supply to maximize profits from remanufacturing. Manufacturing & Service Operations Management, 5(4), 303-316.

Hamel, G., Doz, Y. L., & Prahalad, C. K. (1989). Collaborate with your competitors and win. *Harvard business review*, *67*(1), 133-139.

Heiskanen, E. (1996). Conditions for product life extension. *National Consumer Research Centre Working Papers*, *22*, 1996.

Honeywill, T. (2002). A final bill to pick up. *Professional Engineering*, *15*(6).

Hopkins, W. E., Mallette, P., & Hopkins, S. A. (2013). Proposed factors influencing strategic inertia/strategic renewal in organizations. Academy of Strategic Management Journal, 12(2), 77-94.

Hopkinson, P., & Spicer, D. (2013). Remanufacturing–a proven business model for the circular economy. A new dynamic: Effective business in a circular economy, pp.157-170.

Huff, J. O., Huff, A. S., & Thomas, H. (1992). Strategic renewal and the interaction of cumulative stress and inertia. Strategic Management Journal, 13(S1), 55-75.

Jakobsen, E. W. (2011). Norsk maritim verdiskapning 2009. Retrieved April 04, 2018 from http://www.menon.no/wp-content/uploads/26maritimverdiskaping2000-2009endeligrapport.pdf

Jakobsen, E. W. & Espelien A. (2011). En kunnskapsbasert maritim næring. Retrieved March 28 2018 from http://www.menon.no/wp- content/uploads/04eknmaritimv2menon-rapportnr10.pdf

Jansson, K. (2016). Circular Economy in Shipbuilding and Marine Networks–A Focus on Remanufacturing in Ship Repair. In *Working Conference on Virtual Enterprises* (pp. 661-671). Springer, Cham.

Johnson, G. (1988). Processes of managing strategic change. *Management Research News*, *11*(4/5), 43-46.

Kopicki, R., Berg, M. J., & Legg, L. (1993). Reuse and recycling-reverse logistics opportunities.

Lacy P., & Rutqvist J. (2015) The Product Life-Extension Business Model: Products that Are

Built to Last. In: Waste to Wealth. Palgrave Macmillan, London

Lambe, C. J., Spekman, R. E., & Hunt, S. D. (2002). Alliance competence, resources, and alliance success: conceptualization, measurement, and initial test. Journal of the academy of Marketing Science, 30(2), 141-158.

Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic management journal*, *14*(S2), 95-112.

Linder, M., & Williander, M. (2017). Circular business model innovation: inherent uncertainties. Business Strategy and the Environment, 26(2), 182-196.

Linton, J. D., & Jayaraman, V. (2005). A framework for identifying differences and similarities in the managerial competencies associated with different modes of product life extension. International journal of production research, 43(9), 1807-1829.

Litehauz. (2015). List of acceptable ship recycling yards. Prepared for Danish Shipowners Association, by Litehauz Maritime Environmental Consultancy.

Lloyd's register (2011). Ship recycling - practice and regulation today. Retrieved April 22 2018 from http://www.shipbreakingplatform.org/shipbrea_wp2011/wp-content/uploads/2011/11/Ship-Recycling-Lloyds-Register-report-June-2011.pdf

Lovins, A., Braungart, M., Stahel, W. A., Birkeland, J., Goerner, S., Spicer, D., & Mulhall, D. (2013). A New Dynamic: effective business in a circular economy. Ellen MacArthur Foundation Publishing, 172.

MacArthur, E. (2013). Towards the circular economy. Journal of Industrial Ecology, pp.23-44.

Maersk (2014). Cradle to Cradle. Retrieved April 22, 2018 from https://www.maersk.com/en/explore/fleet/triple-e/the-hard-facts/cradle-to-cradle

Mallette, P., & Hopkins, W. E. (2013). Structural and cognitive antecedents to middle management influence on strategic inertia. Journal of Global Business Management, 9(3), 104.

Marinova, D. (2004). Actualizing innovation effort: the impact of market knowledge diffusion in a dynamic system of competition. *Journal of Marketing*, *68*(3), 1-20.

Mason, R. and Mitroff, I. (1982). Challenge Strategic Planning Assumptions. New York: John Wiley & Sons.

Matsumoto, M., Yang, S., Martinsen, K., & Kainuma, Y. (2016). Trends and research challenges in remanufacturing. International journal of precision engineering and manufacturing-green technology, 3(1), 129-142.

McDonough, W., & Braungart, M. (2010). *Cradle to cradle: Remaking the way we make things*. North point press.

Mehra, A., & Floyd, S. W. (1998). Product market heterogeneity, resource imitability and strategic group formation. *Journal of Management*, *24*(4), 511-531.

Mont, O. (2001). Introducing and developing a Product-Service System (PSS) concept in Sweden.

Mont, O. (2002). Clarifying the concept of product–service system. Journal of cleaner production, 10(3), 237-245.

Mont, O. (2008). Innovative approaches to optimising design and use of durable consumer goods. International Journal of Product Development, 6(3-4), 227-250.

Murray, A., Skene, K., & Haynes, K. (2017). The circular economy: an interdisciplinary exploration of the concept and application in a global context. *Journal of Business Ethics*, *140*(3), 369-380.

Nasr, N. (2015). Remanufacturing and the circular economy. A new dynamic: Effective business in a circular economy, pp.107-127.

Nelson, R. R. (1991). Why do firms differ, and how does it matter?. *Strategic management journal*, *12*(S2), 61-74.

Nelson, R. R., & Winter, S. G. (2002). Evolutionary theorizing in economics. *Journal of Economic Perspectives*, *16*(2), 23-46.

Neuman, W. L. (2013). *Social research methods: Qualitative and quantitative approaches*. Pearson education.

Niinimäki, K., & Hassi, L. (2011). Emerging design strategies in sustainable production and consumption of textiles and clothing. Journal of Cleaner Production, 19(16), 1876-1883.

OECD (2018). Decarbonising maritime transports - The case of Sweden. Retrieved April 04, 2018 from https://www.lighthouse.nu/news/032018/oecd-sweden-world-leader-decarbonization-ship ping.

Pajunen, K. (2006). Stakeholder influences in organizational survival. *Journal of Management*

Studies, *43*(6), 1261-1288.

Pan, S. Y., Du, M. A., Huang, I. T., Liu, I. H., Chang, E. E., & Chiang, P. C. (2015). Strategies on implementation of waste-to-energy (WTE) supply chain for circular economy system: a review. *Journal of Cleaner Production*, *108*, 409-421.

Parida, A., & Kumar, U. (2006). Maintenance performance measurement (MPM): issues and challenges. Journal of Quality in Maintenance Engineering, 12(3), 239-251.

Parker, D., & Butler, P. (2007). An introduction to remanufacturing. Centre for Remanufacturing & Reuse, Aylesbury, UK, last accessed Nov, 6, 2012.

Patton, M. Q. (2005). Qualitative research. John Wiley & Sons, Ltd.

Pfeffer, J., & Salancik, G. R. (2003). *The external control of organizations: A resource dependence perspective*. Stanford University Press.

Piscicelli, L., Cooper, T., & Fisher, T. (2015). The role of values in collaborative consumption: insights from a product-service system for lending and borrowing in the UK. Journal of Cleaner Production, 97, 21-29.

Planing, P. (2015). Business model innovation in a circular economy reasons for non-acceptance of circular business models. Open journal of business model innovation. 1-11.

Preble, J. F. (2005). Toward a comprehensive model of stakeholder management. *Business and Society Review*, *110*(4), 407-431.

Quella, F., & Belli, F. (2013). Reuse of components and products:"qualified as good as new". In Handbook of Sustainable Engineering (pp. 409-426). Springer Netherlands.

Robson, C. (2002). Real world research. 2nd. *Edition. Blackwell Publishing. Malden*.

Roloff, J. (2008). Learning from multi-stakeholder networks: Issue-focussed stakeholder management. Journal of business ethics, 82(1), 233-250.

Rowley, T. J. (1997). Moving beyond dyadic ties: A network theory of stakeholder influences. Academy of management Review, 22(4), 887-910.

Rusetski, A., & Lim, L. K. (2011). Not complacent but scared: another look at the causes of strategic inertia among successful firms from a regulatory focus perspective. *Journal of Strategic Marketing*, *19*(6), 501-516.

Sanchez, R. (2006). Integrating design into strategic management processes. *Design Management Review*, *17*(4), 10-17.

Saunders, M., Lewis, P., & Thornhill, A. (2009). Research Methods for Business Students (5th Eds) Essex: Pearson Education Ltd.

Schoemaker, P. J., & Marais, M. L. (1996). Technological innovation and firm inertia. In *Organization and Strategy in the Evolution of the Enterprise* (pp. 179-205). Palgrave Macmillan, London.

Seitz, M. A. (2007). A critical assessment of motives for product recovery: the case of engine remanufacturing. *Journal of Cleaner Production*, *15*(11-12), 1147-1157.

Shafiee, M., & Animah, I. (2017). Life extension decision making of safety critical systems: An overview. *Journal of Loss Prevention in the Process Industries*, *47*, 174-188.

Solesvik, M. Z., & Westhead, P. (2010). Partner selection for strategic alliances: case study insights from the maritime industry. *Industrial Management & Data Systems*, *110*(6), 841-860.

Sousa-Zomer, T. T., Magalhães, L., Zancul, E., & Cauchick-Miguel, P. A. (2017). Lifecycle management of product-service systems: a preliminary investigation of a white goods manufacturer. Procedia CIRP, 64, 31-36.

Stahel, W. R. (1994). The utilization-focused service economy: Resource efficiency and product-life extension. The greening of industrial ecosystems, pp.178-190.

Stahel, W. R. (1997). The functional economy: cultural and organizational change. The Industrial

green game: implications for environmental design and management, 91-100.

Stahel, W. R. (1998). From Products to Services: Selling performance instead of goods. IPTS Report, 27.

Stahel, W. R. (2010). *The performance economy*. Springer.

Stahel, W. R. (2013). Policy for material efficiency - sustainable taxation as a departure from the throwaway society. Phil. Trans. R. Soc. A, 371(1986), 20110567.

Stahel, W. R. (2014). The business angle of a circular economy–higher competitiveness, higher resource security and material efficiency. *A New Dynamic: Effective Business in a Circular Economy*, 45-53.

Steinhilper, R., Rosemann, B., & Freiberger, S. (2006). Product and process assessment for remanufacturing of computer controlled automotive components. In 13th CIRP

International Conference on Life Cycle Engineering. LCE2006.

Stopford, M. (2009). *Maritime economics 3e*. New York: Routledge.

Subramoniam, R., Huisingh, D., & Chinnam, R. B. (2009). Remanufacturing for the automotive aftermarket-strategic factors: literature review and future research needs. Journal of Cleaner Production, vol.17(13), pp.1163-1174.

Tillväxtanalys (2010). Sveriges sjöfartssektor. En viktig del i en svensk maritim strategi. Retrieved April 04 2018 from http://www.tillvaxtanalys.se/publikationer/rapport/rapportserien/2010-05-07-sveriges-sjofartssektor----en-viktig-del-i-en-svensk-maritim-strategi.html

TPR (2015). Study on the Analysis and Evolution of International and EU Shipping. Department of transport and regional economics. Retrieved April 05 2018 from https://ec.europa.eu/transport/sites/transport/files/modes/maritime/studies/doc/2015-sept-study-internat-eu-shipping-final.pdf

Truttmann, N., & Rechberger, H. (2006). Contribution to resource conservation by reuse of electrical and electronic household appliances. Resources, Conservation and Recycling, 48(3), 249-262.

Tukker, A. (2004). Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet. Business strategy and the environment, 13(4), 246-260.

UN (n.d). (IMO). International Maritime Organization. Retrieved March 30 2018 from https://business.un.org/en/entities/13

Van Nes, N., & Cramer, J. (2006). Product lifetime optimization: a challenging strategy towards more sustainable consumption patterns. Journal of Cleaner Production, vol.14(15-16), 1307-1318.

Webster, K. (2017). *The circular economy: A wealth of flows*. Ellen MacArthur Foundation Publishing.

Whalen, K. A., Milios, L., & Nussholz, J. (2017). Bridging the gap: Barriers and potential for scaling reuse practices in the Swedish ICT sector. *Resources, Conservation and Recycling*.

Wise, R., & Baumgartner, P. (2000). Go downstream: The new profit imperative in manufacturing. *IEEE Engineering Management Review, 28*(1), 89-96.

Wooldridge, B., & Floyd, S. W. (1989). Research notes and communications strategic process effects on consensus. *Strategic Management Journal*, *10*(3), 295-302.

Yin, R. K. (2013). Validity and generalization in future case study evaluations. *Evaluation*, *19*(3), 321-332.

Zand, D. E. (2009). Strategic renewal: how an organization realigned structure with strategy. *Strategy & Leadership*, *37*(3), 23-28.

Zhu, Q., Geng, Y., & Lai, K. H. (2010). Circular economy practices among Chinese manufacturers varying in environmental-oriented supply chain cooperation and the performance implications. *Journal of Environmental Management*, *91*(6), 1324-1331.

Zhao, S., & Zhu, Q. (2017). Remanufacturing supply chain coordination under the stochastic remanufacturability rate and the random demand. Annals of Operations Research, 257(1-2), 661-695.