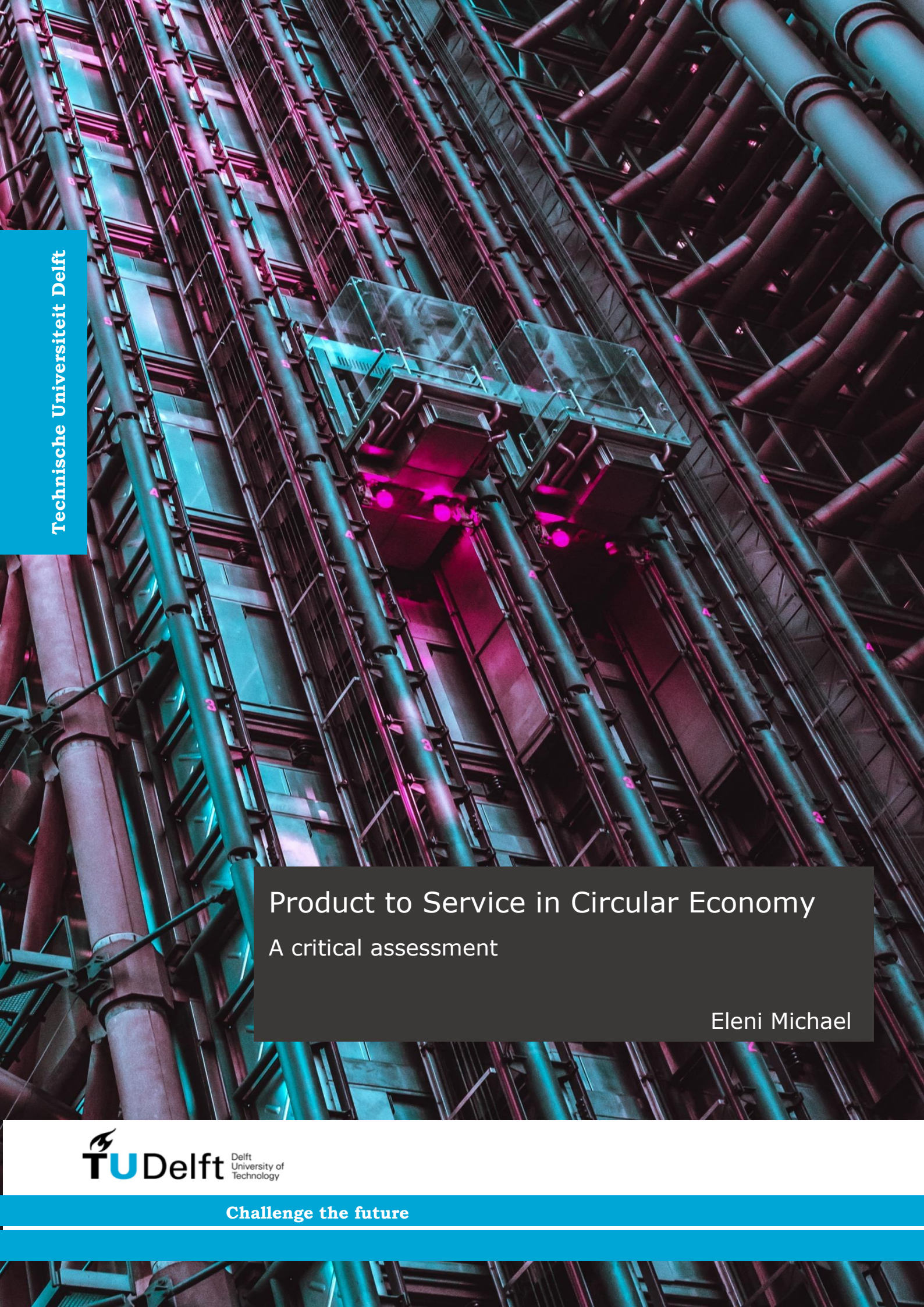

Technische Universiteit Delft

Product to Service in Circular Economy

A critical assessment

Eleni Michael

TU Delft Delft University of Technology

Challenge the future

Product to Service in Circular economy

A critical assessment

Date	7 November 2018

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Eleni Michael,2018

Abstract

Many notions are taken the last decades to control production of waste and solve the scarcity of raw material. Circular Economy is a concept, designed to help solve this problem with a financial and environmental agenda. Combined with a Product to Service model, it can offer new opportunities in resetting the way we see ownership and what should be considered waste. As the combination model of circular lease has started being applied in the market, a lot of questions have arisen about its efficiency and risk allocation between owner and user. The main goal of this thesis is to investigate the aforementioned topics, with a focus on cost, duration and legal aspects, as well as evaluating the role of Circular Economy and whether it affects these topics.

Two case studies were done with the help of four interviews, while a literature research on Circular Economy, Product to Service and relevant legal aspects was conducted. The findings of the theoretical and practical research were compared and used to develop an understanding of risks occurring in circular leases.

This thesis investigates the case where ownership model stays with the manufacturer/supplier. The legal strategy to ensure this is through the right of superficies. This model was chosen as responsibility and ownership are strongly connected and by giving the ownership to the manufacturer/supplier also pushes them to extend the lifecycle of products, minimise the waste during production, reduce the use of raw materials and use secondary materials.

The end result of this research is that the main bearer of risks is the owner of the product. First and foremost, owners have to secure that ownership remain on his/her side. Even though having a constant income during the lease, offers a financial security, the owner must be prepared to pay in case of malfunction and any need occurring from the close maintenance offered to the client. The owner must also take care of the after-end treatment of the product and arrange for a new circle for it. Long duration leases require a strong alliance between owner and client, but also trust that both parties will be able to fulfil their responsibilities. On the client side, they may pay to avoid taking risks, but some risks are still there. The ownership issue is affecting both sides as there is always the risk of bankruptcy. Serviceability-wise the client has to ensure that the level of service is constant through the years and can cover the needs of the client. Committing to same level of needs is a risky move, especially if the type of product is a fast-evolving technology or if the needs of the client are not steady. Finally, the price point is also at risk, in case an intermediate is involved.

Contents

List of Abbreviations

CE:	Circular Economy
DCL:	Dutch Civil Law
DD:	Delta Development Group
EMF:	Ellen Macarthur Foundation
IoT:	Internet of Things
KPI:	Key Performance Indicator
MEE:	Mitsubishi Electric Europe
MoR:	Municipality of Rotterdam
OEM:	Original Equipment Manufacturer
PBC:	Performance Based Contracts
PoR:	Port of Rotterdam
PtS:	Product to Service
SAMLS:	South African Mixed Legal System
TCU:	Total Cost of Use
ZEN:	Zon Exploitatie Nederlands

1

Introduction

1.1. Problem Context

Insights demonstrate that human population is growing in an exponential rate which is illustrated by the fact that in 2016 the number of people living on our planet has been increased by 84 million people, reaching a total of 7.466.964.280 people ("World Population by Year," 2017). This rapid population growth holds direct consequences, especially when considering the modern way of living. For instance, two aftermaths of our lifestyle are the respectively irrational global energy consumption and the unmanageable production of waste. Only in Europe for 2014, 2503 million tonnes of waste were produced by all economic activities and households ("Waste statistics - Statistics Explained," 2017). These numerical data can be justified by the linear approach of production "Production, consumption and waste" in combination with the rapid financial and technological development. Furthermore, the high demand for more goods and the decreasing number of resources will create a pressure on manufacturers and sellers to maintain low production costs and current selling prices (de Jesus & Mendonça, 2018). The anthropogenic damage to the environment is becoming more visible day by day; waste of resources, global warming, shortage of raw materials, environmental pollution and climate change among other things (Prins, Mohammadi, & Slob, 2015).

In an attempt to face the problem of thoughtless waste and imminent lack of natural resources, many methods and strategies have been developed throughout the years. Circular Economy is an idea entailing building capital from our waste and transforms the products we use today as tomorrow's resources. The difference with other concepts used to manage the lack of resources and waste production is that CE has not only a positive impact on the environment but also on economy. It significantly reduces the amount of waste during production and after the end of use. It also reduces the pointless utilization of resources, thus allowing a better waste management (Bourguignon, 2016). This concept aims to put products and their components in theoretically infinite loops while producing the minimum waste. The inspiration behind it is the nature's functions; one species' waste is another species' food (Weetman, 2016). Likewise, the goal of CE is to satisfy the demand for new products while reducing the demand for new manufacturing (Lacy & Rutqvist, 2015). In order to realise this goal strategies such as reuse, repair, refurbishment and recycling are used for the end-of-use of the products (Bourguignon, 2016).

One of the solutions included in the concept of CE is to rethink the way we see ownership. The idea is that we, as consumers, forgo the common tactic of owning products and instead lease from manufacturers, who will not offer only a product but also a service. The answer is evident and has already been successfully in practice for years.

Leasing is not a new idea, it is established in the industry for years. Some examples are Michelin, which leases tires since the 1920s (3-Step-It, 2016) and Interface, which leases their carpets since 1995 ("ReEntry | About | Interface," 2017). The Product to Service model (PtS) fits though in the frames of CE as it takes away the concept of ownership by everyone and introduces the concept of user. Users are leasing a product for an agreed period of time, where the manufacturers or owners receive the product after the end of the lease and re-lease it, recycle it or refurbish it.

This thesis investigates the case where ownership model stays with the manufacturer/supplier. This model was chosen as responsibility and ownership are strongly connected and by giving the ownership to the manufacturer/supplier also pushes them to extend the lifecycle of products, minimise the waste during production, reduce the use of raw materials and use secondary materials.

Like all new concepts there are challenges to be defied at the beginning, which causes many companies to hesitate to take the big leap to CE. First of all, there are additional steps to the process to fit the management of the components after the end of the use of the product. Furthermore, a general redesign of the product and the whole process is required to adjust to the circular requirements. These fundamental changes create huge transitional costs for a company. Additionally, accommodating the CE demands change on multiple levels, from the production process to the marketing methods. This requires adjustments and changes to all the relevant policies, rules and laws from a national to international level.

The application of CE, in combination with PtS, is affected by many circumstances and faces many challenges. As with all the business deals, both sides have to take some risks and prepare for them. One of the main risks that can be linked with offering a PtS package is how can the owner of the product keep the ownership when another party is using it. The relevant legal research will be based on the Mixed Legal System (MLS) of civil and common law in South Africa. The choice of legal system, the South African law, is justified by the fact that literature can be found in English, while on the same time the necessary principles for this thesis are closer to the Civil Law (which is used in the Netherlands) (Mostert, Pope, Badenhorst, & Pienaar, 2010). The other risks to be researched on this thesis are relevant with the cost and duration of a PtS/CE contract, with a focus on the factors affecting them. Both cost and duration are determinant aspects for the clients interested in choosing this model, therefore it is interesting to see how companies set them.

In this thesis I investigate the risk and responsibility distribution in circular leases for both parties involved. The nature of the circular leases will be first researched to understand which factors create more risks (and for which side) and how these risks affect the process. The end result is an overview of the relationship between the parties involved in a circular lease and a risk assessment of this model on legal, cost and duration aspects. In order to reach to the answer, two case studies are analysed, various interviews with stakeholders are conducted and a thorough literature research on all relevant subjects have been completed.

1.2. Problem Statement

Circular Economy is currently promoted as one of the solutions to the unsustainable use of resources and the unaccountable production of waste. To realise the goals of CE, many methods are implemented. One of the most interesting is the "Product to Service" model (PtS), where the products are returned after the end of the lease to continue their lifecycle. Even though on paper it seems simple and without serious issues, it can get problematic on both ends of the deal. Remarkably the owner can suffer many risks, particularly on the legal terms. The legal risks are not yet cleared and especially the risk of retaining ownership. On the side of the client, duration and cost of the lease might not be actually beneficial. Furthermore, clients agree on a circular deal but what does "circular" entails? The attempt of this thesis is to identify what are the risks in circular leases associated with the duration and cost of the lease and the ownership of the product.

1.3. Research questions and objectives

There are three main objectives for this thesis and are listed below:

- To develop an understanding of how Circular Economy (CE) and Product to Service (PtS) is applied in practice
- To identify the risks involved in a PtS/CE project on a legal, cost and duration aspect
- To find out how companies face the above risks

The main **research question** of this thesis that will lead to the fulfilment of the above objectives is:

What are the risks associated with a Product to Service and/or Circular Economy project in a legal, cost and duration perspective and how are they allocated between the parties?

The **sub-questions** that will help to give a full answer to the main research question are:

What differentiates a circular economy product from a traditional product?

The distinction of the differences will help understand where CE suffers or holds advantage. Through the identification of these areas the weak spots of CE will help find possible risks for the clients of the owners.

What legal approach is taken in this type of deals? To what extent does the ownership actually stay with the legal owner?

The legal aspect is focused on the ownership issue that is created when one party is the owner and the other party is the user. Researching on this matter and discussing the findings will help identify the legal risks and approach.

How is the price of a circular lease determined?

A breakdown analysis of the pricing will make clear what is included in the package of a circular product while on the same time pinpoint how this type of products should be priced.

How is the duration of a PtS lease determined?

This sub-question aims to identify the factors affecting the duration of the lease and investigate whether a lifecycle can truly be extended.

1.4. Report's structure overview

The comparison of the two case studies intends to explore the three risk aspects in question. The topic of risks is approached as grounded theory, were the findings are obtained through a comparison of the theoretical and practical information collection. The

structure of the report follows a theoretical framework to guide the reader through all the information necessary to understand the methodology used to reach to the findings.

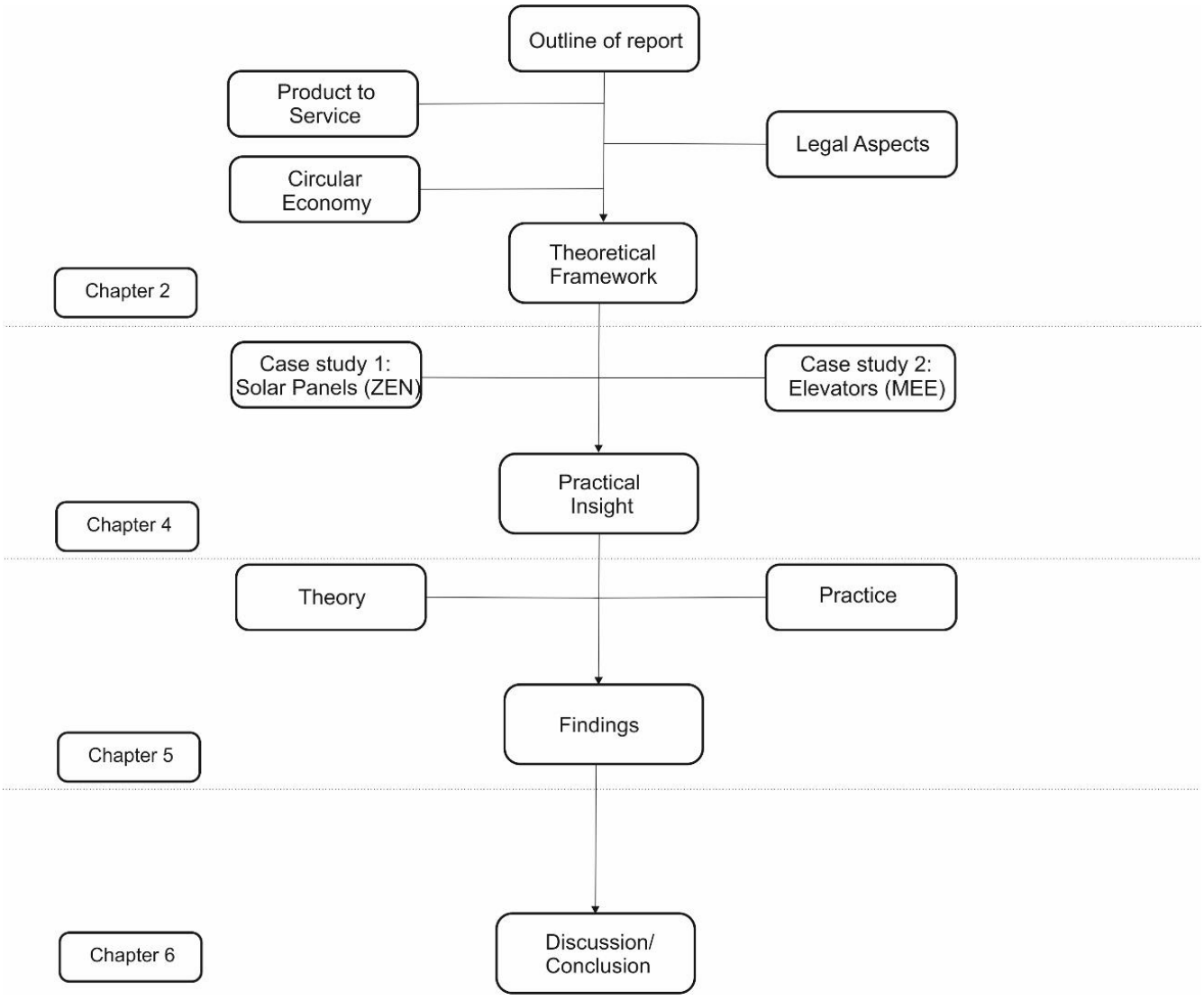


Figure 1: Layout of the methodology and outline of report.

2

Theoretical Framework

This chapter provides all the theoretical information collected for the research of the problem on the three main fields; Circular Economy (CE), Product to Service model (PtS) and the legal aspects that affect the previous two fields. This information will be used to fulfil the thesis' objectives, to merely answer the main research question and to be used as a preparation for the interview protocol and execution.

2.1. Circular Economy

In the past decades technology has advanced with major leaps, while innovation has brought to our lives products and services beyond imagination. Over-consumerism and increased production have become the norm to cover the needs of the modern society (Lieder & Rashid, 2016) through economic development in the past decades (Mathews & Tan, 2016; Siegle & Hanaor, 2006; Strasser, 2000). The combination of these phenomena has led to a market with waste production from the industry and consumer, with direct effects on environment and economy, that is out of control (Kiser, 2016). The majority of this waste ends up in landfill and the opportunity to exploit the residual energy remains unexploited (Kiser, 2016). In addition, the environment is strained in many other ways through collateral effects such as damage of biodiversity and environmental deterioration and pollution of air, soil and water (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). Furthermore, resource depletion creates problems to current and near future production (McDonough & Braungart, 2009).

The aforementioned situation is referred to as the "Linear Economy" model. The entrenched model is typically described as a "produce-use-dump" tactic that has already been proven to be unsustainable (Frosch & Gallopoulos, 1989; Korhonen, Birkie, Nuur, & Feldmann, 2018; MacArthur, Zumwinkel, & Stuchtey, 2015). Figure 2 depicts how raw material is extracted, transported to factories, processed in to products, used by consumers and eventually be disposed. The accompanying financial side effects of the current situation, according to Jackson (2009), Sachs (2015) and W. R. Stahel (2016), are precarious ownership structures, questionable incentive provision, in-controllable market and increased risks for all parties involved. In the Linear Economy model, the easiest and cheapest way to dispose of waste is landfill disposal.

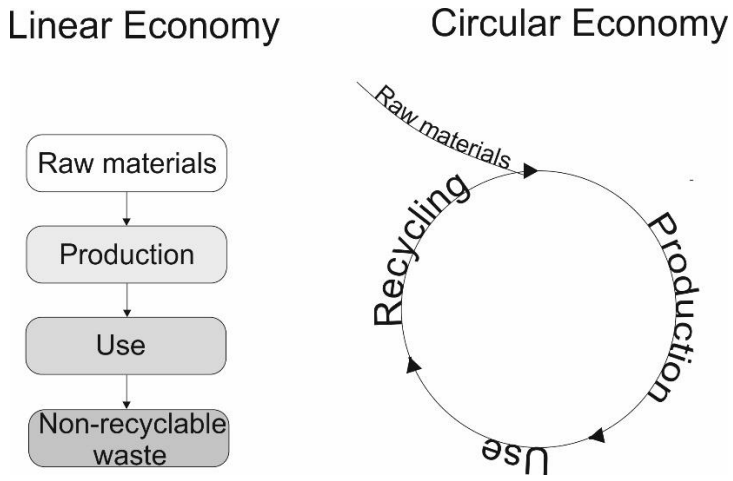


Figure 2:Process of Linear Economy (left) and Circular Economy (right) (MOI, 2016)

Under these circumstances, pressure is put on finding a more sustainable lifestyle. Many solutions have been researched over the last years to solve this issue. One that has drawn a lot of attention, is the reverse of the linear economic model (Geissdoerfer et al., 2017), which has been gaining a lot of attention in the last five years (Kirchherr, Reike, & Hekkert, 2017; Korhonen, Birkie, et al., 2018). The concept of Circular Economy (CE) underscores the cyclical flow of materials while minimizing the by-products of waste (Korhonen, Honkasalo, & Seppälä, 2018), with a focus on reuse on product level (repair/refurbish), reuse at component level (remanufacture) and reuse at material level (recycle) (Zink & Geyer, 2017). As R. Fuller has said, "pollution is nothing but resources we are not harvesting". Both manufacturers and consumers have chosen to ignore the residual value of products at the end of their lives and send them directly for disposal. Circular Economy can impact not only the environment but also the economy, because the more and more payments need to be made to dispose of waste. Indicatively, a study in European countries showed that going circular would decrease greenhouse gas emission by up to 70% and increase the workforce by up to 4% (Skånberg, 2015). A more elaborated analysis of the concept can be found in the following paragraphs.

2.1.1. The Basics of Circular Economy

It is not entirely clear who came up with the concept of Circular Economy (Winans, Kendall, & Deng, 2017). Nevertheless it can be said to be a concept inspired by a combination of several, multi-field ideas, such as ecological economics and industrial ecology (Homrich, Galvão, Abadia, & Carvalho, 2018; Korhonen, Birkie, et al., 2018; Winans et al., 2017). The idea of closed loops was conceptualized by ecological economists like Boulding (1966) (Ghisellini, Cialani, & Ulgiati, 2016; Kiser, 2016; Lieder & Rashid, 2016), but already exists since 1800, at the beginning of industrialization (Desrochers, 2004; Sarkis & Zhu, 2018). Many also attribute the inspiration behind CE to Walter R Stahel and Reday-Mulvey (1981), where proposing the substitution of manpower by energy .The term "Circular Economy" was first used by economists Pearce and Turner (1990) back in the 90s, where they tried to define a framework to move from linear economy to a close loops model after the first and second law of thermodynamics (Geissdoerfer et al., 2017; Ghisellini et al., 2016; Lieder & Rashid, 2016; Sarkis & Zhu, 2018; Winans et al., 2017). China was the first country to officially set a legal framework for CE application in 2018 (CIRAIG, 2015). Below a table (Korhonen, Birkie, et al., 2018), is presented with all the associated concepts with CE found in literature.

Table 1: Description of concepts related to Circular Economy

Concept/Theory	**Definition/ Short Description**	**Source**	**Who linked it with Circular Economy**
Industrial Metabolism, Industrial Symbiosis	Material and energy turnover in industrial systems described as an analogy to the biological metabolism.	Renner (1947) Robert U Ayres (1989) Chertow and Ehrenfeld (2012)	Geissdoerfer et al. (2017) Sarkis and Zhu (2018)
General System Theory	Complex systems have in common organizing principles that can be identified and modelled mathematically.	Von Bertalanffy (1968)	Ghisellini et al. (2016)
Silent Spring	Description of the effects from uncontrollable use of pesticides to the environment.	Carson (2009)	Winans et al. (2017)
Ecological Economics	Bi-disciplinary field of economics and ecology.	Boulding (1966) Georgescu-Roegen (1986) Daly (1997) Ring (1997) Robert U. Ayres (1999)	Kiser (2016) Lieder and Rashid (2016) Winans et al. (2017) Geissdoerfer et al. (2017) Kirchherr et al. (2018) Korhonen, Birkie, et al. (2018)
Limits to Growth	Interrelation of economic and population growth with finite resources, through computer simulation.	Meadows, Meadows, Randers, and Behrens III (1972)	Winans et al. (2017)
Laws of Ecology	Everything is connected (law no.1), everything must go somewhere (law no.2), nature knows best (law no3) and there is no such thing as a free lunch (law no.4).	Commoner, Corr, and Stamler (1971)	Geissdoerfer et al. (2017) Homrich et al. (2018)
Permaculture	Design and maintenance of agriculture ecosystems with a stability, diversity and resilience of natural ecosystems.	Mollison and Holmgren (1978)	Homrich et al. (2018)
Product Life Factor	Description of how the lifecycle of products affects consumption of resources.	Walter R Stahel and Reday-Mulvey (1981)	W. R. Stahel (2016) Kiser (2016) Kirchherr et al. (2017)

Industrial Ecology	Research on how to decrease the environmental impact of industrial systems.	Frosch and Gallopoulos (1989) Graedel (1996)	Ghisellini et al. (2016) Winans et al. (2017) Geissdoerfer et al. (2017) Korhonen, Birkie, et al. (2018)
Regenerative Design	Replacing the current linear system of transfer flows with cyclical flows at sources, consumption centers and sinks.	Lyle (1994)	Winans et al. (2017) Geissdoerfer et al. (2017)
Natural Capitalism	An approach that protects the biosphere and improves profits and competitiveness, through taking better and efficient advantage of resources.	Hawken, Lovins, and Lovins (2008)	Korhonen, Birkie, et al. (2018) Homrich et al. (2018)
Biomimicry	Design inspired by organisms, biological processes and ecosystems.	Benyus (1997)	Geissdoerfer et al. (2017) Homrich et al. (2018) Korhonen, Birkie, et al. (2018)
Cradle to Cradle	Products designed to regenerate the ecosystem as biological nutrients or to regenerate industries in a 100% closed material loop.	McDonough and Braungart (2009)	Kiser (2016) Geissdoerfer et al. (2017) Korhonen, Birkie, et al. (2018) Homrich et al. (2018)
Eco-efficiency	Creating more goods and services while using fewer resources and creating less waste and pollution.	Welford (1998) Huppes and Ishikawa (2009) Haas, Krausmann, Wiedenhofer, and Heinz (2015)	Korhonen, Birkie, et al. (2018)
Blue Economy	The need to find a way of meeting the basic needs of the planet and all its inhabitants with what the Earth.	Pauli (2010)	Geissdoerfer et al. (2017) Korhonen, Birkie, et al. (2018) Homrich et al. (2018)
Product-Service System	Business model combing product and services	Tukker (2015)	Korhonen, Birkie, et al. (2018)
Performance technology	Enabling entrepreneurs to achieve a higher competitiveness with reduced resource consumption and without an externalization of the costs of waste and of risk.	W. R. Stahel (2013)	W. R. Stahel (2016) Geissdoerfer et al. (2017) Homrich et al. (2018)
Cleaner Production	Minimize waste and emissions while maximizing product output	Ghisellini et al. (2016) Lieder and Rashid (2016) Stevenson and Evans (2004)	Korhonen, Birkie, et al. (2018)

Many have tried to define the term "Circular Economy" (Korhonen, Birkie, et al., 2018). Examples of extensive literature research on defining CE can be found by Prieto-Sandoval, Jaca, and Ormazabal (2018), where they review literature of different CE applications and approaches in order to reach to a consensus, by Kirchherr et al. (2017), where they summarize 114 definitions of CE and what the main principles are and last by Korhonen, Birkie, et al. (2018), where they try to prove that CE is an essentially contested concept. Defining exactly the notion of CE is still under research, as it can be a subjective matter that result in different definitions for different people (Gladek, 2017; Kirchherr et al., 2017). One example of this observation is the different perspectives of CE between China and Europe. In China the scope is broad and is a strategy to face industrialization and the fast growth rate, with a focus on environmental issues (McDowall et al., 2017). In Europe on the other hand the scope is narrower, is used as a strategy against waste and resource depletion and is seen as a business opportunity (McDowall et al., 2017).

According to Geissdoerfer et al. (2017) and Kirchherr et al. (2017), claim that the definition by EMF (2013) is the most used and well known in literature. Nevertheless, the definition of Geissdoerfer et al. (2017) is cited below, as it is a result of academic literature research on the subject:

"Circular Economy is defined as a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling."

As summarized in Table 1, CE is influenced by many old and modern concepts stemming from ecology and economics. Boulding (1966) work is worth to be mentioned, as he was the first to discuss closing systems to help maintaining the ecological equilibrium in the environment (Geissdoerfer et al., 2017). Stahel was also one of the main contributors in formulating the concept of CE in its contemporary form and stating its main principles. Along with Reday (1976) they looked into ways to control the waste problem (Geissdoerfer et al., 2017). Furthermore, Walter R Stahel and Reday-Mulvey (1981) suggested the switch from owner to user as the best business model to close loops. Last but not least an important influence, is the Cradle to Cradle (C2C) concept by McDonough and Braungart (2009), which aims at using materials to which waste would become a nutrient to material flows (Kiser, 2016; Linder, Sarasini, & Loon, 2017).

Another relevant concept that is often confused as a characteristic of Circular Economy is sustainability. Geissdoerfer et al. (2017) elaborated on the similarities and differences between these two concepts. The differences are mainly about the origin of the concept, goals, who is benefited, who is lobbying for it, the timeframe and the allocation of responsibilities. On the other hand, the similarities are about the influence of technology, the role of private sector, stakeholders' involvement and necessary changes.

2.1.2. Goals and principles

To put it simply the aim of CE is to extend the lifecycle of a component and reduce the waste of natural resources (EMF, 2013; Korhonen, Honkasalo, et al., 2018) and to fully exploit its value (McDonough & Braungart, 2009; W. R. Stahel, 2016). The goals of CE can also be broken down based on the three-dimensional character of CE; i.e. the societal, economic and environmental dimension (Korhonen, Honkasalo, et al., 2018). Environmentally, the goal is that the thoughtless consumption of raw materials and energy sources/products should be reduced (Allwood, 2014; EC, 2016; Nansai et al., 2014). Economically the cost of the reduction of inputs and outputs of the production

process can be lowered down, while also the marketing opportunities of innovation and sustainability can be exploited. After all, as Ghisellini et al. (2016) and Lacy and Rutqvist (2015) have said, CE is a mean to promote financial growth of businesses, while relieving the environment from the pressure imposed by this need (Ghisellini et al., 2016). Finally, the social objective according to Korhonen, Birkie, et al. (2018) can be defined as closer cooperation between owners and users, creating sharing communities, more job positions and switching from consumer to user. That said, the most dominating aspect out of all three is the financial one, as the market is firmly orientated to maximize financial profit (Yuan, Bi, & Moriguichi, 2006). At the same time, the social impact is the most neglected one, not only in application but also in theory (Borrello, Caracciolo, Lombardi, Pascucci, & Cembalo, 2017; Kirchherr et al., 2018). Moreover, additions are needed to the dimensions of CE, such as a legal dimension, for a smoother transition from linear to circular economy (Ezzat, 2016).

In order to minimize the negative consequences of our modern lifestyle, according to the framework of CE, alterations are required in the collaboration between suppliers and clients. First and foremost the time scale of the collaboration becomes long-term, instead of short term (van den Brink, Prins, Straub, & Ploeger, 2017). Furthermore, the mind set needs to drastically change as in the model ownership stays with the manufacturer/ supplier and the client has only the nature of a user. By making the manufacturer owner, the responsibility for their product is extended until the end of the product's life. Furthermore, manufacturers have the resources and the knowledge to manage their product at all stages. Last but least, as Velis and Vrancken (2015) said responsibility and ownership are strongly connected and by giving the ownership to the manufacturer/supplier also pushes them to extend the lifecycle of products, minimise the waste during production, reduce the use of raw materials and use secondary materials (Mativenga, Agwa-Ejon, Mbohwa, Sultan, & Shuaib, 2017). The product transforms to a service, while responsibilities, rights and risks are redistributed. Therefore, the idea of value is redefined in CE.

The main intention of CE is to preserve the value of an object as long as possible and also take into account its residual value at the end of its use. A circular product can obtain its increased value by the basic principles of CE applied from its conception until its end of use. The basic principles of CE are listed and explained below (Ghisellini et al., 2016; Homrich et al., 2018):

- **Design for reuse**
  From the early stage of design, reuse and disassembly are taken in consideration. Equally important are the options of conserving value in multiple cycles and upcycling, with the ultimate goal to reach to the optimal lifecycle scenario for the product. Thus, material retains its value and does not become waste.

- **Resilience through diversity**
  The diversity of the product can be detected in their endurance in unexpected situations.

- **Energy use from infinity sources**
  The processes to make a circular product may require additional energy. Any energy used in a CE procedure should be renewable, in order to keep up with the philosophy of CE in general.

- **System thinking**
  The idea or closing loops means that systems are central to CE. System thinking supports optimization through feedback loops. By incorporating material flows, the system's time window transforms into the long term.

- **Bio-based foundation**

The last basic principle of CE refers to the choice of materials. The best option is biological materials that could "cascade" in multiple circles.

2.1.3. The Butterfly model

All things considered, a shift to CE would convert the clients to users and shift the responsibility of maintenance and retrieval of products to the owners. Given these points, it is useful to investigate what methods industry uses to implement CE and how they should be prioritized (see ch.2.1.4).

To depict the circular process, the butterfly model from Ellen Macarthur Foundation (EMF) is used. In the butterfly model seen in Figure 3 a regenerating system of multiple cycles is described of both biological and technical components. On the right side the technical materials are depicted which are often finite. The idea for this side of the model is to change from consumption to use. The smaller the circle, the more desirable as it requires less processing and energy, which means that its value is preserved. The several options proposed by CE can be found in ch.2.1.4. On the left side of the figure the organic materials and their circular procedure is presented. The ideal situation is to extract the materials with minimal disturbance from the ecosystem and strive for balance in the long run. Part of the left circles is the "cascading" phase. To define this, cascading is the change of use/ function of a product when it is not possible to use it as it was designed at the beginning. Through this process the quality and value is lowered as well as extra energy is consumed which is not desirable (EMF, 2013). All in all, the model reflects the main goal of CE which is to rebuild capital and increase the lifecycle of each component (EMF, 2013).

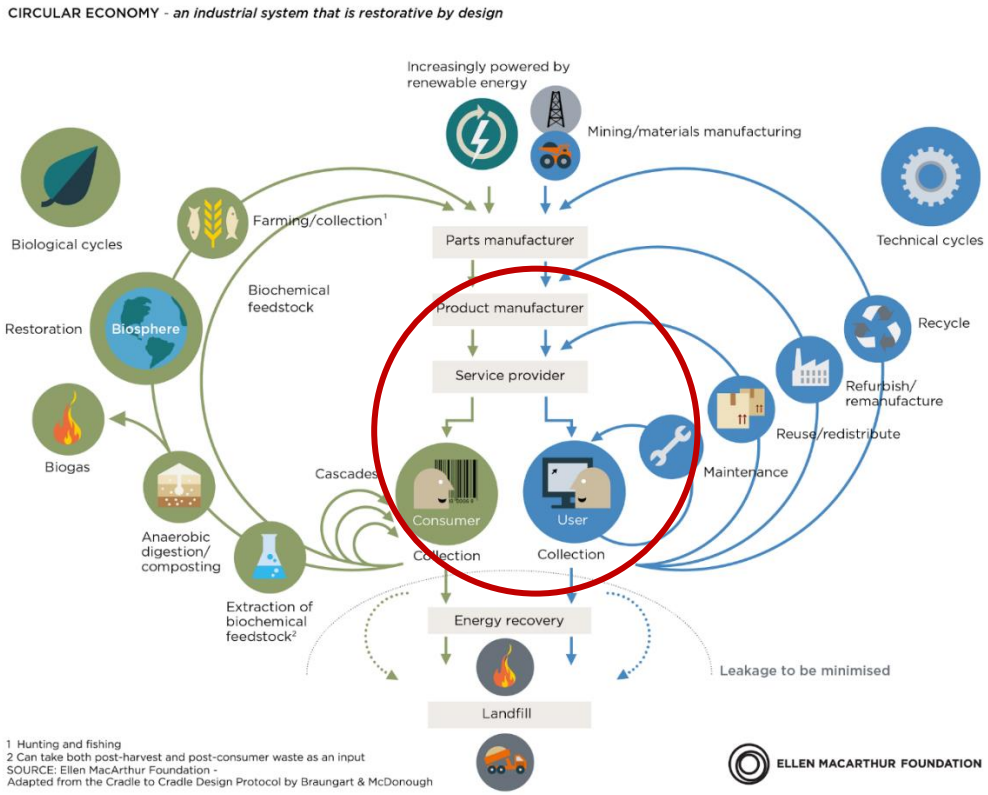


Figure 3: Butterfly model of CE (EMF, 2013). In the red circle the area of this thesis research can be seen.

2.1.4. Circular levels

A core element in the model are the circles. At the end of each use the materials should enter a new circle. This can be achieved in various ways. The choice depends on the environmental impact, the cost of the chosen method and the residual value of the object. In literature there are several suggested options for the end-of-use management, which are called R- factors. The most classic R-factor model contains four options: reuse, recycle, refurbish and reduce (EMF, 2013; Kirchherr et al., 2017). One of the more elaborated models suggested is the 10-R model by Cramer (2017) where a "Ladder of circularity" is proposed with all 10 solutions prioritized. The priority is set according to how close the result is to the original form of the product.

Table 2: Ladder of circularity, the 10-R prioritized factor model (Cramer, 2017)

	Levels of Circularity	
High	1	Refuse
	2	Reduce
	3	Redesign
	4	Reuse
	5	Repair
	6	Refurbish
	7	Remanufacture
	8	Repurpose
	9	Recycle
Low	10	Recover (Energy)

In general, the least favourable strategies are the recovery of energy from the incineration of materials and the recycling (Korhonen, Honkasalo, et al., 2018). Recycling is not preferred as it usually results in low-graded raw materials (Korhonen, Honkasalo, et al., 2018), or may be more expensive than producing raw materials (Preston, 2012) and thus not be cost effective businesswise. Material upcycling is feasible by adding extra energy in the system to raise the quality of material. As a result, the cost increases and the sustainable character of recycling is diminished (Cullen, 2017). Material down cycling on the other hand, is often an option when moneywise is not in the interest of the company to reproduce same quality material as the original (Cullen, 2017).

2.1.5. Opportunities and Challenges

CE is marketed as offering many opportunities. First of all, it is marketed as an environmentally friendly solution that opens up more job positions and business opportunities due to the extra steps in the production process (Korhonen, Honkasalo, et al., 2018). According to TNO (Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013) CE has the potential to gain profits of 7.3 billion euros-and 54000 jobs per year. Additionally, the material costs are reduced as the value is used in multiple cycles, as well as by avoiding the waste management costs (Korhonen, Honkasalo, et al., 2018).

Circular Economy is based on suppliers/ manufacturers to be the owners and offer usage to their clients through operational lease (EMF, 2013). The owner is responsible to ensure that the product or its components will continue moving in multiple circles under the end of each use. Through this change, the client pays only for the use of a product and the services offered by the owner. Because of this change of ownership, manufacturers design durable and high quality products (design for success) instead of lower quality products that will increase their profits and sales (design for failure) (Korhonen, Birkie, et al., 2018). Furthermore, they have the knowledge and technical ability to ensure a multiple-cycle life for the products.

A problem with the CE model is how far Circular Economy can go. A fully circular system is not realistic because of the entropy law (Andersen, 2007; Naustdalslid, 2014) and dissipation. As Haas et al. (2015) have researched, 42% of materials can be returned to the system as a product of reduction of use of materials, reuse, and recycling. Materials and energy have to be infused in every new circle to cover the losses in order to complete production or refurbishment of products (Cullen, 2017). Even if materials move through multiple cycles, the impact of the man-made material flows is not yet known and sustainability cannot be guaranteed as economic and organizational structures are also unknown (Korhonen, Honkasalo, et al., 2018). Recycling was already discussed in the 2.1.4, and unfortunately is often exclusively connected with CE, ignoring the rest of the suggested solutions (W. R. Stahel, 2013). Choices like recycling can leads to more greenhouse gasses emissions than traditional processes to produce material such as mining, and thus making it harmful for the environment (Allwood, 2014). In the end, Circular Economy is not in opus environmentally beneficial.

Moreover, as CE is a different economic model, it needs a different financial management. As the lifecycle of the materials changes, and the owner can find value after the end of use, it is difficult to have solvability and liquidity in a circular company (H. D. Ploeger, Prins, Straub, & van den Brink, 2017). The costs of end- of-use management should not be neglected. Each method in paragraph 2.1.4 has different costs and the residual value also affects the price. This cost could be included in the price of the contract, as well as a risk premium for the legal risks and the uncertainties of changes in demand and supply (van den Brink et al., 2017).

Another problem to successful implementation of CE is that with a lack of proper regulation can be particularly challenging for the market to transit to CE, for companies to survive without support and for moving circular products internationally (Pheifer, 2017; Preston, 2012; Rizos, Behrens, Kafyeke, Hirschnitz-Garbers, & Ioannou, 2015). There is no current framework for circular procurement (Kirchherr et al., 2018) and the current legislation can only be seen as an obstacle for CE (Pheifer, 2017). For instance, modern environmental policies and laws are not putting boundaries to the free waste management (Korhonen, Honkasalo, et al., 2018). One of the most critical legal issues though, and focus point of this thesis, is the retainment of ownership, especially in components with long lifecycles (van den Brink et al., 2017). Without owning all the components of a real estate object for example, no accurate estimation of its value can be made (H. D. Ploeger et al., 2017).

2.2. Product to Service

Since the CE model advocates that ownership stays with the producer, and the consumer thus merely buys a service, the business model that best fits CE is the Product to Service model (PtS). The PtS offers the right to the client to use a specific product for a fixed amount of time, in combination with the provision of relevant services such as maintenance, through the form of leasing (Robotis, Bhattacharya, &

Van Wassenhove, 2012). It specifically refers to 'servitization' of a product, even though the opposite is also possible ('productization' of services) (Baines et al., 2007). Providers of this model create a package of a product and its relevant services, where value can be found in use and focus is at the needs of the client. In this manner, financial achievement is disassociated from constant material consumption (and eventually production of waste) and thus lessen the environmental impact (Baines et al., 2007). Apart from the obvious environmental reasons, the financial, social and strategic reasons have encouraged manufacturers to embrace this model, step away from momentary transactions and turn towards long lasting relationships (Oliva & Kallenberg, 2003; Wang et al., 2011).

It is also known with other names such as IPSS, Integrated Product- Service and Closed Loop Supply Chain (Mahut, Daaboul, Bricogne, & Eynard, 2017; Souza, 2013). The concept was first introduced by Rathmell in the 70s (Pezzotta, Pinto, Pirola, & Ouertani, 2014), where he suggested that services can be provided in combination with a product.

A company can change to a PtS and offer this type of services under specific circumstances. In order to be a profitable business opportunity, the service should be relatable to the main business of the company and be around 25% of the company's operations (van den Brink et al., 2017). The expansion of tasks that are necessary in order to offer more services or products is called organizational stretch (van den Brink et al., 2017) and its effects and feasibility must be researched prior to its realization.

Furthermore a careful analysis must be undertaken at the early stages of planning a business opening like that, on the demand for the specific products (both new and second-hand) (Souza, 2013), on the profitability and customer value for the manufacturers (van Loon, Delagarde, & Van Wassenhove, 2018) on the appropriate leasing period and on the amount of possible leasing times during their lifecycles. According to van Loon et al. (2018), a high demand of a product in the second hand market with high resale values is favourable for the linear economy and respectively hindering for circular economy, as it increases the willingness to pay for new products.

Despite the multiple requirements to be checked from companies interested in diving into the PtS business, there are two major external factors relevant with consumer behaviour that can affect the success of this model. First, clients involved in this model should take good care of the leased product and be educated on the subject of leasing and multiple lifecycles, especially on the ethics of careful use and returning them. Second of all and most important is a legislation that ensures proper behaviour of clients and companies and sets a framework of behaviour on all parties involved (Mahut et al., 2017).

As soon as all the requirements mentioned above are checked, PtS companies have to redesign products to fit in this model. Different materials are used in PtS with longer lifecycle and possibly more sustainable, while the design is based on easy assembly and disassembly. Therefore a lifecycle assessment is necessary as a first step to calculate the impact of the materials on the environment and draw the whole PtS process. This step though, requires some time, as acquisition of knowledge, real time application and familiarity becomes a rather tedious and onerous process (Robotis et al., 2012).

The process to be followed as soon as a potential user is found by the PtS company is broken down below (van Loon et al., 2018):

1. Credit check of potential user
2. Signing of lease contract between company and user
3. Forward transport
4. Lease of product for the agreed period and fee (This step includes use of product, customer service and payment process)

5. Collection and return transport to the warehouse of company

As soon as a leased product returns to the warehouse of the PtS company, the following process is followed (Souza, 2013; van Loon et al., 2018):

1. Full disassembly
2. Quality check
3. Thorough cleaning of each component
4. Making a disposition decision for each part
5. Refurbish parts to restore their functionality
6. Reassembly
7. Testing

The diagram below shows all the main steps included in a PtS process:

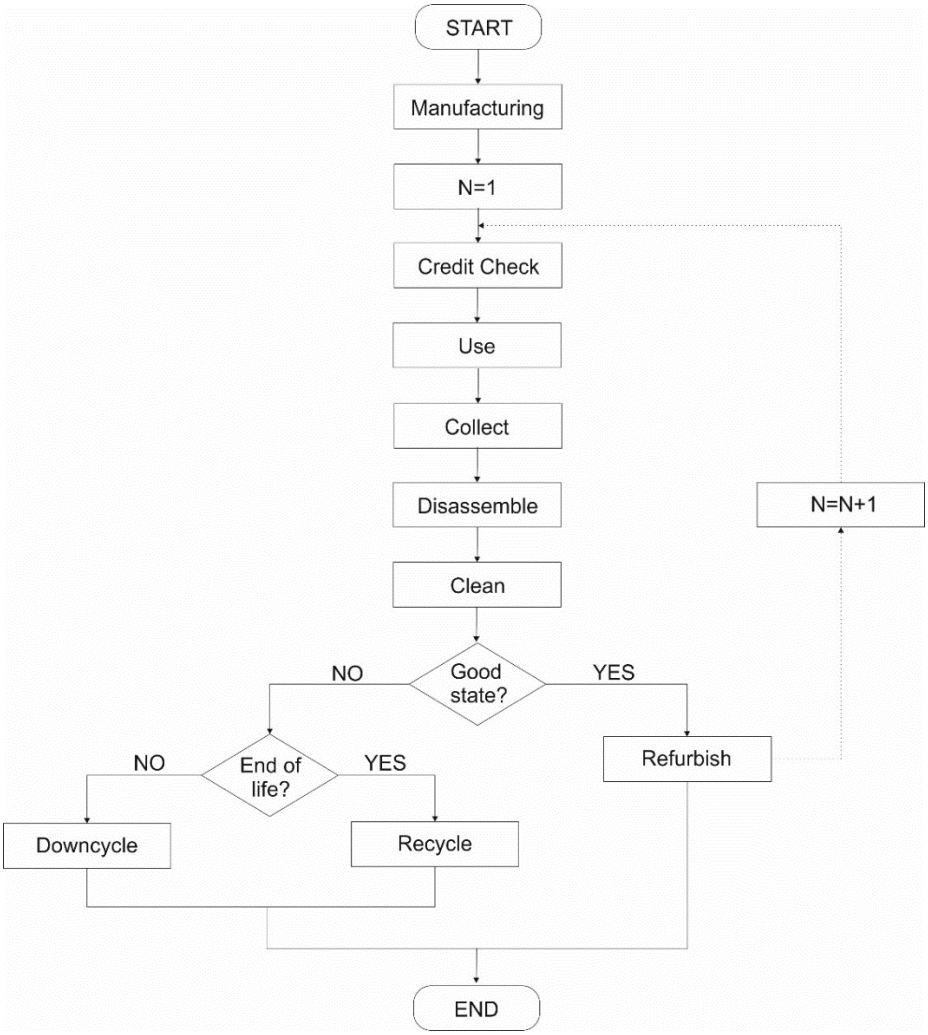


Figure 4: PtS process

The leasing can reach to its end if one of the following conditions is met (van Loon et al., 2018). First, if the end of life of the product is reached, then a decision is made on the type of disposal. Second, if the option of refurbishment is not possible because the quality has lowered to the lowest acceptable level (because of abuse), then again a disposal decision is made. The last condition is if the users do not return a product, then financial penalties take place; these will be discussed further below.

Like all business models, one of the most important things is profitability. According to

van Loon et al. (2018), if after leasing there is remanufacturing involved, heavy assets are more profitable than smaller products. Furthermore, if there are multiple cycles for every product, or if there are refurbished parts, this affects the price over time. This strategy is called "price skimming strategy", where prices get lowered over time and is an efficient way for a manufacturer to collect profits (van Loon et al., 2018).

Usually PtS contracts start with a deposit. This deposit functions a security for the company in the case of no return. Nevertheless, the amount of the deposit is critical; a low deposit will create temptation to the users to not return the product at the end of the lease, while a high deposit will discourage possible clients. To add to the point of the case of high deposit, one of the main arguments of people looking into leasing is to avoid a high payment upfront (van Loon et al., 2018).

The duration of the lease affects the profitability of the company, particularly in terms of liquidity and solvency (van den Brink et al., 2017). If the duration is short, then the total of payments will be fewer and therefore higher, but if the duration is too long it takes away the benefit of flexibility, which is something that a user might be interested in when looking into leasing (van Loon et al., 2018).

If the model includes refurbishment as a solution for the recollected parts after the end of life of a product, the price is naturally affected by that. (Korhonen, Birkie, et al., 2018)Souza (2013) quotes that refurbished products are sold around 60-85% of the price of a new product. The two main criteria to set the price is what the demand is for refurbished products of that category and what the quality is after refurbishment. Generally in leasing, the users are expecting a higher price than traditional buying of a product, as they also pay for services, benefits and low to zero risk (van Loon et al., 2018).

A factor that affects price and duration of a lease is capacity. Capacity is defined by Robotis et al. (2012) as the "maximum rate of products that a manufacturer can produce and maintain during their lifecycle". After the release of the product, if the market is saturated, the company should follow the strategy of price skimming during the lifecycle (Robotis et al., 2012). In this strategy, the price should decline based on the capacity. If the capacity is a limiting factor for the company, then the price reduction should be done according to the market demand and lifecycle length. A low capacity requires low rate of reduction as the demand can surpass capacity and when it reaches very low levels the products are sold at a high price and the duration of leasing is the same as the lifecycle. Robotis has also drawn a relation between capacity, lifecycle duration and remanufacturing savings that affects price and leasing period. This relation is summarized in table 3 below:

Table 3: Cost and duration of lease in respect to capacity and lifecycle (Robotis et al., 2012)

High capacity High remanufacturing saving	**Low capacity Low remanufacturing savings**
Long product lifecycle	
Longer leasing period Low initial price Price skimming	Medium leasing period High initial price Price skimming
Short product lifecycle	
Medium leasing period Intermediate initial price Price skimming	Short leasing period High initial price Price skimming

Finally a risk premium needs to be added in the price as the PtS company have to take into account the fact that demand fluctuates with time, especially in case of long lease contracts, and also as more companies get involved with PtS, regulation might change in order to protect both users and companies. Furthermore, users tend to be less careful with objects they do not own and this risk must be considered when calculating the depreciation overuse cycles. At the same time a company will provide a better maintenance (because of experience, knowledge and business mind-set) than a traditional consumer (owner) (Desai & Purohit, 1999).

Juehling, Torney, Herrmann, and Droeder (2010) claim that services can also offer high profits to a company, when they expand to include services in their packages. This can be argued with the task load increase, which was explained the PtS process breakdown above, which requires a lot of manual work as well as training (Carrasco-Gallego, Ponce-Cueto, & Dekker, 2012; Grubbström & Tang, 2006; van Loon et al., 2018).

This PtS model changes the way consumers see the products and takes advantage of value of a product from the first stage of manufacturing till the end of its life (Evans, Partidário, & Lambert, 2007; Lienert, 2015; Mahut et al., 2017). It offers to companies opportunities and incentives to invest in new and better business ideas, such as a combination with Circular Economy or going into the market of refurbished products (Mahut et al., 2017). In case of electronic products, companies can also collect data of usage and errors to further improve their products and their processes, which can lead to beating their market competitors (Lingegård, 2015; Mahut et al., 2017; Pezzotta et al., 2014). Also, it leads to the so-called "market expansion effect" as leased products (especially refurbished) cost usually less and gain the market share of people not willing to pay the full price of a buying a new product, as well as allowing a company to control also the second hand market of a category of products (Souza, 2013). However, caution must be taken when naming a PtS as "sustainable" as that is not always the case (Agrawal, Ferguson, Toktay, & Thomas, 2012). That is applied especially in the case of companies promoting refurbished products and the majority of the components has low durability (Quariguasi Frota Neto, Walther, Bloemhof, van Nunen, & Spengler, 2010; Sarkis & Zhu, 2018). Furthermore, a major problem is that the current legislation does not cover this model (owners or users) and therefore can leave both parties exposed or unprotected in some cases (Kuo, Ma, Huang, Hu, & Huang, 2010).

2.3. Legal Aspects

One crucial factor for the successful adaption of Circular Economy in the business world is the legislation. As with all new and innovative ideas, legislation can act as a booster or a barrier (Bastein et al., 2013). The ideal would be if that the legal framework could support innovation and moving forward.

The current European legal framework aims to minimize the problems originating from waste and emissions' pollution. Even though this helps controlling the problem, it focuses on the consequences of the problem and not on its solution (MOI, 2016). Therefore, for implementation of CE it is essential to move towards a framework that helps the flow of raw circular materials and the circular strategies as presented in ch.2.1.3 and 2.1.4.

The case studies that will be presented in ch.4 take place in the Netherlands and therefore they are arranged by the Dutch Civil Law (DCL). The information collected though for the analysis of the results is based both the South African Mixed Legal System (SAMLS) and the DCL, due to the fact that the principles of SAMLS are the same with DCL do not imply a language barrier (see ch.6.3).

South African law is a mixed legal system, where each discipline is influenced from

either common law (established during the British colonization) and the civil law(established during the Dutch colonization) (Akkermans, 2008). Furthermore, SAMLS is one of the most important of its kind (Smits, 1998) and has common ground, on the aspects under research in this thesis, with Dutch civil law (Mostert et al., 2010).

2.3.2. Movable and immovable things

According to Article 3:3 of the DCL "*Immovable are the land, the not yet minerals, the plants connected with the land, and the buildings and constructions permanently attached to the land, either directly or through a connection with other buildings or constructions*". On the same article is stated that "Movable are all things that are not immovable".

On the SAMLS the same categorisation exists. Movable are defined as the objects that can be moved without damage, or change of their identity (Mostert et al., 2010).

It is sometimes not evident to determine whether an object is movable or immovable. Naturally this fact can create a legal uncertainty. In order to characterize something as a movable it depends on the type of the object the intention when it was installed and the type of installation (van der Walt & Sono, 2016). Another factor is if the removal of the object in question will cause damage to the main object (H. D. Ploeger et al., 2017). Consequently, it all comes down to the value; if the removal will lower the value or if the rest of the assembly is incomplete without the said object, the object is considered an immovable.

Ownership is defined by the DCL in Article 5:1 as "*…the most comprehensive property right that a person, the 'owner', can have to (in) a thing*". Furthermore, "*The owner of the thing becomes the owner of its separated fruits and benefits, except when another person is entitled to them.*" (DCL , Article 5:1:3). Ownership is important to be defined, as the owner of an object can be determined by the nature of the object, whether it is movable or not, especially in the case where the rule of accession is applied. According to the rule of accession (explained in the following section) the owner of the main object is the owner of all the accompanying parts, with certain legal exceptions. In the following section the rule of accession which determines the owner is further explained.

2.3.3. Principle of Inaedificatio/ Accession Rule

As Aristotle said, the whole is greater than the sum of its parts. In property law this idea is protected by the principle of Inaedificatio (South African Law) or accession rule (Dutch Law) where preservation of value is followed through preservation of unity of things (van Vliet, 2002).

DCL defines accession as the case where "As far as the law does not provide otherwise, the owner of a thing is the owner of all its components." (DCL , Article 5:3). Additionally, "*If a movable thing becomes a component of another movable thing, which has to be regarded as the principal thing, then the ownership of the movable thing passes over to the owner of the principal thing. If none of the movable things can be pointed out as the principle thing and they belong to different owners, then these owners will become co-owners of the new thing, each of them for a share proportionally to the value of the movable thing he owned before. The principal thing is the thing of which the value exceeds the value of the other thing considerably or the thing that is regarded by generally accepted views (common opinion) as the principal thing."* (DCL Article 5:14).

The concept refers to the case where two independent objects are joined together (either physical or other bond) to the extent that one of the two loses its independence

and they are considered as one object from that moment on (Mostert et al., 2010; van Vliet, 2002). A distinction between the main object and the additional object is important, as the owner of the main object becomes the owner of both objects (Knobel, 2011). The distinction is based on three factors: the purpose of the object, the type of connection and the intention of the owner of the movable object (Knobel, 2011; van Vliet, 2002). It is important to note, that the permanent character of connection between the two object is also necessary for accession (van der Walt & Sono, 2016).

The main differences are that both Civil and Common Law use mostly objective standards on deciding whether an object has acceded (depending from country to country), while the South African property law (MLS) use case law and precedent. There are two separate legal risks originating from the connection of two objects. The first one is that the nature of the acceded object could change from movable to immovable. In the second place the owner of land can claim the ownership of everything that is attached to the land (van Vliet, 2002). The second and most substantial risk can be avoided with the methods suggested in ch.2.3.4.

Accession is important in general as it distinguishes the rightful owner of an object (H. D. Ploeger et al., 2017). It also protects the value of the whole object by retaining its integrity (van Vliet, 2002). Even though it is useful in traditional cases and can be decisive in legal controversies, in CE not only is not necessary but it creates complications. First of all, Circular Economy has the goal of preserving the value, which can also be said to be one of the motives of applying rule of accession, but with a totally different manner; there is one user, but several legal owners who have the responsibility of retrieving the product and recycle/reuse its components. The need to look a way to go around this rule, creates at least a complication and time delay.

2.3.4. Right of Superficies and Economic Value

The most secure way to avoid the application of the rule of accession is through the right of superficies (in Dutch "opstalrecht") (Akkermans, 2008; DCL). In the DCL is defined as *"[…] a real property right which enables its proprietor - the 'superficiary' - to have or acquire for himself buildings, constructions or plants (vegetation) in, on or above an immovable thing owned by someone else. The right of superficies may be established on someone else's immovable thing independent or dependent from another real property right or from a right of (farm) lease on that immovable thing*." (DCL, Article 5:101). By applying superficies the obligation of paying rent can be created (DCL, Article 5:101:3) The right of superficies does not create only obligations, but it can also limit the rights of the 'superficiary' to use place and remove other immovable things (buildings or constructions) (DCL, Article 5:102). When the right of superficies is over, the ownership of the object is now given to the owner of the immovable property where the object was installed, unless it was removed by the 'superficiary' at that time (DCL, Article 5:105).

According to H. D. Ploeger et al. (2017) it allows to a party to keep the ownership of an object (and full powers that accompany the ownership right) attached to an immovable object (fixture) owned by another party. It is a limited property right (a right in rem), which is a property right with real effect derived from a right of ownership of a movable or immovable thing (DCL).When superficies is in action, it allows a combination with other property rights (dependent right of superficies). In most cases it is found in combination with a right of use or in a lease. In this situation, the right of superficies is terminated when the agreement or contract is also at the end (Akkermans, 2008). Most companies choose this option, but it is not always feasible as it depends on whether the object is financial independent from the rest of the land or the building (H. Ploeger, Mes, & Janssen, 2016).

When superficies is not an option, the alternative solution is economic ownership. Economic ownership is use of an object with its accompanying financial risks and responsibilities without being the legal owner (H. D. Ploeger et al., 2017) and based on a contract. Not being a proprietary right as such, it is a rather risky option as it has no legal entity, therefore it should only be applied in cases where clients have good credit and are not risky.

In any case, the fact that the right of superficies is used as a loophole to arrange the issue of ownership in circular leases and that there is no existed relevant case law so far, it is not known if it will actually work in practice (Hendrik Ploeger, t.b.a.).

2.3.5. Lease Contract

Leasehold, according to the DCL, is *"[…] a limited property right which gives its proprietor, the 'leaseholder', the right to hold and use an immovable thing of someone else."* (DCL , Article 5:85:1). The duration of the said lease is agreed and defined in the lease in the contract signed by both parties (DCL , Article 5:86). The lease can be terminated by the leaseholder, unless there is term in the contract saying otherwise (DCL , Article 5:87:1). It can also be terminated by the owner of the object if the rent is not paid in a specific amount of time or if the leaseholder does not fulfill all the agreed obligations (DCL , Article 5:87:2). The owner of the object can control through the contract if the lease can be transferred to a third party and to whom with justified reason (DCL , Article 5:91).

A lease deal is closed by a signed contract which defines the rights and responsibilities of each side. According to Akkermans (2008), a personal relation is set between the lessor and the lessee. In case a party involved in a lease (either the lessor or the lessee) has to be replaced, a new contract is created with the new party and the old contract is no longer in effect.

Under the combination model under research (PtS and CE), the product is transformed to a service. The best type of contract for services is performance based (PBC). The focus of PBC is on what it is to be achieved. The idea behind this contract is that both parties decide together the required level of performance. With agreed levels of performance the client has an incentive of letting go of the ownership and choose guaranteed service and functionality. Another reason, why PBC is suitable for circular operational leases, is that responsibilities stay with the owner (supplier) and not move to the client. As an owner it is understandable that he bears the most risks (Roehrich, Glas, Selviaridis, & Eßig, 2016).

The aforementioned levels of performance are called Key Performance Indicators (KPIs) and are defined as measurable objectives agreed and followed by the clients and contractors. KPIs usually follow the SMART rule (Specific, Measurable, Attainable, Realistic and Time-based) and can be defined as critical measurable factors for the success or failure of goals. They are used in contracts and projects as early warning signs to track failures and wrong situations and measure progress (Kerzner, 2013).

3

Methods

In order to answer the research question and fulfil the goals of this thesis, a research strategy was drawn. This strategy outlines which approaches were selected as more suitable for the most effective route to the requested answers.

Due to the many fields involved in the problem under research and the lack of in between links in the existing literature, multiple qualitative approaches seem to be the most fitting option for this research. To put it simply, a qualitative research refers to a contemplative research approach, with an end goal of finding a theory or a pattern through the material collected (Verschuren, Doorewaard, Poper, & Mellion, 2010). The choice of different qualitative method offers multiple perspectives, flexibility during the course of the research, but also the option to validate information (Creswell, 2014).

3.1. Desk Research

The first step for the investigation of this problem is a desk research. The purpose of this approach is to create a theoretical framework that will act as a foundation for the following steps in the research strategy. This approach will provide the necessary theoretical insight to face the problem, while it will support and guide the data analysis and findings. The three main focus points of the desk research are Circular Economy, Product to Service model and the legal aspects involved. The sources used for research are mainly reports, books and papers. The main advantage of desk research is the vast quantity of available information in little time. The disadvantages, on the other hand, of this approach is that all this information can be interpreted in any way the researcher wants, which can result in biased results, and that the researcher is limited on only the information given and missing out on all the non-verbal data such as body language, or on spot observations (Verschuren et al., 2010).

3.2. Grounded Theory and Sensitizing Concepts

Through grounded theory a theory is developed and examined. Grounded theory is an interpretive approach, without any hypotheses, used to solve the problem in question. The research starts with a sensitizing concept, which is a vague concept that is used as a guide to reach to a more specific conclusion (Bowen, 2006). The direction given by the sensitizing concept, which in this thesis' case is to look for the risk involved in a case combining CE and PtS, will help develop a theory. The theory will be grounded on data which will be derived from the desktop research and the interviews conducted about the

case studies. The inquisitive character of the theory can be seen in the comparison of all practical and theoretical information that will lead to the results.

3.3. Case study protocol

The process of conducting the case study research that was followed is presented in the following steps, according to Stake (1995):

- Set the criteria for selecting the cases
- Formulate the research questions/ objectives and issues to be researched
- Gather the necessary information to prepare for the interview
- Analyse and interpret of the results
- Validate of the data and results
- Reporting case studies
- To identify what strategies are followed for pricing and duration of lease and evaluate them

For the choice of case studies selection criteria were set to help achieve the above objectives. The main criteria that each case study had to fulfil are:

- Product to Service
- Advanced technology
- Already implemented
- Long duration (over 15 years)
- Sustainable character

Circularity is found only in the second case study, as this will help with the first goal of the case study research (To identify the differences between a circular and a non-circular project). It will also help to evaluate the circular choices, by making clearer if the real motive was PtS or CE. Furthermore this main difference could highlight a causal connection between the findings relevant to risks and the circular nature of the project.

The minimum duration of 15 years was set in order to make clear that the objects under research will be of a permanent character and therefore have the complication of ownership allocation. Objects installed for such a long duration in a building can be considered part of it and therefor claim their ownership.

The two case studies which are presented in this chapter refer to solar panel installation and elevators. The first case study is a non-circular leasing of solar panels. The second case study is about the circular leasing model of elevators, while on the same time a sale of a traditional elevator is presented to highlight the differences of traditional selling and leasing/usage. The first case has an instrumental character as it is used to present how a traditional PtS model works, while the second case has an intrinsic character as it focuses on the CE aspects, and therefore more weight is given on the second case.

At the second step of designing the case studies, the type of approach is chosen. To solve the research problem and due to limitations (see ch.6.3), the comparative case study type was selected. The procedure of case studies was performed in a sequential order, for the purpose of using the information collected by the previous case to the benefit of the next case (Verschuren et al., 2010). Moreover the objectives of these phases were decided which are stemmed through the issues being researched:

- To identify the differences between a circular and a non-circular project
- To identify the differences between leasing (usage) and selling
- To identify the main risks found in a PtS model
- To find out how companies manage the above risks
- To determine what circular initiative are taken and evaluate them

The preparation phase started with the literature research on chapter 2. Furthermore, literature was studied on how to conduct interviews and how to prepare an interview protocol (Insitu, n.d.). Furthermore, a "test-interview" took place prior to the official interviews in order to check the compilation of questions and the flow of the conversation. The interview protocol can be found in the Appendix in p.75.

Another key point for the quality of the results of the case studies is the choice of interviewees. With this in mind, the persons interviewed were the most knowledgeable on the matters in question and they are all involved in the projects used as examples during the interviews.

Apart from the interviews (see Appendix and further), documents were offered by the interviewees for reviewing as well as from personal research prior to the interviews. A list of the said documents is provided in Appendix. Furthermore, when it was possible, on site observations were made.

The analysis of all the collected information from the previous steps can be found in ch.4 and 5, where all the findings are presented and the report of the case studies, which is the last step, can be seen below. A short introduction is given for each case, which is followed by an explanation how the PtS model works in the specific case.

The data collected from the methods described above are processed in the final phase of the methodology and formulated as results and conclusions. Even though the aim of the research is to reach to a general result, the data interpretation may have some subjectivity due to the limitations of the thesis. A case study research was conducted on two individual cases with common ground the Product to Service model and the main difference the Circular Economy. Information was collected through a series of interviews, both from the side of companies and clients. The purpose of the case study research is to explore if the theory provided in ch.2 is confirmed by what happens in practice.

4

Findings

Chapter 2 gives an overview of the existing literature which is used as a theoretical foundation in the exploration of the research problem. This chapter aims to provide the practical insight to the problem, for the purpose of verifying the theoretical information collected before and offering a different perspective. The two case studies are presented with data from the interviews conducted and the material given by the companies.

4.1. Case study 1: Solar panels on the roof of frigoCare

One of the main goals of the Port of Rotterdam Authority (PoR) is to be one of the most sustainable port of its kind in the world (PoR). Currently the production of solar panels in the Municipality of Rotterdam is 3 GWh, while the goal for 2020 is 20 GWh and for 2030 is 1000 GWh ("Samskip, frigoCare and Zon Exploitatie Nederland to launch the largest solar panel system in Rotterdam," 2016)

As part of accomplishing these goals, they welcome several sustainable initiatives in the area. One of the most substantial sustainable collaborations in the area of the port is the installation of a large solar panel system on the roof of a cooled warehouse of frigoCare. frigoCare is a subsidiary of the global logistics company Samskip while the specific project was implemented in collaboration with the renewable energy company Zon Exploitatie Nederland (ZEN). This project has managed to increase the energy production from solar panels in the municipality by 25% ("Samskip, frigoCare and Zon Exploitatie Nederland to launch the largest solar panel system in Rotterdam," 2016).

In Figure 5 one can see a picture of the installation of solar panel system while in Figure 6 a stakeholder diagram is provided.

Figure 5: Picture from the installation on the rood of frigoCare ("Samskip, frigoCare and Zon Exploitatie Nederland to launch the largest solar panel system in Rotterdam," 2016)

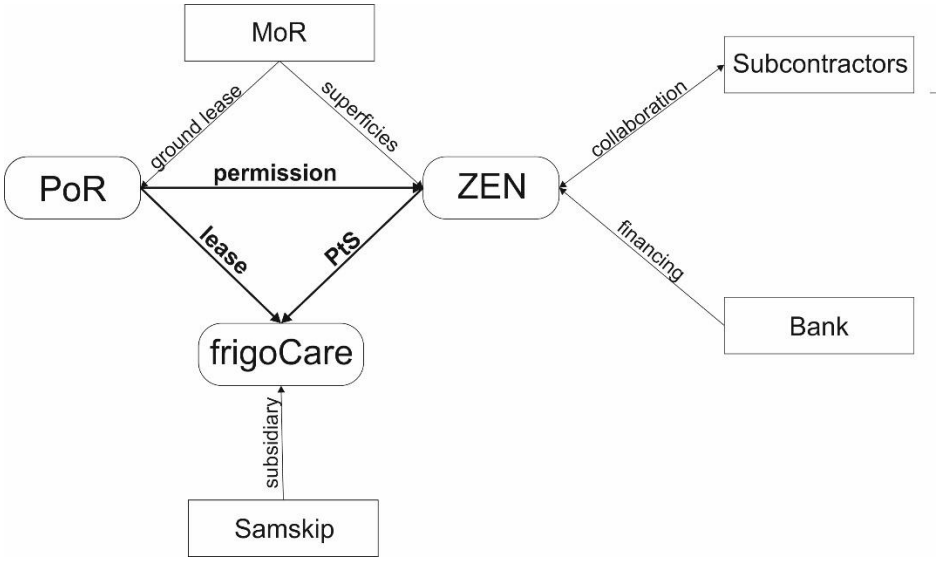


Figure 6: Stakeholder diagram (in bold the main relationships)

4.1.1. How it works

The duration of the collaboration is 16 years, as dictated by the duration of the subsidies, which are the incentives for ZEN to implement this type of projects. The process starts with a technical check on the roof to calculate whether the roof can withstand the weight of the installation. This is also necessary for allocation of responsibilities in case of damage.

The following step is to ask for approval from the PoR Authorities and from the bank that will finance the project. PoR has to be involved as the organization has perpetual lease of the ground which is actually owned by the municipality (east) and the state (west). The client (frigoCare) has the economic ownership of the building and the legal ownership belongs to the MoR. Due to the right of PoR to exploit the ground, permission has to be

granted on third parties that want the right of use, with the option of stipulating extra conditions. ZEN, in order to protect their equipment, they secure ownership with the right of superficies (opstalrecht) provided by the MoR. Further information on this subject was given in ch.2.3.4. Figure 7 explains how all the involved parties that have rights on a specific part of land in the PoR interact (frigoCare is the client and ZEN is the third party).

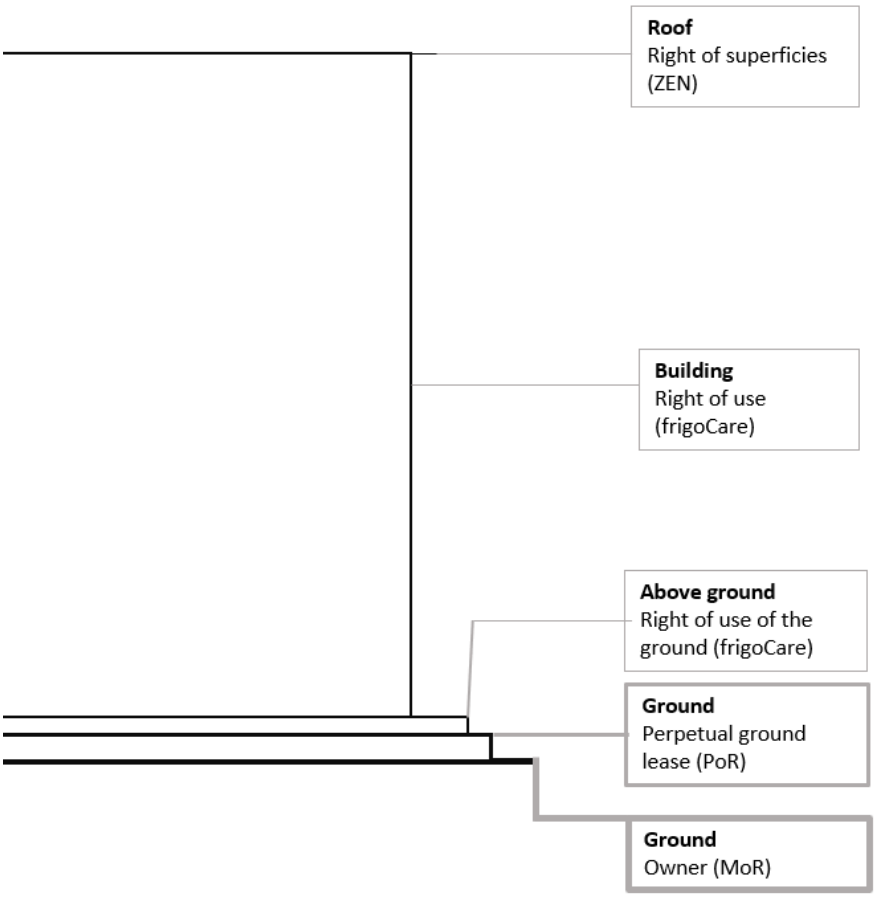


Figure 7: Explanation of relationships and rights on a building in the PoR (with example of leasing the roof)

Meanwhile the technical aspects of the installation are decided according to the needs of the client and the available facilities. The technical characteristics of the installation on frigoCare can be found on the table below. The installation produces one third of the needs of the warehouse (2.7 GWh/year ("Samskip, frigoCare and Zon Exploitatie Nederland to launch the largest solar panel system in Rotterdam," 2016).

Table 4: Technical aspects of installation on the roof of frigoCare (ZEN)

Technical Characteristics	
Quantity of solar panels	3072
Area (m^2)	7500
Power (kWp)	814
Annual production (kWh)	695957 (enough for 244 households)
Annual saving of CO_2 (ton)	278

frigoCare provides the roof's surface for the installation, which is the size of a football field, whereas ZEN owns and operates the solar panels system. In return, frigoCare has a cheaper energy supply and a green sustainable profile in the market. The agreement is that frigoCare will buy the whole production of the system in the same price as from the conventional energy provider (the production level is set according to the needs of the business and/ or based on the available space). frigoCare saves from grid costs and taxes and also as they lease the land (see Figure 7), they do not invest in a permanent installation. Additionally, the installation offers an insulating layer to the warehouse, which makes a small difference in saving on electricity consumption.

As soon as the solar panel is installed, ZEN is responsible for maintaining the installation and delivering the agreed kWh.

One of the main concerns in a collaboration of this type is what is going to happen in case of a bankruptcy of either side. The diagram below shows the results of both scenarios.

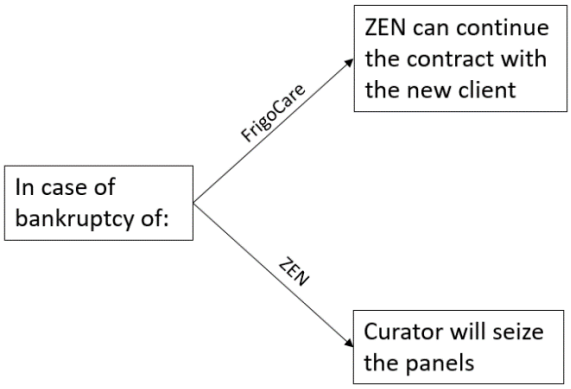


Figure 8: Scenarios of bankruptcy

In case ZEN goes bankrupt, a curator from the bank will come and seize the panels, but not the building. If the client goes bankrupt, the solar panels will not be seized as they remain in the ownership of ZEN. Of course, the cost of removing the installation from the building of the bankrupted client is still considered a financial damage, but it is only limited to that. ZEN is legally covered, and if a client tries to take advantage of the installation (e.g. to sell them), it is illegal and can lead to the court, according to the contract.

4.2. Case study 2: M-Use® Elevators- Mitsubishi Electric Europe

Mitsubishi Electric Europe (MEE) focuses on offering high quality products through a shift from ownership to use. M-Use® is the new circular business model applied by MEE, where MEE remains the owner of the elevator and the client only "uses" it. Like that, the product becomes a service.

The aim of MEE with the introduction of this new business model is to increase reusability of components and minimise waste. The idea behind it, was to find the perfect balance between keeping the quality of the company's products high and surviving the market drop and price pressure. Through this model, MEE offers to their clients top quality, longer product life and genuine durability. This business model represents an innovative sustainable result-oriented philosophy which focuses on the future and includes a long term relationship with the user on the level of partners. The M-Use® elevator is only 1.5 years in the market, with 18 projects (and 90 units) realised so far.

Figure 9: Photograph from the warehouse of Mitsubishi (source)

4.2.1. How it works

M-Use® is not only circular but also advanced in technology and quality. It offers high quality through the intelligent technology of sensors and connections through Internet of Things. This results to close monitoring of the components of the elevator at all times and prediction of the functionality. The maintenance is more efficient and the fees are according to the usage of the client (monthly periodic compensation). The close monitoring of data and components offers the chance to Mitsubishi for optimization of routine but also of the components. Last but not least, the precision of the maintenance plan leads to efficient use of resources which is a prerequisite for Circular Economy.

On the legal aspect, the contract type for M-Use® is performance-based which lasts for at least 20 years. MEE remains the owner of the installation based on the right of superficies (See ch.2.3.4). The long duration of the contract and the close monitoring of the product, create an atmosphere of a partnership where both parties have the same objective; high functionality of the product.

To set up the contract, the Key Performance Indicators (KPIs) are agreed with the client, which can be found below:

- Disturbance
- Downtime in % and maximum hours
- Noise vibration
- Functionality of telephone line
- Zero waste certification

These five KPIs are agreed upon, based on the technical aspects of the elevator, such as the number of disturbances per year. The company collects some initial data to decide the usage level of the client through a lift simulation. This lift simulation also determines the basic design principles. All these features accumulate the periodic fees paid by the client.

There are of course some exceptions to the compliance of the KPIs, such as misuse or improper use of the elevator from the users, damage to the elevator from the elevator and failure of fulfilment of the agreed obligations of the client. The client has also the option to doubt and challenge whether the KPIs are fulfilled. In that case, a third independent party can test and assess the performance of the elevator.

What has been analysed so far, shows only a fraction of the differences with the traditional model sold by Mitsubishi until now. The traditional business model offered by Mitsubishi includes manufacture and sale of an elevator to the client. The owner is the client and Mitsubishi undertakes the maintenance for a perpetual time period. This business model represents a short term relationship with the client, with product oriented philosophy. A comparison on several aspects of the traditional model and M-Use® can be seen in the following table.

Table 5: Comparison of characteristics between traditional and M-Use® model

	Traditional	Circular
Price	100% purchase at start	Installation costs (50%) Financing components (35%) Residual value (15%)
Ownership	Client	Company
Stakeholders	Multiple stakeholders	Company and external inspectors
Risks	On customer (stakeholders)	Mostly on company (insurance and increase of price)
Costs	Fluctuating	Fixed amount per year
Contract period	Free	20 years with option of extension
Quality	Uncertain (stakeholders)	Guaranteed with KPIs
Results	Av. 2,7 disturbances and 88 hrs of immovability/year	Max.1 disturbance and 17,5 hours of immovability/year

One of the initial concerns of the clients is whether a circular lease is more expensive in depth of time. In detail, the choice of M-Use® model instead of the traditional, according to a KPMG report (included in the brochure given by MEE), can save up to:

- ≥ €5000 initial investment
- ≥ €7400 exploitation costs
- ≥ €900 energy costs
- ≥ €3200 incident and disturbance costs

The benefits though are not only with the client. The owner (MEE) receives annual payments, which create a steady secure income. Furthermore, the data collected for maintenance can be used for optimisation of Mitsubishi's technology. The agreed KPIs also give motive to the company to keep high-quality services at all times.

The client has several financial responsibilities, where most of them are periodic. Other than that, the client must also prepare the casings of the lift shafts according to the plans. Also, the client must request and obtain all the necessary building permits and documents on time. Finally, the users are responsible to use the elevator in a proper way, without causing any damage.

On the other side, MEE has to arrange the title of the elevator, in order to keep the ownership and that the elevator will meet the KPIs according to agreement. Last but not least is the compliance of the installation with all the laws and regulations relevant with elevator installations. This is also secured with regular inspections from external parties.

The elevators in M-Use® are built prepared for easy disassembly and for partial replacement of specific components. Furthermore, up to 80% of the components of an elevator is planned to be recycled or reused in the company. The components without high residual value at the end of the initial lifespan are send to external partners for recycle. All procedures for recycling are done according to international standards such as DIN and ISO.

The risks are on Mitsubishi during the whole duration of the lease. In order to manage the risks, third parties are employed, such as insurance companies. The main concern of the clients is what happens in case of bankruptcy of either of the two parties involved. If clients' bankruptcy is occurring, MEE stays owner of the installation and elevator shafts and can have a new lease with the new property owner. The lease contract could include a term about this case, where the new owner is obliged to continue the lease or buy the elevator in a traditional manner (Hendrik Ploeger, t.b.a.). If MEE goes bankrupt the client can take over the elevator against residual value as mentioned in the contract (in time depreciated). On this a further discount is applied. According to Hendrik Ploeger (t.b.a.), in this case, the value is both the physical asset (elevator) and the performance contract signed with the client. Furthermore, another service provider could potentially buy the rights of the contract and continue it (Azcarate Aguerre et al., 2017; Hendrik Ploeger, t.b.a.)

The lift shafts are maintained and repaired by the client and the installation by the MEE. An elevator inspections company is doing the required inspections at the appropriate times, according to the laws and regulations.

At the end of the lease, the client has three options. The first option is to pay the residual value of the elevator and purchase it. The second option is extension of the lease. The last option is to terminate the lease and MEE will remove the elevator from the building.

5

Synthesis

The purpose of this chapter is to discuss what was presented mainly in the previous chapter, in relevance with the theoretical framework analysed in ch.2 and the interviews content included in the Appendix. The two case studies are broken down and analysed on various key "" facts is given in the table below:

Table 6: Recap of case studies

No.	Case study	Project	Product type	PtS	CE	Minimum duration of the contract
1	ZEN	FrigoCare	Solar panels	✓	×	16 y
2	MEE	M-Use®	Elevators	✓	✓	20 y

5.1. Circular Economy Aspects

Chapter 2 has offered a detailed breakdown on the concept of Circular Economy, based on what is written nowadays on the topic in the scientific literature. One of the main points of the concept's analysis is that CE is an escape from over consumption. Therefore the first point to discuss the two case studies presented in ch.4 is if they promote or limiting the overconsuming culture of the market. The first case study by ZEN is about solar panels installation. IEA (2017) supports that solar panels have the biggest market share of the renewable energies at the moment. This can also be seen in Figure 10 where the growth of solar panel in the last 25 years is visible in comparison with other renewables. This fast increase on sales of solar panels though is not alarming, as for other than aesthetic problems, it only benefits the world population and the environment. In any case though, both solar panels and elevators are not fast-consuming goods, which makes them safe from the risk of over consumption.

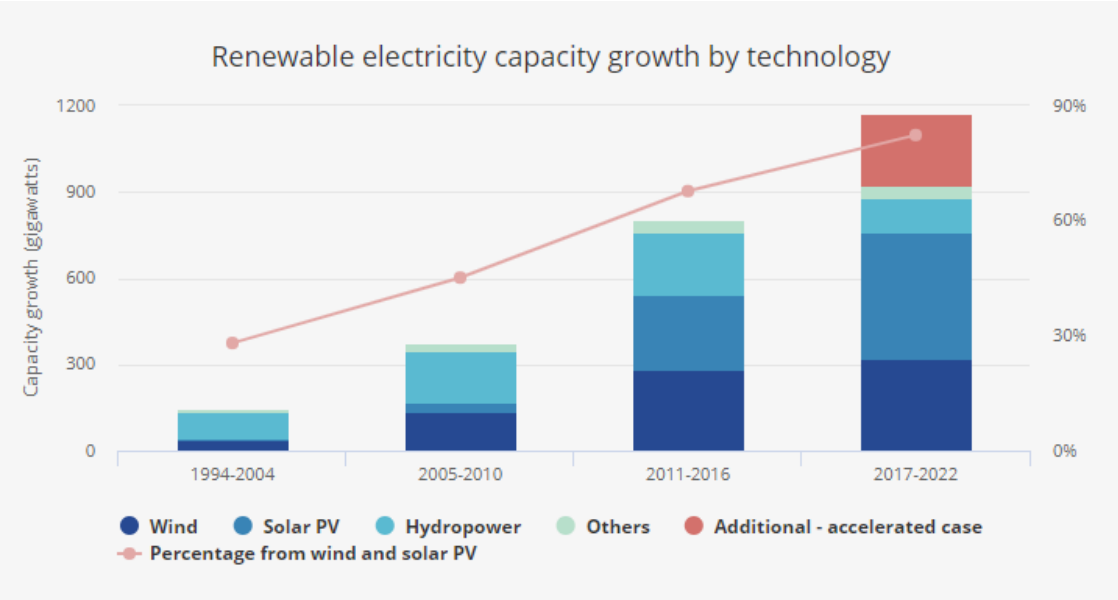


Figure 10: Depiction of growth of renewable energy types (IEA, 2017)

Another of the main points of CE is extending the lifecycle of a product in order to extract the highest possible of the value. In the first case study (ZEN), this is not one of the aims of the company, as they lease the panels for 16 years and "ignore" the remaining 10 years of their lifecycle by either free cycling them to their leaseholder or reinstalling them in smaller projects somewhere else. They are not making any effort to prolong the lifecycle, they only emphasize on the proper functioning during the lease. The second case study (MEE) on the other hand uses the extension of lifecycle as one of the main marketing points of the package. Usually, according to MEE, an elevator has a cost effective lifecycle of around 20 years, but their contract lasts 20+20 years with the same elevator and advanced maintenance to keep it in prime condition. The condition of the components is ensured by a series of KPIs that offer the user the security of constant functionality and availability. The table below shows what is the life expectancy of each part of the elevator, with proper maintenance and coming from a respectable manufacturer, and what the suggested solution is for each part at the end of their life. According to MEE (see Appendix, Interview no.B2), "After 20 years the elevator is still up and running. We have a maximum disturbance of 1 per year and a very low noise limit with a very comfort level. There is no need for change.". The advance technology installed in the M-Use® elevator may optimise the maintenance plan and help calculate the usage, but it is not explaining how the costs of replacing almost all basic parts will be avoided. This may be considered questionable from the circular perspective if for a 20+20 years period, around 95% of the components needs to be replaced to meet lifecycle extension.

Table 7: Breakdown of elevators 'components according to their lifecycle and end-of life suggestion ("Elevator Life Expectancy,")

Equipment Type	Expected Useful Life in Years	Recommended Action
Electrical switchgear	50+	Retain
Electrical wiring	30	Replace
Controller, dispatcher	20-25	Replace
Cab interior	15	Refurbish Interior
Machinery	30	Replace
Shaft doors	20-30	Replace Gibs and Rollers
Shaftways	N/A	N/A
Hoist rails	25	Realign rails
Cables	20	Replace
Travelling cables	20	Replace
Hydraulic piston	25	Replace/ Resleeve Piston
Elevator Call Station	15	Replace
Elevator Car Operating panel	20	Replace

Other than the two main points discussed above, Circular Economy is developed along three main axes, which are the financial, environmental and societal. These three axes can be benefited or affected by the CE implementation in the market. It is interesting to see the impact of M-Use® and ZEN on these three aspects, determine if it is actually beneficial and which weighs more.

One of the main motives for both projects under research, according to the interviews was the environmental benefits of CE and PtS. One exhibit of this motive is the statement from the Interview no.B1 "Our drive is to add value to the world and tribute to the environment." (Appendix). frigoCare, the company who offered the roof for the solar panels' installation, chose this deal to improve its sustainable profile in the market. This company is placed in the area of Port of Rotterdam, in a situation explained in detail in ch.4.1 and Figure 7, PoR is also aiming to have a sustainable profile and to be more specific, to become one of the greenest ports of its kind (PoR). The second case study of Delta Development is situated in a sustainable park with the goal of choosing sustainable options for the building components. They were looking into sustainable choices to equip their buildings. Interviewee from DD stated that "[The motive for choosing M-Use®] … was sustainability and the circular economy." "They are really looking into which materials are best to use and if they can be reused." (Appendix, Interview no.B3). Furthermore, MEE is working with different materials, friendlier to the environment and issues a material passport for them.

As both case studies refer to business projects, the main motive for companies is of course financial. ZEN chooses PtS based on the flexibility and the fact that it allows them to grow fast. MEE, according to Interview no.B2, started working on a PtS and CE package to beat the high competition and the effects of the financial crisis ("Initially we

were looking for a new business model to ensure we could keep our quality at a certain level, because we deliver high quality product lines and basically due to the market drop, price pressure and etc., we were looking for a new way to do our business."). Furthermore this model offers to the company "a stabilized income [of 20 years] and we can invest up front in a better elevator, take care of the total cost of usage to be as low as possible." The model of M-Use® elevator is said to be innovative and with higher technology than a traditional elevator, with "More implemented intelligence and different maintenance program" (Appendix, Interview no.B1).

The least researched category of aspect is the societal, as it can often be ignored by the companies. The relationship between the owner and the users is long, with frequent visits all around the year. MEE discusses the difference between a traditional and a circular model with the statement "In a regular contract you sell an elevator to a certain party and afterwards you go to a contract. This contract is about 3-4 visits in a year for maintenance without any warranties about the usage, performance or that you will keep the maintenance. We promise optimized function during every day of the year.""(Appendix, Interview no.B2). In the collaboration with DD, "…the investor was involved from the beginning, from the conceptualisation and development of this model, he had no problem." (Appendix, Interview no.B3). The collaboration should be peaceful as it is a win-win situation for both parties and it lasts many years. For example, the strong relationship that was created in the lease project under research, lead to more collaborations. The duration of the collaboration and the long-term character of a leasing agreement creates a prerequisite of having a good and solid relationship between the two parties. The pros of getting involved in this type of an agreement was already analysed in chapter 2. This creates an atmosphere of willingness and good faith from both sides. Discussions and compromises go smoother at the early stages of the agreement.

The conclusion coming out of the analysis of the three aspects is that circularity might be used as a marketing strategy for improving a company's profile and some environmentally choices will be taken, but is not the main real motive. Businesses take decisions based on profitability, market survival and competition. Therefore the most important aspect out of all three is the financial one. The societal axis on the other hand is the least researched, which seems to be wrongly based on the fact that consumer's behaviour is what actually moves the market. A well-founded long-term collaboration is the best advertisement for a business after all.

Considerations on Circularity

The circularity in the *M-Use*® starts by the early stages of a project, "by the [stage of] of development of the project" (Appendix, Interview no.B1). Furthermore CE aspects are evident in the material choices "For example the elevator shafts are made out of steel instead of concrete. Steel is more circular. The choice of material is one circular aspect, the easy disassembly is another thing and the option of material passport. But you can still discuss whether all these make it circular." (Appendix, Interview no.B3). According to the interviews, at the end of the lease "[MEE] will buy back the materials based on actual value of the materials and the delivered material passport. It is included in the contract." The plan for the returned components is to exchange, disassemble, reuse and recycle (Appendix, Interview no.B2). MEE says that "what cannot be reused [MEE] will recycle it, [MEE has] a company that is helping to get these materials into a new circle. But still around 20% cannot be reused or be recycled. But possibilities are changing and increasing." (Appendix, Interview no.B2). This shows to the reader that the end-of use plans are not concrete yet and will take advantage of the long duration of the lease to take decisions on the matter. On the other hand though, it is not decided yet how many circles can every component do, which raises a question on what kind of preparation and

research was done before the start of M-Use®, and what will happen if an elevator is return sooner than the scheduled lease.

Another difference between a circular and non-circular project, is how the price is affected from the multiple circles a product may do. Naturally, if a product is reused multiple times, its price is expected to go down after each cycle. For example, a discount of around 70 % is expected on a refurbished product according to Souza (2013). Even though MEE has designed a circular product, the M-Use® elevator, there is no indication that the price will change if reused components are incorporated in an elevator. To be more specific, there was no clear statement on what after treatment the components will have. The idea given from the statements in the interviews involved in the M-Use® project (Appendix, Interview no.B1, B2, B3) is that the end of lease plan is still under discussion, as there is plenty of time for it (20 years at least of lease). This raises the question again about whether it is truly circular. Circularity is translated on how many times you use a component, but finding different uses or solutions for the hundreds of pieces of an elevator is a difficult and time consuming task. Also the fact that there is no reference for re-used/recycled parts on the advertising/ informative brochure of MEE, further confirm the suspicion of lack of plan, as this would be one of the biggest cards for promoting the sustainable and circular aspect of the project. Finally, the fact that no reused or recycled parts are already in use, creates a contradiction with one of the main goals of CE, reducing raw materials used in manufacturing.

The ZEN company is not currently involved in any circular projects. This, according to Interview no.A1, is due to the fact that "there are not a lot of people currently who think like that [circular]" and thus, that is not attractive to their target group. Even though, in some cases they remove the solar panels at the end of the lease and reinstall it on another projects, they do not consider panels suitable for circulation, as new relevant technology is coming out every day and solar panels are not effective anymore at the end of use ("they are produced with a certain capacity but after 5 years better technology is out."). An argument on this statement is that not all components of solar panels lose their efficiency after the end of the lease, but of course a more detailed answer could be given by a mechanical engineer. Furthermore, another interesting solution seen on the chapter 2.1.4 is repurpose. In a short research online though, there were no suggested solutions of this type identified. On the other hand, it showed a big market for broken solar panels on a low price, where buyers save multiple properly functioning cells from broken panels. Furthermore, what worries ZEN about CE is how much the market is interested in this type of model. This interest can be cultivated through cultural education.

Another problem of CE is that it usually requires high upfront investment, when a company decides to switch from traditional manufacturing/selling to Circular Economy. That would be the case for both of the case studies of this thesis, as the equipment to be installed is expensive, and needs to be in stock for potential clients. MEE covers this risk with a high initial deposit, almost equal to the buying cost, but this will be further analysed in the following subchapter.

5.2. Product to Service Aspects

Both companies offer a combination of product and services, as the PtS model describes. At the suggestion of Van den Brink et al. (2017), for a company to decide to extent its business to include services, the product has to be 25% of the company's operations. In both companies, is without a question the case, as ZEN is exclusively working with solar panels, while MEE was already offering services on sold elevators, but usually not on such a long term as the lease duration.

Referring to the organizational stretch, ZEN chooses to avoid the risks that accompany it and outsourced almost all the relevant tasks of the projects for the sake of flexibility and fast growing of the company (Appendix, Interview no.A1). MEE is not overextending that much from the past tasks, as they were already undertaking in some cases for maintenance of the sold elevators in the past. Nevertheless, transitioning to a PtS model brought along a lot of additional tasks, which were not included beforehand (see ch.2.2, p.26). They only outsourced risk assessment for each project (Appendix, Interview no.B1).

Even though both companies offer maintenance outside the PtS model, the maintenance offered in this case is different. Both companies claim to offer advanced maintenance to their longstanding leaseholders with the assist of IoT and sensor technology. This high-tech equipment offers to the company constant data about the functioning of the products (usage level and behaviour) from a distance on a daily basis. This makes the usage measurable and the maintenance more trustworthy as a failure of the system is immediately detected. Additionally, the different maintenance plan lowers the cost of maintenance (Appendix, Interview no.B3).

As it was already discussed from the CE perspective, consumers' education is crucial for entrenching this model in the market. The importance of education is also high from the PtS perspective, as proper use is necessary to ensure that value of product is not lost and it can keep circulating after the end of lease. With proper education from the side of clients, as if they know beforehand about CE or PtS, they will understand easier the financial and functional aspects of the deal. This part can be rather challenging to sell to potential clients according to DD (Appendix, Interview no.B3). In Interview no.B2, MEE discusses the risk of leasing and clients' behaviour with the comment "Yes the risk is higher because we are the owners and sometimes clients are not using the elevator properly, then you have a discussion." Frequent maintenance and constant data collection serve also as close monitoring of the product's condition.

Pre-installation and post-use preparation

A lot of preparation is needed before starting implementation of this model. A necessary step of the preparation is researching the level of demand for the combination of product and service as a combination. Clients are still in difficulty to let go of ownership and still match quality with newness. This type of research was necessary for MEE, as the specific elevator model in M-Use® is not sold in traditional mode. This is justified by the higher cost of the model from the advanced technological components of it.

In chapter 2.2 first a process sequence was given on how to close a PtS agreement between the manufacturer and the client and then on the process to be followed at the end of the lease. When both companies were questioned on the first process, both commented on the first step of "credit check of potential user". ZEN said that they do not check the trustworthiness of the client yet but it is bound to happen. It was also stressed that it is a necessary check, because many companies may look seemingly fine, but in the books to be a complete mess. They do though a risk assessment on political and financial aspects according to the market situation. MEE, on the same topic, commented that they do a risk assessment beforehand within the company with the help of lawyer (Appendix, Interview no.B1). For the following steps, ZEN checks the stability of the building and a plan of how many solar panels will be installed (Appendix, Interview no.A1). They emphasize on the necessity of a good preparation beforehand as it could be crucial in case of damage and responsibility allocation at a later stage.

Both of the companies involved in the two case studies of this thesis have designed their products with easy assembly/ disassembly in mind. Minimum damage on the

leaseholders' property at the moment of removal is part of the agreement as leasing has a temporary character. This type of design takes also in consideration the possibility of reusing components and to preserve their value, as both companies remain owners at the end of the lease.

As it was already discussed above, MEE has a well thought plan for the end of lease to treat the components in such a way to continue circulate. ZEN, on the other hand, offers two options at the end of the leasing contract to their clients. They can keep the solar panels (as according to the interviewee after 16 years, the solar panels have low residual value for them- Appendix, Interview no.A1). They can also request the removal of the panels, in which case they would be installed in a project with lesser importance (quote).

The speed of the technology evolution, is a criterion for the duration of the lease. MEE consider the evolution of elevators to be mainly constant or slow processing, and therefore the long duration of their lease is not containing a high risk having to deal with unusable technological parts at the end of the lease. Another criterion for ZEN is the subsidies given for solar panels. In their case, they offer a lease contract with the exact same duration of the subsidies given in the Netherlands. The main criterion though for MEE is the high cost of the elevator which can be lowered down only if it is shared in small instalments through the years

The responsibility according to both case studies is sided with the owners. They are responsible for the maintenance and ensuring constant and proper functioning. They generally try not to interfere on the actual building to avoid paying damages at the end of the lease. The fact that the user has really low risk and a lot of benefits is reflected on the price, as it is analysed in the next subchapter.

5.3. Cost Analysis

The theoretical side of CE and PtS was explained in detail on Chapter 2 and was compared to real time cases of the market. At this point, a cost analysis is given to determine how pricing is decided, from what factors is affected and if it is on the right point. Both cases have in common the costs of manufacturing. Logistics, maintenance (including substituting broken parts), a risk premium and costs of removal. The only difference between the two case studies is the cost for the end of lease solution which may include reuse (refurbishment), recycle or exchange.

The first instalment to be paid in a lease and usage scheme (either circular or not), is a deposit at the beginning of the contract. Usually this deposit is higher than the rest of the instalment, because it works as a security for the clients especially on the case of no return at the end of the lease. Furthermore, the high first instalment is used for financing the manufacturing of the product. What is important though, is how high this deposit is. A high deposit will discourage potential clients, especially as many clients choose leasing to avoid a paying a large sum at once. For example, in M-Use® case, the fact that the deposit is around 65% of the price of normal traditional elevator, cannot be justified even with the added costs and takes away the advantages of paying in instalments (see fig. 3.5a, taken from MEE brochure)

The high cost of the circular elevator is justified by clients and company (see Appendix, Interview no.B1, B2, B3) from the higher quality of materials and components and the service part. On the same time though, MEE is not considering selling an elevator as a traditional or offer this "advanced maintenance plan" as an individual package, as they think that there is no market for them. Contractors are looking to buy something that will fulfil the purpose of going from A to B, without raising significantly the price of the whole building.

Despite the pricing of the product and services and the risk/responsibility takeover form the manufacturers, they also have a lot to gain, even indirectly. The advanced technology used in the elevators and solar panels to close monitor the functioning of the equipment is providing them with constant data flow. The data collection can be used for optimisation, for testing new technologies and even more business activities to increase their profits. In case they had to buy this amount of data, it would cost a lot of money and it would be difficult to find clients willing to provide this data. Furthermore, according to Interview no.B2 and B3 the model of elevator used in the circular package is not sold as traditional because there is no market for it (due to high price and lack of interested in the high tech specifications.

On another subject, a factor interconnected with the price point of the packages is duration of contract. Specifically in the first case study (ZEN), the duration is defined based on the subsidies given by the government and their duration, while on the second case the combined high cost of the product and services requires a long period of payment, in order to be market competitive. Indicatively, the statements of both manufacturer and client of MEE support this argument.

Both duration and price though are affected by capacity, as seen in ch.2.2. Capacity is defined by Robotis et al. (2012) as the "maximum rate of products that a manufacturer can produce and maintain during their lifecycle". In case of market saturation a price skimming strategy should be followed, which means the price is affected by the capacity. In the case of MEE, according to the given definitions of capacity and relevant concepts in ch.2.2, elevators fall into the category of Low Capacity and Long product lifecycle. According to the table by Robotis et al. (2012) the high initial price of the M-Use® contract is justified, but not the long 20-year (or even 40-year) duration. The long duration of M-Use® takes away the flexible aspect of leasing, which is also a benefit in the real estate market. In the case of ZEN, solar panels fall into the category of high capacity and long product lifecycle, which makes the pricing and duration of the contract justified.

Table 8: Cost and duration of lease in respect to capacity and lifecycle (Robotis et al., 2012). Green rectangle is MEE and blue is ZEN

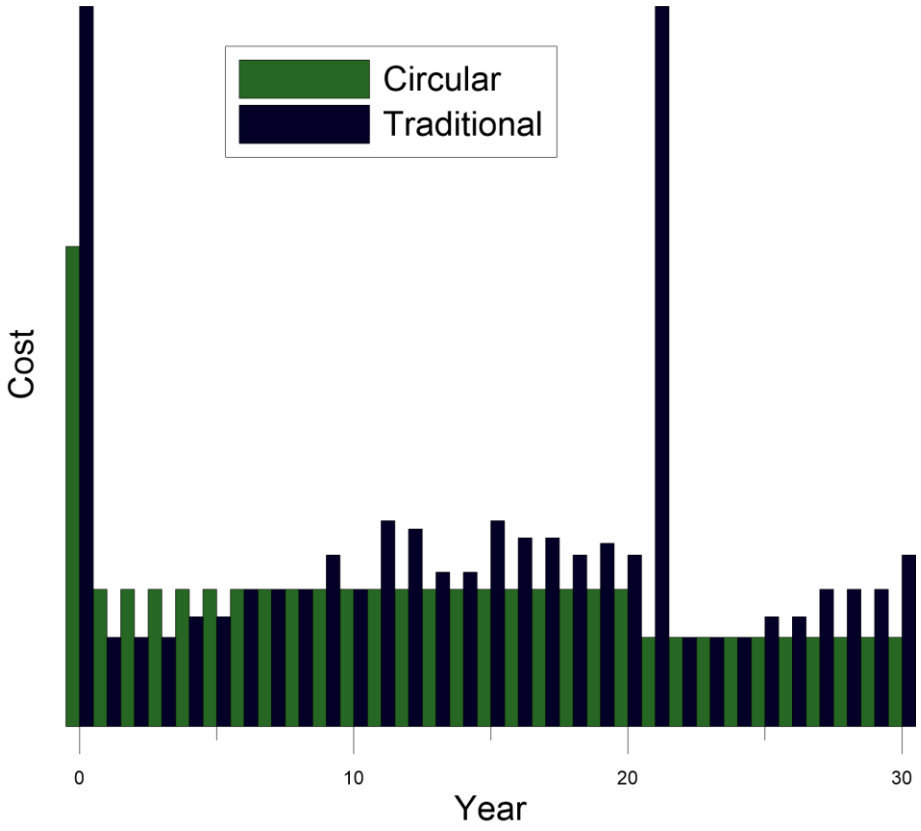
High capacity **High remanufacturing saving**	**Low capacity** **Low remanufacturing savings**
Long product lifecycle	
Price skimming Low initial price Longer leasing duration	Price skimming High initial price Medium leasing duration
Short product lifecycle	
Price skimming Intermediate initial price Medium leasing duration	Price skimming High initial price Short leasing duration

Capacity is not the only issue relevant for the demand of a product in the market. Two effects associated with the PtS model are market expansion effect and cannibalisation effect. Market expansion effect is debatable whether it is relevant with this combination

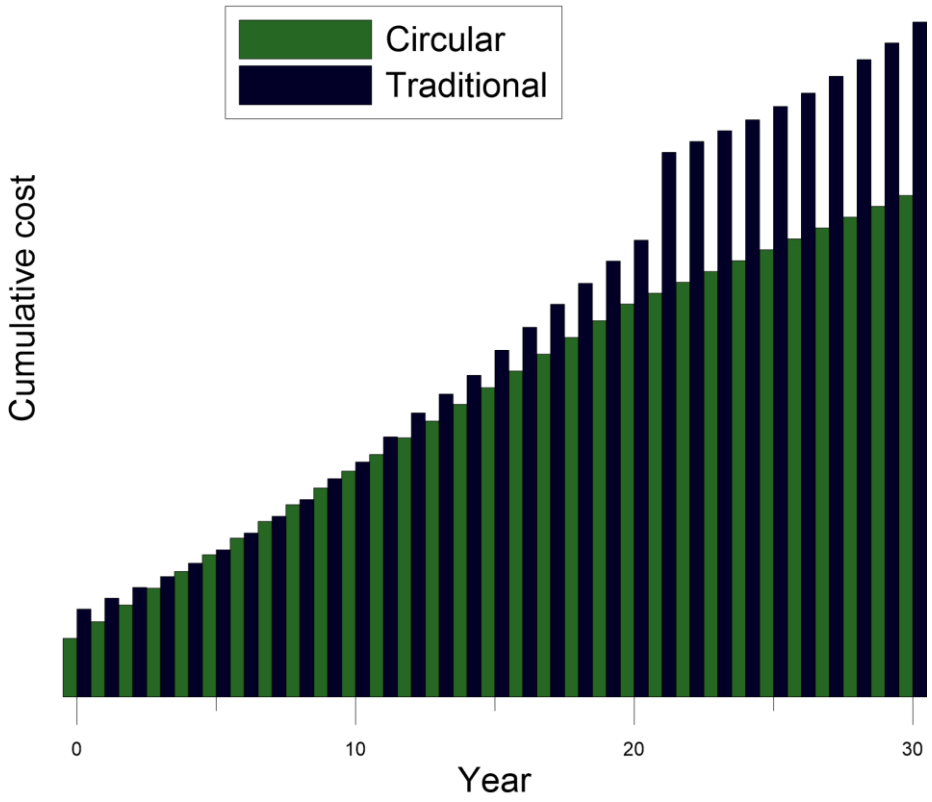
of CE and PtS as it is associated with the price level. It refers to the situation where the market expands to include also the clients that will now buy the product, as due to refurbishment or recycling is at lower price. Furthermore, it also refers to the control of company of the second hand market. The fact that MEE may exchange some parts of the elevator at the end of the lease, does not grand them to control the second hand market. The second hand market of elevators only refer to individual components and not an elevator as a whole. Cannibalisation risk is also not relevant with the case. This phenomenon refers to a company that provides both new and second hand products, and loses sales of new products over the lower-priced second hand products. ZEN is only providing new leased panels, therefore not relevant and MEE could have this risk only if they sold the circular advanced elevator in traditional way too.

Evaluation of data provided by MEE

In Figure 11 a comparison of costs is made for a traditional and a circular elevator. The first graph is offered by MEE at their leaflet for informing clients about CE and its benefits. It shows the costs of the two elevators in a time frame of 30 years, with the conclusion (according to MEE) that the CE option is cheaper at the end. The second graph represents the cumulative costs in a 30-year period to show the actual difference.



(a)



(b)

Figure 11:Comparison between traditional and M-Use® *models in a period of 30 years: (a) analysis of costs (b) cumulative analysis of costs (Brochure given by MEE)*

Of course, the source of information makes it hard to trust this figure. Furthermore, the fact that the figure is vague, without any given numbers, strengthens the argument that the MEE is not telling the full story here. If the statement that CE is cheaper option was valid, they would not hesitate to show it with real numbers. Indeed, the comparison is made between two different types of elevators and different maintenance plans. The client interviewed on this subject said about the price that: "It depends on the building, the elevator type, how many elevators etc. It is really hard to compare these amounts." Therefore this data are deemed as unusable, and the question still remains if it is actually cheaper than buying an elevator.

Pricing of a PtS model involving an intermediate

The specific case study relevant with the M-Use® elevator, involved an intermediate party, Delta Development. In order to explain how the pricing for the clients of the development company was decided, a series of diagrams is given and explained which were obtained from the involved intermediate. The diagrams can be used to understand the pricing of any circular product with an intermediate party, but for comprehension purposes the data from the case study will be used.

The first diagram of the series, depicted in Figure 14, shows the costs for each party involved in the deal, while on the same time comparing circular and traditional product.

One of the first observations to be made is that the circular model costs around 30% more as an initial investment for the developer, but almost 70% less for the investor in terms of costs per year in average. Furthermore, residual value is double in case of the circular model, and positive as opposed to the traditional model. But the main conclusion of the graph is that a circular model can be financially beneficial for the investors and tenants, but that is not the case for the developer. Therefore this would create problems in promoting circular economy products. The higher investment can be justified by the high quality of material used in circular products and the optimized services that keep the product in top shape. Therefore, the incentives for developers are not right and have to be re-adjusted.

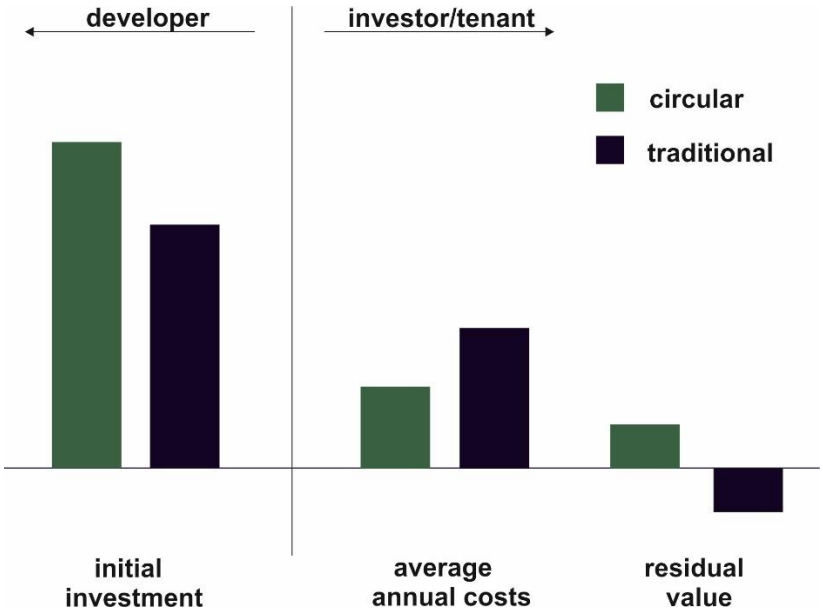


Figure 12:Actual cost analysis for developers and investors/ tenants (Zachariasse, 2017)

The next figure reaches to the same conclusion by showing the Total Cost of Use (TCU) in relevance with time. The observation is the same as with the above figure; the developer has to invest more at the beginning for the circular model (initial investment) while the costs for the investor are lower in comparison with a traditional model (see slope in both lines). To clarify, the traditional line shows a sudden rise of the TCU, because MEE (see Figure 11) and Zachariasse (2017) assume that around the milestone of 20 years a traditional elevator has to be replaced. This is debatable as it depends on various factors such as the level of use, quality of components and frequency/ quality of maintenance. Furthermore, the slope of each line shows the service costs for the tenants/ users. The steeper the slope, the higher the costs for the tenants.

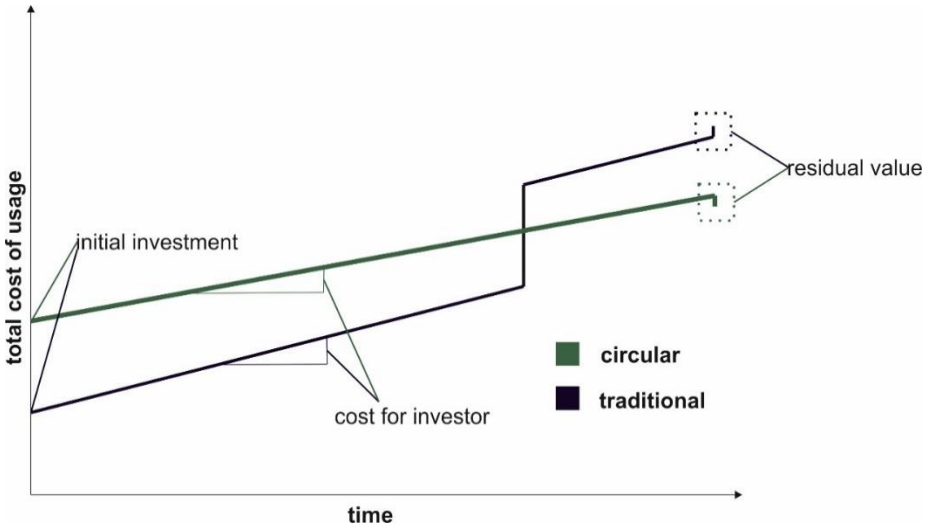


Figure 13: Total cost of use with respect to time for the traditional and the circular model (Zachariasse, 2017)

In order to give incentives to developers to invest in Circular Economy, a finance redistribution was necessary. In Figure 14 the new allocation of costs is depicted where the initial investment of the circular model is decreased (hatched big blue rectangle on developer's bar). The subtracted cost is transferred in the average annual costs (solid dark blue rectangle), that much as to relieve the developer from the higher cost but not as high as to result in more expensive yearly service costs than a traditional model. The residual value for the circular model is lowered (as much as the hatched blue rectangle) but still positive, which shows lower investor's costs. The hatched rectangles show the size of the decrease while the solid dark blue rectangles represent an increase. By this new form of costs' distribution all parties have something to gain, the product is competitive for the market and can be sold as a cost-saving option, while the user will benefit from better quality and not harm the environment in the process.

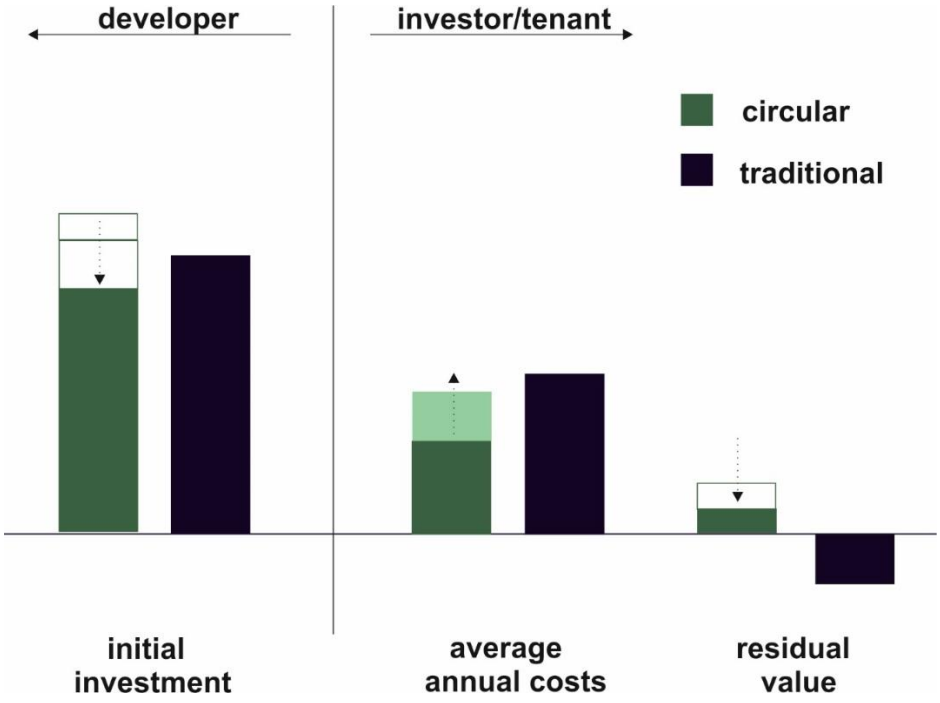


Figure 14: Financial redistribution (Zachariasse, 2017)

Comparing Figure 11 and Figure 14, it is evident than the circular option is in reality more expensive than a traditional product. What happens though is a re-allocation of costs between the developer (intermediate party) and the client, in such a way that it is slightly cheaper for the client to choose CE and financially better for the client. This shows an "inside" collaboration" between MEE and developers, as MEE would have to agree to this redistribution of costs during the transfer of the contract from the developer to the client. The questions are what the motives of the developer are to promote this circular option (financial, environmental etc.) and what happens when an intermediate party is not involved and an individual has to make the initial investment. In that case the circular option is significantly more expensive and not competitive with the traditional option.

Clients though are accustomed to paying more in a lease situation (e.g. car leasing). The extra money is justified by the higher level of services offered and the lower risks allocated to the client. The fact that MEE and DD have difficulties explaining to their clients the argument of "CE is cheaper than traditional" shows what clients really expect in terms of pricing in a lease contract (see Interview no.B3).

5.4. Legal Aspects

One of the first tasks to do, as a company involved in a PtS model, is to assess what are the legal risks and secure their assets. One of the issues of leasing a product is that the product (if immovable, such as an elevator or solar panels) immediately becomes part of another person's property by accession, which complicates financing from banks or in the case of bankruptcy (see ch.2.3.3). The only way to ensure that they keep ownership is through the right of superficies (see ch.2.3.4). Companies involved with PtS models and CE, know and expect that they have to take this extra step of claiming the right superficies, but that does not make it easier. It takes times and extra workload on the department and in some cases is not applicable. Of course, the solution of superficies does not exist in all countries, and it has to be kept in mind that how strict is the law, depends on the culture of each country.

Nevertheless, the importance of right of superficies, especially in cases like these, is highly important as it ensures that the users cannot take advantage of the lease (e.g. sell the product). Both companies confirmed that this is how they retain the ownership of products, but also referred to the problems of this solution. As it was mentioned above, it takes time to arrange all the legal procedures and is not very client friendly having to explain all these legal complexities (see Interview no.A1, B1, B2, B3).

Settling the ownership issues is important in case of bankruptcy of either side of the collaboration. Both sides want to ensure that in case the other side is unable to offer what was agreed upon, the financial damage will be minimum. Though the solution of the right of superficies, the issue of bankruptcy and its risks is resolved. In case the owner goes bankrupt, the bank can seize the product, but nothing else (nothing that belongs to the user). For the bank, both the product and the performance contract are valuable (Hendrik Ploeger, t.b.a.) and can be sold to a new owner. In case the user goes bankrupt, the owner and the products are secured and are not seized. The owner is free to start a new lease contract with the next user. The only financial damage in this case is the cost of removing the equipment, if necessary. The contract though can include a term for this case, where in case of a client's bankruptcy, the next user of the building will have to continue the lease contract or buy the product in a traditional manner (Hendrik Ploeger, t.b.a.).

The plus side of having the manufacturer or supplier to remain owner and responsible of a product is that it gives them motive to improve their products, have a longer lifecycle

and financial security, as their relationships are now long term and not momentary transactions. Furthermore, through the advanced maintenance plan with the use of IT, companies have the opportunity to collect valuable data for optimization and use in future products. The data collection though requires data protection, as the privacy of their client can be violated or compromised.

The existence of KPIs in the lease contract offers an insurance to the clients and keeps the quality level steady and high. Additionally KPIs allow a personalization according to the needs of each client. What is questionable though, is the duration of these contracts as they restrict flexibility, which is necessary in the current real estate market. Likewise, it creates a problem as it is hard to commit to the same needs for so many years.

5.5. Overview of Results

The two case studies have many similarities, as one of the most weighted characteristics of them is the combination of products and services. The main difference of them is the circular aspect, which after careful consideration of the collected theory and the case study of M-Use®, is lacking preparation on the side of M-Use®. M-Use® in essence is a PtS model with some sustainable aspects, which seems to be the case with many "circular" products in the market.

Out of the two researched cases, M-Use® is the one raising more flags especially on the cost and duration aspect. Even though the potentials are high, there are still a lot of questions to be answered. One of the main problems of this model is how it can be marketed and properly promoted. It is hard to convince the clients to pay almost the same amount of money for a product that includes services, but forego the ownership rights. Furthermore, the circularity aspect is still questionable as there no finished projects yet and the plans for the end of use are still only on paper. The overall cost of the package is high and only slightly lower than a traditional elevator (including the service cost for it). The calculations to show which option is cheaper are not clear, especially on the residual value part, where in traditional option is discounted (negative value) as they consider the cost of removal, but not the value of the materials removed. This is not the case in the circular option where the removal costs are not considered and the value of materials are creating a positive residual value. There might be differences in the material choices between circular and traditional options, but the majority of components are of the same material. The small difference in price can only be attributed in making the product market competitive. Additionally, lease is a go to option for clients seeking flexibility and easiness in paying in instalments. Both of these advantages are taken away in this case as the long duration of the lease, "locks" down the client with a medium for 20 consecutive years. Considering that most of the buildings are rented in a 5+5 years duration due to the low demand of real estate market, duration of M-Use® can only be seen as a disadvantage, unless the building is resold. Last but not least, a table is given below with the summary of all the main points of comparison between the two case studies.

Table 9: Summary of comparison points

	MEE	ZEN
LIFECYCLE EXTENSION	Guarantee of 100% increase of the lifecycle (questionable)	No interest in extending the lifecycle
ENVIRONMENTAL MOTIVES	Collaborating with sustainable parks	Improving companies' sustainable profile
FINANCIAL MOTIVES	Make company market competitive	Leasing provides flexibility and fast growth
SOCIETAL MOTIVES	Security of long collaboration	The collaboration is a win win situation
CIRCULARITY	At the present, only seen on material's choice	Not attractive to their target group
END LEASE POLICY	Retrieval of components for recycling or reuse	Gift to the clients or removal and reinstallation to other projects
CULTURE	Providing brochures to inform about CE	Affects the difficulty of doing projects
TECHNICAL HINDRANCES	None so far	Fast upgrade of technology
MAINTENANCE	Use of advanced technology to collect data and keep constant functionality	Use of advanced technology to collect data and keep constant functionality
EASY DISASSEMBLY	Project designed with this factor in mind	Minimum damage on building during installation
BANKRUPTCY	MEE: client can buy the elevator at a discount Client: MEE continues with the new building owner	ZEN: bank seizes the panels Client: ZEN continues with the new building owner
OWNERSHIP	Superficies solution In some cases economic ownership (by a lease)	Superficies solution
PAYMENT	According to the usage level	According to the usage level

6

Summary and Discussion

6.1. Summary

Many notions are taken the last decades to control production of waste and solve the scarcity of raw material. One of these notions is Circular Economy which is gaining momentum in the last years both on research and on business manner. Combined with a Product to Service model, it can offer new opportunities in resetting the way we see ownership and what should be considered waste. As the combination model of circular lease has started being applied in the market, a lot of questions have arisen about its efficiency, risk management and contractual interaction of the involved parties. The main goal of this thesis is to investigate the aforementioned topics, as well as evaluating the role of Circular Economy and the extent to which it affects these topics.

In order to reach to an answer for the research problem, an extensive literature research was conducted and then two case studies were developed with the help of a series of interviews. The two case studies under research showcase the differences between a traditional lease, a circular lease and a traditional buy of a product. Through the analysis of all findings, conclusions are extracted and validated through comparison of theory and practice.

The end result is that the main bearer of risks is the owner of the product. First and foremost, owner have to secure that ownership remain on his/her side. Even though having a constant income during the lease, offers a financial security, the owner must be prepared to pay in case of malfunction and any need occurring from the close maintenance offered to the client. Owner must also take care of the after-end treatment of the product and arrange for a new circle for it. Long duration leases require a strong alliance between owner and client, but also trust that both parties will be able to fulfil their responsibilities. On the client side, they may pay to avoid taking risks, but some risks are still there. The ownership issue is affecting both sides as there is always the risk of bankruptcy, with all its. Serviceability-wise the client has to ensure that the level of service is constant through the years and can cover the needs of the client. Committing to same level of needs is a risky move, especially if the type of product is a fast-evolving technology or if the needs of the client are not steady. Finally, the price point is also at risk, in case an intermediate is involved.

6.2. Research questions

The **sub-questions** that will help to give a full answer to the main research question are:

What differentiates a circular project from a traditional product?

The differences between a circular and a traditional product start from the design of a product. A circular product is usually designed with easy assembly/disassembly in mind, while the choice of material is based on their sustainability and what can be done with them after the end of use. Consumers forgo ownership rights on the product and instead of a single transaction, form long relationships with manufacturers or suppliers, which are now considered the owners. The product itself has a longer lifecycle, due to the quality of materials and the different maintenance. The quality and maintenance also raise the level of functionality (and often the quality of usage). By forgoing ownership, consumers transfer the majority of risks involved in owning and maintain a product, while manufacturers take over extra responsibilities (tasks) that come with being owners (with financial or other types of benefits of course). At the end of the product's life a solution is found in order for it to continue doing circles, either with the same use or with a different identity, which is rarely the case with a traditional product. Last but not least, the costs of a circular product include the services provided, the different materials and the end-of-life treatment.

What legal approach is taken in this type of deals? To what extend does the ownership actually stays with the legal owner?

In order to guarantee to the user the optimum services and that paying extra for them is worth it, companies set KPIs, usually on the technical aspects. That said, KPIs should be revised at least once during the contract, as the needs change and technology upgrades fast. Including KPIs in the contract can give a clear picture on what the company can offer and what the client needs, without leaving room for misinterpretation. KPIs though should not be limited in the technical characteristics of the product, but include other aspects relevant with CE or PtS, such as the state of the product if they guarantee lifecycle extension.

One of the issues of leasing this type of products is that by connecting it to another person's property, it automatically becomes part of another person's property through accession. This can create complications with financing (banks, mortgages, etc.) and problems in case of bankruptcy. Problems associated with bankruptcy is financial damage to the non-bankrupted side, unfulfillment of the contract and in some cases, the bankruptcy might be "staged", in order to get away from responsibilities or save money. Owners of product, prior to the beginning of leasing, arrange a right of superficies which in essence allows to someone to keep the ownership of an object attached to another person's immovable property. This arrangement is also useful to limit the risks of financial damage in case the opposite side goes bankrupt. Through the right of superficies, bankruptcy scenarios are treated the same way as in a traditional case (explained more extensively in chapter 4 and 5.4).

Keeping the ownership is important when the same product will be leased multiple times during its lifecycle (which means the remaining value after each lease is still high). In the case study of MEE, the elevator is leased during its whole useful lifecycle. The fact that the components of the elevator are send back to Mitsubishi only for implementing the disposal plan, makes the concept of ownership less important. This contract can be interpreted as a sale of a product and its accompanying services with a buy-back situation at the end for responsible disposal. This type of plan is no different than what

MEE was offering before this new model, except the end of life treatment, which raises the question why not offer the option to buy back traditional elevators and take responsibility to dispose them in a responsible environmental way. Importantly, it can be argued that the best business model here is with the developer. (See later).

The last issue to discuss is the fact that there is no control yet on how to implement CE. Anyone can name their product circular, while doing the minimum circular effort. Furthermore, there are multiple ways to treat a product at the end of its life (see ch.2.1.4) but the choice can change, based on the type of motive (financial or environmental). The fact that leased products (circular or not) use IoT to collect data and monitor the functioning of the product, raises a question on whether there is any data protection and how the privacy of the clients is compromised. If a circular framework was in place, CE would not be used as a marketing scheme and the rules would protect the environmental values of CE which seem to suffer from the financial motives of businesses. The fact that the companies are not pushing for a change shows that the current legal situation might be convenient for them, as there is no control and deals with developers and such are allowed and not scrutinised. The right of superficies might require extra paper work, but who knows what a circular legal framework would require and if it would be beneficial for the clients or the owners.

How is the price of a circular lease determined?

The price of a circular lease is depended on the material types and the service packaged offered. A higher quality of materials, high-tech components and constant services are included in the lease price. Furthermore, as discussed in the second sub-question the main risk bearer is the owner, which financial-wise is translated as a risk premium. On the other hand though, something that many clients may oversee, companies accumulate high volumes of useful data from monitoring their leased products. This data is valuable both in financial and technical aspects. Additionally, in many cases companies gain incentives (often in financial form, e.g. subsidies, tax reduction) from government for their environmental initiatives.

As seen in ch.5.3, another factor determining the lease price is whether an intermediate party (developer) is involved. Figure 11 shows that circular product over traditional product is more expensive in initial investment. This difference is justified by the different materials, technology and services involved. The conclusion though is that when an intermediate is involved, the initial investment gets lower to save money and the difference is transferred to the annual cost paid by the client. This shows a strong alliance between company and intermediate, as when the intermediate sells the property including the leased product, the lease is transferred to the client with the new financial terms. The question is what is the motive for the intermediate party to get involved in such case if initially the product would cost more than in a traditional case.

The above situation shows that a circular lease can cost more than owning a traditional product. Clients though expect it as this is usually the case when you lease a product including the services (e.g. car leasing), as paying more is translated in flexibility and fewer risks. The collaboration between developers and companies to promote circular leases cast doubt on who actually benefits from this type of deals and what are the real motives to instigate such a collaboration.

How is the duration of a PtS lease determined?

The duration of a PtS lease is determined by the type of product and its lifecycle. The type of product is also important on the matter of how fast the specific technology is progressing. Consumers prefer a shorter lease for products that upgrade often, e.g. mobile phones or cars, as lease is a flexible option to stay up-to-date with the available

technology. Another factor affecting the duration of the lease is the cost. Expensive products and services usually require a long lease in order to make small instalments and market competitive. The financial crucial may be crucial in other ways to, like the case study of ZEN where the lease duration is the exact same as the duration of subsidies given by the government.

Even if the best technology is used to monitor the usage level and the state of components, while on the same time the best maintenance plan is offered, the lifecycle cannot be increased by 100% as MEE claims to do. In the case of MEE the components of the elevator have a 25-year average lifecycle, which means that at some point of their 40-year lease, almost all components will be replaced. Rebuilding an elevator makes no difference financially and environmentally with buying a new one. At best, with quality materials and a good maintenance plan, the lifecycle can be extended by 5 years, in contrast with the expected 20-year lifecycle of an elevator, but not by 100%. What does extend though in reality, is the relationship between seller (in circular case owner) and client (in circular case user).

Having answered the above sub-questions, the answer to the main research question is given

What are the risks associated with a Product to Service and/or Circular Economy project on a legal, cost and duration perspective and how are they allocated between the parties?

From the side of the owner of the product, the risk from a legal perspective is retaining ownership. Retaining ownership of the product gives protection to owner in case of client's bankruptcy and in case of product's damage. The measure to eliminate this risk is securing a right of superficies, which legally allows to the owner to retain ownership. On the financial perspective, as the owner is responsible for the maintenance and aims to continue take advantage of the product after the end of the lease, the risks of trusting someone else taking good care of the product and use it properly is on the owner. In case something goes wrong and there is problem in functioning, the owner has to pay for fixing it and for a penalty (according to the terms of the contract). The last aspect, duration, is a risk for both sides, in the sense that no one knows where they will be at the end of the lease and if they will have the ability to be right with their responsibilities (either technical or financial). For this reason, circular leases should be as short as the cost and type of product allows.

From the side of the client (user), the risk from a legal perspective is also about the bankruptcy of the owner and what happens in that case with the rest of property (which is owned by the client). As said above, the solution is the right of superficies. Another legal risk is how a good steady level of serviceability can be guaranteed over a long lease (and consequently an old product). This is secured through KPIs agreed between the owner and the client according to the needs of the client and the capabilities of the owner. On financial terms, the client does not have any severe risks and that is because the client pays more (risk premium) to avoid this risk. This though is depended on whether an intermediate is involved. In case an intermediate is involved, a client runs the risk of paying more, depending on the agreements between the intermediate, the new client and the owner (MEE). Last but not least, duration-wise, in case of a long lease, clients have to stay committed to the same product for the duration of the lease even if their needs change. To face this risk, a revision of the agreed KPIs is suggested at least once during the lease contract.

6.3. Limitations

Although sufficient answers where given to the research questions of this thesis, there are some limitations to be mentioned.

Finding companies to collaborate on case studies development in the Netherlands was hard and time consuming. First, companies having circular leases are still rare and not always open to collaboration and transparent, especially discussing contractual and financial issues. Next, many companies could not collaborate as the available material that could help my research was only available in Dutch.

Another limitation is the fact that on such a broad subject of research there were a lot of interesting areas to focus, but I lacked relevant knowledge. Examples of these areas are the legal aspect and the technical aspect. Due to the limitation of time, even some areas where I gained knowledge through the literature research where ignored due to time and literature limitations. An area that was overlooked during this thesis was the cultural and societal impact of CE. In terms of how consumers perceive circularity, there is hardly any literature available. Foregoing ownership can be seen as an extreme by a big part of the consumers and without proper education and incentives, it can hinder the CE transition (Tukker, 2015).

6.4. Recommendations for further research

Discussing all the above issues and risks that both parties have to face, many questions are created which can be translated into recommendations for further research. The recommendations are listed below.

- **Deeper research on owners' motives**

The fact that companies have found a way to work around the issues to be found in a circular lease, and sometimes in their favour, raises the question whether the industry is actually pushing for a specific circular change in legislation. Furthermore, claiming that the profits are lower from CE products and are cheaper for clients comes in controversy with their business motives. The question to be answered through this research is who actually benefits the most from this type of deals

- **Development of a suggestion of legal framework for CE**

The above said windows in legislation may allow companies to take advantage of the clients or hindrance the application of CE. A more specific legislation can protect both consumers and owners from risks relevant with CE, guide new companies in the CE department and give incentives to other companies or clients to get involved.

- **Technical research on whether the lifecycle can be extended**

The lack of technical knowledge and the small amount of case studies does not allow me to reach to a general conclusion on the matter. A bigger sample, more input information and technical knowledge will help give a more specific answer.

- **Creation of circularity measurement scale**

A circularity measurement scale, which may be included in the above suggested legal framework, will help avoid cases where companies advertise circular products without that being true. This will also give an answer on what can be considered circular and what not.

- **Bankruptcy consequences on circular leases**

As it was explained in this thesis, bankruptcy in a circular lease has the same effects as in a traditional case due to the right of superficies, and leaves the other side relatively unaffected. Because of the lack of legal knowledge though, a deeper research is suggested to validate these results and also investigate whether bankruptcy can be used as a "scam" to resolve a circular lease or get away from legal responsibilities.

7

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