Steering the Transition towards a Sustainable Plastic Industry:

Exploring the opportunities and barriers of a transition to a circular economy of plastics

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Preface

Before you lies the thesis '*Steering the Transition towards a Sustainable Plastic Industry*' which marks the completion of my Master Environment and Society Studies at Radboud University. In the past years as a student, my passion and interest for sustainability and the environment grew exponentially which let me to this master and the complex world of plastics. The research and writing process was executed predominantly during the global pandemic of 2020.

I would therefore like to give sincere thanks to my internship organization, Renewi, and my internship supervisors Kim Meulenbroeks and Sophie Heyns for remaining enthusiastic and continuing to support and guide me from a distance. Their feedback and assistance helped me to pursue my research through this exceptional period.

My appreciation also goes out to my supervisor Mark Wiering for his support and valuable recommendations during the entire research process. His perception and remarks have stimulated me to take a critical look at my own work throughout the whole process.

Additionally, I would like to thank all of the experts and organizations that participated for their willingness and openness during the interviews.

Finally, a special thanks goes out to my family. This period has been extra turbulent for us, and despite everything they have supported, encourage, and motivated me throughout the ups and downs that occurred in these months.

Enjoy reading!

Eva Fens,

Tilburg, July 2020

Summary

Virgin, fossil-based plastics are becoming a thing of the past. The establishment of the Paris Agreement in 2016, in which is stated that the global temperature increase should be kept to a maximum of 1,5°C, kick-started a chain reaction throughout Europe, with the creations of several plastic pacts, the European Green Deal and eventually the Circular Economy Action Plan. All of these elements arise from the fact that 90% of greenhouse gas emissions are generated from resource extraction and processing, a large part of that being fossil-fuel. Therefore, the linear model of consumption can no longer be sustained. The plastic industry is at the beginning phases of a transition towards a circular economy of plastics, where the input from raw materials no longer comes from the ground, but from recycled products.

This research focusses on the opportunities and barriers that the industry faces in the process of transitioning. It takes a multilevel perspective to observe the effects of the exogenous environment and niche-innovations on the deep structure of the plastic sector, to determine what the likely transition pathway is, and how the transition can best be governed. The central research question therefore is:

What are the main opportunities and barriers of a transition towards a circular economy with regards to the use of plastics, and how can this transition best be governed?

The study takes on two case studies: the fast-moving consumer goods regime, and the slow-moving consumer goods regime. Data has been gathered by desk research, 6 expert interviews, and 13 semi-structured interviews with various types of organizations in a plastic chain.

The data shows that the fast-moving consumer goods regime is at the start of the transition. There are promising innovations and technologies that when stimulated will allow the transition to be possible. It is vital that these innovations get the space and resources needed to scale-up before this regime can transition successfully. For the slow-moving consumer goods, recycled material has been used for much longer. Therefore, the producing parties in the regime are more prepared for circularity. The technology necessary to transition is integrating itself into the regime, mostly via the form of mechanical recycling. The largest barrier that is recognized is the price and quality differences between virgin and secondary plastics. The secondary plastics market needs to grow, but there is a need for a push from law and legislation

that forces the use or recycled content, which in turn will improve technologies and the quality of the materials.

The aspect that has proven to be the most complicated in the transition is the plastic material that comes in contact with food. Understandably, the standards for this material have been set extremely high in order to regulate the health and safety of people. However, this comes with the barrier that it largely prevents the use of recycled material at all, as it is very difficult to determine origin and previous content of plastic. It appears that the best options for this issue lie either with the still underdeveloped and expensive chemical recycling, or with the use of alternative materials.

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Table of abbreviations

CE	Circular Economy
MLP	Multi-Level Perspective
SSCM	Sustainable Supply Chain Management
CLSCM	Closed-Loop Supply Chain Management
RL	Reverse Logistics
OEM	Original Equipment Manufacturer
CPG	Consumer Packaged Goods
FMCG	Fast-Moving Consumer Goods
SMCG	Slow-Moving Consumer Goods
ABS	Acrylonitril-Butadieen-Styreen
PET	Polyethylene Terephthalate
HDPE	High-Density Polyethylene
LDPE	Low-Density Polyethylene
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl Chloride

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1. Introduction

1.1 The New Economy

As more and more businesses, states, and societal actors are realizing that resources are limited, as well as that resource extraction is one of the biggest causes of greenhouse gas emissions and biodiversity loss (EC, 2020), the realization is made that our current take-make-waste economy, (also known as a linear economy) cannot be pursued this way for much longer (EMF, 2016; KPMG, 2018; Perey et al., 2018). A new type of economy is necessary, one where waste will no longer be viewed as a burden, where resources are valued and utilized to their maximum potential, and where extraction of materials is limited as much as possible (EMF, 2016; Perey et al., 2018). To prevent waste and to utilize resources fully, the new type of economy must include the closing of raw material and product loops, which is in line with the Circular Economy (CE) (Jonker et al., 2018). The definition of a CE according to the Ellen MacArthur Foundation is: “[An economy that] is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems” (2015). This is exactly the route that many countries, including the Netherlands, are aiming to take (IenW, 2016; EC; 2020). Slowly, law and legislation in Europe is changing to the circular economic model that is supposed to be completed in 2050.

On a global level, the report from Circle Economy (2020) shows that the economy is only 8,6% circular, compared to a 9,1% two years ago. In a report by MVO Nederland (2020), it is argued that an average of 12,1% of the Dutch companies is currently circular. They also argue that before 2025, the average will need to be at 20% in order to reach the goal of complete circularity by 2050 (MVO Nederland, 2020). They hypothesize that after the goal in 2025 is reached, the economy will become more sustainable in an increasing rate. All in all, though, a lot will need to change to close this circularity gap before it will be too late.

1.2 Problem Statement

A large part of the problem is fossil-based plastics. Plastic in itself is an incredibly versatile, lightweight material that is easy to work with. In 1907, Leo Baekeland invented the first fully synthetic plastic, of which no molecule could be found in nature (PlasticsEurope, n.d.). World War II initiated an exponential growth of the plastic industry and played a large role in military success of the United States. However, after the war, the plastic production kept increasing and there was a shift in consumer behaviour: plastics gave the people the opportunity to create a living with a rich material wealth, something that had not been possible in the previous years due to the Great Depression and World War II (SHI, n.d.). This consumer behaviour and the easy disposability of plastics is what (partially) created the linear, take-make-waste model (EMF, 2016).

As the first plastic debris was noticed in the oceans in the 1960s, mankind started to become more aware of the environmental and health problems of the material (SHI, n.d.). The production of plastics, however, continues to increase exponentially: in 1952, 2.3 million tons were manufactured. This number grew to 448 million tons by 2015. If nothing changes from our current linear economic system, this amount is expected to double by 2050. Besides the large amounts of plastics in the environment, this plastic is also based on fossil oil, creating increasing extraction rates to keep up with the demand. As mentioned earlier, extraction and processing of resources is the cause of "half of total greenhouse gas emissions and more than 90% of biodiversity loss and water stress" (EC, 2020, p. 1).

Still, plastics are not entirely awful. Due to the diverse characteristics of the various types of plastic, it can be used to battle food waste, provide effective insulation, create lifesaving developments in modern medicine, and in general, raise the standard of living (SHI, n.d.; PlasticsEurope, n.d.). A great example that depicts the duality of plastics is the COVID-19 pandemic of 2020. On the one hand, plastic has played a major role in protecting key workers and individuals by means of masks, gowns and gloves (Hughes, 2020). Its versatility and affordability have also permitted the quick production of ventilators and other medical equipment. On the other hand, the increase of single use plastic for protection has already led to the escalation of plastic pollution in the environment (The Economist, 2020).

It is therefore essential that the extraction of materials is avoided as much as possible, but that simultaneously a method is found to keep the already existing plastics on the market. This way, sustainability will increase, whilst the benefits of plastic can continue to remain beneficial to living standards of humanity. So, how can parties that are already directly involved in the plastic supply chain and industry change their ways of doing, in order to increase the levels of recycled plastic in products?

1.3 Scientific and Societal Relevance

Scientific

Limited research has so far been conducted regarding the circulation of secondary plastics and the creation of a circular plastic economy from the perspective of stakeholders directly involved in the industry. The recent report from MVO Nederland on the "Second lives of plastic packaging: lessons from practice" published in November of 2019 provides a great example of the bottlenecks and positives that can be experienced when constructing a new secondary plastics chain. However, the information gathered here is solely on implementation of secondary plastics in packaging and therefore neglects the rest of the plastic industry. This thesis adds to not only the plastic packaging regime, but also discusses the situation regarding slow goods. Next to this, with regard to the circular economy and the transition from a linear economy, many reports have been published (KPMG, 2018; RVO, 2020; CBS, 2020; Circle Economy, 2020) and several agreements have been signed (Dutch Raw materials agreement, 2020; Dutch Plastic Pact, 2018; European Plastic Pact, 2020). This shows that change is inevitable, but what it does not show is how individual organizations approach and address this change. The research done in this thesis contributes to a more detailed understanding of how various types of organizations frame the transition towards circularity, and what they observe to be necessary factors to completing or accelerating the transition.

This research will provide a broader understanding of the opportunities that organizations experience to transition towards a circular plastic economy, but also what aspects are holding back this transition on a value chain level. The differentiation made between different plastic regimes shows the complexity of the entire industry and provides a perspective on the varying bottlenecks and gaps between these regimes. The knowledge gathered from this research will also present insight on how parties directly involved in the plastic supply chain can overcome these barriers and assist each other in making circularity possible, as well as provide recommendations on the direction and implementation of future policies.

Societal

The societal relevance of this subject can be found in the creation of a sustainable relation with the environment to ensure that humankind can continue to exist and flourish on this planet. The increase of plastic recycling and the move away from the 'take-make-waste' economy can bring down the extraction of resources such as fossil fuel greatly, and in turn also decrease CO2 emissions. This decrease is a necessary factor when it comes to limiting climate change and the increasing average temperatures we face today. This research can contribute to the successfulness of the transition towards circular plastics, therefore increasing the change that the rise of temperature can be kept to a minimum and the effects of climate change reduced.

For society to obtain a better understanding of why the transitioning to secondary plastics is necessary, and that the quality and safety do not automatically decrease compared to virgin products, will further help stimulate the transition pathway as consumer behaviour has an influence on the drive for organizations to change or not. This research can contribute to the recognition that an increase of price, and a modification to product design can be related to sustainability and should not be immediately shunned.

1.4 Research Aim and Research Questions

For the plastic industry to follow the transformation to a circular economy in the European Union, a great amount of effort will have to be made. The aim of this research comes in twofold. Firstly, it is to map out the most prominent opportunities and barriers of the transition towards a circular plastic economy. This will contribute to a better overview of what problems need to be tackled to continue the development of circularity. Secondly, by observing the problems at the supply chain level, the aim is additionally to provide recommendations on how to overcome these problems and how to manage the transition towards a circular plastic economy. It can therefore help not only parties directly involved in the plastic industry, but also governmental actors in their approach to guiding the transition.

Consequently, the main research question is formulated as follows:

> **What are the main opportunities and barriers of a transition towards a circular economy with regards to the use of plastics, and how can this transition best be governed?**

The barriers and opportunities will primarily be based on the categories as found in the multilevel perspective on sociotechnical transitions (Geels & Schot, 2007; Meadowcroft, 2011). The second half of the question will largely be based on the principles of transition management as theorized by Rotmans & Loorbach (2009) and the observations and knowledge gathered from the interviews. To answer the main question, a division is made between five sub-questions. The following five sub-questions are used to navigate this research into answering the main research question.

1. *What does a general linear plastic chain look like, and according to parties in the chain, what would the ideal circular chain look like?*
   This question is of importance as the division of roles and responsibility can vary widely per organization or part of the chain. It will also show what changes will have to take place in order to reach the circular value chain.
2. *What are the opportunities that promote the creation of a circular plastic chain?*
   Sub-question two allows for an in-depth analysis of the opportunities that endorse circularity, following the categories that will be discussed in chapter 2.
3. *What are the main barriers that hinder the creation of a circular plastic chain?*
   Sub-question three also allows for an in-depth analysis of the barriers that hinder circularity, following the categories that will be discussed in chapter 3.
4. *According to the multilevel perspective, what pathway is currently being followed?*
   This question will provide information on how the transition can best be managed, as different pathways have different success rates and outcomes.
5. *How can the transition best be governed?*
   This question looks at how the barriers can best be overcome, and the transition managed based on the transition management theory and system instruments.

1.5 Thesis Outline

In the following chapter, the theoretical framework will start of by discussing theories that are relevant to sustainable transitions. Here, the focus will lie on the multilevel perspective on sociotechnical transitions, transition management, and the circular economy and sustainable supply chain management. In chapter 3, the plastic sector will be explained. Here, the policy field, plastic production and plastic recycling are introduced. In chapter 4, the research methods and methodology of this thesis will be elaborated on. In chapter 5, the results and findings that were gathered during empirical research will be presented. In the final chapter, a discussion and conclusion will be drawn based on the findings, and suggestions for governmental actors will be presented. Additionally, this chapter will also include reflections on the research project, limitations of this research, and a recommendation for further research. After chapter 6, there will be a reference list and the appendices.

2. Theory

2.1 Theoretical Framework

2.1.1 Structuration Theory

Structuration theory is a social theory that combines both structure and agency, without preference to either (Giddens, 1984). According to the theory of structuration, the base of social science is "social practices ordered across space and time" (Giddens, 1984, p. 2), and not the experience of an individual, nor society as a whole. Social practices are continuously created and recreated by the actions of the agents. A large part of the knowledgeability of agents is reflexivity, which is the ability to constantly monitor activities that are displayed by agents and expected be displayed in others. This implies that society is reproduced consciously through every social (inter)action. An individual agent and the actions they take therefore produce and reproduce the structure. However, the structure also determines the activities of the individual, creating a duality of structure where "structure enters simultaneously into the constitution of the agent and social practices, and 'exists' in the generating moments of this institution" (Giddens, 1979, p. 5).

2.1.2 Multi-Level Perspective on Sociotechnical Transitions

The multi-level perspective (MLP) on sociotechnical transitions is "a quasi-evolutionary theory that is much concerned with the role of time in innovation processes inspired by historical studies of technological change" (Raven, Schot, & Berkhout, 2012, p. 65). It is also a framework designed to comprehend the fundamental transitions in systems that are needed to address sustainability (Geels, 2019). These systems are social systems such as agriculture or energy systems that supply end-of-use service and/or societal roles.

The MLP explains transitions and system changes via three levels of analytical concepts (Rip & Kemp, 1998; Geels & Schot, 2007), namely: sociotechnical landscape, sociotechnical regimes and niche-innovations. The MLP is not only a theory of evolution, it can also be argued that it follows the discourse of structuration theory to a degree, as it builds upon the idea that actors that are part of a social group share deep structures made up of culture, beliefs and symbols, as well as that it combines macro-cultural changes on a landscape level (Geels, 2010). However, it extends the theory to address the cultural interactions that occur between different levels. For example, actors within the regime have to be open to discussions with actors in niche-innovations on a deep cultural level and provide legitimacy for their actions and technologies. Outside actors can also frame the industry in a way that could delegitimize it, or frame the niche-innovations in a particular light to increase the legitimacy (Freeman et al., 1983; Oliver, 1992)

The first analytical concept: the sociotechnical landscape, is the external environment that has an indirect influence on the regime and niches. The external environment usually evolves at a slow pace and can include deep cultural patterns, political developments or social processes that can be interrupted by major world events, like natural disasters or wars (Geels & Schot, 2007; Raven, Schot, & Berkhout, 2012). The landscape also forms the macro-level.

Second, a sociotechnical regime can be understood as a social group that shares cognitive routines, beliefs, capabilities and competences, legally binding contracts and favourable institutional arrangements and regulations (Geels, 2011). Engineers, scientist, policy makers, users and special-interest groups all have an influence on creating patterns of technological development (Geels & Schot, 2007). These regimes make up the meso-level. In an already existing regime, innovation is mostly in line with already existing technologies, beliefs and capabilities (Geels, 2019). Path-dependency is common in a regime and numerous lock-in mechanisms can occur. Three categories can be distinguished:

The first category are techno-economic mechanisms, specifically (a) sunk investments that hold back transitional change, and (b) the high-performance, low-cost features of dominating technologies (Geels & Schot, 2007; Geels 2019). The second category is social and cognitive, including (a) routines and shared beliefs that lead to blindness of actors to situations outside their regime, (b) the alignment of social groups, resulting in social capital, and (c) life styles of users that are organized around specific technologies (Geels, 2019). The last category is institutional and political mechanisms, where (a) an uneven market can be created due to favouritism for incumbent parties by politicians, existing regulations and standards, and (b) regulatory change and radical innovation are hindered by vested interests (Geels, 2019).

The final analytical concept is niches-innovations, which make up the micro-level. In these niches, radical innovations emerge, which are developed by dedicated actors, such as start-ups or entrepreneurs, in small networks (Geels & Schot, 2007). The level of radicality is dependent on the differences from the existing regime and its dimension (Geels, 2019). Some examples of types of niche-innovations are: radical technical innovation, grassroot and social innovation, business model innovation and infra-structural innovation (Geels, 2019).

The three levels are integrated in the MLP in a manner that they connect and structure each other in distinct ways. A transition occurs through a unique pattern of temporal actions between the three levels of niches, regimes and landscapes. Exogenous pressures can create windows of opportunity and tension within a regime, and when this occurs developed niche-innovations can break through (Köhler et al., 2019). Following the structuration theory of Giddens (1984), duality of structure can be found in sociotechnical regimes, as the regimes are the outcome of the action as well as the medium (Raven, Schot, & Berkhout, 2012). Geels (2011) explains this duality as "On the one hand, actors enact, instantiate and draw upon rules in concreate actions in local practices; on the other hand, rules configure actors" (p. 27).

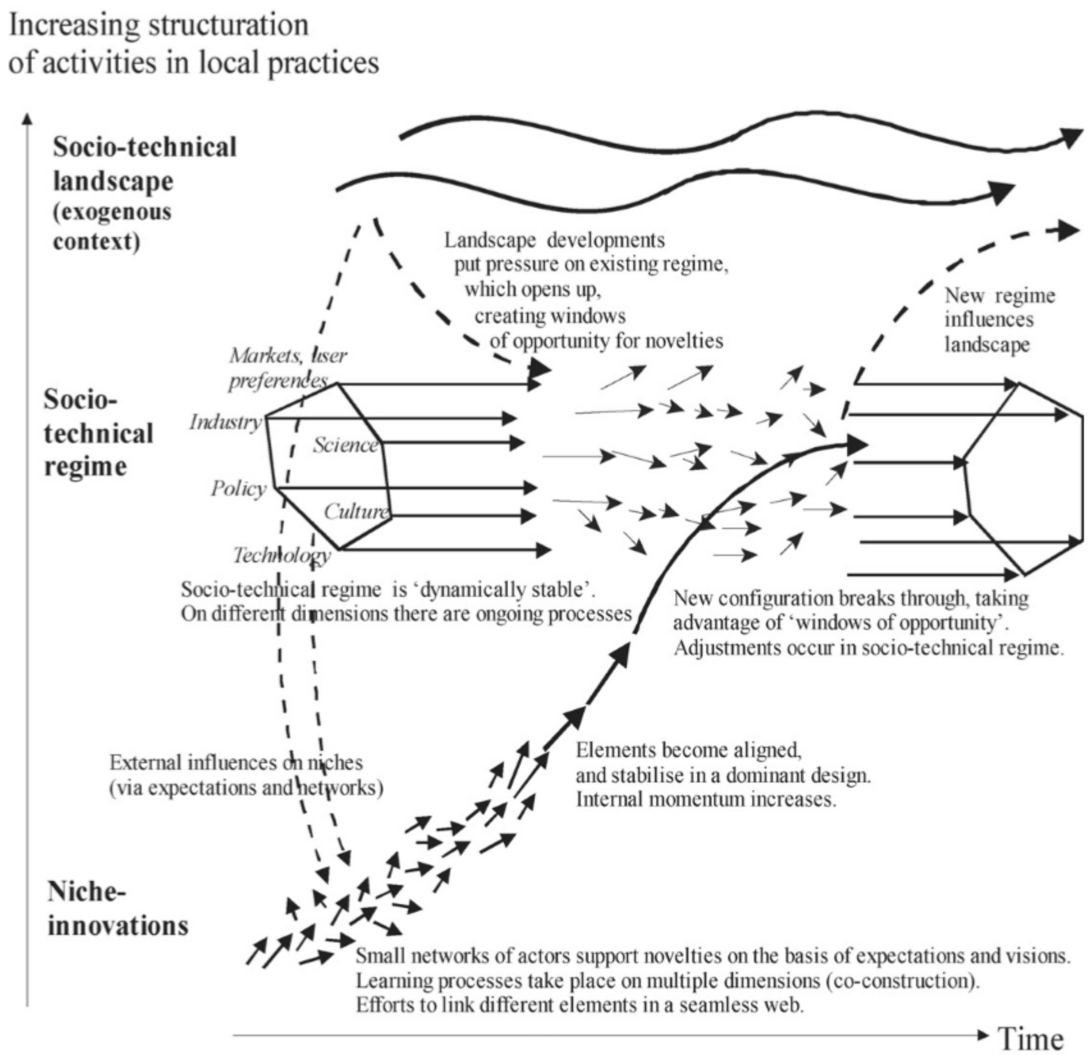

Figure 1. Multi-level perspective on sociotechnical transitions (Geels & Schot, 2007, p. 401).

Additionally, the second generation of MLP considers space to have an impact on the transition processes (Raven, Schot & Berkhout, 2012). An absolute spatial scale explains a transition or an innovation by factors such as territorially bounded institutions, resources and labour forces and how and why it may only occur in a particular area and not others. The other, relative spatial scale is socially constructed by networks and can extend territories. Raven et al., (2012) expand that with relative spatial scales:

> "*[..] actors are theorized as being connected and standing in relation with each other, creating and reconfiguring networks and power within these networks, causing knowledge, resources, technologies and innovations to flow. […] As such, transitions do not simply occur within a certain territorially bounded space, but emerge out of tensions created in multi-scalar interactions between spatially distributed actors embedded in multi-level structures with different temporal dynamics*" (p. 70).

Two added factors that are overlooked and under-theorized in the first MLP generation, but that do have a significant effect on transitions, are politics and power (Meadowcroft, 2011; Raven et al., 2012). With politics, the main concept is that policymakers and incumbent business actors often form 'a core alliance at regime level', as to maintain the status quo of the regime (Geels, 2014). This kind of alliances can be found regarding the fossil fuel industry, for example with 'minerals-energy complex' which concerns the capital accumulation by fossil fuel organizations that are supported by policymakers (Fine & Rustomjee, 1996, as found in Geels, 2014). It is speculated that such alliances are formed due to mutual dependencies, as industries are dependent on government actors for establishing certain rights and governance structures that provide forms of corporate behaviour (Fligstein, 1996; as found in Geels, 2014). Simultaneously, governments have a central role to pursue the general interest of capital, and large organizations have a form of structural power in steering actions of the state, since they provide large amounts of jobs and economic growth (Geels, 2014). It is important to include these core alliances between policymakers and incumbent businesses because it can present resistance to a fundamental change.

Transition pathways

Not all transitions are similar, they can occur in many different ways, with interactions on multiple levels. Geels & Schot (2007) have defined several different types of pathways based on two criteria: (1) The timing of the interactions, and (2) the nature of the interactions.

The timing of the interaction relates to the timing the landscape pressures on the regime, but with reference to the development of the niche-innovations. Niche-innovations can either be fully or not fully developed when the landscape pressures hit the regime, which in turn determines the transition pathway. As the definition of a fully developed niche-innovation can be considered subjective, Geels & Schot (2007) have identified 4 factors as signals of stabilization and ability to break through:

> "*(a) learning processes have stabilised in a dominant design, (b) powerful actors have joined the support network, (c) price/performance improvements have improved and there are strong expectations of further improvement (e.g. learning curves) and (d) the innovation is used in market niches, which cumulatively amount to more than 5% market share*" (p. 405).

The nature of the interactions refers to the relationship between the regime and niche-innovations and landscape developments. The landscape developments can either clash (disrupt) with the regime, which can create pressure on the regime that could lead to change, or landscape developments can reinforce the regime. A reinforcing relationship can stabilize the regime further and does not drive change. Additionally, a niche-innovation can have either a competitive or a symbiotic relationship with existing regimes. With a competitive relationship, niches compete with regimes, with the aim to replace them. A symbiotic relationship enhances the existing regime, often solving problems and enhancing performances (Geels & Schot, 2007). Based on these criteria, the following pathways can be distinguished (Geels & Schot, 2007):

a) *Reproduction process*. There is a complete lack of external pressures. This means that even if there are radical innovations present, the reinforcing developments from the landscape will continue to stabilize the sociotechnical regime. The regime will extend its reproduction.
b) *Transformation path*. With this there is moderate, disruptive change coming from the landscape, but at a period in time where the developments in the niche-innovation field are not yet sufficient. With this path, the outsiders are an important factor, because they tend to evoke awareness to the negativity that actors in the regime tend to ignore. This can be done by social movements, outside scientist or outsider firms that develop new or alternative technologies. This way, niche actors can become the frontrunners that slowly change the regime rules. The process is usually not smooth but can involve power struggles and conflicts. All in all, "new regimes grow out of old regimes through cumulative adjustments and reorientations" (Geels & Schot, 2007, p. 407).

c) *De-alignment and re-alignment path*. There is a large, avalanche like change in the landscape that quickly create problems in the regime, eventually causing the regime to collapse and de-align. Parties involved then lose confidence in the regime and uncertainty arises surrounding innovation efforts. If there is then a lack of developed niche-innovations, multiple niche-innovations are brought to light by outsiders, and there is a prolonged span of time where niches co-exist, experiment and compete for resources. Finally, there will be one niche-innovation that grows to be dominant, allowing for the re-alignment of a new regime.
d) *Technological substitution*. This occurs when there is a great amount of landscape pressure at a point in time that a sufficiently developed, radical niche-innovation exists. The technology that the niche-innovation has then will replace the original technology of the regime, and with this the old regime.
e) *Reconfiguration pathway*. Radical innovations that are symbiotic to the regime have been developed in the niches. These innovations are embraced by the regime to solve existing problems. If the newly accepted innovations then create combinations of the new and old elements, this can create space for the continuation of the adoption of new innovations, and with the repercussions of landscape pressures can lead to drastic regime changes. This pathway is in particular relevant for systems that exist through numerous technologies, such as agriculture, retailing and hospitals, as transitions here are not created by the advancement of one innovation, but by various component-innovations.
f) *Sequence of transition pathways*. This occurs when the landscape shows a disruptive change, as the disruptive change is slow and does not immediately create the need for regime actors to change drastically. The actors change the direction of their trajectories and activities, but as the pressure from the landscape increases, problems will continue to grow. This can set off the adaptation of symbiotic innovations in the regime, which could leave the regime intact, following pathway b. Does the regime not stay intact, then pathway e is followed. If this then solves the problems, the actors will survive. But, if landscape pressure continues to grow, the regime will continue to face a growing amount of problems. Here, a developed niche-innovation could break through and cause pathway d. Finally, if there is no developed, dominant niche-innovation, pathway c will occur.

2.1.3 Transition Management

A successful transition to sustainability cannot be based solely on the influences of the landscape and niche-innovations, as the landscape and niche-innovations can prove to be unpredictable. For a success/desired transition, a transition should be managed. Transition management is a concept based on a process-oriented ideology and focuses on policy creation in order to deal with uncertainty and complexity (Loorbach & Rotmans, 2006; Köhler et al., 2019). In this thesis, the framework on transition management as defined by Loorbach (2010) will be followed, as it is based on complex systems theory whilst following the definition of a sociotechnical transition as practiced in the MLP (Geels 2007). Complex systems are groups or organizations, made up of numerous parts that interact with each other (Mitchell & Newman, 2001). The systems theory "addresses complex patterns of interaction between different components in complex adaptive systems" (Loorbach, 2010, p. 164). The framework can help understand and analyse both societal and governance complexities. Governance is a complex system that involves multiple actors, without being centralized in one place. Three societal domains that are often recognized are the governmental domain, the business domain and civil society (Steurer, 2013). The three domains all have certain methods of steering that are domain-specific, it is co-regulation between the domains that is necessary. Additionally, the framework can not only be applied at the level of society, it can also be used on subsystem or even project level (Loorbach, 2010).

Principles of governance

Loorbach (2007; 2010) defines certain principles of governance that are based on transitions in complex systems. To begin, it is not enough to solely use process management, since insight into the system or regime is also necessary for effective management. Next, by thinking about long-term goals (>25 years), the short-term policies can be formed. Here, both short- and long-term goals, as well as future developments have to be reflected on. On a system level, the objectives should remain flexible, as the complexity of the system would clash with strictly set objectives. The intervention should be effective and immediate in both positive and negative situations. Both equilibria and disequilibria should be used to steer the system in the wanted direction. A space should be created for niche-innovations and alternative regimes, whilst structures and systems should to be directed from the inside. Also, it is necessary to understand the perspectives of different actors as a precondition for change. Finally, stakeholders should interact and participate for promoting policies and to engage each other into reframing both problems and solutions.

Governance typology

Furthermore, four different types of governance are defined that can be differentiated between when observing the behaviour of actors in relation to a transition (Loorbach & Wijsman, 2013). These types are: strategic, tactical, operational and reflexive, and their relation to each other can be found in Figure 2. Each type of governance also has systemic instruments that can be established in order to influence and guide activities in a desired direction (Loorbach, 2010).

Strategic governance consists of the activities on a systems level that are connected to structuring complex issues and envisioning alternative futures on the long-term horizon. The actions, such as politics, opinion making, and envisioning, mostly deal with the culture of the system (Loorbach, 2010; Loorbach & Wijsman, 2013). To promote strategic governance, a transition arena can be created where a limited group of frontrunners (10-15 actors) from different environments and with different perspectives gather. The objective is to face confrontation and discussion regarding the problem, with the ability to step out of the role as representative of a company and be open to innovation, new ideas, and so on (Loorbach, 2010). It is therefore important that autonomous individual join and that the arena remains open: actors should be able to drop out or join in. Through the interaction of divergent actors, a new perspective is created, and based on this, long-term sustainability visions are formed (Loorbach, 2010).

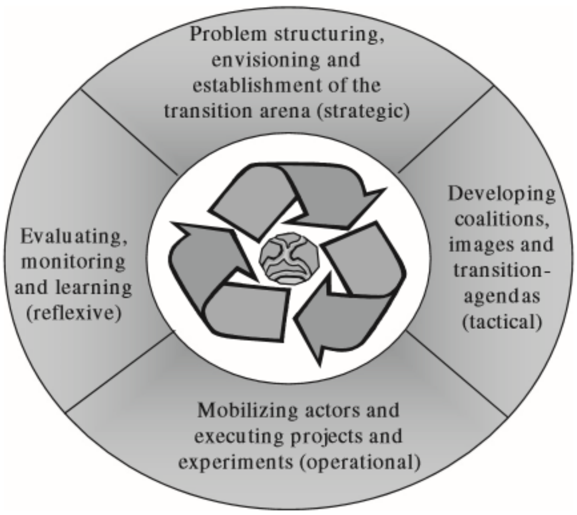

Figure 2. The transition management cycle (Loorbach, 2007).

Tactical activities are identified as activities that deal with the structure of the system, on a (sub)system level. They are used to steer aspects of the regime, such as institutions, regulations and financial and physical infrastructures. The steering aspects are established via collaboration, lobbying, and so on (Loorbach &Wijsman, 2013). The systemic instrument that can be used with tactical governance is the establishment of a transition agenda. This agenda is based on the sustainability visions and ideas of the future as created in the transition arena. The translation of the arena to the agenda on a tactical level is the realisation of structural or regime barriers, such as regulatory or economic conditions, physical infrastructures or consumer routines which can be explored via transition scenarios (Loorbach, 2010). From the transition arena, often coalitions are formed that follow certain transition paths to reach the vision in mind. Here, the interests of different actors also come out into the open and debates will be held regarding investments and individual strategies. From here on, it is also essential that representatives are willing to be involved in the project for a longer period of time, and that they have not only sufficient authority within the organization to move around, but also that they have the capacity to convert the transition vision to the agenda of their own organizations (Loorbach, 2010).

Operational activities concern every day and short-term decisions, and here actors can recreate or restructure systems and actions (Loorbach & Wijsman, 2013). The operational activities are often referred to as innovation, which includes "all societal, technological, institutional, and behavioural practices that introduce or operationalize new structures, culture, routines, or actors" (Loorbach, 2010, p. 170). On an operational level, it is required that space is designed for experiments and actions as to find new innovations but also to broaden or size up existing initiatives. The experimentation is related to the niche-innovation level, as experiments are often of high risk that could prove to be of great importance to the transition (Geels & Schot, 2007; Loorbach, 2010). Besides, the experiments can compete or enhance each other, as well as explore other various opportunities (Loorbach, 2010).

The last type, reflexive governance, includes all activities that relate to evaluation, monitoring and learning of the structure and social problems. This is mostly done via evaluations, assessments, research and debates (Loorbach & Wijsman, 2013). For systemic instruments, a differentiation is made between monitoring the process itself and the monitoring of the management of the transition. Whereas the supervision of the transition process is concerned with physical changes in the system, such as slow macro developments, quick niche developments and the movements of actors in the regime, the supervision of transition management involves separate aspects (Loorbach, 2010). First, the behaviour, activities and responsibilities of actors in the transition arena need to be closely monitored. After, the actions, instruments and goals that were agreed upon in the transition agenda need monitoring, as well as possible new knowledge and insight gathered from transition experiments where it is also important to learn how this information is transferred and how parties are educated. Last, the process of the transition itself needs supervision in regard to the speed of the progress and the barriers that need to be overcome (Loorbach, 2010).

2.1.4 Circular Economy

The economy that is currently dominant globally is one that is linear. In a linear economy, manufacturers extract materials from the earth, a product is made and bought, and at the end-of-life state of the product it is seen as non-valuable waste and is disposed of. This economic system, which has been in use since the first industrial revolution (Bonciu, 2014), is detrimental to nature and the environment. This is due to the fact that our global economy is now so immense, it is exhausting environmental resources. As stated in the report by the Club of Rome in 1972, human actions may deplete the natural environment, and therefore there are boundaries to what we can use. If we continue living as we are doing now, it is expected that by 2050 our consumption levels rise to the extent that we would need three planets instead of one to sustain our needs (UNEP, n.d.).

The slow-changing landscape that is resource depletion is why our economic system needs to change; to continue on a linear path is not sustainable. In the European Union and its member states, as well as in other countries globally, the Circular Economy (CE) is gaining popularity. The CE is about the redesigning of production systems in a way that focuses on value preservation of materials and goods, in a closed loop system (Jonker, Stegeman, & Faber, 2017, see Figure 3). The manner in which organizations have to work to create a CE is different than when following a linear economy. This is due to the fact that a CE requires different skills and a different composition. The CE entails that organizations are no longer the only aspect that needs to be organized; there needs to be a form of co-operation between networks and clusters of organizations (Jonker, Stegeman & Faber, 2017).

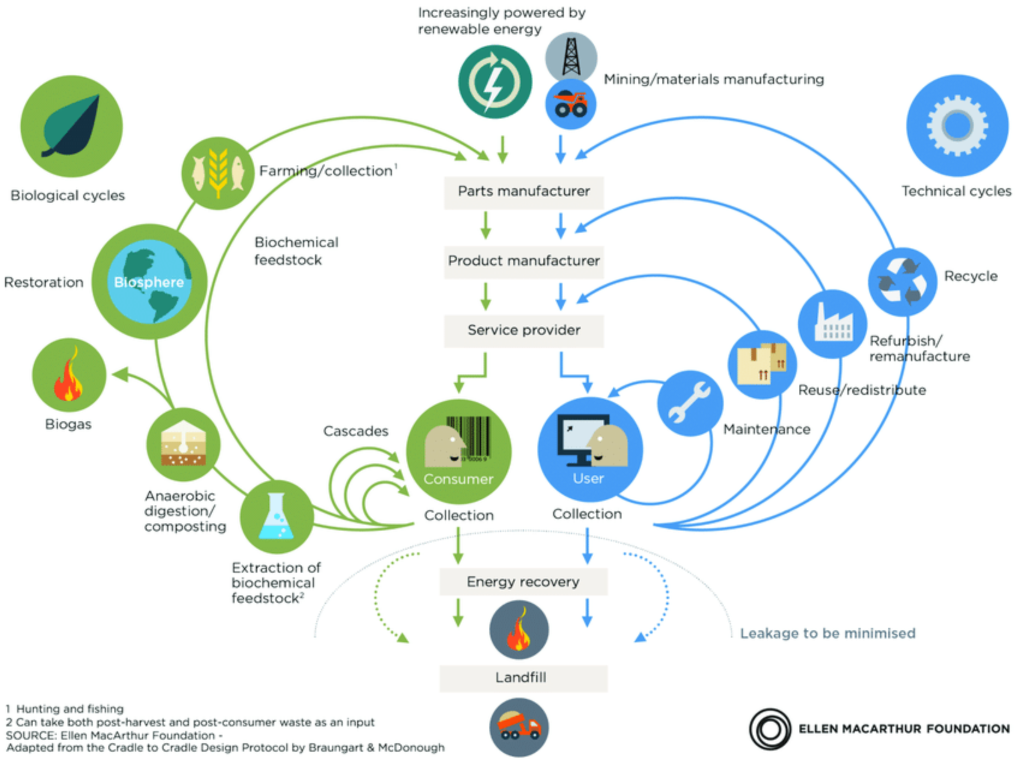

Figure 3. The Circular Economy (Ellen MacArthur Foundation, 2017).

Sustainable Supply Chain Management

As mentioned earlier, to establish a circular economy, loops need to close in order to preserve, recycle and reuse the products and materials. Sustainable Supply Chain Management (SSCM) considers the environmental impact, the value chain and multi-perspectives on the entire product life cycle and can be defined as "[The integration of] the environmental, social and economic aspects that allow an organization to achieve long-term economic viability in supply chain management" (Tseng, Lim & Wong, 2015, p. 437). SSCM can be used as a strategic move towards realizing an organization's sustainable goals as a method to increase competitiveness, increase profitability and enhance customer services (Tseng, Lim & Wong, 2015). The main element of SSCM is the creation of green products throughout the entire lifecycle of a product from origin to sustainable consumption. To successfully reach a sustainable supply chain, it is key that there is cooperation of interconnected networks and channels. This is because partnerships are the factor that can make a supply chain sustainable, as it is vital for all organizations that information, risks and rewards are shared, as well as that decision-making about a product is done in collaboration with multiple parties in a supply chain. Transparency throughout the inter-organizational supply chain creates the possibility of the formation of a closed-loop supply chain, which is a form of a sustainable supply chain.

Closed Loop Supply Chain Management

Closed loop supply chain management (CLSCM) is crucial to the evolvement of the circular economy. This type of supply chain management focuses not only on the traditional forward and linear flow of materials that goes from manufacturer to consumer, but also on the reverse flow of materials. It is designed "to consider the acquisition and return flows of products, reuse, remanufacturing and recycling activities, and the distribution of recovered items" (Difrancesco & Huchzermeier, 2016, pp. 446-447).

The main concept that allows for the creation of a CLSC is the product return from consumers to retailers and manufacturers. Guide and Van Wassenhove (2009) differentiate between three different types of return. First, commercial returns, which can be classified as defective and non-defective. This essentially entails that the product is either broken, or that the customer is not satisfied with the product. This can also imply that the product is practically new and can be resold after a small touch up, refurbishing and repackaging (Guide & Van Wassenhove, 2009). Second, end-of-use returns occur when a customer is finished with the product, but the product is still working properly. This is mostly the case with technological products, for example when there is a technological upgrade (Guide & Van Wassenhove, 2009). Last, there is the end-of-life return where the product is no longer functioning. The optimization of a CLSC therefore requires the creation of a backward supply chain flow that allows for the processing of these returns, which is done with the use of reverse logistics.

Infrastructure

Reverse logistics is defined as:

> "*The process of planning, implementation, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or of proper disposal.*" (Rogers & Tibben-Lembke, 1999, p. 2)

To plan for reverse logistics is more complicated than planning for forward logistics. This is because reverse logistics requires the forecasting for products accessible for collection, transportation and recycling, in order to achieve the highest and most efficient level of performance (Agrawal, Singh, Murtaza, 2015). Agrawal, Singh & Murtaza (2015) have identified four key processes that play a role in the creation of reverse logistics: product acquisition and gate keeping, collection, inspection and sorting, and disposition (shown in figure 2).

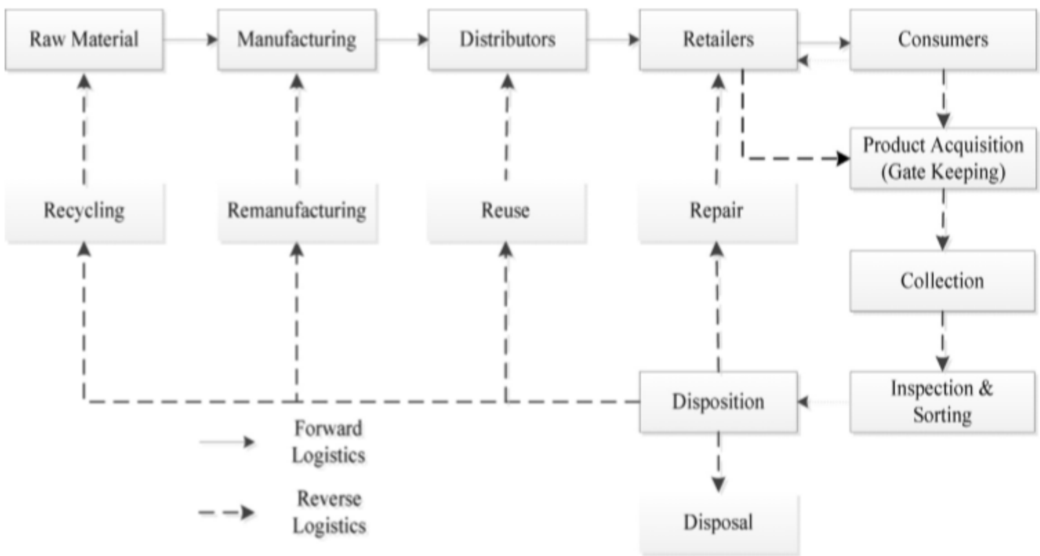

Figure 4. Basic flow of forward and RL processes (Agrawal et al., 2015).

Product acquisition and gate keeping are important for the uncertainty surrounding quantity and quality. It involves the identification of products that are allowed to enter the reverse logistics system and products that need to be given back to the consumer after repair or refurbishment.

The collection of products is the process in which an organization gains ownership of the products/material. What type of collection is used is dependent on the quantity of the collection, the type of product, as well as on the cost structure. It is more likely for a manufacturer to consider third-party collection when it comes to end-of-life products, rather than other forms of return (Kumar & Putnam, 2008). Also, third-party collection can be beneficial with large quantities of returns. For example, a large enterprise with a great and steady amount of returns is more likely to use a third-party for collection than small and medium enterprises with a varying amount of returns (Atasu et al., 2013).

Next is inspection and sorting, which is necessary not only because it is not always clear why a consumer returns a product (Rogers & Tibben-Lembke, 1999), but also because the status of a product can vary greatly. The type of material in a product and the status of a product, can determine whether it is approved to be recycled or incinerated, or whether it has to go to a landfill. This has to do with different aspects; for example, older products are more likely to contain dangerous elements, such as lead, chrome-6 or asbestos (Ministerie van Infrastructuur en Waterstaat, 2019**)**. Based on this evaluation, the products can be sorted in the most effective way for the final step, disposition.

Disposition is the decision about how a product will be processed. The most commonly found decisions are reuse, repair, remanufacturing, recycling and disposal (Agrawal, Singh & Murtaza, 2015). Kumar & Putnam (2008) suggest that the processing of products can also be done via a third-party. This is valuable when there are economies of scale from manufacturers, as well as when a third-party is working with more than one organization or manufacturer, since this can save costs due to the high numbers of collected products, as well as that only the valued parts or components can be returned to the manufacturer which can lower the transportation costs (Kumar & Putnam, 2008). Based on this argument, a third-party collector and processor can then also share elements of a product that the manufacturer does not consider valuable to party another who does consider it of use. This way, the least amount of waste will need to be incinerated or go to landfill, which will make the supply chain more sustainable.

Especially with the use of a third party for the collection, processing, and recycling, it is important to have well organized coordination between the parties involved, as research shows that supply chain collaboration and integration have a positive effect on the performance of a supply chain (Gupta et al., 2019). The choices that the individual parties make are in line with the interests of their own company, and therefore these decisions are often not taken from a holistic point of view about the overall circumstances (Yuan, Yang, Li, & Li, 2020). The coordination of interests of such a closed-loop supply chain is thus key (Krapp, & Krauss, 2017).

Collaboration

Formal and informal governance mechanisms create a sense of focus and motivation to the parties involved and are simultaneously a method that is designed to direct and control the behaviour of parties (Im, Rai & Lambert, 2019). Im, Rai, & Lambert (2019) argue that: “Formal agreement mechanisms include goal congruence, coordination structure, collaborative agreement, and incentive alignment” (p. 661). However, as the decision-making activities in supply chain coordination are argued to serve the overall intention of the system, it can be stated further that goal congruence, collaborative agreement and incentive alignment are also important for the creation of a successful collaboration (Sahin & Robinson, 2002). The informal agreement mechanisms are aspects such as commitment and trust (Im, Rai, & Lambert, 2019).

Next to motivation and trust, a closed-loop supply chain also becomes valuable and well-coordinated via resource-sharing (Im, Rai, & Lambert, 2019). The resources that can be shared can be both tangible and intangible. A form of intangible resource-sharing is knowledge-sharing. The sharing of knowledge allows for learning and discovering, which in turn creates value in long-term supply chain partnerships (Im, Rai, & Lambert, 2019). Additionally, Im, Rai, & Lambert (2019) state that there is ambidexterity regarding knowledge-sharing. On the one hand, there is exploitative knowledge-sharing, which is related to the exchange of knowledge regarding short-term rewards, the inquiry of risk-adverse behaviour, and the survival of the entire system's components. On the other, there is exploratory knowledge-sharing, which concerns the exchange of knowledge regarding long-term rewards, the inquiry of risk-taking behaviours and the durability of the system as a whole. However, Information asymmetry in a multi-organizational supply chain can prove to create difficulties in trust and collaboration. It is important that all parties involved should aim to be as transparent as possible to increase effectiveness and a change of survival for all parties involved.

2.2 Conceptual Framework

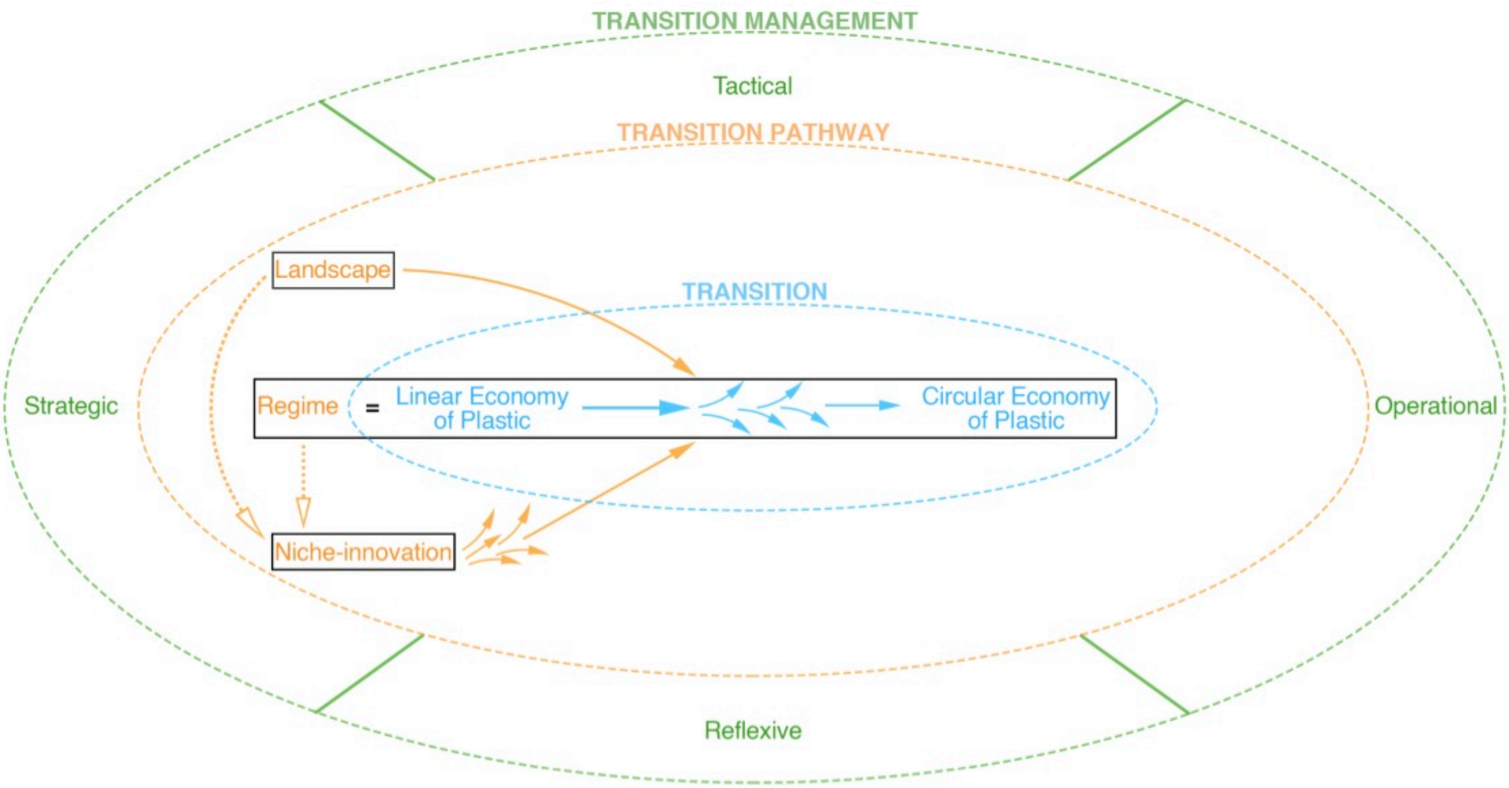

Figure 5. Conceptual Framework

The conceptual framework is composed out of three parts that interact with each other. First, shown in Figure 5 in blue, is the transition from a linear economy of plastics to a circular economy of plastics which is the main focus of this research. To discover how the transition is occurring, and what influences it, the multilevel perspective on sociotechnical transitions is used as a base. Here, the sociotechnical landscape, the sociotechnical regime and niche-innovations are the main variables that are studied. The research will collect data about the three levels and the factors that are parts of these levels, such as market, technology or politics which are part of the regime. By observing how these three levels act and interact, and what factors within these variables are affected most, the transition pathway can be discovered, shown in orange in Figure 5. In the chapter 5, the analysis, the transition pathway will be discussed and explained further with visuals to show what specific pathway is being followed according to each case study. The third layer, shown in green, includes the different aspects of transition management as proposed by Loorbach (2010). Based on which transition pathway is being followed, combined with which specific factors play a prominent role in this transition, the steps and systemic instruments can be defined. There are four steps: strategic, tactical, operational, and reflexive, and these steps can affect the entire transition process. To conclude, the transition from linear to circular economy is analysed by the MLP and the main, most outstanding barriers and drivers are discussed. Then, based on this information, the transition pathways are mapped out. Last, governance activities will be discussed that can help steer or speed up the transition in the desired direction.

3. The Plastic Sector

3.1 Policy Field

The underlying cause for policy development regarding circularity as well as plastics in the Netherlands and Europe, is the Paris Agreement, which is a part of the United Nations Framework Convention on Climate Change as signed in 2016. This legally binding, global agreement states, amongst others, that the average temperature increase needs to remain below 2ºC pre-industrial levels, and that the greenhouse gas emissions are reduced significantly (EC, 2019b; UNFCCC, 2020).

In answer to this, the European Union created The European Green Deal, which is the "roadmap for making the EU's economy sustainable" (EC, 2019a). The deal expresses for the EU to become climate neutral by 2050, as well as that the EU moves towards a circular economy whilst restoring biodiversity and cutting pollution (EC, 2019a). Based on these goals, the Circular Economy Action Plan was formulated, where the agenda for sustainable growth is provided (EC, 2020). In this Action Plan the European Commission proposes legislation to reduce packaging and packaging waste, to drive design for reuse and recycling, and to reduce the complexity of packaging. Additionally, for plastics, a couple of other points are mentioned. First, a proposal has been made to have mandatory requirements for recycled plastic content. Second, a ban of intentional micro-plastic use, combined with regulatory measures for unintentional use has been proposed, and third, it is proposed to provide an assessment for bio-based and bio-degradable plastics to ensure correct labelling. Furthermore, EU waste laws that have been in effect since the 1970s will be revised; targets will be set for waste reduction; and end-of-waste criteria will be (re)assessed (EC, 2020). However, the options mentioned here have been proposed but not yet implemented. To go even deeper in accelerating the circular economy, the European Union next created a European Plastic Pact (European Plastic Pact, 2020). This initiative emerges from both The Netherlands and France, who already created their own Plastic Pacts in 2019 (IenW, 2019; Ministère de la Transition Écologique et Solidaire; 2019). With these initiatives all different types of organizations throughout the whole value chain collaborate to stimulate the plastic transition (European Plastic Pact, 2020).

There are other laws and legislations that influence the plastic sector, such as the single-use plastics directive (2019/904), but what is also of influence are laws regarding waste collection and management. Whereas the European Commission has proposed to set recycling targets up to 75% 2030, and reduction in percentage of municipal waste that ends up in landfill to a maximum of 10% by 2030, within countries waste collection can be more confusing (EC, n.d.). For example, within the Netherlands, each individual municipality can decide how to collect waste and therefore also what needs to be separated and what can be thrown away together (IenW, 2019b). Besides, the ‘Landelijk afvalbeheerplan’ (LAP; national waste management plan), prescribes how waste needs to be collected, and which permits organizations need to deal with certain materials (IenW, 2019b).

3.2 Plastic Production

To understand which parties are involved in the plastic production process, it is vital to understand how plastics are made. Plastics are derived from crude oils and can be divided into two categories: Thermoset and thermoplastic. Thermoset plastics are hardened once in order to maintain their shape. They are durable and hard plastics, used for amongst others, car parts, tires or airplane parts. Thermoplastics are less solid and can soften after heating. This type can easily be moulded and is often turned into films and packaging (Freudenrich, 2020).

The raw material is first refined into ethane and propane (Thisisplastic, 2020), which is then treated with high heat. This process is called ‘cracking’, and this makes (hydro)carbon monomers. In large polymerization plants, these monomers execute reactions that produce polymer resins. These resins are processed further, and here additives can be implemented such as flame-retardant chemicals or colour dye (Freudenrich, 2020). After this the resins take the shape of beads or pellets. This material can then be shipped to factories to be turned into the final product, and depending on the type of product various steps are involved (Thisisplastic, 2020):

- Extrusion, usually used to create plastic film;
- Injection moulding, used to create plastic containers;
- Blow moulding, often used to create plastic bottles;
- Rotational moulding, used to make large plastic items such as toys (Freudenrich, 2020).

After this, a product can enter the market. The next step in the supply chain occurs once a product or material is collected as waste and can be recycled.

3.3 Plastic Recycling

Currently in the Netherlands, only an estimated 24-40% of plastic in particular is recycled, whereas 58% is burned (CE Delft, 2019). Yearly, from the amount of plastic that is brought into the market, 86% is still new fossil plastic, 13% is recycled plastic, and 1% is new bio-based plastic (CE Delft, 2019). What also has to be noted, is that research from Brouwer

& Thoden van Velzen (2017) shows that not all forms of plastic are currently recyclable, or are very difficult to recycle (see table 1).

Table 1. Recyclability of types of plastic (translated from Brouwer & Thoden van Velzen, 2017).

	PET	PE	PP	Film	MIX	PET trays	Sorting residue	Unsorted material
Good	85%	91%	75%	68%	55%	14%	4%	4%
Not ideal	9%	0%	1%	4%	3%	1%	0%	1%
Future	4%	0%	2%	1%	4%	81%	0%	1%
Bad	0%	1%	2%	18%	13%	1%	6%	4%
Non-packaging	0%	6%	16%	3%	15%	1%	9%	1%
Rest	1%	1%	4%	6%	10%	2%	80%	89%

Recycling is defined by the European Union as “any recovery operation by which waste materials are processed into products, materials or substances whether for the original or other purposes” (Eurostat, 2014). This does not include reprocessing of materials that are used for fuel, energy recovery, nor backfilling operations. For waste to turn into recycled materials, a conversion needs to occur. Most waste is currently mechanically recycled. This mechanical recycling process can consist of one or more of the following steps (Ragaert et al., 2017):

- Separation and sorting;
- Baling;
- Washing;
- Grinding;
- And compounding & pelletizing.

Mechanical recycling today is the main technology regarding waste, because it is an easy process with overall low costs. However, it also has some negative aspects. For example, during the mechanical recycling of plastic, impurities such as dust cannot be removed. Besides, because of the recycling process itself, the plastic’s physical properties have been altered which means that it can no longer be used for certain applications, such as food packaging (Lux Research, 2019).

There is another method of recycling that can overcome such barriers, which still belongs on the niche-innovation level. This is chemical recycling, which according to Ragaert et al. (2017) can create valuable products such as petrochemical feedstocks from waste materials. There are certain methods such as solvent-based recycling that appear to be a promising method for recycling certain types of plastic but are as of yet are not profitable.

4. Methods

This chapter elaborates on the methods used in this research. Firstly, the research strategy will be discussed, then it will be explained how participants were selected. After, it will describe the different methods of data collection and how the data will be analysed, and finally the validity and reliability of this research will be described.

4.1 Research Strategy

Research philosophy

The paradigm that this research is built on is post-positivism. The ontology – "What is the form and nature of reality and, therefore, what is there that can be known about it?" (Guba & Lincoln, 1994, p. 108) – of post-positivism, is that reality is believed to exist, yet the nature of human's intellectual capabilities allows only for the partial observation of reality, which means that reality cannot be perfectly understood (Guba & Lincoln, 1994). The goal of this research is to map out the main opportunities and barriers of the transition towards a circular economy on plastics in Europe, with the understanding that there are limitations and restrictions regarding the observation of the full reality. The epistemology, which specifies the nature of the connection between the researcher and what can be known (Guba & Lincoln, 1994), is, in the case of post-positivism, objective. It also modifies the concept of duality as found in positivism (Guba & Lincoln, 1994), recognizing that this type of thinking is inadequate as "multiplicity and complexity are the reality of all human experiences" (Henderson, 2011, p. 342). It is important that the objectivity is guarded throughout the research, and that the researcher remains aware of their own subjectivity with the aim to limit subjectivity as much as possible. The final aspect, the methodology, asks the question of "how can the [researcher] go about finding out whatever he or she believes can be known?" (Guba & Lincoln, 1994, p. 108). For post-positivism, and for this research, qualitative research techniques are often used, with an emphasis on the creation of triangulation of data. Triangulation in social science research refers to the use of multiple forms of methods as a way to critically inspect both data collection and results (van Thiel, 2014).

Research Design

As the aim of this research is to obtain a deeper understanding of the barriers and opportunities that Dutch and European parties in the plastic industry face, a qualitative research design appears to be most appropriate. With the use of qualitative methods, there is the possibility for new options to be discovered, as well as that people involved in the plastic industry can expand on or give explanation for certain barriers and opportunities. With a quantitative research design, this would not be possible.

Following the post-positivistic approach, this thesis largely used a deductive approach which is defined as "*the process of reasoning by which logical conclusions are drawn from a set of premises*" (Miller & Brewer, 2003, p. 67). However, it is not completely deductive as the research reflected back the theory, which makes it partially inductive. A theoretical framework has been developed as a base and guideline for the empirical research, but if the data collected showed new or undiscussed factors, they have also been explored. Expert interviews and desk research have been used as a technique to check whether the framework covers the main topics or whether the framework needs to be adjusted. Moreover, the research concentrates on two cases/units in particular that are part of a bigger, embedded case study that is the plastic industry.

4.2 Selection of Participants

Context

This research has been conducted in partnership with Renewi. Renewi is a large European waste management organization with roots in the Netherlands, and have agreed to provide the internship position that is required to complete this Master's degree. They thereby also provide guidance regarding the research and the research process.

Renewi itself is rather new, as it was only created in 2017 with merger of Van Gansewinkel Groep BV and Shanks Group plc, but due to this merger they can provide a large range of services, experiences and technology. The organization follows the motto '*Afval bestaat niet*' ('Waste no more'), which is in coherence with their aim to become the leading waste-to-product organization. The waste-to-product idea is in line with the circular economy, as it uses waste exclusively to regain value from and therefore prevents it from going to landfills or being incinerated (Renewi, n.d.). Via the researcher's supervisors at Renewi, both the expert and organizations were found.

Experts

The selection of experts was done in conversation with the supervisors at the waste management organization. Based on a list of subjects and information/goals that needed to be obtained, the appropriate experts were chosen. This could either be employees within Renewi, or experts outside of Renewi. The list of subjects with related experts can be found in appendix

1. As by request of Renewi, to keep the anonymity of the experts, their title plus the assigned codes can be found in table 2. A total of 8 people were contacted, from which 6 agreed to an interview, covering topics ranging from the secondary plastic market to juridical considerations.

Table 2. Experts with their assigned codes.

Titles experts	**Codes**
Director Public Affairs	EX 1
Legal Council	EX 2
Trader	EX 3
Senior Program Manager – Sustainable Chemical Business	EX 4
Manager Plastics	EX 5
Manager Corporate Materials Sales Advice	EX 6

Organizations in value chain

The following parties were interviewed: primary raw material producers, injection moulding companies, brand owners, plastic recyclers, a retailer, and a waste management association, and a waste management company. As the researcher works for a waste management company, it was chosen not to interview other waste management organizations as the competition between organizations could lead to a skewed picture of reality. Therefore, the decision has been made to interview a waste management association that is less biased as a direct competitor. Next to this, someone in the board of Renewi, but who was not directly involved in this research, was also asked to be interviewed. In table 3 the type of organizations can be found, including the codes they will be addressed as in the analysis. Out of the 14 organizations contacted, 13 agreed to an interview.

Table 3. Types of organizations with their assigned codes, and in which case they fall.

Type of organization	**Code**	**Case**
Primary producer – Petrochemical industry	PP 1	Both
	PP 2	Both
	PP 3	Both
Moulding producer – Moulds plastic into desired shape.	MP 1	Case 1
	MP 2	Case 1

Producer/Brand Owner – Fills/sells products, without physical stores.	Prod 1 Prod 2	Case 1 Case 2
Waste management - Collects, sorts and possibly washes end-of-life materials.	WM 1 WM 2	Both Both
Plastic recycler – receives products for waste companies and other parties, creates materials that can go back to moulding company.	PR 1 PR 2 PR 3	Both Case 2 Both
Retailer – Sells products in a physical (and online) store, not limited to one specific brand.	RT 1	Case 1

4.3 Data Collection

Desk Research

Desk research uses already existing data sources that have been developed for reasons other than research (van Thiel, 2014). The data sources used to gather information in this research are primary materials which concerns written sources that have not been created for research purposes (van Thiel, 2014).

First, research has been done regarding plastic policies, initiatives and other forms of advice. This data is important to gather as it can provide an understanding of how strict and how fast governments aim to implement circularity and other laws regarding the plastic market. For this, websites of the Dutch and Flemish government and the European Union were checked for action plans, and existing and future laws and legislations. After this, the website AfvalOnline was checked to gather extra information, such as advice from other parties with influence.

Second, information has been gathered on pledges and agreements regarding plastic and secondary plastics, that have been signed by organizations. Here, it has been analysed what goals the parties have agreed on or set for themselves, which has been done as a method to obtain a perspective on what organizations are likely to invest in in the upcoming 5-10 years. The following documents have been analysed: Plastic Pact NL, European Plastic Pact, Raw Materials Agreement (Grondstoffenakkoord) NL, UN New Plastics Economy Global Commitment, and the Circular Plastic Alliance. For the Raw Materials Agreement NL, it is importance to note that this agreement is signed not solely on the topic of plastics, but also biomass & food, manufacturing industry, and construction and build. The list only consists of organizations that have a share on the European or Dutch market, and does not consist of governments, municipalities or charities.

Third, during the desk research and expert interview, a clear distinction appeared between plastic for packaging, and plastic for durable goods. Therefore, to gain a deeper understanding of the various plastic uses and possible differences in barriers and diver, two case studies were elaborated on: fast-moving consumer goods (FMCG) and slow-moving consumer goods (SMCG). A case study investigates the real-world context and setting, which is especially useful when assuming that a real-world case will display relevant contextual conditions (Yin, 2018). Case study research has roots in qualitative research approaches, in multiple disciplines such as anthropology, sociology and psychology (Harrison et al., 2017). These disciplines investigate the lives and experience of humans, including how individuals experience their own worlds and therefore, these examinations were, and are mostly done in natural settings (Harrison et al., 2017). The background of these cases has been gathered via desk research, observations, and personal communication with employees of the internship organization. Certain organizations interviewed can work with either FMCG or SMCG, but there are also organizations that are involved in both, this can also be found in table 2.

Participatory Observation

As the researcher was partaking in an internship at a company that is also part of plastic supply chains, information could be gathered in other settings such as meetings and conversations as well. Since these types of interactions are not recorded, notes have been written down on paper first during the meetings, and immediately afterwards, these notes have been expanded on and explained in a word document. In the word document, the date, people involved, and notes taken are written down and expanded on if necessary. If the researcher believed information that was gathered in these meetings are of importance to the research itself, the information has been double checked with the expert/person that the meeting was with. The researcher has chosen not to record general meetings as this can change the conversations and topics that might be discussed during these meetings. Furthermore, the researcher only involved themselves in a meeting in order to ask for additional explanations of concepts. Additionally, sensitive information regarding the company and strategy could be discussed, and this ensures that this information will stay private and will not be shared without permission.

As the researcher was forced to work from home due to COVID-19 after a month at the internship, and therefore was not able to attend as many meetings, the participatory observation has been limited, and is therefore not used as a reliable source but only as additional information.

Expert Interviews

There are two different types of interviews that were held as part of data collection. The first are unstructured interviews with experts. The aim of these expert interviews was to obtain a perspective on (1) aspects that might have been missing in the theoretical framework. If new information is gathered for these interviews, the theoretical framework will be adjusted, and (2) what the bottlenecks and problems are observed in their field with respect to the secondary plastic supply chains. Participants were also asked how certain bottlenecks could be solved. The main goal of these interviews is to test if the literature/theory is line with what occurs in practice. These interviews therefore consisted of different topics, and research objectives. Based on the research objectives, a number of questions have been formulated as to provide a guideline for the interviewer, however questions could be added or subtracted during each interview to remain flexible, making it an unstructured interview (Bryman, 2008; Seale et al., 2006). As the objective was to gain a better understanding of the practice of certain fields, the interviewer asked follow-up questions to ensure that the interviewer did not misinterpret certain terms/concepts or the participant.

Value Chain Interviews

The second type of interview are semi-structured, in-depth interviews with different parties in a supply chain. In this situation, a semi-structured interview allowed for the certainty that specific topics were covered, while it simultaneously allowed the interviewee to speak freely and the interviewer to ask spontaneous question. The interviews cover two case studies. Whereas some organizations fit in one of either two cases, most organizations are involved in both, which means that these organizations work with both durable plastics and plastic for packaging (Table 2).

The following topics were discussed in each interview, and the complete interview guide per type of organization can be found in appendix 2:

- Reasons for or against the transition, what bottlenecks are experienced with transitioning towards circularity and what can be done to help the organization to transition (limited to plastics);
- The roles of parties in the transition, what the organization expects of themselves and other parties;
- The (wish to) use of secondary plastics in specific products. Here aspects such as bottlenecks regarding collaboration, technology and knowledge will be discussed;

- The potential threats the organizations might face, which markets are they competing with;
- The future of the secondary plastic market according to the organization.

It is to be noted that this research started right before the pandemic of COVID-19 began and continued during the social distancing/lock-down. Since the pandemic has an influence on the economy as well as organizations, the decision was made to include interview questions regarding the effects the pandemic has had on the organizations in order to obtain a better picture of reality. If needed, the interviewer also specified to answer the original questions with the "normal" situation in mind, instead with the "temporary" situation in mind.

All interviews were done via online platforms. All participants were asked for consent to be recorded before the interview started. If a participant did not agree to be recorded, extensive notes were made during the interview. As certain information might be sensitive or confidential, experts were given the option to state that particular topics or sentences were not allowed to be transcribed or used in the research. This option was given not only to create a sense of trust between the interviewer and interviewee, but also because the interviewer was simultaneously doing research for the internship organization. Data that is shared could be necessary or useful for the research internship, but confidential to the company. This information was then kept out of the transcription or memorandum. Finally, experts have been mentioned with their last name, but the value chain organizations are kept anonymous.

4.4 Data Analysis

Method of analysis

All of the interviews were recorded with permission of the participant and transcribed by the researcher. The interviews have been analysed with ATLAS.ti, based on a coding scheme. This scheme was made beforehand but adjusted accordingly if certain large factors appeared to be missing.

Coding

A differentiation is made between analytical and factual codes. The analytical coding is in regard to the levels in the MLP, namely: regime, landscape, and niche-innovation. This will be used to analyse the stability of the regime: What are the deep structures that are still present and what signs are shown that suggest a change in the regime, what influence does the landscape have on the regime, and what influence do niche-innovations have on the regime? As can be found in Table 4, the landscape coding is divided in short-term versus long-term. Short-term landscape pressures include factors such as the pandemic, whereas long-term landscape pressures include problems that will not disappear in the <10 years, such as climate change. The niche-innovation category is divided into enhancing and competing.

The factual barriers and divers are partially based on the factors that make up a regime as shown by Geels & Schot (2007). They are: market, technology, politics, culture, industry and science. Geels (2002) has also mentioned infrastructure to be of importance. These can be coded as such, but some factors have sub-divisions to make the analysis process easier. These sub-divisions are based on the theoretical framework and can also be found in Table 4.

For market, there is a distinction made between EU market and global market. The sub-divisions of technology dive deeper into the plastic industry: is it related to mechanical or chemical recycling, or is it about the collection or sorting process? As organizations in the value chain use many different technologies and methods, it is chosen to make this differentiation because these aspects are the ones that are new compared to the technologies used in forward logistics (with virgin materials). In the category politics there is also power, law and legislation, and contracts. These have been categorized together as power and politics can often overlap, and as stated in the theoretical framework, law and legislation can be influenced by powerful alliances between organizations and politicians. After comes culture, for culture there is the difference between inter-organizational and intra-organizational. There can be pre-existing culture between organizations that usually work together or clashing culture between organizations that normally are not used to working together. Intra-organizational culture covers the beliefs and traditions within an organization itself. The industry is a category that is used to focus on a specific part of the whole regime, such as the recycling industry or petrochemical industry. This can show certain problems that might occur within an entire industry, but not the entire regime. The category science is used to address scientific knowledge in the regime, and the infrastructure refers to the logistics in a value chain.

Finally, a category that is not mentioned as part of the regime in the MLP, but that is vital to the circular economy, is collaboration. This category is divided in size, trust, finances, and participation. This is to get a deeper understanding of what organizations prefer or where problems may lie exactly.

All of the (main) categories mentioned above are also coded on barriers, opportunities, and possible solutions to the barriers. A large part of the interviews was held in Dutch, as nearly all participants as well as the research speak Dutch. Quotations used in the analysis to describe and explain certain phenomena have been translated to the best of the ability of the researcher and have been checked by a third party for accuracy.

The analysis of the expert interviews mainly focuses on factual barriers, such as problems in the market, or with existing or upcoming technology. The analysis of the interviews with organizations puts greater focus on the analytical aspect, meaning that it concentrates more on the landscape, regime and niche-innovation factors to observe the stability of the regime and the influences from external elements.

Table 4. Codes used for analysis.

Analytical Codes	Factual Codes	Subdivision factual codes
Regime: Opportunity Barrier Solution to barrier	Technology*	Mechanical Recycling Chemical Recycling Collecting Sorting
	Culture*	Interorganizational Intra-organizational
	Industry*	-
	Infrastructure*	-
	Market*	EU market demand – supply EU market price Global market demand – supply Global market price
	Politics *	Power Law and legislation Contracts
	Scientific knowledge*	-
	Collaboration*	Size Trust Participation Finances
Landscape: Opportunity Barrier Solution to barrier	Short-term	
	Long-term	
Niche-Innovation Opportunity Barrier Solution to barrier	Enhancing regime	
	Competing (with) regime	

* Have a distinction between opportunity, barrier, and solution to barrier as well.

4.5 Reliability and Validity

Reliability

To ensure the internal reliability of the researches, nearly all interviews are transcribed and coded in detail, which limits the subjectivity of the interpretation. One interview has been described in notes, which were handwritten during the interview and afterwards typed down and expanded on. The external reliability is related to the replicability of the research, which means that if the same study would be conducted by someone else, the same results would be found. Transparency regarding the research process is an important factor here, so, next to the transcription and coding of the interviews, a list of topics for the expert interviews has been created, as well as an interview guide for the value chain organizations.

Validity

To ensure validity is to ensure that one measures what they stated would be measured. For this research, this is safeguarded by triangulation of research methods. The multiple forms of data gathering are used to check whether the data and information actually can be proven via more than one source. The use of desk research, expert interviews and interviews with organizations as part of the case study allows for the triple checking and legitimizing of the data found.

The generalizability of qualitative research is more difficult to realize than with quantitative research, as the sample size is smaller than what would be possible with quantitative methods. However, the two cases studies allowed for in-dept observations of the plastic industry. This way, a deeper understanding of the transition and the industry could be realized, therefore providing valuable information to society. The study adheres to analytical generalization and has results in line with similar case studies (KVG, 2019). It can therefore be stated that the research is generalizable.

5. Analysis

In chapter 5 first, the current division in roles in a value chain and what the ideal chain and division of roles in the future would look like will be discussed. Afterwards, there will be a permanent distinction between two cases. This is done because there are great differences between fast-moving consumer goods such as plastic packaging and slow goods such as fridges. A differentiation needs to be made as there are different rules, technologies and bottlenecks between the two that would create a skewed picture of the entire plastic regime. Fast-moving consumer goods is case 1 and slow goods is case 2. Both cases will be analysed based on the stability of the regime – the deep structure, core beliefs, routines, path dependency, etc. – and which barriers and opportunities can be identified that influence the regime either from within the regime (market, politics, technology, etc.), or from outside the regime (landscape and niche-innovations).

5.1 Value Chain Role Division

The value chains have been simplified for readability, as in practice there can be a large variety of organizations, process steps, and relations.

Current value chain

In the linear value chain, it all starts with new, virgin fossil-based material which is then turned into granulate by the petrochemical companies. These companies send their material to injection moulding producers from all types of markets, for example automotive, packaging or construction. The injection moulding producers create the product for brand owners/OEMs who then fill the product and sell it to a retailer (see Figure 6). Waste materials are collected from all previously mentioned parties. Materials collected from the chemical industry, up until the retailer is classified as post-industrial waste, material collected from the consumer is post-consumer waste. Currently, after the collection, all waste is sorted which is often done based on material type/physical appearance (Bongers, personal communication, 2020; EX 3). Material that is contaminated or difficult to recycle is send to the incineration, and with very specific conditions can be send to a landfill location. Material that can be recycled is at present mostly recycled via mechanical recycling, after which it is predominantly send back to injection moulding companies who can then mix it in with virgin materials to create a new product. A part of the materials that are recycled consists of a relatively clean stream that can be incinerated for energy use (Personal communication, 2020).

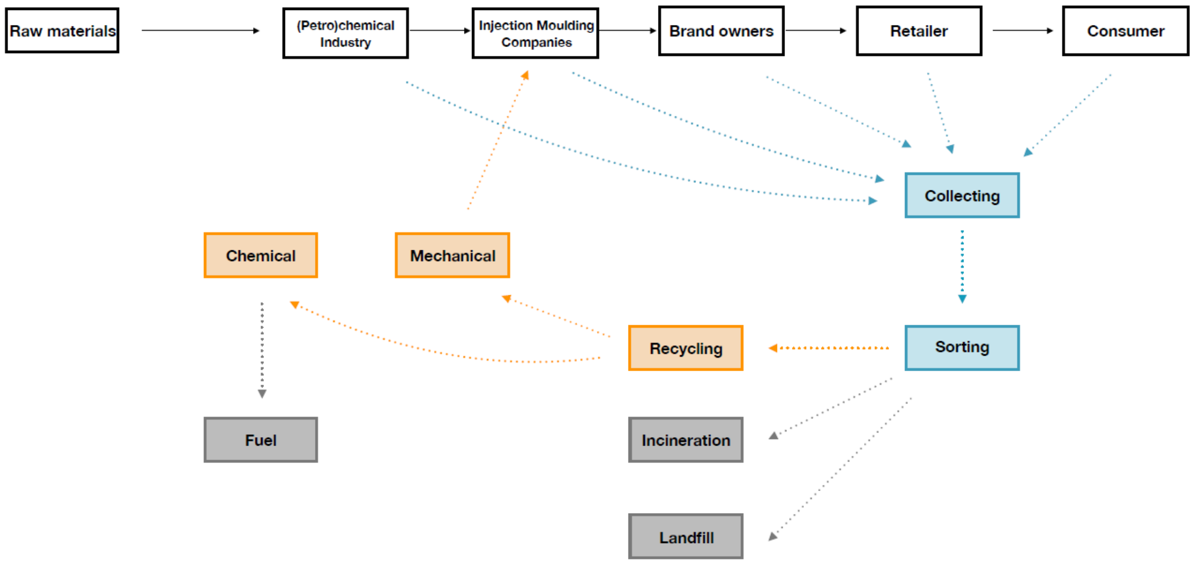

Figure 6. Current linear plastic chain – simplified.

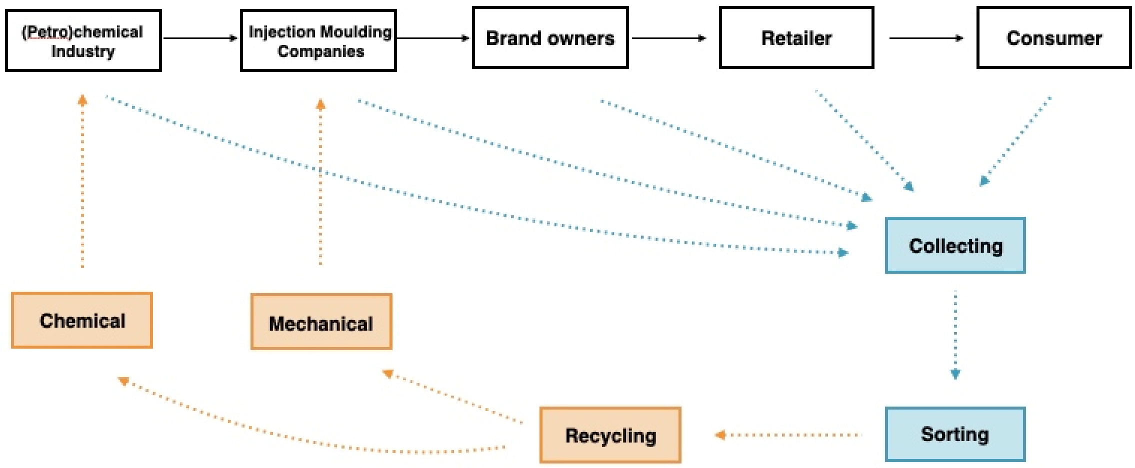

Figure 7. Ideal circular plastic chain – simplified.

Ideal future value chain

In a circular economy, it is clear that the input of virgin raw materials needs to diminish, and that landfill and incineration should be avoided in order to create a (semi) closed loop. However as was stated in chapter 2, for most parties interviewed, the main difference between the linear value chain and one that aims for circularity is the collaboration with other parties. The collaboration between multiple parties is a factor that needs to become central in order to create a better, more sustainable plastic chain.

Before, there was very little collaboration between waste management organizations and the chemical industry or moulding companies apart from collection contracts, but strategic partnerships are now becoming more relevant and necessary.

> "*Circular economy or our chemical recycling needs a value chain approach and it needs beyond that, who are new on the block are really the waste companies. So, for me it is clear. The waste companies are an integral part of delivery and I would say so far I have learned that there are companies who really have assets that are producing […] some are only sorting and then forwarding, some play only in the logistics part a key role, but they are required so I would say this is for me in the last year a big revelation*" (PP 1).

> "*Well, an example that we see to grow further in a circular economy is really partnership. That means that you both from the front, the input, as from the back, on the output side need to work together with partners. […] So, you create chain integration in which the waste collectors, the recyclers and the producers find agreements between the three of them and thus enter collaboration*" (PR 1).

> "*Yeah the collaborative [aspect] is something we in principle haven't done so far. These are the first times and that's why I'm so excited about it because I think that once you have the right partners together and can show what kind of impact you can make, even if the first step is small*" (Prod 1).

A prominent aspect in this collaboration is the idea that different types of organizations should become consultants to each other. As the field is so specialized, that open communication and knowledge-sharing is key to understand the full picture and knowing what choices to make (PP 1, PP 3).

> "*We can be hugely relevant if we work better together on how we meet those challenges. And in that new relevance, you just have to be open with each other. […] I have nothing to hide from you, because I mean, you're not a competitor to me." (PP 3)*

An issue that parties will have to navigate around and overcome is what knowledge and information can be shared in collaborations. Especially with larger organizations that could be direct competitors of each other, competition law could become a bottleneck that prevents necessary collaboration (EX 2; EX 4).

Next to collaboration, a division in opinions can be found in the size of the value chain, which shows that certain goals and incentives are not aligned among all parties. Certain parties see importance in limiting the size of a chain by keeping it in the Netherlands or Europe as a method to reduce the environmental impact caused by the infrastructure whilst also keeping the value of the chain in the country (PR 1, PR 2).

> "*The ideal chain is that we will recycle and sort on a small scale. Look, what you see now is that we have a couple of large sorting centres in the Netherlands, a couple of large parties that make regrind and a couple of large parties who create the raw material for the plastic industry. We travel relatively many kilometres to get through the whole chain*" (PR 2).

Other companies believe that enlarging the chain and the volumes that go through the chain is necessary in order to create a stable secondary raw material market (Prod 1, Prod 2).

> "*You need reliable partners that can control a stream, which allows you to make progress and you know what [plastic] is coming back, and that you can make good agreements about not only our plastics but also that of our competitors and other parties. So, the larger the scale becomes the better, the ideal cycle is not just a small loop like PET is now*" (Prod 1).

5.2 Opportunities to the Transition

In this section, a differentiation is made between two cases. The first case is 'fast-moving consumer goods', the second is 'slow goods'. Before each case will be analysed, an explanation of the case and its setting is provided. The analysis of both cases will be divided in regime, niche-innovations and landscape, and within these paragraphs, the factual aspects as discussed in the theoretical framework will be discussed.

5.2.1 Case 1

Case 1: Fast-moving consumer goods (FMCG)/Consumer Packaged Goods (CPG)

"Products that move off the shelves of retail shops quickly, which therefore require constant replenishing. Fast-moving consumer goods include standard groceries, etc., sold in supermarkets as well as records and tapes sold in music shops" (Law, 2009, p. 127). As this type of products usually have a low profit margin and are sold in large quantities, plastic is often the preferred choice of packaging since it is cheap to produce (Malhotra, 2014; Kenton, 2020).

Plastic packaging can generally be created from a couple of different types of plastic: PET, HDPE, LDPE, PP, PS, PVC, or others which include multi-layered plastics and types of plastic not suitable for recycling (Hahladakis & Iacovidou, 2018). Simply put, plastic packaging can be divided in two categories: food and non-food grade. Both categories need to be designed in a way that can then easily be recycled. Whereas non-food packaging is ideal for the use of recycled materials, the laws and regulations regarding products that come in contact with food are very strict to ensure safety (KIDV, n.d.).

For example, the European Food Safety Authority (EFSA) has provided guidelines stating that 95% of recycled PET, often used in bottles, has to come from food packaging. This is to rule out that the recycled product contains hazardous substances, i.e. leftover paint or cleaning products (KIDV, 2019). To reach the required 95%, a closed loop including collection is necessary, which is the reason why in the Netherlands we work with a plastic bottle deposit system.

For other plastic packaging, collected via i.e. post-consumer PMD waste, no guarantee can be given that the material has not come in contact with hazardous substances, and it is therefore not allowed to use this kind recycled materials in food grade materials yet. As it would be too confusing and overwhelming for consumers to recycle all types of plastics separately, it is not a viable idea to continue the current PET bottle recycling method with other plastics in order to create closed loops. Unilever therefore has created 'Field Lab' in 2019, here organizations come together to search for new, different solutions (Van der Ent, 2019; Maas, personal communication, June 2, 2020). Besides researching methods to use recycled materials in food grade packaging, they also look for other ways to recycle the (food) packaging. An example of this is large buckets made from PP, which can be used in the catering industry for sauces, but they can also be used for paint. To ensure high-quality recycling of this product, without complicating the collection and sorting process, they are currently turned into benches, chairs, and so on (Maas, personal communication, June 2, 2020). This way, the use of recycled content is promoted, even though the laws and legislations regarding safety and food packaging only allow for the use of virgin, safe plastics, and eventually circular packaging could be reached. Here, the question that remains is: How is the industry dealing with these difficulties, and are there other barriers that they face?

Regime

In general, good indicators that the transition is stimulated and expected are over 600 organizations with market shares in Europe that have signed agreements and pledges to tackle the plastic problem. There are 5 major documents, four of those setting goals for 2025, one for 2030. The New Plastic Economy Global Commitment and European Plastic Pact emphasize the recyclability of plastic packaging, as well as the use of recycled content in plastic packaging (EMF & UN, 2019; EPP, 2020). Besides, the Circular Economy Action Plan from the European Union promises to execute law and legislation that minimizes the use of packaging and packaging waste, drives the design for recyclability of packaging, as well as decrease the number of materials and polymers used for packaging. Next to this, it also focuses on the creation of a labelling and collection system that would increase the transparency regarding the source of the product, which effectively could also aid the establishment for better health and safety food rules (EC, 2020). These indicators demonstrate that both the market and the industry of the old regime are breaking structures, and that change is anticipated within the regime.

For non-food plastic packaging, there are a couple of opportunities that encourage the transition. First, there are examples that show that it is possible to use a certain percentage of recycled content in packaging. Dove bottles, for example, are made out of 97% recycled plastic content since the end of 2019 and the company is working on creating a high-quality stream of recycled PP that can replace packaging made from virgin materials with a full 100% (Unilever, 2019). This shows that certain claims organizations make regarding the complications that occur when creating products with recycled content are less legitimate as originally expressed and could drive organizations into rethinking their business model (Prod 1). These small examples can break social and cognitive lock-in mechanisms, such as routines and shared beliefs that can lead to blindness in a regime, as actors realize their assumptions are no longer valid.

Next to demonstrations in practice that show change is possible, there is also a growing critique from outsiders to the regime that push transformation (Plastic Soup Foundation, n.d.). The effects of outside pressures can be seen with the ban of single use plastics by the European Commission. The public started to realize the effects of plastic on nature due to education from NGO's and charities, and as a result, politicians and governments were forced to tackle the issue. Whereas some might say that this is 'symptom politics' (MP 1), which means that only the visible symptoms are taken care of, instead of the underlying issues, the changes caused by pressures from outside of the regime could also be argued to be a start towards transitioning.

Niche-innovations

There are various niches under development concerning plastic and plastic packaging. First, as mentioned before, there is the chemical recycling. Even though chemical recycling has certain negative aspects to it, it is also a promising solution for plastics that cannot be mechanically recycled. This niche, if done right, could even extend the life cycle of a material far beyond the capabilities of mechanical recycling.

> "*I am an absolute advocate for chemical [recycling], because it also ensures that the quality is maintained. Mechanically [recycled plastic] continues to become dirtier, there are contaminants in it, so you should indeed create a cycle where you can upgrade*" (Prod 1).

In addition, as certain types of chemical recycling break down the material to a level where additives can be extracted to create a clean material, this could also be an outcome for food grade packaging and other food grade plastic products.

> "*We see of course that food grade material or medical grade material is not reachable via mechanical recycling. So, we have to go to chemical recycling, it is very important for us and a technology that we will need. So, we will continue mechanical recycling where ever possible, because that is the most interesting from a monetary point of view, but for grades where we cannot use that, we will search for chemically recycled material*" (Prod 2).

Apart from chemical recycling, there are other niche innovations that could prove to be a threat to the fossil-based plastic industry such as bio-based and biodegradable plastics. Another option is the use of alternative materials for packaging which could eliminate the need for plastic (Prod 1), such as simply packaging in carton or paper, or having the consumer bring their own containers to put the product in. These niche-innovations could be opportunities for the plastic industry to invest in technologies and innovations that do not threaten their business models, but it could also provide solutions for issues that cannot be solved with current possibilities. An example of this could be that plastic waste could lose its quality and that can no longer be fully recycled. A small amount of bio-based virgin plastics could be added to the recycled material to increase the quality of the plastic, without having the detrimental carbon effects that fossil-based virgin plastics have (PP 1, WA 1, MP 1, MP 2).

Furthermore, it is important to mention the effect of actors outside of the regime pressuring the current regime again. Factors such as the demand for a ban on single use plastic not only force the regime to alter their behaviour, it also allows for a space for niche-innovations to develop. This is because outside actors have the power to frame the industry in a negative light, and frame new, developing niche-innovations in a positive light, cause it to grow in legitimacy (Freeman et al., 1983).

Landscape

The COVID-19 crisis has had an effect on the production of products, containing both virgin and recycled materials, due to the economic effects that followed total lock-downs of countries and states. Nonetheless, there are also positive opportunities that result from it. Not only does it provide the opportunity for organizations to focus on what is truly important to them (Prod 1), it also shows that if necessary, law and legislation can be adopted and changed quickly.

> "*A very beautiful example from the pandemic is that we in collaboration with the TU Delft and with Van Straten Medical Green Cycle have managed to create a return system for used face masks, which we, also via lobbying, managed to get a permit for within two weeks. Something that normally takes over half a year*" (EX 6).

The long-term landscape changes relating to the planet and environment, such as resource depletion and climate change are also continuing to stimulate the transition to a circular economy and sustainable use of plastics. The Paris Agreement which came into force in 2016 states that the heating of the earth needs to be limited to a maximum of 1.5 degrees, as well as that use of fossil fuels will have to come to a halt (UN, 2015), and this will continue to drive legal developments such as the Circular Economy Action Plan of the European Union.

5.3.2 Case 2

Case 2: Slow-moving Consumer Goods (SMCG)/Slow Goods

"Slow-moving consumer goods, which have a longer shelf life and are purchased over time, include items like furniture and appliances" (Kenton, 2020). In this research, the slow goods that are discussed are objects such as fridges, vacuum cleaners or printers. These objects are made of hard plastics, consisting generally from PP, PS or ABS. Often, these are the items that you use for 10-20 years, and then when they are broken or outdated, dispose of to get the updated version. The plastics in slow goods, despite facing degradation over time, can be recycled/upcycled rather easily. However, the ideal situation would be to create a closed loop, gathering plastic from a type of product, recycling it, to then use it in the same type of product again.

An example of this is the circular vacuum cleaner from Philips. Here, discarded vacuum cleaners are gathered, sorted and recycled by Philip's partners, for the material then to be used in new vacuum cleaners. This is just the beginning of circularity, as so far 36% of the plastic weight in the product is recycled. Another example that shows that it is in fact possible to create a (near) closed loop is the collaboration between the company Coolrec and large original equipment manufacturers (OEMs). This collaboration focuses on the use of recycled PS in fridges. So far, the OEMs can use > 80% recycled materials in their new fridges (Bongers, personal communication, June 10, 2020**).** A 100% closed loop at this moment in time is not yet possible, as there are limitations caused by food safety legislation as imposed by the EFSA. For slow goods, there is also REACH that needs to be accounted for. REACH was created to protect the health and wellbeing of humans by identifying, evaluating and restricting chemicals (EC; 2019c).

Nonetheless, it shows that the recycling of hard plastics as used in slow goods is possible, and that the transition towards circularity should be easier here compared to packaging. Though, the question that remains is: What is holding OEMs and other organizations back from adopting recycled content in their products, and can these barriers be overcome?

Regime

The main sign that shows breaks in the deep structure is that in the last couple of years (2-3) a large number of organizations have signed agreements and pacts, which simultaneously comes with the realization that business models will have to change if organizations want to survive the transition successfully (PP 3, MP 2). The organizations that have signed agreements relating to circularity and plastics, and set goals for change, are no longer limited to only the frontrunners. The variation in types of organizations, sizes, locations, etc., show that the awareness and dedication is growing, and that organizations are (trying to) break their path-dependency.

The Dutch Plastic Pact, which was created in 2019 is "voluntary but not non-binding" (EX 1), which also counts for certain other agreements. This means that organizations are expected to hand in data about their progress to the RIVM or other governmental organizations (EX 1). These pacts combined with the proposed and suggested law and legislation, for example with the Circular Economy Action Plan, will force organizations to alter their business models sooner or later. A petrochemical organization stated that:

> "*I need to go circular otherwise I can't even realize a future. That's how simple it is. I need all the plastics available to squeeze oil out of*" (PP 3).

Another petrochemical organization, when asked if the transition would pose a threat to their business answered:

> "*Yeah there are big threats of course. I would say for the plastics industry we have to reinvent ourselves so that big of a threat I would say. It is not that we are panicking, but yeah [...] that is why our strategy is also very clear, because that is where we need to influence. [...] We will survive and be innovative in that way*". (PP 1)

Both of these answers from petrochemical organizations show a clear break in the deep structure and core beliefs of the regime, especially in the social and cognitive lock-in mechanisms, as organizations are starting to realize that they need to evolve to remain in the future regime, and in fact are opening their eyes to the situations outside of the regime. To further support this realization is the fact that the culture within organizations is changing as well. For example, in WA 2, the organization noticed that by making sustainability goals for the company, people with a "larger than average motivation" (WA 2) for circularity and sustainability are attracted to the company. This then ensures that over time the culture within organizations become more open to this new way of living/working, which in turn could influence the relations between organizations and the entire regime.

Niche-innovations

The niche-innovations that could drive the transition forward, have more room to explore and experiment in the slow-moving consumer goods regime compared to the fast-moving consumer goods and food grade goods. The demands that come from producers and moulders such as the desire for coloured material or higher quality material are all aspects that technology and innovations are quickly responding to. The costs that come with certain available, but new technologies can still be very high and not necessarily profitable in the near future, however, it shows that options are achievable. For example, there are recyclers that have started working with the use of robots in order to avoid human error as well as transcend human capabilities by the use of infrared scanners to determine the type of material more accurately (PR 3). This technology is self-learning, and over time will not only pick up speed, it will also become more accurate, and more profitable. There are also recyclers that are developing separating techniques that can separate base colours in growing quantities.

> "*For post-consumer recycling use colour sorting yes. […] The larger the volume and if there is a demand for certain colours, for example white, yes than it pays off to use colour sorting on that*" (PR 1).

Therefore, with the adequate space and possible monetary assistance from governmental actors, these enhancing niche-innovations could develop in the appropriate time frame of the transition, speed up the transition, and improve the regime and industry.

Landscape

Compared to Case 1, the landscape opportunities that effect slow-moving consumer goods remain the same. Again, the slow changing landscape pressures such as climate change and resource depletion, and the law and legislation that is based on dealing with those factors have a positive effect on the transition towards a circular economy of plastics. However, as the slow-goods regime appears to be more flexible compared to the fast-moving consumer goods regime, the effects of landscape pressures could turn out to be greater and more powerful. This is because the regime has the opportunity and space to evolve along with the landscape pressures, which in this case could evolve the transition along better.

5.3 Barriers to the Transition

In this section, again the fast-moving consumer goods (Case 1) and slow goods (Case 2) will be discussed separately. The barriers of both cases are divided into the three analytical factors of the MLP: Regime, niche-innovations, and landscape. Within these analytical factors, the most outstanding factual aspects as mentioned in the theoretical framework will be discussed.

5.3.1 Case 1

Regime

The fast-moving consumer goods regime faces multiple large problems that prevent it from transitioning from virgin materials to secondary materials. The main issue that companies within the Netherlands and the European Union face is related to the law and legislation. As mentioned in the case explanation, the EFSA laws prohibit the use of recycled content in food packaging when less than 95% of the stream is a clean monostream, as can be found with recycled PET. The strict guidelines set from the European Union create a large hurdle for organizations to experiment, innovate and invest in niches and new technologies:

> "*Because we also know that food contact is impossible, we do not put effort in [redesigning] kettles as that is almost completely food contact so then we just say never mind. That doesn't make any sense. We are working on projects but that doesn't have first priority*" (Prod 2).

This shows that the main lock-in mechanism that is at play here is institutional/political mechanisms where radical innovations and regulatory change are hindered by not a monetary interest but by health and safety regulations.

In moulding companies, other bottlenecks regarding technologies arise. This can for example be found in organizations that produce products for both food and non-food packaging:

> "*I have to say with the use of recycled materials I often say to our customers that we can do that without problems, and we can and we do, but on the other hand we have to take that into account and do things [differently] in our company. [Recycled materials] cannot be used for food products and it will actually go through the same system in which food products are made too, so we have to separate properly, we have to clean extra carefully […] and that is super complicated because that really etches into it"* (MP 2).

This bottleneck then not only creates problems related to food grade products, but it also increases the price of non-food related products, affecting the entire value chain. It could be that this also comes from deep structures within the regime and is a sign of sunken investments, as it would require a change of systems and/or procedures that previously cost time, money, and/or effort to build and run smoothly.

In addition, the lack of adequate education of consumers also proves to be a bottleneck. First, there is an unawareness of the importance of correct recycling, which leads to (1) polluted plastic steams, which can then not be recycled to a high quality and (2) the pollution of nature, which is harmful to nature and biodiversity (Prod 1, MP 1). Second, because the consumer does not understand why products could appear different and more expensive, it is harder for producers and retailers to sell and continue investing in secondary plastics (Prod 1). The lifestyle of consumers could therefore additionally be creating path dependency within the regime.

Niche-innovations

There are possible niche-innovations that could create opportunities to recycle products in such a manner that the material will be allowed in food grade products, the predominant innovation being chemical recycling (or pyrolysis). With this type of recycling, all of the additives and harmful substances can be removed from the material. This provides a clean material that can then be reused in food grade materials. There are several problems that arise concerning chemical recycling.

Firstly, it is proven that chemical recycling can be done (MP 1, MP 2), but only on a small scale and upscaling is possible in theory but can cost billions. For the upscaling, multiple companies – sometimes in the same industry – need to collaborate and invest together. The high-performance, low-cost that come with the existing technologies and business models can therefore be much more attractive to continue compared to more sustainable ways. There is also a trust issue that arises between organizations when they need to collaborate on projects of this size:

> "*The risks are not too great, because they are all truly billion-dollar companies so a billion does not bother them but at a certain moment they will have to collaborate and then the NMA* (Dutch Competition Authority) *gets involved and they do not trust each other*" (MP 1).

Organizations appear to be risk-averse, not only to investing large sums of money, but also towards collaborating with others with the fear that other organizations could drop out of the partnership and/or other (legal) problems could arise, which in turn would result in losing large sums of money as well.

What adds to the complication is the debate whether chemical recycling is at all comparable to mechanical recycling, and whether it is more sustainable or not. This could in turn slow down the transition too, as it can prevent organizations from making changes whilst they wait for chemical recycling to become cheaper, or mechanical recycling to evolve further.

> "*I mean it has been proven to be possible, but it is a very complicated process, you need a lot of heat, you need a lot of energy and this is then not good for your CO2 levels, which counteracts it a little bit. It doesn't make it easier, plus you need very large installations considering the volumes that exist today*" (MP 2).

> "*So, at the moment, [chemical recycling is] the only choice we have for our materials such as PP, there is no food grade mechanically recycled PP, but we know that fundamentally we would be able to do it cheaper and cleaner than with a chemical process*" (Prod 1).

Another possible niche could be related to bio-based plastics, which are made from renewable biological materials (PlasticsEurope, 2020). Yet, there are many different developments regarding many types of bio-based plastics, varying in materials, biodegradability, and composability. Currently, multiple bio-based plastics are already used and implemented in the petrochemical phase, which means that bio-based plastics are therefore also in plastic products as this is the product that the chemical industry provides (PP 1, PP 2). The problem that emerges is that if these products are collected and recycled with fossil-based materials and the same infrastructure. This is because the bio-based products are sorted out of the plastic stream and can no longer be recycled, which means that it has to be incinerated (PR 2). Even if these plastics could be recycled with the current infrastructure in place, the same legislations that are in place for virgin materials would also count for bio-based plastics, which would then still not be permitted as a material for food grade materials.

Landscape

Next to before mentioned factors, the COVID-19 pandemic, a landscape level pressure, also has shown the consumer/society the importance of using plastic packaging and the positive effects it has on health. The realization that packaging, as well as (single-use) personal protective gear, is something that protects and secures the health and well-being of individuals provides a setback in pressure from outsiders of the regime as people's opinions on plastic change. It promotes the use of plastic packaging to the extent that personal protective gear such as face masks are pollution the environment months after the pandemic started. This movement then also works as a factor to keep organizations in their path of (over)producing packaging.

> "*I do think [the realization that plastic can be positive] is a beautiful something, because there was a lot of fruit and vegetables that were no longer packaged in plastics, not that I have been able to visit supermarkets abroad, but I can see it here of course, everything is back in plastics. […] But I do think the negativity surrounding plastics has somewhat gone down. That is an advantage. However, I do not know how to react to this the best way in order to promote circular plastics*" (Prod 1).

> "*On the long term [the pandemic] is a big advantage for us because people are realizing again why something is being packaged. We had forgotten and then when you bring your own jar to the store, or on some places where you can collect candy by hand, everyone is sneezing on top of it […] and I think people started thinking and realized that that is not very good*" (MP 1).

The influences from a landscape level, whether it is short-term or not, combined with the underdeveloped and complicated niche-innovations do not appear to generate enough tension in the regime to break the stability nor start a change. In some organizations, research is done, products are mapped out, but there does not appear to be a real motivation to alter the way the company functions as there are limited options (RT 1). Overall for the plastic packaging regime, outsiders, scientists, and politicians will most likely have to be the force that cause the regime to crack and transition.

5.3.2 Case 2

Regime

The slow goods plastic regime shows signs of instability, but there are still deep structures that need to be broken. There are a couple of main arguments that producing organizations or brand owners give for not transitioning towards circularity and secondary raw materials. One of those is that the secondary plastics are not as high in quality as virgin materials:

“*[producers] still too often use excuses on the trend of the quality is not good enough, and there are too many additives in the recycled content that cannot be taken out*” (WA 1).

However, the question is whether this problem lays with the recyclers, or perhaps at the producers’ side. WA 1 also points out: “There are too many additives, that is correct, but in the end, it is the producers who decided to put them in there in the first place”. Nonetheless, because virgin material can be used as a clean slate and recycled material is more difficult to work with, often the choice is made to choose for virgin where recycled would be possible.

This is also because brand owners can still be attached to certain qualities of virgin products that they would like to see in their products with recycled content, mostly related to the colour, sheen or scent of a product:

“*Colour freedom is what we are looking for, and for us black is also a colour. Deep black, you know, cannon black or however they call it is very difficult to produce so that is what we are looking for. And then we are also looking for base colours that we want to have but at the same time we are also looking for food grade or medical grade materials*” (Prod 2).

The underlying bottleneck, nevertheless, seems to be the prioritization of monetary value over sustainability. Virgin materials are chosen over recycled materials due to the fact that more additives are necessary to create the same product with recycled materials, which makes it more expensive. Fundamentally this is a techno-economic lock-in mechanism as the existing techniques and methods are preferred due to the high performance for a low cost. Also, even though the market price of recycled plastic is more stable and consistent, the market price of virgin fossil oil has been dropping, which further eliminates incentives to choose sustainability over profit (Gerecycled plastic onverkoopbaar, 2020; EX 3; EX 5).

An aspect that did come forward in several interviews is the relationship between petrochemical organizations and the government (PP 2, PP 3), which could be a sign of a core alliance between these parties and could prove to be a barrier in the near future. Nonetheless, it can be argued that this is a situational relationship, as these organizations were given a pat on the back by the government for their quick and adequate response to the COVID-19 pandemic. Apart from this situational alliance, no further strong core alliance between large parties and state actors was noted.

Niche-innovations

Contrarily to the fast-consumer and food packaging goods, the regime for slow goods is much less rigid, and niche-innovations have more room to grow. There are no laws as strict as EFSA that require strict and clean streams of recycled content, and plastic recyclers and sorters are growing in technologies and innovations. However, legislations such as REACH that test, control and authorize or prohibit certain chemicals in products can prove to create complications. This is because there is constant testing and research done regarding said chemicals, which indicates that the list of forbidden chemicals can change every (couple of) years. Innovations related to sorting or treatment that previously improved the regime can suddenly require changes due to changes in legislation (WA 2, PR 2).

Sorting products on colour and material specifications is growing in popularity and availability (Personal Communication, 2020; PR 1; PR 2), and the use of robots to create cleaner plastic streams of higher quality is also gaining recognition (PR 3). A setback that could be noticed is the lack of willingness to invest in technologies, due to the higher costs of new innovations or the uncertainty that it is going to benefit an organization enough in the near future (EX 2; EX 5).

The innovations that are seen as required and/or desired to expand the recycled content in slow goods and hard plastics are additions to the already existing mechanical recycling. Few organizations believe for example, that chemical recycling should compete with mechanical recycling; however, most state that it should just be used as a supplementary system when the plastic is of low quality or when mechanical recycling is not possible on a particular stream of plastics.

> "*Yes, chemical recycling of course is super good when it comes to plastics that are not mechanically recyclable, and that can be in all sorts of areas, but in the end with regards to the CO2 footprint, it is much worse than mechanical recycling*" (PR 2).

> "*I do believe in chemical recycling; however, we have to be aware with recycling streams chemically that would also technically be suitable for mechanical recycling*" (PP 3).

Landscape

The transition success of the regime is heavily dependent on the oil prices, which can drop or increase relatively easily. In the regime, profit and margins are still valued more compared to sustainability and therefore sudden changes in the virgin prices can have large effects on the transition of the regime. Currently, there are two forces pulling the prices down.

The first is the price war between Saudi Arabia and Russia as occurred in March of 2020, where both parties opened the tabs on oil production, which overflowed the market (Turak, 2020). The second, which occurred parallel to the price war, is the COVID-19 pandemic. The pandemic cause production of goods to halt, and the use of diesel or petrol also diminished. In the end, this meant that oil became so cheap that "in some markets raw oil is sold for below zero euro's, which means that you get paid for buying it" (EX 5). Additionally, the sudden onset of low virgin prices can result to organizations partially or fully backing out of partnerships and collaborations with recyclers:

> "*[The OEMs*] say, yeah look at the offer I get from a virgin producer, they drop their price per ton down with many euros. Yeah then [the collaboration*] either stops, or they will say, look we won't turn our entire production facility around, but we will start smaller. We will for the most part continue to create our [products] from virgin materials, and a couple of models we will change to your material*" (EX 5).
>
> * Information is redacted in order to protect the parties involved.

5.4 Transition Pathways

In this section, three different transition pathways will be expanded on in this section. First, case 1 – fast-moving consumer goods - will be discussed, then case 2 – slow goods – will be discussed, and third a separate pathway based on food grade plastics will be discussed.

5.4.1 Case 1

Non-Food Packaging

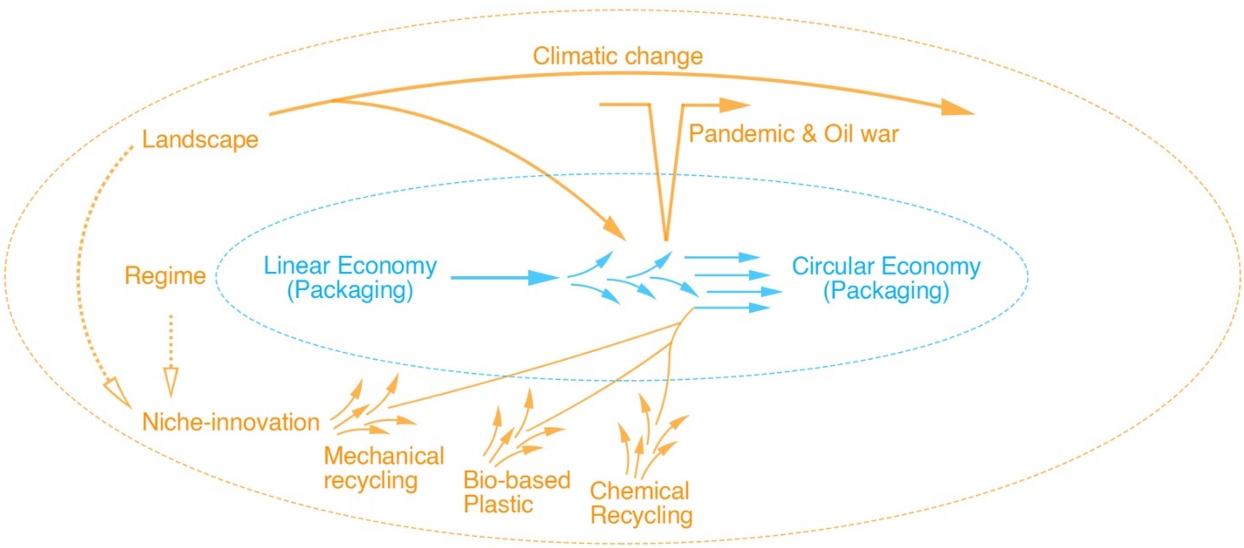

Figure 8. Fast-moving consumer goods – Technological Substitution Pathway.

In the fast-moving consumer goods regime there are pressures coming down from the landscape level. One is the long-term effects of climate change and the agreements and legislations that come with it, such as the Paris Agreement or the Circular Economy Action Plan that aim to tackle the rising temperatures, pollution, resource depletion and so on. The other is a short-term, shock-like pressure which is a combination of the COVID-19 pandemic and the oil war between Saudi-Arabia and Russia. The reasons that these two are linked is that on the one hand they happened simultaneously, and on the other hand, the pandemic caused this war and the drop in oil prices to become more important and visible, with greater effects to the whole plastic industry. The shock caused by the pandemic might have set back the positive developments towards circularity, as organizations mention that the pandemic has forced the business to focus on day to day tasks, rather than to continue innovations, and testing and piloting alternatives (Prod 1).

As can be seen in Figure 8, there are (radical) niche-innovations that have developed enough to enter the mainstream regime, these are innovations that actors within the regime are investing in. The three innovations: mechanical recycling, bio-based plastics, and chemical recycling are pushed forward to replace old traditions and technologies such as incineration or landfilling. Chemical recycling for durable goods is still developing but is certainly gaining interest from parties in the regime and is thus worth mentioning.

Additionally, there are parties from outside of the regime, such as NGOs and consumers (i.e. Plastic Soup Foundation; Plastic Pollution Coalition), that have expressed their disagreement and critique towards the current status of the regime and demand change. This critique is a further drive for a transition of the regime.

Therefore, for (non-food) packaging, the current path the transition seems to be taken is mostly in line with the technological substitution (d; see Figure 8). This is because there is a moderate disruptive change that forces organizations to reflect and alter their business cases, while at the same time, the niche-innovations have developed enough to take over the supply of materials from virgin to recycled. The effects of the pandemic most likely have set the transition back in time, however these effects are of short term and can be argued to be overpowered by the heaviness of the long-term landscape pressures. So, overall, this then creates a new regime where organizations such as waste management organizations and recyclers gain importance and acknowledgement (PP 1, PP 2, MP 1, MP 2), and forces parties that solely deal with virgin materials out of the regime (PP 3).

5.4.2 Case 2

Non-Food Slow Goods

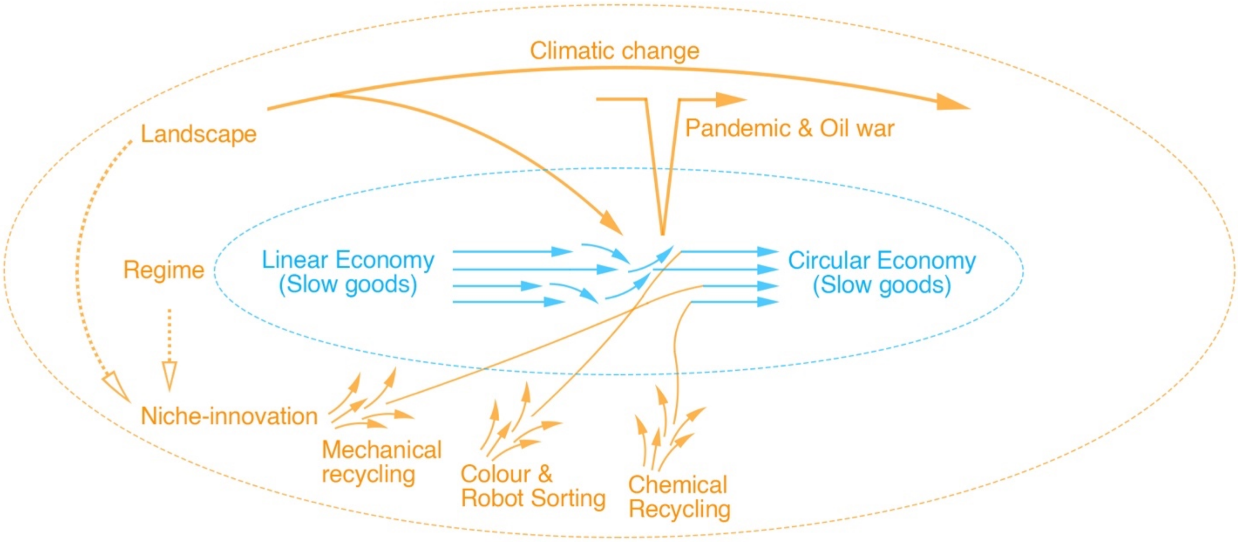

Figure 9. Slow Moving Consumer Goods – Reconfiguration Pathway.

As can be seen in Figure 9, the landscape pressures are consistent with the previous pathway. The differences are (1) the status of the slow good regime and (2) the niche-innovations and the uptake of these innovations. With the long-term landscape pressures such as climate change and the expected laws and legislations on a European level, the regime within Europe could transform drastically within the upcoming years. Actors within the regime are acceptant of the change and stability is breaking. It is, however, partially dependent on the right implementation of policies. This is because the price of virgin fossil oil is likely to continue to drop, and if it does, organizations need a force to steer them away from that monetary profit. If the right policies do not occur, it could be easy for the pathway to shift from a reconfiguration pathway to a transformation pathway where the regime could still change, simply at a much slower rate and with much larger conflicts and power struggles.

When inspecting the niche-innovations, it appears that the innovations are slowly accepted into the regime without completely breaking up the regime. A good example of this is the sorting with the use of robots (PR 3). This is done to improve the technology and system of the regime without having to break up the old system or patterns. As this innovation continues to develop more, it is likely that sorting done by hand will fade out of the regime and that robot sorting will take over.

For these reasons, the slow-moving consumer goods regime presently seems to be following the reconfiguration pathway (e; see Figure 9). Whilst there is some push back from inside the regime (EX 3, EX 5), a large part of the regime recognizes the need for change and embraces the radical and upcoming niche-innovations. This constructs a merger between the old and new regime, as parties are accepting of the changes and continue to create space and money for new technologies and innovations (Prod 2, MP 1, MP 2).

Food Grade Plastics

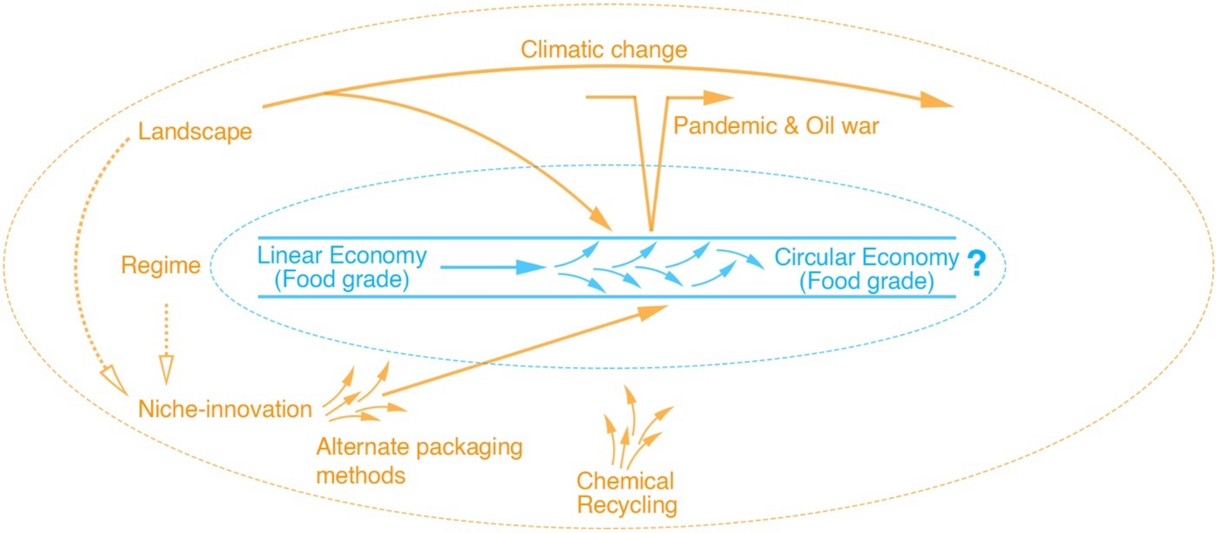

Figure 10. Food Grade Plastics – Transformation Path.

For the entire food grade plastic regime, the pathway towards circularity is less optimistic. Whereas the short- and long-term pressures from the environment are unchanged compared to the other two cases, there are such strict laws and legislations (EFSA) in the deep structure of the regime, that niche-innovations do not get a chance to experiment or develop enough to challenge the current regime (Prod 1). This is why the transformation path (b) is followed at the moment (see Figure 10). With the transformation path come the factor that the regime does not break enough. There is change present in within the regime in the form of reorientation, however this does not show in a sudden window of opportunity.

For the niche-innovations, the option that appears to be most viable to develop is to use alternative packaging methods, such as carton packaging or zero-waste packaging where the consumer brings in their own container. The bio-based options are not as viable here as the rules regarding food safety remain equal, meaning that products can still not be recycled in a closed loop. Chemical recycling is an upcoming innovation that is gaining popularity here too, however it is still an underdeveloped niche.

Additionally, there are presently small altercations caused by social movements, but most of the 'negativity' is still ignored by actors inside the regime (RT 1). It could require a large amount of conflict and struggle between currently dominant parties and outsiders for the transition to occur successfully.

5.5 Transition Management

5.5.1 Case 1

For the fast-moving consumer goods regime, there are plenty of frontrunners that could be chosen for the creation of a transition arena, and some have started to form their own versions of this. An example of this is Fieldlab, which was started by Unilever, but involves various parties in different areas of the industry. Here, problems regarding plastic packaging, whether it may be recycling, design or something else, are put forward and the organizations in Fieldlab work together to envision what could be and how problems could be solved in practice (PackOnline, 2019; Personal communication, June 2, 2020). This could be developed further by creating an independent transition arena that is not linked to a specific organization but completely kept autonomous. Furthermore, the actors that come together in said arena should not only think about what is possible with current technologies and infrastructures but strive to create an ideal vision that all the parties involved can work towards. The creation of more structured and reoccurring workgroups could assist this process.

Subsequently, the transition agenda is not altogether absent from this transformation. There are regulatory barriers that steer the regime in the right direction, such as the Single Use Plastics Directive and the Packaging and Packaging Waste Directive implemented by the European Commission in 2019 and 2018 respectively (Directive (EU) 2019/904; Directive (EU) 2018/852). Nonetheless, with the ideal situation of circular plastic packaging in mind, the use of more regime or/and regulatory barriers appears to be necessary to move the transition forward and stabilize the market.

> "*I mean, there are organizations that create, I'm just giving an example, shampoo bottles from recycled plastics, and there are ones that don't do that, and then I think to myself that actually all organizations should be obliged to use it in their shampoo bottles, at least partly, and of course you don't immediately have to start at 100 percent, but with a certain minimum amount and that will eventually provide security with organizations in the entire chain*" (WA 1).

On the other hand, the plastic regime needs a certain degree of flexibility at the experimental and operational level. At this moment in time, the strict regulatory barriers that are designed to keep food safety simultaneously block technological and institutional innovation and opportunity that could push transformation.

> "*Law and legislation, at least in the Netherlands, I think it works delaying. And I think, in the Netherlands, and especially because of Fieldlab, we have created a certain environment and that is also because we are pretty entrepreneurial, but we are being kept short because of the climate we are living in*" (Prod 1).

Lastly, the reflexive governance and monitoring of the transition management is key. Not only is it important to supervise the progress of the actors in the regime in order to reach the sustainability goals and circularity at the desired moment in time, it is also key that, as the line between health and safety and sustainability becomes blurred to allow for experimentation, that niche-innovations and new knowledge are closely observed to ensure that the right regulatory barriers can be set up.

5.5.2 Case 2

For the slow goods regime, there are plenty frontrunners and working groups that facilitate the ability to envision a sustainable future. In the Netherlands, MVO Nederland have created several networks where organizations can come together and learn from each other, such as the "*Koplopernetwerk*" (frontrunner network), and "" (large organizations network) (MVO Nederland, 2020a). Additionally, certain pacts such as the Dutch Plastic Pact, also provide working groups for parties that have joined the pacts (Van Bruggen, Dekker & Waaijers-van der Loop, 2019). If frontrunners and other parties involved continue to gather to educate and support each other, the transition will continue to develop.

With regards to tactical governance and the transition agenda, the regime appears to steer in the right direction. First, it is important that the proposed regulatory guidelines and barriers in the Circular Economy Action Plan will be implemented rapidly, as this ensures the stabilization of the secondary plastics market and forces organizations to use recycled content. This force could then also enable better collaboration between various organizations in the industry, which is essential in a circular economy (MVO Nederland, 2020b).

For the operational governance, enough space seems to be available to experiment with technological innovations, but it is of essence that the innovations are monitored, and that information and knowledge are shared. As possibilities and innovations on a technical level are demonstrated and promoted, the deep structures and culture within the regime and individual organizations will also be challenged, which could eventually allow a shift in the behaviour and routines of actors involved.

> "*So, every business unit is asked to participate and show examples [of circularity] and that is usually also something that reduces hurdles. Show positive examples where it can work, even if it is small and then people believe in it easier and don't give up saying this will not work technically*" (PP 1).

6. Conclusion

This final chapter will provide conclusions to the main research question, and recommendations for future policies. After, the limitations of the research and recommendations for future research will be discussed. Finally, a reflection on the research process will be provided.

6.1 Discussion and Conclusion

This research focussed on answering the following research question:

> What are the barriers and opportunities of the transition towards a circular economy of plastics, and how can the transition be governed?

To answer this question, the fundamental change that needs to occur in order to advance from a linear economy of plastics to a circular economy of plastics needs to be discussed. In short, the producing organizations in a chain, whether it is the petrochemical industry or a brand owner, all have to implement recycled material as their primary input. With this shift, the idea of waste as currently exists also needs to change. Whereas end-of-life products are originally seen as wasteful, valueless material, it should now be seen as material with value and purpose. This requires altercations in law and legislation, where the term 'waste' should largely be replaced with terms such as 'end-of-life' and 'resource', as the collected material will be recycled into new materials, products and life.

The transition to recycled input means two factors have to transform. First, in the ideal situation organizations have to move away from the perception that monetary profit is the most important factor of business. This is then consequently the largest barrier to the transition, as organizations are not always ready to make this payoff. It can be noticed that organizations favour the short-term monetary benefits of virgin materials, over choosing a more stable secondary material market as is the case with plastics. Another aspect that plays a part here is the higher risks that come with secondary raw materials, due to the newness of technologies and the fact that virgin material is a clean slate. As a consequence of these factors, it is unlikely that the secondary plastics market will accelerate as much as desired without law and legislation that obliges the use of recycled content, as the monetary importance remains at the core the regime. The threats of climate change and resource depletion by themselves are not a strong enough factor to change the core business of capitalism and the 'take-make-waste'-model; sustainable transformation will need to be forced via implementation of rules and guidelines.

Second, the transition towards circularity means that all parties in a value chain will need to collaborate with, educate and connect each other. The focus of collaborations should be on (1) making redesign for recycling and recycled content the standard procedure, and (2) supporting niche-innovations in their developments.

For the (re)design for recycling and the use of recycled content, collaboration is important as all steps in plastic production and plastic recycling features of the industry are highly specialized and require high levels of expert knowledge. Without assistance from various types of parties in the value chain, knowing how best to (re)design can be impossible. Parties in the 'forward logistics' need to be highly communicative with parties in 'backward logistics' to not only consider how a product can be recycled as effectively and efficiently as possible, but also consider if and how producing parties can use this recycled material in their products. It is therefore essential that parties discuss the chain from raw material to end product, and back.

The second aspect, supporting niche-innovations, can be executed via the creation of networks, for example, between universities and multiple (front-running) organizations. This would allow organizations to ask for help with technological issues/bottlenecks, whilst it simultaneously gives the opportunity to pitch and research new ideas and technologies. Additionally, all parties in the value chain have different parts of the puzzle to circularity and when placed together, the transition can excel forward at a higher speed, with a higher success rate. This collaboration can be done via working groups or networks, a design table, or partnerships between two or more organizations. Again, knowledge-sharing, and in this case, problem-sharing, gives the opportunity to solve bottlenecks at a faster and more efficient rate.

There are multiple radical niche-innovations that could either enhance the regime (mechanical recycling) or compete with the regime (bio-based plastics), both will help overcome barriers experienced when it comes to technology and infrastructure. For food grade materials, the radical niche-innovation that is necessary but still underdeveloped is, chemical recycling. This is partially due to regulatory and economic barriers, partially due to the carbon footprint the technology has. This can prove to impede the transition, as it forces the regime to maintain its original routines, beliefs and technologies. It is therefore either vital that subsidies are provided to move this technology forward, or that space is provided to develop completely new technologies that could fill in the blanks in a circular food grade material chain.

To conclude, organizations are getting ready for change, they are slowly accepting that their business models will have to adapt to circularity, but the current linear mindset of take-make-profit is still overpowering. For transition management, the right, and speedy implementation of policies either from a European or Dutch level, will push the overall transformation forward. It is also necessary to continuously reflect on the speed of the transition and adapt guidelines, regulatory and economic barriers accordingly. This is because certain drastic events from a global or landscape level, such as the oil war, can quickly turn the regime around to its old habits and structures. In the end, the culture within organizations will have to change with the realization that sustainability has to inevitably become a part of the legacy of a company.

6.2 Suggestions for Future Transition Governance

On the surface, there appears to be a paradox between creating stricter regulatory barrier and easing the regulatory barriers. To understand this complicated situation, it is essential that the realization is made that the plastic industry is not one large, monotonous industry, but consists of many divergent aspects. There are fast- versus slow-moving consumer goods, which are generally created from different types of plastic. Next to that, each sector has a food versus non-food grade division, sometimes adding a medical grade on top of this. Each of the aspects have different rules, require different technologies, and have different markets. For a successful transition throughout the entire plastic regime, it is therefore crucial that these parts are monitored separately, not as a whole, and acted upon wherever and whenever necessary. Of course, this is easier said than done, but for the entire plastic industry to rely on recycled content as their primary input, it is fundamental that there is some level of distinction made.

Overall, however, this governance recommendation comes in threefold. On the one hand, on a European level it is crucial that legislation is developed quickly that stimulates the secondary raw material market. The faster the use of recycled content is mandated, the better the transition will move along. By setting mandatory targets, preferably increasing the percentage every few years, not only will the secondary plastic market grow larger, it will also stabilize. This allows for larger investments in new or improved technologies, security and trust between parties, and the development of niche-innovations, all because it is determined that the use of recycled materials is the way forward. It will take away part of the fear that organizations might drop out of partnerships or collaborations last minute due to sudden drops in virgin prices or other reasons. Growing the market will additionally lower the expenses of (new) systems and technologies, and increase the profit margin. Furthermore, a taxation on the use of virgin materials will motivate organizations extra to definitively move to secondary raw materials and continue to break the deep structures of the regimes.

On the other hand, niche-innovations and experimentations need to be given the space and resources to develop in a secure arena. It is recommended that this is done smaller scale first, on a country level, to be able to keep a better overview of the developments of upcoming innovations and after can be escalated to a larger scale. The stimulation of collaborations, networks and working groups is critical for this to occur. For governmental actors to collaborate with and/or monitor the academic world, as well as help link the academic world to the industry allows for a better understanding of where the plastic industry is heading, what technologies are promising is scaled up, and which main bottlenecks the industry faces. To gather information and knowledge this way supports fast responses where necessary. It shows what policies are too strict and where frameworks and guidelines can or need to be stricter. It is advised that different networks and/or knowledge institutes are encouraged for different parts of the industry, so, specially focussing on i.e. food grade plastics, plastic packaging, or the chemical industry. Here, the government should take on an active role attending gatherings, listening to various parties and collection information. It is after all vital to change the economy to save the planet and humankind, thus creating active collaboration and open discussion with civil society and the market can provide the best information and knowledge to not only change the country, but also set an example to the rest of Europe and the world.

A third, separate aspect that should be kept in mind is that the circular economy does not equal sustainability, it is only a section of the bigger picture. With this comes that the Paris Agreement describes the long-term (>25 years) vision and goals, lays focus on the abolishment of fossil fuels to lower the earth's carbon footprint (UNFCCC, 2020). Therefore, it is recommended that attention is also placed on what technologies and opportunities can outlast the current transition. To think beyond what is necessary to transition, and to what is necessary to sustain circular living is also fundamental. For example, there is currently still a lot unknown about how often plastic can be recycled, what does to the quality of the material, and what happens when the lifecycle of the plastic ends; can chemical recycling solve these issues, or will incineration remain necessary?

6.3 Limitations and Further Research

All of the parties interviewed are in some shape or form related to the internship company. They are also larger or front-running companies, both of which could give a skewed perspective of the real deep structures of a regime. The researcher had a limited time schedule and was therefore unable to interview a larger group. In the research, certain parts of the industry were not interviewed. It would be interesting and recommended to interview parties that are in the incineration or landfilling business as these organizations also have a significant influence on the politics and structures in the regime. It would also be recommended that the status SMEs is researched, as to receive a better perspective on the whole regime. What this research also did not cover, but what is also vital to the transition, is the influence of the consumer on the transition, what can be done to educate the consumer on recycling, product altercations, and other changes.

Next, due to the size of the paper, only the most prominent barriers and opportunities could be discussed. However, it is to be noted that the plastic industry is larger and more complicated as presented in this thesis, and the problems that arise are more intricate and challenging to solve than what might be suggested. More focus should be put the perspective of other stakeholders involved, such as NGOs, politicians and consumers.

Furthermore, what should be noted as well is that the theoretical framework and the dominant theory used to analyse the transition, the MLP, still only allows for a simplified version of reality. Whereas the theory separates the regime from the niche-innovations (Geels & Schot, 2007), this distinction is not as clear in reality. What can be found in practice, is that the larger organizations with power are also the ones that research and invest in new technologies, and that it is not likely that small organizations with new innovations can replace the ones in the old regime. Especially in the plastic regime, which crosses many industries, innovation and evolvement is already part of the business model. The fluid relationships between the multiple levels is something that could be researched further, in order to understand and aid the transition further.

6.4 Reflection on Research Process

Writing a thesis is never an easy process. It involves dealing with problems and challenges head on, with continuous reflections of the steps and choices made. The research and the internship gave me a much deeper understanding of the complexity of the plastic industry, and especially due to the pandemic, I have come to appreciate not only several positive characteristics of plastics but also the waste management industry and its growing significance. However, the following section will reflect on some of the challenges and problems that have arisen during the process.

First, there were difficulties that I experienced in finding a balance between writing academic social sciences research and doing practical research for an organization. As I did not want my academic research to be influenced by the fact that I was doing an internship with a waste management company but wanted to remain objective and observe the regime and value chain as a whole, it proved to be a challenge to find the right research objectives for both. Thankfully, the supervisor(s) at the internship company have been flexible and supportive in regard to finding this balance, which made the process significantly easier. However, finding the right experts to interview could have been done better, as I did not fully finish my theoretical framework by the time I started interviewing the experts, and reflecting back on this I realize the expert interviews could have been more valuable if I had had a better understanding of the theory and the plastic industry.

Second, the pandemic has proven to be a challenge in regard to gathering data. Originally, to ensure triangulation of data, the idea was to take notes during meetings and conversations (when allowed to). However, as the internship continued from home after a mere three weeks at the office, the notes taken were limited, as well as the information that I could have gathered from working experience. Yet, I believe that the diversity of interviewees combined with extra online meetings and more extensive desk research as originally intended has ensured the validity of the results.

Third, the original idea was to organize one or two focus groups with various types of organizations to discuss problems and solution, in trend of a transition arena. However, due to certain ongoing collaborations and innovations between parties, as well as the size of the parties, it would have been extremely difficult to navigate in such a short period of time. The fact that certain organizations have signed NDA's with each other regarding said projects, combined with the fact that the competition authority law can influence collaboration between large organizations, made the creation of a successful, objective and viable focus group unlikely and the choice was made not to hold them. This would have given a deeper understanding of the collaboration between parties and the way in which they would be able to educate each other.

Last, it is necessary to mention the research paradigm chosen, post-positivism. During the research process, it came to my attention that the paradigm might not have been the most fitting to the research as I originally expected. The idea of finding set barriers and opportunities in the transition fit the thought that there is one "true" reality although not completely understandable by humans. In reality, every party, every actor in the supply chain paints their own picture of the situation, and therefore constructivism could have also been an appropriate fit. To remain at a post-positivistic standpoint without ignoring the fact that everyone experiences the situation differently, I have tried to paint an objective, general picture of the situation based on the information gathered, whilst simultaneously acknowledging the individual frames each actor has in order.

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