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Emerging business models in plastics reuse and recycling

Master's Thesis
Espoo, July 31, 2020

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ABSTRACT OF
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Plastic is an excellent material and its usage will only increase in the future. However, the current plastic lifecycle is linear and a has lot of issues such as emission, leakage to nature, and low recycling rates. Changing the linear lifecycle to a circular plastics economy would solve many of these issues. Thus, plastics reuse and recycling business models has extremely important role in making the plastics lifecycle circular and to a sustainable base. This study seeks to increase and build understanding on the possible business model categorization and the barriers, enablers and challenges the businesses face in plastics reuse and recycling industry.

This study adopts a qualitative research approach to analyse the business model categories and the barriers, enablers and change needs they are facing. First, an online search of emerging business models in plastic reuse and recycling is done to identify and describe the business models in different parts of plastic value chain. Then, companies in each stage of the plastic value chain are interviewed to deepen the business model understanding and to see what kind of barriers, enablers and change needs they face and see.

The findings are three-fold: First a business model description of the companies in each stage of the plastic value chain are provided. Second, the result present what kind of barriers and enablers the businesses face. Thirdly, the findings provide the change needs the businesses deem necessary in the future to drive the change towards circularity.

The study contributes to the existing knowledge by developing the first business model categorisation for circular economy and plastics reuse and recycling industry. The categories are: technology, circular reuse, and flow business models. In addition, some additional perspectives are brought to enablers and barriers of the industry and new insight on the future change needs.

Keywords: circular economy, circular business model, sustainable business model, recycling, reuse, plastic

Language: English

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Muovi on erinomainen materiaali ja sen käyttö tulee vain lisääntymään tulevaisuudessa. Muovin nykyinen elinkaari on kuitenkin lineaarinen ja omaa paljon ongelmia: päästöt, päätyminen luontoon ja alhainen kierrätysaste. Tämän muuttaminen kiertotalouden mukaiseksi ratkaisisi monet näistä ongelmista. Siten muovin uudelleenkäyttö ja kierrätys liiketoimintamalleilla on erittäin tärkeä rooli tässä muutoksessa. Tämä tutkimus pyrkii kasvattamaan ja luomaan ymmärrystä liiketoimintamallikategorisointiin sekä haasteisiin, mahdollistajiin ja tulevaisuuden muutos tarpeisiin muovin uudelleenkäyttö ja kierrätys toimialalla.

Tämä tutkimus käyttää laadullista tutkimustapaa analysoimaan liiketoimintamallien kategorioita sekä haasteita, mahdollistajia ja muutostarpeita. Ensiksi tehtiin etsintään internetin kautta uusille liiketoimintamalleille muovin uudelleenkäytössä ja kierrätyksessä, jotta voidaan tunnistaa ja kuvata eri liiketoimintamallit muovin arvoketjun eri vaiheissa. Tämän jälkeen jokaisesta arvoketjun vaiheesta haastatellaan yrityksiä, jotta liiketoimintamallien ymmärrystä voidaan syventää ja nähdä millaisia haasteita, mahdollistajia ja muutostarpeita liiketoimintamallit ovat kohdanneet.

Työntulokset ovet kolmijakoiset: Ensiksi esitetään liiketoimintamallikuvaukset arvoketjun mukaisesti. Toiseksi tulokset esittelevät millaisia haasteitä ja mahdollistajia liiketoimintamallit kohtaavat. Lopuksi tulokset kertovat mitä muutostarpeita nähdään tarpeelliseksi lisäämään muutosta kohti kiertotaloutta.

Tutkimus tuo nykyiseen kirjallisuuteen ensimmäisen liiketoimintamallikategorisoinnin kiertotalouteen ja muovin uudelleenkäyttö ja kierrätys toimialalle. Kategoriat ovat: teknologia, kiertävät uudelleenkäyttö ja virta liiketoimintamallit. Lisäksi tutkimus tuo uusia näkökulmia haasteisiin ja mahdollistajiin, sekä näkemystä tulevaisuuden muutostarpeille.

Asiasanat:	kiertotalous, kiertotalouden liiketoimintamallit, kestävät liiketoimintamallit, kierrätys, uudelleenkäyttö, muovi
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Espoo, July 31, 2020

Lars Vilén

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Chapter 1

Introduction

Plastic materials are used in almost every industry and thus nearly everyone is in contact with them daily (World Economic Forum et al. 2016, European Commission 2018). They have reached this workhorse material status of our modern economy due to their low cost and unrivalled properties (World Economic Forum et al. 2016). These properties include high strength-to-weight ratio, versatility and durability (World Economic Forum et al. 2016). This provides many economic and environmental benefits in different industries: in transportation plastics save fuel and cut $C0_2$ emissions due to their light weight; in construction high-performance plastic insulation materials decrease our energy consumption and save on energy bills; in packaging plastic containers ensure food safety and also reduce the amount of food waste (European Commission 2018).

During the last 50 years, our dependence on plastics has increased steadily(World Economic Forum et al. 2016). The production of plastics has increased twenty-fold globally from the 1964 to 2014 from 15 million tonnes to 311 tonnes(UNEP 2014). In 2018 the plastic production reached already 359 million tonnes (Plastics Europe 2019) and the production amount is expected to double in the next 20 years and be four times as large by 2050 (World Economic Forum et al. 2016). This increase in demand is mainly driven by the increasing consumption in Asia. In Western Europe and in North America the per capita plastics consumption is around 100kg per year. In Asia, the same number is just over 20kg but expected to grow rapidly. (European Commission 2018)

Even though plastic has a lot of applications in many different industries and it has lot of advantages to other materials its usage does not come without its own issues. The current plastic life cycle and economy is too linear and fragmented, where most of the plastics end up in incineration, landfills and the environment (European Commission 2018, World Economic Forum et al. 2016). Plastic packages collection rate for recycling is only 14% globally. In sorting and the processing of the recycled material additional losses is made, so only 5% of the material value

is actually collected for further use. Thus, 95% of the value of plastic package material, between 70 and 105 billion EUR annually is lost to the economy after a very short first-use cycle. And this is for plastic packaging, which has the best recycling rate of all plastics. Other plastics, and thus plastics overall, have even worse value capturing through recycling. (World Economic Forum et al. 2016) Compared to other material, plastics recycling rates are extremely low, since recycling rate for paper is 58% (ICFPA 2014) and for iron and steel 70 - 80% (Graedel et al. 2011).

In addition to capturing the economic benefits of plastic life cycle through of more circularity, there is lot of environmental challenges in plastic usage. These overshadow the plastics production, use and consumption creating a need to change the plastics life cycle (European Commission 2018). The two main problems related to plastics are their leakage to nature causing harm, especially to the oceans, and plastic production and incineration, which are causing emissions. Of the plastic packages globally, 14% goes to recycling and of the rest 86%, 14% goes to incineration and/or energy recovery, 40% to landfills and 32% is leaking into the nature (World Economic Forum et al. 2016).

Energy recovery of plastics that cannot currently be recycled effectively is in principle a good thing, but it does not capture the labour and effort used to create the material (World Economic Forum et al. 2016). In addition, energy recover has high capital investment need and low operating costs, which might lead to a lock-in to a suboptimal value capture method compared to recycling plastic back to plastics (World Economic Forum et al. 2016).

Plastic waste ending up in the nature and especially into the oceans is one of the most visible problems of plastics and plastic waste accounts around 80% of the marine litter (European Commission 2018). Current best research estimates that our oceans have over 150 million tonnes of plastics (Ocean Conservancy 2015) and increasing at least 8 million tonnes per annum (Jambeck et al. 2015). The amount of plastic in the oceans have and will accumulate over time since it will last there over hundreds of years(World Economic Forum et al. 2016). Furthermore, microplastics, plastic fragments below 5mm in size, are also a potential problem, which are accumulating into the oceans, but they have also been found in the air, drinking water and some foods such as honey and salt (European Commission 2018). However, their impact on human health is uncertain and requires more studies (European Commission 2018). Lastly, plastic waste in the oceans is not just harming the environment, but causing economical losses to tourism, shipping and fisheries (European Commission 2018).

One of the most obvious problems is the fact that plastics production relies heavily on fossil fuels, which account for over 90% of the feedstock (World Economic Forum et al. 2016). According to the best estimates around 6% of the world's oil production is used to make plastics, half of it used as fuel for the pro-

cess and half as material feedstock (Plastics Europe 2015). Furthermore, natural gas is also used on top of the oil consumption in plastics production. By 2050 the oils consumption by plastic production is estimated to be 20% of the total oil consumption (World Economic Forum et al. 2016). Plastics production and plastic waste incineration are responsible for around 400 million tonnes of $C0_2$ a year globally (European Commission 2018) and will increase drastically since the consumption of plastics will increase (World Economic Forum et al. 2016). Reusing and recycling plastics will reduce the amount of fossil fuels that is needed for plastics production and decrease the $C0_2$ emissions. Recycling 1 million tonnes of plastics would equal the $C0_2$ emissions of 1 million cars (European Commission 2018).

In summary, there is no drastic decrease in plastic usage due to its unbeatable features, on the contrary the usage will increase significantly in the future. The current plastics life cycle and economy is too linear and fragmented. However, this creates the opportunity to change the plastics industry to a more circular direction decreasing the leakage and emissions. Circular and sustainable solutions in plastics reuse and recycling will decrease and solve the impact of these problems have and allow plastic consumption to continue without hampering the future of the environment.

1.1 Objectives and research questions

As described above, there are multiple different problem areas which need attention. This thesis is part of the ValueBioMat project (`www.valuebiomat.fi`) which develops new technological solutions and business-related insights for transitioning from fossil raw materials to bio-based and circular economy models in the plastics industry. The research at the Department of Industrial Engineering and Management at Aalto University focuses on the development of new solutions and business models to speed up this transition across the plastics value chain from raw material suppliers to manufacturing and plastic recycling.

This thesis focuses on the business models that have emerged in the plastic reuse and recycling area, the barriers and enablers they have faced and what kind of changes are deemed necessary for change towards circularity in plastic recycling. The objective of this thesis is to describe different business models in plastics recycling and identify factors that constrain and enable the development of new models in this area. The problem is divided into three research questions:

RQ1: What kind of business models have emerged for plastic reuse and recycling and how they can be categorized?

RQ2: What kind of enablers and barriers the business models are facing?

RQ3: What kind of changes are needed to improve circularity in plastic reuse and recycling?

1.2 Structure

The thesis is structured into 6 chapters each outlining a separate section of the research. This introduction has briefly explained the background and motivation for the research, presented the research questions and the objective of the study.

The second chapter goes through the existing literature of sustainable and circular business model research and what kind of barrier and enablers have been noticed for emerging business models in plastics reuse and recycling. The major concepts under investigation in this thesis are presented and a basis for the challenges and opportunities for new business models in plastic industry. In addition, the theoretical framework to analyse the businesses is developed.

The third chapter presents the chosen methodology for the research. The research approach, process, data collection and analysis are explained. The fourth chapter provides the findings of the empirical research. The findings are divided into two parts, first focusing on the first research question followed by the two other research questions.

The fifth chapter answers to the research questions and compares the empirical findings to the literature. Furthermore, a business model categorization is developed based on the analysis. Moreover., the chapter elaborates how the findings contribute to existing literature and increase our understanding related to business model categories and the barriers, enablers and future change needs in plastics reuse and recycling. Lastly, the sixth chapter provides practical implications for managers. Moreover, the research limitations and recommendations for future research are addressed.

Chapter 2

Background

2.1 Business model framework

2.1.1 Business model

In terms of academic research, the business model concept is relatively new. Only at the start of the 2000s the business models started to be academically more systematically analysed. This academic attention was following the rise of new forms of capturing and delivering value through e-businesses. (Osterwalder 2004, Amit & Zott 2001) However, there is still a lot of different business model definitions and frameworks used in different research papers depending on the focus of their analysis. Even though the business model definitions have differences, they include four main components: value proposition; customer interface; the infrastructure of the operations; and the financial structure (Osterwalder 2004, Boons & Lüdeke-Freund 2013). One of the most used business model definitions is the one developed by Osterwalder (2004) and a good summary of this business model canvas is in a book by Osterwalder & Pigneur (2010).

The definition of a business model can be shortly stated as: "A business model describes the rationale of how an organization creates, delivers and captures value" (Osterwalder & Pigneur 2010). To expand on this the definition, as noted in Lüdeke-Freund (2010), definition by Teece is very comprehensive:

"The essence of a business model is that it crystallizes customer needs and ability to pay, defines the manner by which the business enterprise responds to and delivers value to customers, entices customers to pay for value, and converts those payments to profit through the proper design and operation of the various elements of the value chain." (Teece 2010, p. 179)

This definition crystallises the ideas of most of the strategy-oriented business

model authors (Lüdeke-Freund 2010). The focus in the definition is in the most central element of the business model: the customer value proposition, and how the customer value is created and delivered (Osterwalder & Pigneur 2010). This is the first of the four pillars of a business model as first described by Osterwalder (2004) and adopted as a business model representation base since (Lüdeke-Freund 2010). The customer value proposition is the products and services the business offers for their customer, which represent substantial value to the customers, and the customers are willing to pay for it (Ballon 2007). The other three elements besides the customer value proposition of the business model are: the relationship the business has with the customer, to satisfy their needs and generate revenue; the infrastructure, key activities and different partners that are needed to create value and to maintain a good customer relationship; and the financial structure of running the business as in costs and revenues generated by all the other pillars of the business model (Ballon 2007).

The business model visualisation can be seen in figure 2.1. All starts from the customer value creation (value proposition pillar in the middle). The value proposition is the combination of products and services that create value to the customer segment. It solves customers' problem or satisfies their need and it is the reason why they select a certain business over others. (Osterwalder & Pigneur 2010)

To deliver the value to different customer segments, distribution and communication channels as well as customer relationships have to be established and maintained (customer interface pillar in the right). Customer segments means the clusters of potential customer groups, which can be people, organizations and companies to which the value is offered. The channels are the way the business reaches and communicates with its different customer segments. The customer relationships describe the what kind of relationship the organization want to establish with the customer segments depending on the customer's expectation and the goals of the business. (Osterwalder & Pigneur 2010)

To create the value the business has to manage and operate its activities, resources and partnerships (infrastructure management pillar in the left). The key resources are the core assets the organization need to have a functioning business model. These enable the organization to create and offer the value proposition through the channels to the customers, maintaining the customer relationships and generating revenue. The key activities are the most important activities the organization need to do to make the business model work. Like key resources, they are required to create and offer the value proposition through the channels to the customers, maintaining the customer relationships and generating revenue. The key partnerships are the required suppliers and partners for the business model to work. They can provide key resources or/and key activities that the organization

is not capable or willing to do themselves. (Osterwalder & Pigneur 2010)

Lastly the financial structure represents the costs and revenues generated by the infrastructure and the customer side, from which the business appropriates economic value for themselves (financial structure pillar at the bottom). The revenues streams describe how the business makes money from the customer and they depend on the pricing model and strategy of the company. The cost structure describes the operating costs of the business that incur from each stage of the business model to deliver and capture values. (Osterwalder & Pigneur 2010)

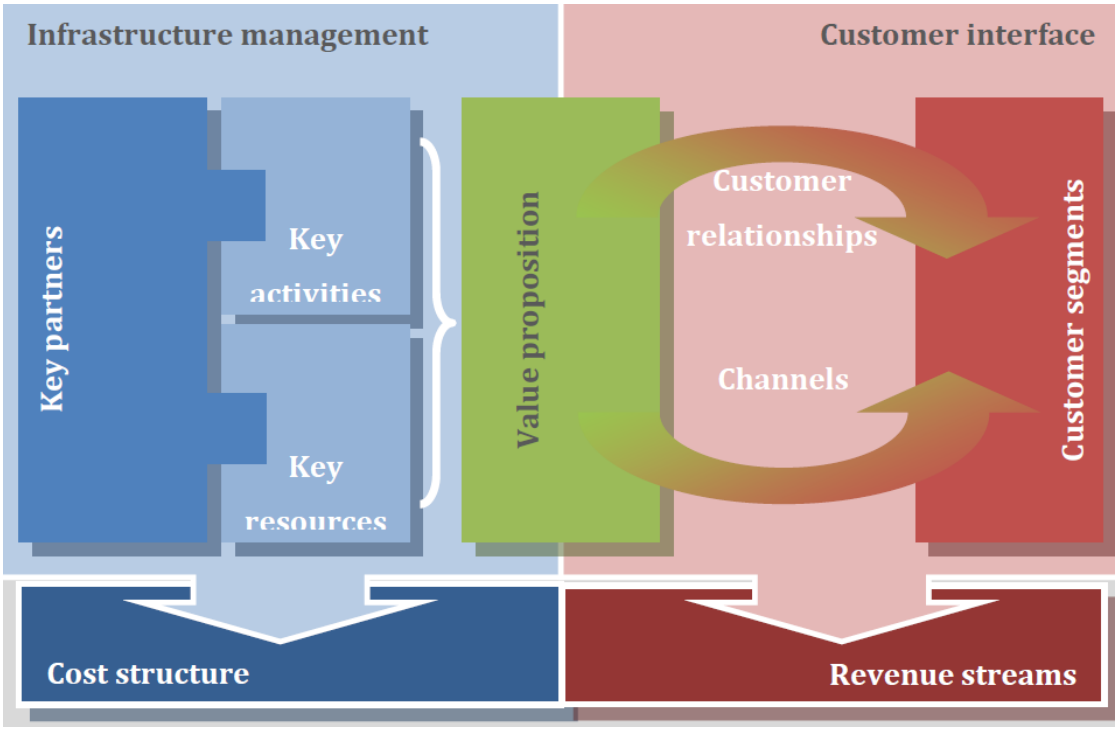

Figure 2.1: Modified version of the business model canvas.
Taken from (Lüdeke-Freund 2010, p. 16) and originally made by Osterwalder (2004)

2.1.2 Sustainable business model

Sustainability has many different definitions and there are multiple different terms used in the case of sustainability, such as corporate sustainability, social sustainability, ecological sustainability, and sustainable development (Stubbs & Cocklin 2008). There is a variety of sustainability worldviews in the literature and thus no consensus on the definitions (Stubbs & Cocklin 2008). The most cited definition

for sustainable development is by the World Commission on Environment and Development WCED (1987), which:

"touches on environmental, social, and economic aspects of sustainable development such as the notion of resource limits (energy, materials, waste, and land); equitable access to constrained resources; intergenerational and intragenerational equity; and a progressive transformation of economy and society." (Stubbs & Cocklin 2008)

Table 2.1: Imperatives of ecological sustainability and economic development. Made by (Huber 2000, p. 271) and presented in (Lüdeke-Freund 2010, p. 16) (quotes in left column)

Normative rules of ecological sustainability	Main concerns
"Population development must be in keeping with the carrying capacity and productive forces of the ecosystem."	Population; carrying and productive capacities of ecosystem
"Ambient concentrations of pollutants in environmental media and living creatures must not exceed their absorption and regeneration capacity."	Concentration of pollutants; absorption and regeneration capacity of ecosystem
"The consumption rate of renewable matter and energy ... must not exceed their given rate of reproduction."	Consumption and reproduction rate of renewable resources
"The consumption rate of exhaustible resources ... is to be minimized by (a) substituting renewable resources for exhaustible ones; (b) increasing material and energy efficiency; and (c) recycling to the extent that is ecologically reasonable and economically justifiable."	Consumption rate of non-renewable resources; substitution, efficiency, recycling
"The development and introduction of ecologically benign, clean resources, technologies and new products is to be intensified."	Ecologically benign resources, technologies, products

This could be crystallised so that the goal of sustainable development is to fulfil

current needs without restricting or preventing future generations' ability to satisfy their needs. Instead of going through different definitions and concepts, here we focus straight on sustainability strategies of ecological sustainability which shall regulate economic development. Based on the same WCED (1987) report Huber (2000) have compiled five ecological sustainability imperatives, which can be seen in the table 2.1.

These imperatives however cannot be straight translated to strategies for businesses. Thus Lüdeke-Freund (2010) has created imperatives of business development based on the ecological sustainability imperatives. These are sufficiency, efficiency and consistency. Sufficiency means having enough, and in the business sense means reduction in use of resources, substituting non-sustainable practices and focusing on conservation of nature. Efficiency in the business sense means reducing the environmental load per unit of output with improved technologies and organizations. Consistency in the business sense means going towards material and energy cycles separate or consonant with natural setting and away from flows that have environmental protection measures at the end-of-pipe or downstream. (Lüdeke-Freund 2010) Each of these strategies by themselves support sustainable development but are limited in their effects (Huber 2000). Improvements in one area need to be met with no changes or improvements on the other areas to have a positive impact (Lüdeke-Freund 2010).

Even though these sustainable development imperatives have been adapted to strategies for businesses, they do not directly fit into the business model canvas used in 2.1.1. Companies are not compensated for the public benefits they create, such as positive contributions or reducing negative impact to society and environment (Schaltegger & Wagner 2006). Thus, companies try to avoid these activities if there are not for example regulations or they do not create additional costs (Coase 1960). To overcome this, sustainable business models need to move beyond just thinking about the customer and the value created to them, and focus on creating value for the company, the customers, and the public. This is named as extended customer value (Lüdeke-Freund 2010).

Extended customer value can be separated to four different value creation modes, which affect the impact the business model has. These are as mentioned in Lüdeke-Freund (2010):

(1) creating value for individual customers and the company,

(2) creating value for the public and the company,

(3) creating value for the public and individual customers,

(4) creating value for the public, individual customers and the company

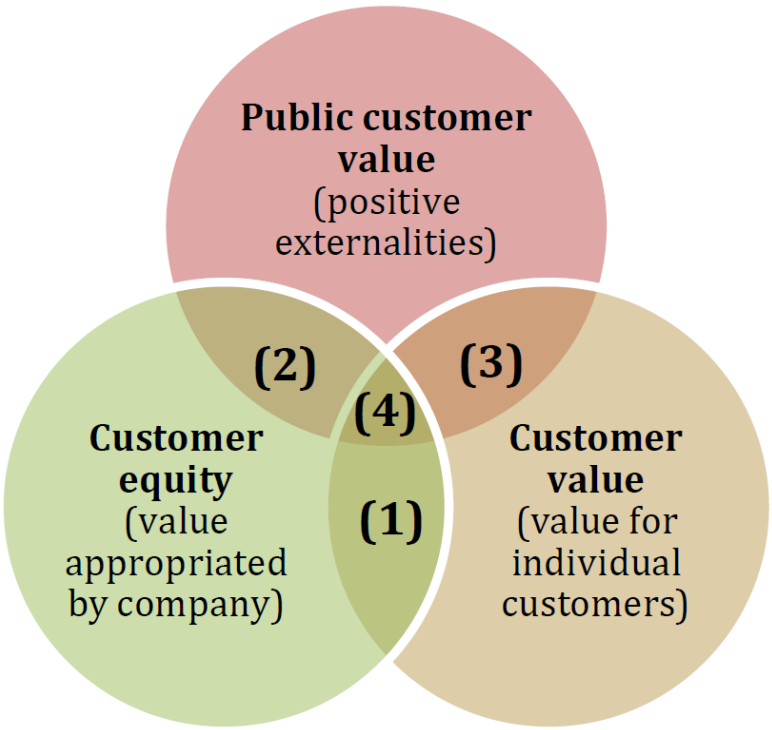

Figure 2.2: Concept of extended customer value (Lüdeke-Freund 2010, p. 19)

The four modes can be seen in figure 2.2. The first mode is the conventional business model way: company offers products and services to customers, which creates value for both. The second case requires some additional mechanisms, such as incentives and/or regulation, to encourage the company to creating value for the public and itself.(Lüdeke-Freund 2010) One example of this is incentives in Finland to energy producers to create more wind power. Without the incentives at its current state wind energy does not create value for the company, but it does for the public. For the customers it does not really change their value capture since there is no direct change for them.

The third mode can be achieved by a company for example through creating a protected natural area for native inhabitants. Here the term customer is used quite loosely since these are not usually part of the core business of a company. The fourth mode requires the company to create value to itself, the customers, and the public simultaneously. For example, instead of exploiting the eco-systems to create value as in the mode 1, the company focuses on keeping the eco-systems unharmed and protected for future generations. (Lüdeke-Freund 2010)

Moving beyond mode 1 and towards modes 2, 3 and 4 requires fundamental changes in the value creating logic in a sustainable business model. Companies

need to figure out how they at the same time create value to the target groups, create public customer value and at the same time has the company collecting value from both of these value creation processes. (Lüdeke-Freund 2010) Sustainable business models bring long-term perspective, sustainable value and pro-active multi-stakeholder management compared to previously defined business model as can be seen from figure 2.3.

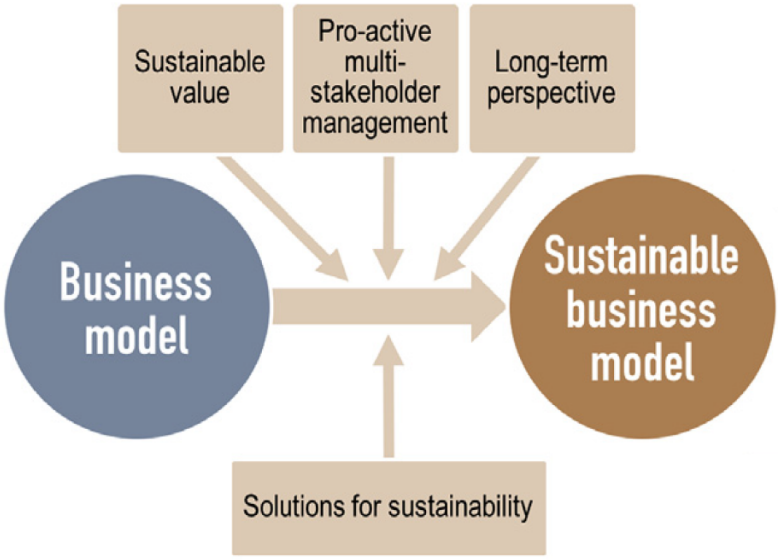

Figure 2.3: What sustainable business model brings more to regular business model (Geissdoerfer et al. 2018, p. 714) (modified)

2.1.3 Circular business model

Sustainable development concept has been lately noted some researchers to be too vague to be implementable and thus it has started to lose momentum (Van den Brande et al. 2011). Some have called it more of a theoretical dream than actually implementable reality (Naudé 2011) and some even calling it "sustainababble", where the term of sustainable development is today used to mean anything from environmentally better to cool (Engelman 2013). The circular economy concept is one that has risen more in traction due to it being less vague and more implementable(World Economic Forum et al. 2016).

As sustainable development, circular economy (CE) has multiple different definitions. Kirchherr et al. (2017) has developed a well accepted definition of circular economy which is used in this thesis. In their analysis the typical definition for circular economy was:

"CE is [a] closed loop material flow in the whole economic system ... in association with the so called 3R principles ... Taking into account economic aspects CE ... minimizes matter ... without restricting economic growth." (Lieder & Rashid 2016)

Building on this and the other definitions, Kirchherr et al. (2017) define the circular economy as:

"A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level, (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations." (Kirchherr et al. 2017).

Translating this definition to circular business model, means that compared to sustainable business model definition the circular business models are not creating only sustainable value, but also close, slow, dematerialise, intensify and narrow resource loops (Bocken et al. 2016, Geissdoerfer et al. 2018). This way the resource inputs and at the same time the waste and emission leakage generated by the organisation are minimised, which leads to improved sustainability performance. Slowing, narrowing and closing the resource loops mean, use phase extensions (slowing or extending), efficiency improvements (narrowing), and recycling measures (closing) (Geissdoerfer et al. 2018). Furthermore, the dematerialising and intensifying means, adding substitution of product utility by software and service solutions (dematerialisng), and more intense use of products by for example easy repairability and design for longevity (Geissdoerfer et al. 2018). These are presented in figure 2.4

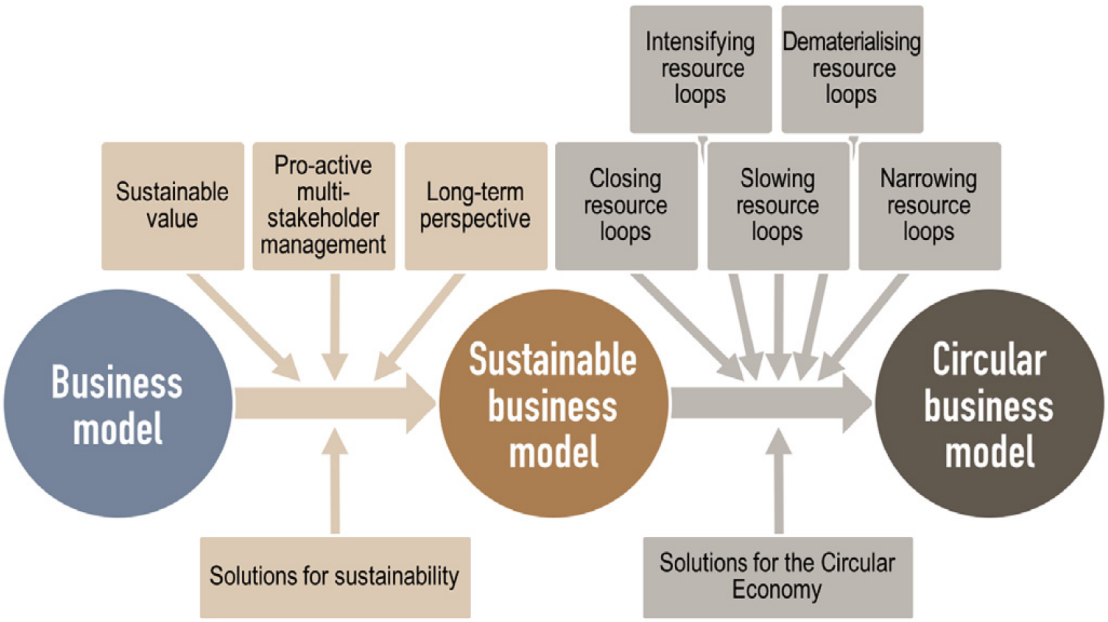

Figure 2.4: What circular business model brings more to regular and sustainabel business model (Geissdoerfer et al. 2018, p. 714)

2.1.4 Business model framework for analysis

Sustainable business model literature brought one clear more aspect to look at when analysing business models: extended customer value. Only looking at the value for the customers and the value for the business does not take into account does the business model do harm, improve or has neutral effect on environment. Thus, the public customer value is important addition to the business model canvas developed by Osterwalder (2004).

The circular business model literature focused more on different strategies how companies can achieve circularity. Thus, it did not bring clear elements to brought to the business model framework. However, it increased the understanding of the strategies and way circularity can be achieved and make it easier to understand are businesses circular and how.

Based on these the developed framework for the analysis include the following aspects:

(1) Value proposition for the customer,

(2) Value proposition for the public,

(3) Customer interface,

(4) Infrastructure management,

(5) Financial structure

2.2 Barriers and enablers in plastic reuse and recycling

2.2.1 Plastic value chain

The plastic industry value chain is presented in 2.5. Plastics are mainly made of oil, but also some gas is used(World Economic Forum et al. 2016). The process starts with separating the oil to different types called fractions in oil refinery plants. Next plastics are made either through polymerisation or polycondensation and the products are small plastic pellets that are sold to intermediates, some oil to plastic producers can also work as intermediates themselves. The intermediates work with brands and their manufacturing companies to provide them with the right type of plastic with the right type of features such as colour and right additives. Then the plastic products are manufactured to the market for consumption by brands and their partners. Largest part of the consumption goes to plastic packaging followed by construction, and electronics (World Economic Forum et al. 2016, European Commission 2018).

After the products are consumed, they either leak to the nature or collected to proper waste management streams to be sorted. Some businesses repair and reuse these products and they thus end up back into the consumption. In the other cases, the products end up in landfills, energy recovery processes or to recycling. There are two different types of recycling in use. Mechanical recycling means crushing the plastics mechanically into small pieces that can be used again in plastic manufacturing. Mechanically recycled plastic usually has a lot of quality and contamination issues and thus they can only be used in low value applications. Chemical recycling means a group of different technologies in which the plastics are transformed back to oil or monomers. This means the oil can be used to make any kind of new plastic without any contamination or quality issues.

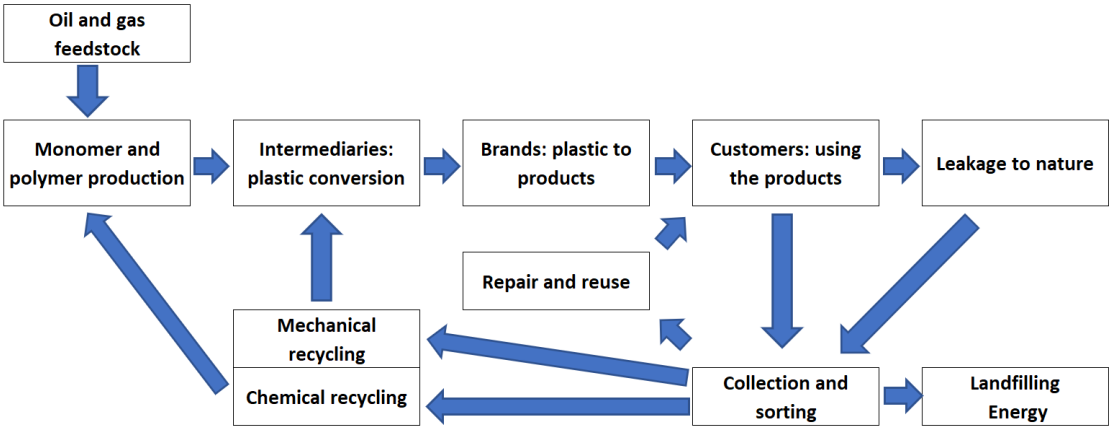

Figure 2.5: Plastic industry value chain

After plastic package usage, only 68% of the plastics is collected. The rest 32% is leaked into the environment such as oceans. Even though 68% of the plastics are collected only 14% of that is going for recycling. Of the rest, 54%, 14% is going to energy recovery processes, usually with mixed waste, and 40% is going to landfills. With other plastic types, and thus plastics over all, has much lower recycling rate and higher energy recovery, leakage and landfill percentages.(World Economic Forum et al. 2016)

Of the 14% going to recycling, 8% is downcycled through mechanical recycling to lower-value plastic applications. This is due to the plastic quality and contamination after mechanical recycling processes does not meet the high-quality standards set for example for food packaging materials. Furthermore, the end product is usually grey or black in colour due to the mixed colour plastic waste. Only 2% end up in closed-loop recycling, which means recycling of plastics to same or similar quality applications. This happens through chemical recycling or mechanical recycling that has a closed supply chain, so it does not have contamination issues. With the chemical recycling the plastics are returned back to their original oil form and it does not have any impurities. With the closed supply chain mechanical recycling there is no contamination and mixing of different plastic types risks, so they can be used gain in high-quality applications. The rest 4% is lost in the recycling processes. From the mechanical recycling the plastic pellets end up through intermediaries back to the production and consumption. From chemical recycling the plastic is going back to polymer production either straight or through oil refinement. (World Economic Forum et al. 2016)

There are four areas where the current life cycle can be improved. Firstly, the plastics lifetime could be lengthened through reusing and repairing products before they end up in the recycling process. Secondly the collection systems need

to be improved so most of the plastic ends up in the recycling process and landfilling, energy recovery processes and leakage to environments is as close to zero as possible. Thirdly the recycling technologies are improved so the efficiency improves, all the plastic can be recycled, and the plastics are downcycled as little as possible. The fourth is the need of intermediaries, so the recycled plastics end up in manufacturing by companies. The intermediaries are also in important role to help the companies to design the products with the recycled plastics, creating new use cases and building the market.

2.2.2 Waste hierarchy

The waste hierarchy is one way to prioritize waste management based on environmental performance and it is advocated in the EU Waste Framework Directive (WFD) 2008/98/EC (European Parliament and Council 2008). The waste hierarchy, as presented in figure 2.6 below, composes of different levels of opportunities to manage waste. In plastics case, the highest hierarchy advocates for prevention, meaning stopping plastics from being created and thus not consumed, with different materials or delivery channels such as digital products or services. Next is reuse, which also include refurbishing, reassembling, and repairing products. This is then followed by recycling, which include both downcycling and upcycling, where the products are made into new or similar products with lower (downcycling) or higher (upcycling) quality. Next is energy recover processes, such as pyrolysis or incineration, in which the energy of plastics is captured to be used for example as heat and/or electricity. (Dijkstra et al. 2020) The final step in the waste hierarchy is disposal of the waste, which means landfilling, burning without energy recovery or the plastic ending up in the environment otherwise (Lazarevic et al. 2010, Huysman et al. 2017).

Dijkstra et al. (2020) has added one more category to the waste management hierarchy, being the removal and capture from the environment after disposal. This collected waste can be reinserted into the existing plastic economy and can be reused, recycled, used in energy recovery processes, or disposed more appropriately (Dijkstra et al. 2020). Capturing and removing the plastic from the environment is the least efficient option to reduce pollution, and also can be difficult and extremely costly to remove (Geyer et al. 2017).

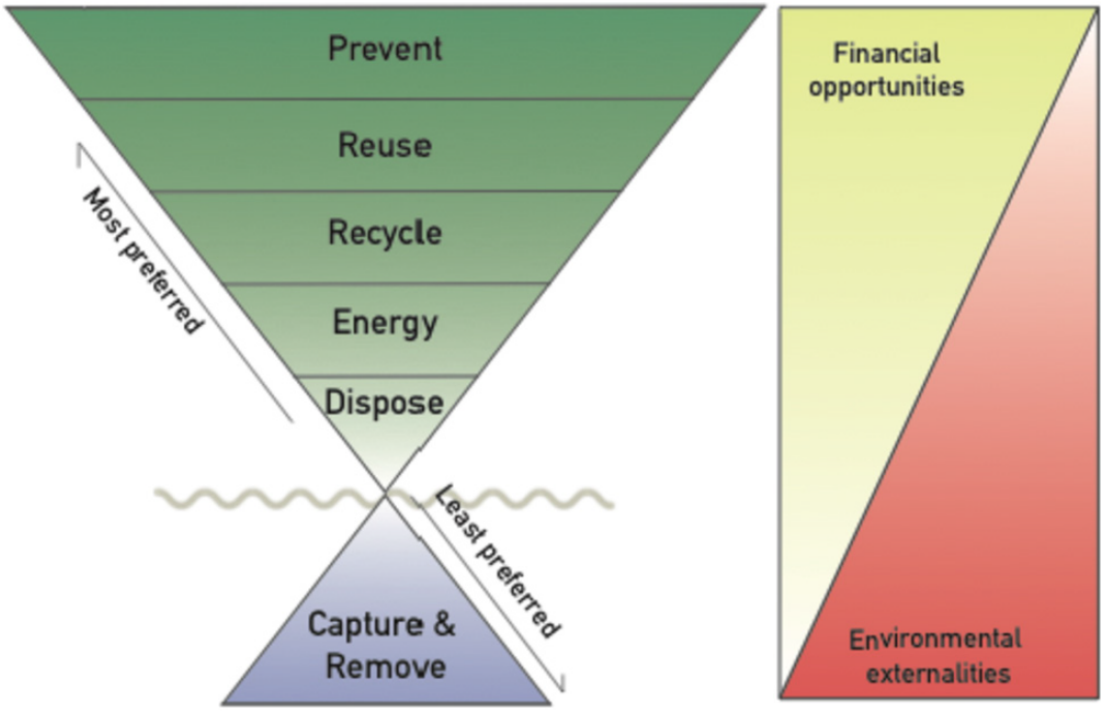

Figure 2.6: Plastic waste hierarchy (Dijkstra et al. 2020, p. 3)

The waste hierarchy is a great framework to prioritize and communicate waste management, but in plastic case there are some debates and caveats worth noting (Dijkstra et al. 2020). Depending of the plastics materials some of the options are not always available. For example, certain composite materials, for example plastic-paper-aluminium sheets in drink cartons are difficult to separate and thus hard reuse or recycle (Xie et al. 2013). Furthermore, some already recycled plastic product are sometimes unable to be upcycled and need to be downcycled, used in energy capture or disposed (Huysman et al. 2017).

The waste hierarchy can also be linked to sustainable and circular business models. As seen in figure 2.6, there is an inverse relationship between financial opportunities and environmental costs. The higher the level of the hierarchy, the higher the financial opportunities are for businesses, and the environmental costs are the smallest (European Parliament and Council 2008). The further down the hierarchy one moves the higher the environmental costs become and the financial opportunities diminish (Hultman & Corvellec 2012). Plastic prevention has the highest financial opportunities, since there a lot of flexibility for the organization can do to in regards of changing plastic to something other material (Dijkstra et al. 2020). When moving down the waste hierarchy, the financial opportunities decrease, due to increased costs of decreased value of the material and cost asso-

ciated in the used plastic management which can include for example collecting, sorting, cleaning and transforming the plastic (Dijkstra et al. 2020). Thus, this decreases the amount of profitable business cases to be made while going down the hierarchy. Furthermore, this could limit the involvement of the private sector, thereby maintaining environmental degradation and not decreasing it. On the other hand, changing consumer demand, government support and technological improvements can lead to new business opportunities and shifting incentives (Dijkstra et al. 2020).

2.2.3 Barriers for plastic reuse and recycling businesses

One of the biggest barriers for plastic recycling is comparable the chicken or the egg dilemma: which came first. There are a lot of uncertainties regarding supply of recycled plastics (Dijkstra et al. 2020, European Commission 2018). Many businesses fear that recycled plastics supply will not have high enough volume, that is reliable and has consistent quality. Currently recycling is done in pretty small facilities that are regional, so there is lack of scale and standardization. Then at the same time, the uncertainty of the demand for products of recycled plastics and the overall profitability are holding back investments for scaling and modernising plastic recycling and thus increasing supply. (European Commission 2018) So in plastic recycling, both the demand and supply are uncertain, and they both hinder each other's increase and resolving the issue.

Looking at the plastic recycling from the consumer perspective, the large masses do not know and do not want to take responsibility on the recycling. Furthermore, their willingness to pay for recycling taxes or similar additional costs is low. (Gong et al. 2020) The consumers also mostly have low awareness of the plastics' challenges in recycling (Dijkstra et al. 2020). This leads to low demand for recycled plastic products since they are not aware or interested in the environmental impacts the linear plastic value chain has. There is also a lack of government support for change in the plastic recycling (Dijkstra et al. 2020) and there is need for multi-level efforts and support from consumers, businesses, public sector, and other smaller players (Lüdeke-Freund 2010).

When looking at the businesses and the way they operate, there are also many challenges to overcome. One of the biggest is the reluctance to change. Changing from a linear existing operation ways of working, that has been dominant for a long time, to a completely different way of working requiring basic and system level innovation and change is seen as threat for their own existence (Huber 2000, Lüdeke-Freund 2010). Moreover, reluctance within the organization, especially in the top level, towards change is preventing change (Dijkstra et al. 2020, Gong et al. 2020). Especially in the waste management industry, the infrastructure is built for long investment cycles, preventing them of making quick changes and decision as

conflicts against the current way of operating (Gong et al. 2020). The change would also be from a linear solution to more complex new systems that decreases the willingness to change (Dijkstra et al. 2020). Furthermore, businesses are focused on the growth and profitability of their business. As mentioned above, there are concerns for the supply and demand of recycled plastics. Thus, if changing the way of operating is only seen as a cost and not providing any growth, it is not seen as a viable option (Lüdeke-Freund 2010).

In financial terms, as mentioned in section 2.2.2 Waste hierarchy, the financial opportunities for businesses decreases the further down the waste hierarchy one goes. So in the recycling level of the hierarchy it is harder to make profitable business cases (Dijkstra et al. 2020). Furthermore, the related investment and transition costs of new technologies and R&D are high (Dijkstra et al. 2020) and the change towards circular economy in plastic is going to cost a lot of money (Gong et al. 2020). There are also technological bottlenecks that need addressing (Dijkstra et al. 2020). Current mechanical recycling has its limitations and the chemical recycling technologies are still mostly in development (World Economic Forum et al. 2016). So harder to make profit at the recycling level, high investment needs, limiting technology, and on top of that the production costs are usually higher than in the linear solutions (Dijkstra et al. 2020). The operations costs depend on the consumer participation in the waste separation, as waste streams that are not sorted can be too costly to utilize. Moreover, even the stream with proper separation needs to have some kind of sorting and different treatments, which create costs. (Dijkstra et al. 2020)

There has been a case in the Netherlands regarding PET-bottle deposit solution and the opposition it has faced form the industry (Smink 2015). This explains well the change resistance industries might have for circular solutions and how much they are ready to put effort to prevent them from not being implemented. Different businesses in the industry and their supporting organisation used disruptive institutional work to attack against the circular deposit solutions and presented their own solution. They did this since they deemed the deposit model to be too expensive, even though it has more environmental benefits than their solution. They used three different ways to affect the opinions of the government: framing, conducting research and negotiation.

Framing means they overly emphasized the disadvantages of the unwanted systems and overly highlighting the advantages of their competing solution. Most importantly the environmental gains of the deposit system were downplayed, and the alternative system cost-efficiency was emphasized. Conducting research means funding and conducting research that is biased form the start setup. The framing and scoring of the research on the different options where done in a way that the competing solution would always be the best. Negotiation meant lobbying

the decision makers against the deposit model continuously. Furthermore, it was mentioned that the government was not strict enough on the industry side and gave them too much slack and allowed different more powerful government ministries silence less powerful ones. (Smink 2015) This case proves many of the barriers mentioned previously in this chapter in action.

2.2.4 Enablers for plastic reuse and recycling businesses

One of the biggest enablers for plastic recycling is the increasing demand for recycling and recycled products (Dijkstra et al. 2020, Gong et al. 2020). The demand is not yet so great, but it is going to the right direction and the increased consumer demand leads to larger markets for recycled material and products and thus also to more supply (Dijkstra et al. 2020). This should fix the mentioned chicken egg dilemma in 2.2.3. Also, the government support and regulations are driving towards more recycling solutions (Dijkstra et al. 2020). Governments decision on regulations and requirements on fees for landfilling, landfilling bans, enforcing extended-producer-responsibility (EPR) and providing funding for R&D has driven the change towards more circularity and technological development (Dijkstra et al. 2020). For example, the effects of the landfilling regulations in EU has had a big change on the amount of waste ending in landfills (European Commission 2018, World Economic Forum et al. 2016).

In the businesses themselves, the senior level and management support and commitment within the organisation to drive towards sustainability is one of the key aspects on change and getting everybody on board with the change (Gong et al. 2020, Dijkstra et al. 2020). Moreover, internal collaboration within the company can have a big assistance on the ease of change (Gong et al. 2020). Also, collaboration downward and upward in the supply chain, within the industry and with different players and the government will drive towards change (Dijkstra et al. 2020). Furthermore, the industry collaboration will share knowledge and costs, which make the burden of R&D and investments smaller for one business alone (Gong et al. 2020). Being early with the change, can give competitive advantage to the business and at the same time more competition is driver for innovation and product differentiation (Dijkstra et al. 2020). In addition, the recycled products can be marketed as sustainable for the increasing target group and they might have properties that are attractive for the manufacturers (Dijkstra et al. 2020).

From the financial side, businesses will have costs savings from using waste as input compared to high prices of virgin materials (Dijkstra et al. 2020). Furthermore, R&D funding and access to finance for plastic recycling is increasing, giving more opportunities for different business models and solutions. Also, there are a lot of new technologies under development to capture the lower financial opportunities for recycling efficiently (Dijkstra et al. 2020). Moreover, the change

form linear economy to circular economy with 0 waste is seen to be more lean and efficient, which will decrease the value of the linear economy, but more examples are needed for businesses to see this better (Gong et al. 2020).

Chapter 3

Research methods

3.1 Research approach

This thesis uses qualitative research approach to find different plastic recycling business models, analyse their differences, categorize them, and describe different challenges and opportunities they are facing. The goal is to get a comprehensive view of the different business models and the barriers and enablers they are facing. Thus, interviews are the best approach to get new understanding that can be research further. Furthermore, the focus is on the whole plastic recycling value chain, businesses in different parts of the value chain needs to be identified and interviewed.

The process started by defining the initial research objectives based on what other research in the same ValueBiomat project had found lacking. This was followed by literature review to gain understanding of the plastic value chain, develop the theoretical framework to compare and analyse the business models and lastly to see what kind of barriers and enablers are already identified in other research for plastics recycling. Next an online research was done to identify different emerging businesses in plastic recycling, describing their business models and comparing and categorizing them. This was followed by interviews with business in each stage of the plastic value chain to understand better their business models and see what kind of barriers and enablers they are facing. Lastly all the findings were analysed, compared to the literature and conclusions were drawn.

3.2 Data collection and analysis

Data collection was done in two parts: online search for the business models and interviews with the businesses. For the online search the main sources to identifying the emerging companies were different sustainability rankings, websites of

organisations involved in industrial sustainability, and Google search with different key terms. The sustainability rankings used were: Corporate Knights top 100, The Guardian Green, Sustainable Business Awards, Dow sustainability index, and Forbes top 100 sustainability leaders. The industrial sustainability organizations were: WBCSD, UNIDO, World Bank, UNEP, INGOs, Forum for the Future, and WRAP. In the google search the following terms were used: plastic waste startups, sustainable plastic packaging startups, and circular economy plastic startups.

This resulted in finding over 100 different companies in plastics recycling, of which 59 was used in the analysis. The companies were described with the selected framework in a table and a version with the company names, part in plastic value chain and short description can be found in Appendix A. Some of the companies were discarded due to not being actually plastic reuse or recycling focused and thus not in the scope of the study. Furthermore, some of the companies were discarded because they did not have enough information available or the information online was conflicting between different sources. The sources for the companies' business models was mostly based on the companies' own sites, but sometimes some additional sites were found and used. For some of the companies, not all information was available, which led to some blanks to the analysis in some cases.

After the initial descriptions of the companies they were compared to each other and the descriptions were developed further for each of the 5 main blocks of the framework and understanding their specific characteristics. The companies were initially described in the plastic value chain perspective to keep a strict focus and help the initial comparisons and analysis. After this the most interesting companies were selected to be interviewed.

The interviews were conducted with the target to have at least one company from each of the following plastic value chain stages: reuse, collection, sorting, mechanical recycling, chemical recycling and intermediary. At the end, eight interviews were used for this thesis. Each of the stages had one interview except collection, which had two. In addition, there was one interview conducted with a company that works with the whole plastic industry to improve recyclability. Three of the interviews were conducted specifically for the thesis, whereas the remaining five were secondary interviews conducted as a part of the broader research project this thesis is a part of.

The interviews were carried out through semi-structured interviews and the interview structure can be seen in Appendix B. It has the most important high-level questions and some support questions to guide the interviews. The base was slightly adjusted for each of the interviews if needed. Furthermore, additional questions were asked based on the interviewee's answers to get more deeper knowledge. Each interview had one or two interviewees and the duration ranged from 45 to 91 minutes, with an average of 69 minutes and a total of 9 hours and 12

minutes.

The interviews analysis was built inductively. The process started with the transcriptions of each interview and the main quotes of each interview were analysed and compared to each other. Th goal of this was to understand the common themes emerging from the interviews. This data was used to deepen the analysis on the business models and their descriptions. Furthermore, the interviews provided the empirical results for the barriers, enablers and change needs for the plastics reuse and recycling industry.

The goal of the research was not generalization of the findings but instead increasing and building understanding on the possible business model categorization and the barriers, enablers and challenges the companies face in plastics reuse and recycling industry. Thus, only 1 or 2 interviews is a reasonable approach for the research. Furthermore, the interview findings were in line with each other and also mostly in line with the previous research results. Thus, this support generalization of empirical findings.

Chapter 4

Empirical findings

4.1 Business models in plastic value chain perspective

The business models in the plastic value chain context are discussed below as follows. Firstly, we will focus on the first improvement area, about lengthening the life cycle of products and what kind of business models there has been developed. Then we will look at the second improvement area of improving collection and sorting solutions and related business models. This is followed by focusing on the third improvement area of improving the recycling technologies. And lastly, we will look shortly at the intermediaries.

4.1.1 Reuse and repair business models

The reuse and repair models do not always have plastics in the centre of their operations, but they are important to understand how these models can work, what kind of solutions are made and what possibilities might there be in the future. There are two main categories in this section: used products platforms and reusable food containers. The first one consists of different businesses selling used and possible repaired products to consumers. The second one consists of businesses with different business models developed to replace single use food containers with reusable ones. The parts we are focusing on the plastic value chain in this section can be seen from figure 4.1 as highlighted in grey boxes and green arrows.

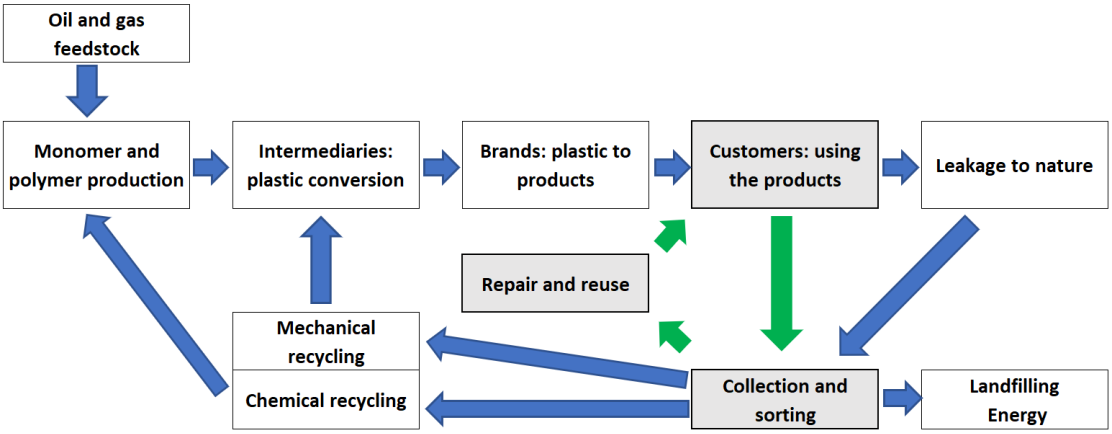

Figure 4.1: Plastic industry value chain, focus on reuse and repair

4.1.1.1 Used products platforms

The businesses in this area can be divided into two categories: the ones actually purchasing products to be sold on their marketplace and the ones only having the marketplace for others to sell on. The focus on these businesses were on electronics, clothes, or office furniture. The ones purchasing and owning the products had their own operations where they collect the products, prepare them for reselling and sell them to customers through their channels. The ones only having the marketplace let their suppliers to handle this, with some support for delivery options. Furthermore, these businesses had differences in the way they operated. Others had other companies as their suppliers and individual consumers as customer (B2C model) where companies could sell on their platform to consumers. The others had consumers as suppliers and purchasers on the platform (C2C model).

What all these businesses have in common is their value propositions for the customers and the public, customer segments and channels and revenue sources. The value proposition for customers is fully functional products with similar or slightly lower appearance to new ones with lower price and at the same time being more environmentally friendly option. The value proposition for the public is lengthening the lifecycle of products through reuse and/or repair before they end up in recycling. The customer segment is price sensitive and/or customers wanting to make more sustainable purchases. Furthermore, all these businesses reach the customers through their own ecommerce platform. Lastly, the revenue comes mostly from the product sales, while some of the businesses are selling some additional products and services for their products, but this is most likely quite small part of the total revenue.

The businesses having their own operations has their business focused around

the overall process of collecting products, preparing them for reselling and delivering them to the customers and how to do this as efficiently as possible. Furthermore, almost all are capturing almost the whole reuse and repair value chain from collection to the sales of the products. The supply sources for the products collection vary between direct purchase from consumers and businesses, and/or purchase through some middlemen businesses. The businesses purchasing straight from the source (consumer/business) at the end of consumption, has the largest part of the plastic value chain in their control. Some businesses only had this closest to the source supply, while some had on top of that or as a only source the option to purchase through some middlemen businesses who purchased the products closest to the source. This affects the total value capture available from the value chain, but only slightly, since they business purchasing from middlemen lose some margin to the middlemen business' operations and profit.

Due to having the whole process in their own hands and owning the products these business models require lot of capital to run the operations, if the businesses do not have long enough payment terms with their suppliers. Furthermore, with the electronics focused businesses, which have their own operations, the value of used electronics drops quite fast due to new generation products coming to the markets. Thus, on top of capital heavy business model their inventory value decreases fast, encouraging them to have as fast inventory turnover as possible to capture as much of value as they can on the products. On the other hand, when the operations grow they can leverage economies of scale in the operations in the long term.

The businesses having only a platform for others to sell on do not have their own operations and the business is focused on the platform development and the experience around it from supplier and customer sides. Since they do not have the operations and they do not own the products the model is not capital heavy and requires less resources to run the business. However, on the downside they have only own the platform and thus can capture only a small part of the whole value chain creation. These businesses will take a certain percentage of the revenue going through the platform and thus the overall income is much smaller compared to a business owning the whole operations.

4.1.1.2 Reusable food containers

Before going into the reusable food containers, it came up in the interviews that there are a lot of different plastic containers and pallets in reuse in different industries. For example, in the beverage industry, these containers are used to move the bottles safely from one part of the chain to the other. Their flow is tracked and made sure that businesses return the containers they use to some other company in the chain. Usually the logistics work in a way, that when full containers are

delivered, empty containers are collected and brought back to the earlier part of the process. Each of these companies participate in the costs and they do not need to use single use containers or pallets as much or at all.

These business found in the reusable food container area are focusing on replacing single use food containers with reusable ones and have a different approaches to the problem. DeliveryZero food delivery company is using its own reusable containers. When ordering through them, you do not have to pay extra for the container, but if you do not return it within 6 weeks, the customer is charged a small fee for the container. The container can be returned to the participating restaurants or at the time you receive your next food delivery.

The second business, Pantix, offers lunch restaurants a reusable food container the restaurant has an option for the customers. If customers choose to select the reusable container, they pay a deposit for it. When they visit a participating restaurant again, they can return the container and have their next portion in a new container or get the deposit back.

The third business, Keepa, is like the combination of the previous two. It offers restaurants and food delivery companies and their customer restaurants with the reusable container. These delivery companies' customers just have the containers in stock, and they will get new ones from this business. The business manages the collection and washing of the containers and resupplying them to the delivery companies' customers. If the container is not returned to a drop of point, they have to pay a weekly rent for the container until the container is returned.

All these three models have in common is that they are service businesses and that they are changing the current process of linear consumption to circular but trying to run the same process with at the same cost level. There is no additional cost for the consumer, but they need to return the containers. The value proposition for the customer and for the public is a more sustainable solution and less waste creation compared to the current single use plastics. Thus, the customer segment is clearly more environmentally concerned individuals for DeliveryZero, and more environmentally concerned business for Keepa and Pantix. Furthermore, the key activities are the same, running the collection and washing operations and for Keepa and Pantix also the delivery of the containers to the restaurants. Plastic value chain wise these businesses are covering extremely narrow area, focusing only on the food containers. Furthermore, they need to operate with same or lower operational costs as the single use containers or to bring some additional benefits through data collection through apps used or marketing opportunities in the containers.

There are also differences between the models. The DeliveryZero model do not have any actual revenue stream, only if the containers are not returned, they will keep the deposit or charge the fee to purchase a new container to replace the un-

returned one. They are replacing the purchasing costs of the single use containers with running the operation with reusable containers. Keepa's and Pantix model is charging the customer businesses to run its operations. Furthermore, since both of them are selling their solution to multiple companies, they can decrease their costs in the long term due to economies of scale.

4.1.2 Plastic collection and sorting business models

The regulations in different regions in the world have a big impact on the implementation on public collection and sorting operations and requirements. There are big differences around the world and the regulations are quite strict in the EU and the implementations are usually taken the furthest in the Western-European countries, such as here in Finland. In these countries there are basic infrastructure and sorting requirements for consumers, businesses, municipalities, and cities, which dictates and forces one to take the required action. In the context of this research these are not included in as new business models as we are focused on private and market-based solutions. With this exclusion, we are left with three main categories: collection before ending in nature, collection from nature and sorting solutions. The parts we are focusing on the plastic value chain in this section can be seen from figure 4.2 as highlighted in grey boxes and green arrows.

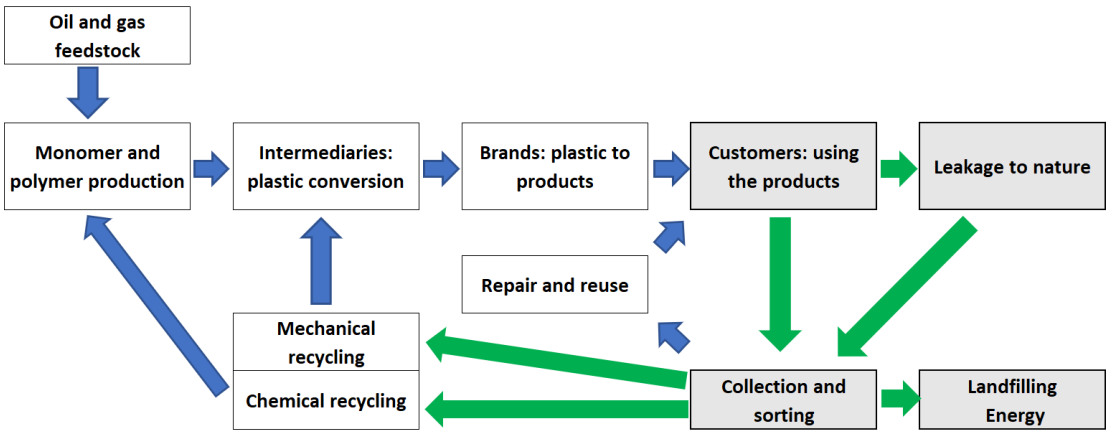

Figure 4.2: Plastic industry value chain, focus on collection and sorting

4.1.2.1 Collection before nature

Before going into the emerging business models, there are deposit models used in the Nordic countries for example PET-bottles. In Finland it is called Palpa, a non-profit organisation, that actually only manage the whole value chain. They do not

have their own operations but manage the different partners in each stage through collection to mechanical recycling and then to reselling. The revenue streams for the consists of the unreturned bottles and the fees collected form the companies using the plastic bottles. Since the organisation is non-profit their focus is on making the whole process as smooth as possible and allow the different players make money on their operations. In Denmark they have a similar solution, but there their equivalent of Palpa owns the whole process from start to finish and operates it themselves and captures the profits. These PET-bottle deposit models are some of the first circular solutions developed to manage plastic waste.

There were only two emerging business models found in this section. The first one, company called PantaPå has a business model where individual consumers get monetary return for the return of their plastic waste to collection points. The second one, company called Bureo, has a business model where fishers have an easy way to dispose of their unusable fishing nets and they are provided information regarding it. And these models are so different, that the only common part they have is the value proposition for the public: improving plastic waste collection rates and decreasing leakage into the environment.

The PantaPå value proposition for the customers is to get monetary return for recycling their plastic waste. The customers are individual consumers and the model works through a mobile application, in which the consumers read the barcodes of the plastic packages they are depositing at a collection point and the customer gets monetary return for themselves, which is either cash or coupons. The revenue for PantaPå comes from the participating companies, which pay them a yearly fee to be part of this solution. Only scanning plastic waste from these brands is possible. Thus, the key activities for PantaPå are the development of the mobile application and managing and creating new partnerships with brands. They also provide the brands data on the collection rates and customer behaviour, which they can use to see for example how well their products are recycled. This is one motivation for the brands to be part of the application, since if the recycling amount are high or increasing, they might be more interested in using recycled plastics in their products in the future. Lastly, from the plastics value chain perspective PantaPå takes a small part, since they are only encouraging people to dispose of their waste and they only have the application and the partnerships.

The Bureo value propositn for the customers, the fishers, is an easy way of disposing of their fishing nets waste instead of just dumping it into the ocean and improving their industry's livelihood in the long run. Bureo takes care of managing the waste and ensuring it ends up in different use cases. The process consists of the collection of the nets, cleaning separation and packaging of the nets, transporting them to for mechanical recycling and the pellets are used for new products with partner brands. Everything after the collection of the nets

phase is outsourced. The revenue for Bureo comes from selling the plastic pellets to the brands to be used in products. Furthermore, the key activities for Bureo are creating and upkeeping the collection points, managing the partners that are part of the process and developing and managing the current partnerships with the customers of their product. Plastic value chain wise the whole business model is part of a large part of it, but on the other hand they are mostly just managing partnerships.

4.1.2.2 Collection from nature

There were two main categories found in this area: businesses focused on preventing plastic from leaving the canals and rivers to the oceans, and a model trying to encourage individuals, businesses and public players to collect litter and dispose of it correctly. These models have in common the value proposition for public: collecting plastic waste from environment and preventing it for ending up deeper into the environment where they are harder to collect. In the case of the first model, rivers and canals are the biggest source of plastic waste leaking into the oceans. This is especially a problem in Asia, where the largest amount of plastic waste ends up in the oceans.

River collection business models have cities, municipalities, ports, or governments as their customers. The value proposition is providing them with a greener image and showing that they care about the environment and cleanliness of the living areas. There does not seem to be any actual monetary return for the customers from these solutions, so it might require regulation to encourage more action towards these kinds of solutions. The technology used is the same as in preventing oil spills in the oceans from affecting larger areas. Thus, the key activities are managing the customer relationships and maintenance of the technology. The revenue for the businesses comes from either leasing or selling the technology. Plastic value chain wise these businesses work in small part of the whole value chain and thus capturing quite limited value. Furthermore, as mentioned already, the large scale of implementation of these solutions might require regulatory action as the value proposition for customers might not be enough as is.

For the litter collection business model, there are two different customer groups, other businesses, and public players such as cities and then individual consumers. For the businesses, the value proposition is providing them with a greener image and showing that they care about the environment and cleanliness of their living areas. For the consumers, the value proposition is to have an impact on the cleanliness and recycling of waste, but at the same time challenge and inspire others to do the same. This business is a non-profit organization and its revenue streams are not mentioned in the website. They might require some money from the participating businesses or public players or rely on donations. The key activities

are the app development, and the partnership management. Value chain wise this business work in small part of the whole value chain and thus capturing quite limited value.

4.1.2.3 Sorting solutions

The sorting solutions consists of three different types: robotics solutions for waste sorting, software solutions for waste sorting and technology to separate plastics or laminated materials. These businesses are quite similar and can be actually analysed together. Their value proposition for the customers is improved sorting or separation efficiency. The value proposition for the public is that this improved efficiency leads to higher amount of plastics that can be recycled instead of going to energy recovery processes or landfilling.

The customers for these businesses are different waste management companies doing plastic handling and sorting. These businesses key activity is the technology development, to create the new solutions to the market. Thus, they require lot of funding and time for the R&D of these technologies. Revenue wise they are either selling or leasing the technologies to their customers. Value chain wise these businesses are only technology providers and thus take narrow part of the total value chain.

4.1.3 Recycling technology business models

The recycling technology business models can be divided into two main categories: the once focusing on mechanical recycling and the ones focusing on chemical recycling. The mechanical recycling models include businesses doing mechanical recycling and selling the plastic pellets they make to intermediaries. However, some these businesses have tackled the barriers for low demand in the markets by developing their own products to be sold to consumption or as raw materials to be used in for example construction industry. Thus, they have their own plastic conversion and/or plastic to products operation, and work as intermediaries and/or brands. The chemical recycling business models are focusing on developing the technology and either selling the technology, using it by themselves or making plastic products for intermediaries and brands. The parts we are focusing on the plastic value chain in this section can be seen from figure 4.3 as highlighted in grey boxes and green arrows.

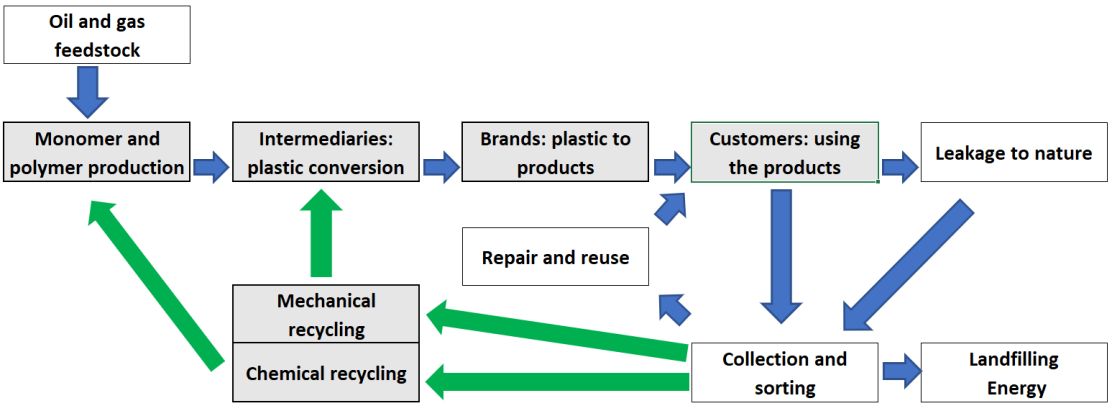

Figure 4.3: Plastic industry value chain, focus on recycling

4.1.3.1 Mechanical recycling

The more common way of operating in the mechanical recycling is to recycle the plastics to pellets. These businesses have the same value proposition for the customers: plastic can be recycled and sold, so the waste can be turned into monetary value. For the public, the value proposition is that plastic is recycled and end up being reused instead of the plastic ending up in energy recovery or landfills. These operate only in the mechanical recycling part of the value chain, so a narrow area where to capture value from. The key activities are running the operations and this requires some capital to have all the facilities, machines and operating them. The customers are the intermediaries of the industry.

The largest part of the businesses is creating products out of the recycled plastic for other companies to be used as is or as raw materials, and some of them also made products straight to consumers. The ones focusing on businesses, their value proposition for the customers is turning hard to mechanically recyclable plastics to products to replace of usage of other materials in construction and manufacturing. The value proposition of the ones selling for consumers is to have more sustainable alternative to other products. For the public, the value proposition is that hard to mechanically recyclable plastic ends up in new applications instead of straight to the nature or energy recovery processes. All of these businesses' key focus is in the recycling and manufacturing processes they have in turning the plastic waste to the products they are selling. Compared to the businesses just mechanically recycling the plastic, these are changing the products to actual products or raw materials and thus take a larger part of the value chain in their hands as they operate as intermediaries or brands as presented in figure 4.3.

There are also differences between the models. Most of the businesses get their revenues from selling the products. Byfusion is the only business selling and/or

leasing the technology to their customers. Basically, they give the tech to their customers, who can then make the end product and sell it to end customer. Their product is the plastic construction bloc, so Byfusion is also focusing on creating demand for the blocs, so it is easier to sell the technology to recycling plants. The customers for businesses selling to companies are mostly in construction industry. There are a wide variety of products they offer and they include: plastic panels for furniture manufacturing, decking boards of recycled plastic, replace the usage of traditional construction materials in insulation as plastic blocks, provide plastic in a form that can replace gravel in concrete, or plastic in a form to be used in asphalt manufacturing to replace bitumen usage. With these solutions these businesses are tackling the no demand issue, by creating their own products directly and building demand for recycled plastics themselves. This will definitely improve the demand and at the same time the supply of recycled plastics.

However, there might be some question about the real sustainability and circularity of the solutions that are used in concrete and asphalt. They are most likely extremely hard to be recycled after their use and the leakage to nature might hard to prevent during their lifecycle. They add one more use cycle for the plastics, so it is better than energy recovery processes, just dumping the plastics to landfills or them leaking into the nature. Thus, they are more sustainable than some of the alternatives, but not truly circular.

4.1.3.2 Chemical recycling

Chemical recycling businesses was the largest group found in the online search. There were three different kind of operators found: the ones focusing on creating the chemical recycling technology and selling or leasing it to waste management companies, ones who did the recycling on their own plants and sold the end product to monomer and polymer production companies, and the ones who created their own plastic product after the recycling. Some of the companies in the first section might end up switching their focus since their technologies were still in development and no commercial plants were open.

All these three categories had similarities business wise. For the public, the value proposition is to be able to recycle currently unrecyclable plastics and have more upcycling opportunities compared to the mechanical recycling solutions. In addition, the key focus for all these businesses is in the R&D of their recycling technology, which requires a lot of resources. Thus, all these businesses have required a lot of capital, time, and knowledgeable individuals to come up with these solutions.

There are however lot of differences between the main groups. The technology selling businesses' value proposition for the customers is to be able to recycle the plastic waste they currently cannot, and it has actual monetary value since the

end products have same features as virgin plastic raw material, crude oil. Their customers are waste management companies, and the revenue comes for selling or leasing the technology to them. These businesses take the smallest part of the plastic lifecycle value chain since they only proved the technology to the companies doing the recycling and taking a larger part of the total value chain.

The businesses having their own plant and the ones creating their own plastic product have some similarities. Their customers are pretty much the same: intermediaries or companies making plastic products. Furthermore, they get their revenue from selling the end products. The differences lie in the value proposition for the customers, costs and value chain capturing. For the businesses having their own plant, the value proposition for the customers is to have recycled plastic raw material that can be transformed to virgin quality plastics(upcycling). For the businesses creating their own product, the value proposition for the customers is to have plastic granule ready for product manufacturing in high-value applications (upcycling). Businesses having their own plant has smaller cost structure of these two, but larger than the technology selling or leasing businesses. In addition to the R&D, they have to run their own recycling operations, but at the same time they capture a larger part of the plastic value chain. The third group has the largest cost, since they also have to run their manufacturing process of making the end product, but they capture the largest part of the value chain.

4.1.4 Plastic intermediaries business models

Plastic intermediaries are in an important role in creating demand and helping companies developing products using recycled materials. The parts we are focusing on the plastic value chain in this section can be seen from figure 4.4 as highlighted in grey boxes and green arrows. In the online research there were three kind of businesses found to offering a marketplace for recycled plastics. The difference between these three are that one of them is more like a regular intermediary, selling also recycled plastic, the second one work as sorted plastic waste marketplace, whereas the third one is only focused on recycled plastic made of plastic collected from the oceans.

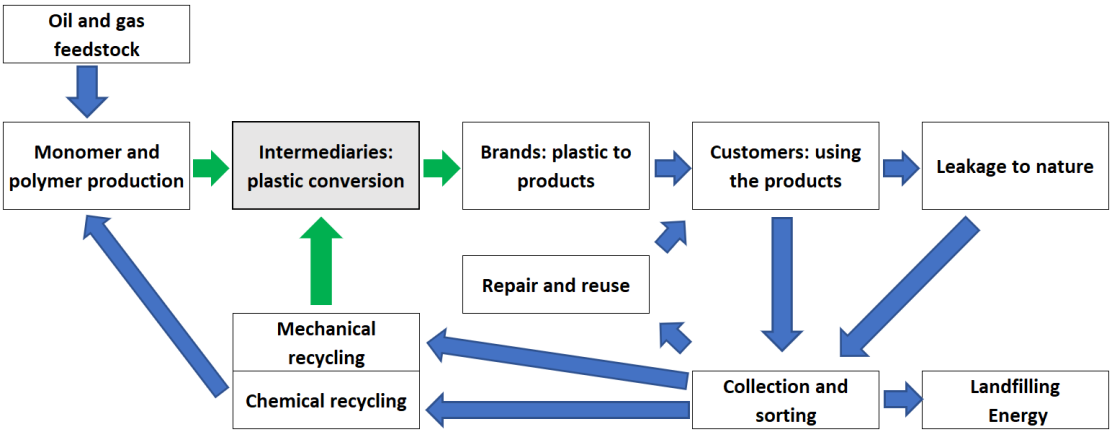

Figure 4.4: Plastic industry value chain, focus on recycling

These businesses have a lot in common. For their customers, the value proposition is offering a place to find reliable supply of recycled plastics from reliable suppliers. For the public, the value proposition is creating demand and supply for recycled plastics, so there is actually a recycled plastics market. The customers are other intermediaries or plastic producing companies. The focus of these companies is in developing the marketplace and the experience around it from supplier and customer sides. The revenue comes for taking a small cut of the revenue of the sold products on site, and thus they are capturing a very limited part of the plastics value chain.

4.2 Barriers, enablers and change needs in plastic reuse and recycling

4.2.1 Barriers in plastic reuse and recycling

The main barriers found in the interviews were:

(1) Demand and supply dilemma

(2) Negative value of plastic waste

(3) Mechanical recycling limitations

(4) Funding hard for local and smaller scale businesses

(5) Businesses focusing on the short term profits if possible

The interviewees also saw the same fundamental problem as previous research: there is not enough demand for recycled plastics and at the same time there is not enough supply of recycled plastics. Big consumer brands require stayed flow of supply and with recycled plastics, there are limited supply and lot of uncertainty linked to it. Thus, there is need for more supply before the demand will be created. However, at the same time the limited demand is hampering the increase in supply, since why invest in something that has limited and uncertain demand now. Furthermore, the prices of recycled plastics need to be lower than the virgin equivalent, but at the current oil prices (due to the COVID-19 pandemic) that is not possible and really hampering the demand at the moment.

Even though the regulations for recycling are driving to recycle more, if the demand does not exist, you are recycling just because you have to recycle and then you still have material that has no demand. However, this might be too negative perspective on the whole problem. Since the problem is both in supply and demand, you need to fix first either one to fix the other. Thus, using regulation to increase recycling and thus create more and more stable recycled plastic supply will then fix the need for steady flow of recycled plastic in the demand side. However, it is seen that even though EU has large targets for recycling for the coming years there is still too much just talking on the topic and not that much action in in the industry to do actual changes yet.

The negative price of plastic waste is also seen as a big problem. Compared to other waste, like metals and wood, they have value as waste. Since plastic does not it is hard to make the operations financially profitable to collect, sort and recycle the waste plastics. Now companies have to pay each other to take the waste plastic for further handling, such as mechanically recycling, even though they make products and revenue out of the recycled plastic. Some of the businesses have decided to tackle this by making their own products and thus they make something that has a positive value instead of a negative one. But overall, this creates lot of challenges on making the waste management profitable and thus hampering investments on it.

Mechanical recycling has lot of limitations. Of current packaging only 2/3 can be mechanically recycled. Furthermore, the contamination problems in the plastic collection and sorting flows prevents most of their use in food packaging. Furthermore, mechanically recycled plastics usually have some impurity problems, and the impurities are not stable at every batch, because it differs on the supply of waste plastics that are recycled. This creates changes on the plastic quality and challenges to operating with it. Thus, there is clear need for chemical recycling and the benefits it provides. However, the machines and technology now are still mostly in pilot phases, they are expensive, and they need high volume to be viable in economic sense. Moreover, there is still a long way to go with the technology

and what kind of solutions will come out on top as the most efficient and most flexible.

Investors who are investing in green businesses are also interested in making decent money, so for smaller scale and more uncertain start-ups and businesses in these areas it harder to get financing. Many of the things we need to do to change the way we operate will probably cost a lot of money, but not make so much profit. However, there are lot of talented people focused on these issues, but they do not have the financial backing available, hampering their idea development.

Businesses have shareholders who sometimes are just looking at the short term profits, and if the companies can make more profit using cheaper virgin materials and get away with it, they will do it instead of using more sustainable options with less profits. Similarly, it is not enough for businesses that new solutions bring sustainability. They need to have some kind of added value on top of just sustainability to make sense for the companies to engage in it. Of course, there are some actors who interested on just the sustainability, but they are smaller part of the total industry. The largest part sees just the sustainability focused solutions as a cost, and if you want to become a large player and grow fast, your value proposition needs to add additional value than sustainability or circularity.

4.2.2 Enablers in plastic reuse and recycling

The main enablers found in the interviews were:

(1) Chemical recycling development

(2) Increasing demand and awareness

(3) Regulations driving supply and change

(4) More funding available for sustainable businesses

(5) Unused applications for mechanically recycled plastics

Chemical recycling is developing and seen as the only solution for plastic waste that has been in contact with other kind of wastes and be contaminated. The ability to change plastic waste back to oil or gas and then back to virgin quality plastic open ups a lot of applications for recycled plastics. High quality recycled plastic that can be used in food packaging has a good market, that can become even bigger when more brands begin to use recycled plastics. The Finnish deposit system of plastic bottles and its aftermarket is seen as one good example. Even though it is done by mechanical recycling, it is a closed collection and loop, and thus waste is not in contact with other substances and plastics, so it is not contaminated and can be thus used again in high quality applications (upcycling).

Chemical recycling can create similar recycled products for all different plastic types, without having to limit the collection and the loop to be closed, since the contamination is not an issue after the plastic is transformed back to oil or gas. Lastly, in the EU at least, the chemical recycling of plastic back to oil and using it as a petrol fuel is not considered as recycling, which forces and encourages that the end products are used to make new plastic.

More and more people are concerned about the planet and paying attention in sustainability, recycling, and circularity. This kind of consumer demand for recycled products creates need for consumer brands to take action and start to use recycled plastics. They need it to meet the consumer demands, but at the same time it has a large impact on their imago on showing they care about the planet and not just doing profit. Furthermore, many companies are seeing how the way we currently are doing things might affect their business' livelihood in the long run. This is forcing them to take action and change their linear way of working and bringing more sustainability and circularity.

Regulations and legislation overall are seen as an enormous enabler to force more recycling in the plastics and thus more recycled plastic supply to fix the demand supply dilemma. Again, the Finnish Palpa comes as an example, when it was created to enable the beverage manufactures to be able to not pay a tax for their products when they created this circular recycling solution. There are similar solutions in all the Nordic countries and other deposit models are tested for example for plastic bags in Sweden with clear positive effects on the recycling after the waste has value. Creating a value for all type of waste encourages the customers to take care of it after it is seen as a waste and it does not end up in environment or in other waste collection. Pantapå and the other PET-bottle deposit systems are an excellent example of this.

There are starting to be more totally green investor funds, investing in sustainable businesses trying to solve the current sustainability challenges we are facing. This creates lot of opportunities for businesses focusing on the sustainability and circularity issues. Furthermore, many other investors are not anymore investing in companies that do not have the sustainability aspects considered in their business models someway.

The collection systems for plastics are already good in Finland and in the other Nordic countries. So, a good amount of the consumer plastic waste is collected separately of other waste and the rest can be separated from the mixed waste. Currently almost all the recycling of plastic is done mechanically through using the plastic in lower value applications (downcycling). However, there is lot of unfound applications where the mechanically recycled plastic could be used, even though it cannot be used in food packaging due to contamination related risks. Companies currently usually have too high-quality standards for the plastic they use, but this

is seen to be changing and more opportunities for mechanically recycled plastic should start to emerge.

4.2.3 Change needs in plastic reuse and recycling

The main change needs found in the interviews were:

(1) More regulation to drive the development

(2) Creating value for the waste

There is need for even more legislation and regulations to drive development in chemical recycling and investments on building recycling capacity. Furthermore, legislation is needed to have changes on where the plastics end up. The landfill limitations in EU has affected the plastics end destinations, but for example in Finland lot of the plastic waste now ends up in energy recovery. Thus, further regulation needs to be put into place to have the plastics going to the recycling.

One of the biggest changes required was the need for companies to be accountable for their products for their whole lifecycle until it is recycled. There is existing extended-producer-responsibility, but it should be taken even further so the businesses actually put more effort on the sustainability and circularity. This would increase the focus on design for recyclability, require proper tracking and transparency on the way products are used and where they end up. This would have huge changes for the business models and force the companies towards circularity.

Deposit systems or other ways to make the plastic packaging and plastic waste to have a value are seen mandatory to improve the collection rates, and thus making the recycling have larger volumes overall. There are a lot of cases in the Nordic countries of how the deposit models work and how they are beneficial for the collection. Furthermore, since the value of plastic waste in the waste management streams is negative, it is hard to make profitable businesses and there is not much effort put on the development. This hampers the development on business basis, without regulation.

Chapter 5

Discussion

5.1 Answering the research questions

This thesis sought to increase understanding of what kind of business model have emerged in the plastic recycling area and what kind of barriers and enablers they are facing. To address the study objective, three research questions were formulated and adopted a qualitative interview approach to interview at least one company in each part of the plastic value chain. This section reflects the findings to the research questions aiming to verify these finding with the previous findings in literature and provide answers to the research questions of the study.

5.1.1 What kind of business models have emerged for plastic recycling and how they can be categorized?

In chapter 4 the found 59 business models were presented from the plastic value chain perspective, in each stage of the flow: reuse models, collection and sorting models, recycling models and intermediaries. Looking at these companies from pure business model perspective they can be divided into three main categories: technology, circular reuse, and flow business models.

The first category, technology business models, are focusing on creating new and improved technologies and selling or leasing it to the companies actually doing the sorting, collection and recycling. Their value proposition for the customers is improved efficiencies and/or higher yields in the process stage their technology focuses. For the public, the value proposition is decreasing the environmental load of plastics, since more of the waste is recycled and more efficiently. The key activity for these businesses is the R&D of the technologies to make sure they are satisfying the customer needs. The R&D also drives the financial of the businesses to have high capital need due to long development times and lot of need

for testing and pilots. Thus, these businesses are often really dependent on funding from e.g. venture capital firms, governments or other large industry players. The customers of these businesses are either in collection, sorting or recycling and it depends on the developed technology's use case. But mostly the customers are thus existing waste management companies, cities, and municipalities. One dominant example in the data for this category set is chemical recycling technology companies developing their technology and selling/leasing it already existing waste management companies to be able to transform the waste plastics back to oil and selling it for the companies making plastic out of oil.

The second category, circular reuse models, are creating service solutions to replace single use products with circular flows of reusable products. Their value proposition for the customers is a more sustainable solution, but since this usually is not enough, some additional value needs to be created. For the public, the value proposition is decreasing the amount of waste generated. The key activities of these businesses are the logistics and operations to make sure products are in the right place and they are in the same condition when they first started in the process. From the financial perspective, these solutions have quite strict cost they have to meet, since they are replacing a single use products with certain cost level. Thus, the key activities have lot of pressure to be as efficient as possible to meet the cost level of the linear system. The customers were mostly restaurants and food delivery companies in this data set, but these solutiosn can be expanded to other industries. One good example of this category is Keepa, and their solution to bring reusable food containers to restaurants and food delivery companies.

The third category, flow business models, are focusing on operating in some stage with the plastic waste streams in collection, sorting or recycling. Their key activities is on moving the materials through the processes in high quantities and making use of the different technologies they have purchased for their use. Basically, these companies are the customers of the technology business model companies. Their value proposition for customer, which is usually are the municipalities, cities or other waste management companies, is to properly handle the plastic waste generated that they cannot themselves manage. For the public, the value proposition is that the waste is not ending up in environment, but is ending up in as high percentages to recycling and thus to new products and when this is not possible they are handled properly to landfills and incineration. Since these companies are purchasing or leasing the technologies and operating high qualities of waste their operations are asset heavy and require lot of capital. Usually the revenues for these companies come from gate fees, so they are paid to take the waste in and handle it. Some of these companies have to move the plastic to some other companies in the next step of the waste stream an pay them also some gate fees. However, if they make some products that have more value, such as

mechanically recycled plastic pellets, they also get revenue from selling them to intermediaries. One good example of a company in this category is Fortum and their mechanical recycling of waste plastic model, which they get from other waste management companies.

Even though these three categories are the main ones found, not all of the businesses fit into them directly. If looking first at the technology category, there are some companies who are actually developing technology and using it themselves in the managing the waste streams and not selling it to other companies. Thus, they belong to both the flow and technology category. They do the R&D and have the costs related to it, but they are then also the only one reaping the benefits of using the technology. This way they have even higher capital requirements, but on the other hand they take a larger part of the available value in plastic waste management area. Also, the used products platforms partly go to the flow category, but they have also a lot of features from the circular reuse category. They are not directly in contact with pure plastic waste stream, as the other flow category businesses, but with products that have plastic in the products. They are then making sure these products have a longer lifecycle by selling them again to customer so making a more circular solution as the circular reuse businesses. However, these products are usually long times without the contact of the companies, and they do not have control on the products after they are sold, as the circular reuse category work on a service basis with shorter cycles. Furthermore, even the different marketplaces have large differences between them. Some are purchasing the products and having their own operations for e.g. refurbishment and/or cleaning and thus need lot of capital and have high operational costs. However, these have also a higher value capture potential. The others are actually just an open marketplace where used products can be sold by other businesses or consumers. This way they do not need capital to keep the stocks and lower operational expenses to run the marketplace.

5.1.2 What kind of enablers and barriers the business models are facing?

The found enablers and barriers are presented overall in the chapter 4. Here we focus on the three main categories presented in section 5.1.1 and what kind of barriers an enablers they are facing. Each of these three categories have two big enablers in common. The first one is the increased consumer demand and awareness for sustainable and circular products and solutions. This should resolve the chicken egg issue of the supply and demand in plastic recycling and create more demand and thus increase the supply consecutively. The second one is the increasing regulation for recycling, single use plastics and reuse models.

For the technology category specifically, the biggest barrier and at the same time the biggest enabler is the capital requirement. These technological developments require lot on capital to develop, but at the same time the funds for circular and sustainable solutions are increasing. The problem is mostly in the scale of the solutions. If the solution is fixing large scale issues and can be used widely it has more opportunities to funding. But then smaller scale solutions that have more narrow focus might have harder time to get funding. Another enabler in technology is the interest towards chemical recycling and how it can bring more options to the waste management companies and enable more business cases to capture the low value available from currently hard to recyclable plastics.

For the circular reuse category specifically, the biggest barrier they have is that for their consumers the sustainability aspect is usually just not enough alone to change their way of working from linear solutions. The companies need to have something on top of that to provide for the customers, such as data and/or marketing opportunities, as additional value. This way the option is not just a sustainable option with a more complex system but brings more value for the customer also. However, the additional value bringing solutions can decrease the cost pressure they have to meeting the current cost level the customers have. Another barrier is that these solutions are usually more local, smaller scale and harder to expand to large markets. This decreases the funding interest of potential investors.

For the flow category specifically, the largest enabler is the technology developments that are happening and how they can bring better efficiencies and enable more possibilities to capture the low value available. From the barrier side, one of the biggest is the negative value of plastic waste. So, companies need to pay to get rid of the plastic waste that can be used transformed back to new plastic products. However, the increasing demand for the recycled plastic should also drive the prices higher for the recycled plastic products and thus also the price of the plastic waste. Lastly the supply will be lacking investments in more capacity and better technology unless the regulations or demands force it develop faster.

5.1.3 What kind of changes are needed to improve circularity in plastic recycling?

The two biggest change needs found were need for more regulation and creating value for waste. Increased regulation is seen as the main way to drive change towards sustainability and circularity. The recycling regulation is already driving the supply side and more is required. However, there is need to create some regulation on the demand side also, to force businesses to use the recycled plastics in their products. Businesses themselves are otherwise seen not to do enough

changes on their current way of operating. Furthermore, the extended-producer-responsibility (EPR) was seen to be extended even more to require important changes in the business model level to tackle the issues.

The second change is that plastic waste needs some mechanisms to create value for it. Since other types of waste have actual value, companies are paying for example metal waste. For plastic, the value is negative, and the waste management companies need to pay for other companies to take the waste. This makes it hard to make profits and operate on a financial basis. Furthermore, some kind of deposit systems for all plastic waste or other ways of making the consumer get monetary value of returning plastics would increase the collection rates and decrease leakage to nature. This would then also consecutively increase the recycling opportunities.

Lastly, there is clear need for businesses to change the way of operating and thinking. The circular and sustainable solutions are what the planet needs and sticking with the current linear environmentally unsustainable solutions is just not possible. This requires businesses to move beyond the current business model thinking and focus on growth and profits. They need to start thinking about how they can achieve profits and growth, without hampering the future for new generations.

5.2 Contributions to existing literature

5.2.1 Plastic reuse and recycling business model categorization

The main contribution of this thesis to the existing literature is the first business model categorization built for plastic reuse and recycling. The three categories developed were: technological, circular reuse and flow business models. Furthermore, this is the first contribution into circular economy business model categorization. There are some existing categorizations to sustainable business models, such as archetypes developed by Bocken et al. (2016). However, these categorizations are on a high level, looking at all kind of sustainable business models across different industries and not focusing on circular economy. General categorization is a good starting point for researches going deeper on a smaller focus area. They can provide some initial idea of what kind of categories can be found in different industries.

However, the general categorizations are not specific enough for one specific industry alone. Thus, this business model categorization in plastic reuse and recycling brings more value than trying to put all the businesses in some existing general categorization, without looking at the specific features this industry has. Moreover, this categorization serves as good starting point for future research in

plastic reuse and recycling. Lastly, the circular economies in different industries can differ a lot depending on the products, materials and services they are producing and selling. Thus, looking on circular economy business models, there is definitely need to look on specific industries and not trying to develop general categorizations, as this research did.

5.2.2 Barriers in plastic reuse and recycling

The barriers for business models in plastic reuse and recycling from the literature and the findings were mostly in line with each other. The main barriers found in previous research were: demand and supply dilemma, low consumer awareness and responsibility taking, businesses' reluctance to change, and low financial opportunities and high investment needs in reuse and recycling. The main barriers found in this research were: demand and supply dilemma, negative value of plastic waste, mechanical recycling limitations, Businesses focus on short term profits.

The supply and demand dilemma was noted in both the literature and in this thesis. It is clearly in the core of the plastics reuse and recycling and hampering the development. In addition, the reluctance to change was noted in both, but with little different focus areas. The literature looked at comprehensively the way firms operate and found different barriers such as long investment cycles, top level mentality, and change seen as a threat to existence. In the interviews the focus was on the businesses focus on short term profits and thus not looking on long term circular options if they are not forced to. Lastly the mechanical recycling limitations were talked more thoroughly in the interviews than in previous literature. When in literature it was noted the mechanical recycling has limitations, in the interviews all the different aspect were gone through. These included that not all plastic can be recycled with mechanical recycling solutions and they usually have lot of quality and composition issues that affect their usability in plastic production.

In the findings of this thesis, there was one barrier areas that have not been noted in previous literature. It was the negative value of plastic waste. It makes difficult to make profitable business in waste management, since you have to pay to get rid of the plastic. Some businesses have tackled this by making their own products of the plastic and thus are not paying to get rid of the waste, but actually making revenue from selling products.

5.2.3 Enablers and future change need in plastic reuse and recycling

The enablers for business models in plastic reuse and recycling from the literature and the findings were mostly in line with each other. The main enablers found

in previous research were: slowly increasing demand, regulations driving towards more recycling and thus more supply, technological development and increased funding available. The main enablers found in this research were: chemical recycling development, increasing demand and awareness, regulations driving supply and change, more funding available for sustainable businesses, and unused applications for mechanical recycling.

The increasing demand and awareness was noted strongly in both previous research and in the interviews. This was seen also to see to maybe fix the supply demand dilemma, since increased demand would create more supply. In addition, the regulations were seen as an important enabler for the industry in both. They were seen as the main driving force towards circular changes, more recycling and thus more supply. Lastly, the funding availability was seen as strong enabler also in both. It creates more opportunities for existing and new business to develop new solutions.

Where the literature and findings had a different approach was in the technology side. While the literature shortly mentions that technology development is an enabler for the industry, it does not go really deep into it. In the interviews it was talked more and how chemical recycling is seen as the way to go truly circular economy, since it makes it possible to return plastic back to its virgin form without any quality and contamination issues. Furthermore, the literature did not touch at all on the unused application mechanically recycled plastics has. In the interviews it was mentioned how currently plastic quality requirements are too high. Thus, mechanically recycled plastic could be used in more applications, if the quality standards would be decreased. And the development is seen to going into this direction.

In the literature there was no research on the change needs for the plastics reuse and recycling industry. Thus, the interview findings are the first contribution in this aspect. The two main change needs were: even more regulation and creating value for the plastic waste. The first one means overall more regulation to drive the supply and also to drive the demand side of things. Furthermore, the responsibilities of the producers of plastic and plastic products should be increased even more. This would force them to think about the businesses from a circular and sustainable view and changing the business model level of companies to tackle these issues.

Chapter 6

Conclusions

6.1 Practical implications

The practical implication for managers are:

(1) Consumers and businesses demand and awareness is increasing

(2) Chemical recycling is coming to change the recycling

(3) More regulation is most likely coming

The increased demand and awareness will create need to create supply and answer to that demand made by the markets. Thus, being an early adopter might bring some competitive advantage. When the supply is still limited, there are not many places to meet the demand. At least it can create temporary competitive advantage and new customer relationships.

The chemical recycling is coming to fix many issues and will change the recycling totally. However, many of the technologies are still in development and only a few of the businesses found in this research were in commercial use. This also gives opportunities to partner with some technology provider to be in the forefront of the development.

Lastly, the regulations are increasing and most likely more are coming. This emphasises it even more to be aware of the changes and ready to move with the changes. Otherwise the competition who reacts first, will get the advantage and be ahead of the competition, while others start to make changes. In other words, by being the first one to react can create competitive advantage and help the business thrive through the change from linear models to circular ones in plastics reuse and recycling industry.

6.2 Limitations of the study

The core limitations in this research concern the empirical data, methodology, and research context. Since the study used a qualitative approach, the results are exposed to subjective biases of the researcher and the informants. These are difficult to eliminate. Furthermore, there are now standard methods for analysing qualitative results, which questions the reliability and validity of the results.

The research was also completed in limited project time, which limited the number of interviews could be conducted and some previously conducted interviews needed to be used. These interviews were always conducted with a broader focus on plastic value chain overall. This limited the results, but since the goal was not generalisation the interview amount and scopes are suitable for the research goal. Furthermore, the selection of the companies for the interviews also has an influence on the generalisation of the findings. All of the interviews were conducted with European companies. Thus, the views on the barriers and enablers differ a lot depending on their own operating context. There are large differences in countries plastic waste management streams, regulation and thus on the reuse and recycling opportunities and challenges.

6.3 Future research

There are multiple areas that require future research. First, the business model categorization needs to be validated with more research. This was the first categorization done for plastics reuse and recycling, and also for circular business models. For the results to be validated there is need for qualitative analysis of larger scale, to get more insight to different business models and thus develop the categorization further or validate it as it is. Moreover, a quantitative analysis is needed for to generalise the results to larger scale.

Secondly, regarding the barriers, enablers and change needs, there is need for research in different context and areas. This research had interviews in Europe, and it has its own specific regulations, barriers and enablers. Even in EU level, there are differences in local legislation, what kind of solutions there are, and how far their circular solutions are developed. For example, in the Nordic countries a bottle deposit system is the norm, but it is not in South-European countries. Thus, research focusing in different geographical areas on the barriers, enablers and change needs will tell about the differences of the areas and different challenges.

Thirdly, one topic that rose in the interviews somewhat was the recyclability of bioplastics. There is lot of talk how they will remove the use of oil and gas in plastic manufacturing. However, it was sometimes mentioned that their recyclability could become an issue. If the recycling is not figured out in the development phase

and/or if it requires own technical solutions, it will even further complicate the recycling flows. Thus, there is need to research the recyclability of the bioplastics and how it is taken into account in their development.

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Appendix A

Found business models

Company	Category	Short descriptions
Backmarket	Used product platform	Ecommerce platform for used electronics. Platform is open for companies who get their hands on old electronics and refurbish them for reselling.
Emmy	Used product platform	Ecommerce platform for used clothes. Consumers drop clothes to drop of point or through post to Emmy and are sold online.
Pa-Ri Materia	Used product platform	Extends the service life of office furniture: the company receives, refurbishes and sells large volumes of used office furniture
Swappie	Used product platform	Ecommerce for used iPhones. Own operation of refurbishing the phones.
Taitonetti	Used product platform	Ecommorce for used high-quality leased computers. Own testing operation.
Varusteleka	Used product platform	Buying used products from customers (which Varusteleka have sold to customer) if they are intact and reselling them on their site. The customer gets credit to purchase products from their site.
Zadaa	Used product platform	Marketplace app that allows you to buy and sell second-hand clothes.
DeliveryZero	Reuse	Food delivery company that has reusable packaging used with their partner restaurants

Company	Category	Short descriptions
Keepa	Reuse	A supply and wash service for food retailers, replacing single-use takeaway containers with a reusable and recyclable alternative.
Pantix	Reuse	Food takeaway container for lunch restaurants. Customer pays a deposit for the box that can be switched to a new one when you buy food again or returned the box for the deposit.
Bureo	Collection before nature	Collecting discarded fishing nets with dedicated collection points in fishing harbours.
Pantapå	Collection before nature	Deposit application to get monetary return when you recycle plastic packages.
Litterati	Collection from nature	App to encourage people, companies and public players to collect litter and dispose of it correctly and challenge others.
Ichthion	Collection from nature	Three products to remove plastics in rivers and coastal area.
The Great Bubbel Barrier	Collection from nature	Barrier to stop plastic from flowing past it in rivers, canals and costal area.
AMP Robotics	Sorting	Robots and AI software to sort waste.
Greyparrot	Sorting	AI-based waste recognition software to power sorting robots.
Impact Recycling	Sorting	Technology that separates mixed rigid plastics.
No Waste Technology	Sorting	Technology to separate laminated materials.
Saperatec	Sorting	Technology that can separate composite materials.
Umincorp	Sorting	Process to convert mixed plastics into a 99% pure recycled plastics with their separation technology.
Zenrobotics	Sorting	Waste-sorting robots, which separate different materials for reuse from waste.

Company	Category	Short descriptions
Arqlite	Mechanical recycling	Recycling unrecyclable plastics into plastic gravel that can replace totally or partially mineral gravel or crushed rock for example in concrete.
Byfusion	Mechanical recycling	Mechanical recycling and a steam-based process to convert unrecyclable plastics into By-Bloks which is a building material.
Clean Plastic Finland	Mechanical recycling	Mechanical recycling to plastic pellets.
Continuus Materials	Mechanical recycling	Recycling plastics and paper waste into a building material which is currently used as roof cover board.
ECO Plastic Solutions	Mechanical recycling	Make products out of hard to recycled plastics to construction industry, such as decking, kerbing, fencing and in marine construction.
Fortum	Mechanical recycling	Mechanical recycling to plastic pellets.
Gomi	Mechanical recycling	Make products out of hard to recycled plastics to consumers, such as Bluetooth speakers.
Macrebur	Mechanical recycling	Recycling plastics to pellets that is then used in asphalt manufacturing to partly replace bitumen.
Neoplastics	Mechanical recycling	Mixed plastic into aggregate that can be used in concrete and asphalt manufacturing.
Neular	Mechanical recycling	Recycling hard to recycle plastic into products such as decking boards.
Newtecpoly	Mechanical recycling	Make products out of hard to recycled plastics to construction industry.
Plstct	Mechanical recycling	Turning waste plastics to plastic sheets that can be used in different products.
Replastic	Mechanical recycling	Make products out of hard to recycled plastics to consumers, such as phone covers, or into new raw materials, like 3D printer filament.
The Good Plastics Company	Mechanical recycling	Mechanically recycling plastic to plastic panels that can be used to furniture and as construction material.

Company	Category	Short descriptions
Agilyx	Chemical recycling	Chemical recycling technology.
APK AG	Chemical recycling	Chemical recycling technology.
BioCellection	Chemical recycling	Chemical recycling technology and making their own plastic with it.
Carbios	Chemical recycling	Chemical recycling technology.
Fuenix	Chemical recycling	Chemical recycling technology.
Gr3n	Chemical recycling	Chemical recycling technology.
IBM Research	Chemical recycling	Chemical recycling technology.
Ioniqa	Chemical recycling	Chemical recycling technology.
Lehigh Technologies	Chemical recycling	Chemical recycling technology.
Leitner Technologies	Chemical recycling	Chemical recycling technology.
Licella	Chemical recycling	Chemical recycling technology.
Lowsulph	Chemical recycling	Chemical recycling technology.
Obbotech	Chemical recycling	Chemical recycling technology.
Plastic Energy	Chemical recycling	Chemical recycling technology.
Plasticback	Chemical recycling	Chemical recycling technology.
Pyrowave	Chemical recycling	Chemical recycling technology.
Recover Brands	Chemical recycling	Chemical recycling technology.
Recycling technologies	Chemical recycling	Chemical recycling technology.
Resynergi	Chemical recycling	Chemical recycling technology.

Company	Category	Short descriptions
Worn Again	Chemical recycling	Chemical recycling technology.
Morssinkhof Rymoplast	Intermediary	Intermediary with recycled plastics in its offering.
Oceanworks	Intermediary	Global marketplace for recycled ocean plastics.
Scrapo	Intermediary	Plastic recycling marketplace. Place to directly trade with suppliers and buyers.
End of Table		

Appendix B

Interview structure

1. Introduction
   (a) Asking for permission to record the interview and clarifying the confidentiality of the interview.
   (b) Introduction of the interviewers, research project and the master's thesis context.
   (c) Introduction of the interviewees and company in brief
2. Business model
   (a) How your organization operates?
      i. What kind of activities and functions does your operation consists of from start to finish?
   (b) How are the different activities and functions organised (in-house vs with partners)
      i. What are the most important for the success of your business?
      ii. Key suppliers, customers, other partnerships?
   (c) Who are your customers and what is your offer to them?
      i. Customer segment & value proposition
      ii. Interaction with customers
   (d) What is the revenue model like?
      i. Cost structure?
3. Plastic recycling challenges, opportunities
   (a) How would you describe the current state of plastics recycling at the moment?

   i. How has it changed (in EU) in the last 10 years?

(b) What kind of challenges have you faced for your business model in plastic recycling?

   i. Regulatory, technological, business/market-related? Other?

(c) What kind of drivers and enablers have you faced for your business model in plastic recycling?

   i. Regulatory, technological, business/market-related? Other?

(d) What about the plastic recycling overall: What kind of additional challenges and/or drivers do you see for increasing the recycling of plastics?

4. Plastic recycling challenges, opportunities

(a) What kind of changes do you anticipate / find necessary in the plastics value chain to increase the use of recycled plastics?

   i. Changes related to firms' business models, strategies?
   ii. New or improved technology?
   iii. Changes to the structure of the value chain (e.g., new roles, relationships)?
   iv. Customers' decisions, behaviour?

(b) On the flipside: Which factors do you see as the strongest in opposing the transition to recycled plastics?

   i. E.g., existing practices & competences, lack of incentives & regulation, inappropriate business models...

(c) Which actor(s) should be the one(s) driving the development of new models for plastics circulation?

   i. Who stands to benefit most? Who has the most to lose?

5. Ending questions

(a) Is there still something important that we have not discussed you want to mention?