Institutional incentives in Circular Economy

The Case of material use in the Dutch Textile Industry

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1. Introduction

In the status quo of our linear economic system it is puzzling to understand how to use natural resources in a way that does not put a strain on our natural environment. After an era of almost continuous economic growth, starting at the industrial revolution, since the 1980's it has become clear that this system of ever increasing production and economic growth is coming to an end. We are running out of resources, causing price volatility, uncertainties and economic crises (*Ellen McArthur Foundation*, 2013). Besides the economic urgency to change, there is the topic of climate change and environmental degradation. Emissions caused directly and indirectly by human consumption (of fuel, food etc.) increased levels of CO2 and methane, resulting in a rising temperatures. Global warming will have an irreversible effect on organisms, sea levels and human habitats (Barker, 2007). Climate change is not the only thing damaging ecosystems around the planet. The vast consumption of natural resources and minerals has a devastating effect on ecosystems around the planet. These ecosystems, sometimes seemingly far away and irrelevant to our city-lives, play a vital role in human existence. They provide us with certain 'services', like for example the plants that are used in medicines and the oxygen we breathe that is created by the trees. The value of these 'ecosystem services' is often challenging to assess. Studies regarding these ecosystem services have tried to give them a (monetary) value in order to account for them in discussions about capitalizing on ecosystems (Groot, Wilson, & Boumans, 2002). In short, one can conclude that our current system is neither capable of providing us with economic prosperity (*Ellen McArthur Foundation*, 2013), nor with the vital living conditions for human beings and many other animal species (Costanza et al., 1997). Since it seems impossible to align what is healthy for our natural environment, and implicitly our own health and survival, with what is healthy for our economic system (Groot et al., 2002) we have to rethink this system.

There has been a lot of theorizing about the way to solve this paradox. Since the Bruntland report (1987) put sustainability on the international political agenda (year, source), scholars have come up with different ways of mapping and decreasing corporate activities harming the environment. Concepts like carbon footprint[1], life cycle assessment (LCA)[2], zero emissions 2,3,4 in (Braungart, McDonough, & Bollinger, 2007) and eco-efficiency (Verfaillie & Bidwell, 2000) are examples of frameworks to tackle environmental degradation and climate change. These concepts are all in one way or another concerned with using less resources and producing less emissions, i.e. being more efficient. They start from the status quo of a linear, one-way flow of materials. First materials are extracted from the earth, made into products and finally after being used they are incinerated or landfilled (Braungart et al., 2007).

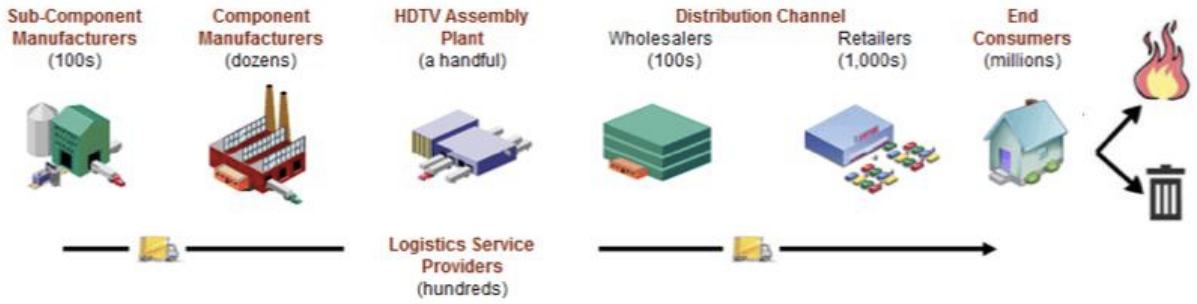

Figure 1. Visualization of a linear supply chain ending in incineration or landfilling.

[1] The Carbon Footprint concept is explained at http://www.carbontrust.com/home
[2] The LCA concept is explained at http://www.gdrc.org/uem/lca/lca-define.html

Eco-efficiency approaches attempt to minimize the velocity speed, toxicity and volume of material flows, but it does not challenge the linear approach and disposal of materials at the end of the life cycle. Seen from an economic point of view, eco-efficiency can result in a short term cost reduction, because of cutbacks in speed, toxicity and volume of material streams. However, reducing costs as a result of using fewer materials will reach a limit, since we still need food to eat, clothes to wear et cetera. It is simply impossible to reach a state of complete dematerialization. When a company grows, production grows and use of materials and energy consumption increases which automatically results in increased emissions. Hence in the long term the concept of eco-efficiency contradicts the concept of economic growth (Braungart et al., 2007), leading to the conclusion that the ecological objectives of zero waste and eco-efficiency cannot be unified with the economic objective of eternal growth (Braungart et al., 2007).

Besides this theoretical argument there is also the fact that a relative reduction of material use in combination with economic growth will still result in a net increase of materials. To give an example, a study on 'Material Outflows from Industries' shows a dematerialization of 25 years of five leading world economies while their waste increased by 28% in total (Matthews et al., 2000). In conclusion, the attempts to be more eco-efficient can result in an (temporary) improvement, but does not provide a long-term solution.

In contrast to these solutions that do not challenge the status quo of a linear 'cradle-to-grave' material flow, a solution can be found in the cyclical metabolisms of Circular Economy (*Ellen McArthur Foundation*, 2013). Circular Economy is an *industrial economy that is restorative by intention and design*. One of the main principles of circular economy is 'waste is food'. This means that all materials and products that are used can be seen as a temporarily depot of materials (or nutrients) that will become the input for new products after their lifecycle. In circular economy the concept of waste is eliminated by carefully designing products and industrial processes in such a way that materials are nutrients in a perpetual flow in either the biological metabolism or the technical metabolism. Circular economy can solve the paradox of uniting economy and ecology by aiming at intelligent design of products and processes in ways that the materials they are made of maintain their status as a productive resource (Braungart et al., 2007) instead of aiming at minimizing material streams.

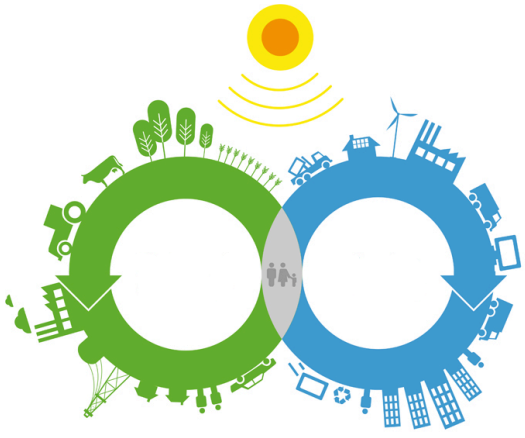

Figure 2. Visualization of circular material flows in biological- and technical metabolisms (Cradle to Cradle, 2015).

Thus theoretically circular economy can reunite economy with ecology. The reality of the current linear economy however creates institutional barriers that have to be overcome in order to transition from a linear- to a circular economy. Institutions are "*humanly devised constraints that shape human interaction*" (North, 1990). They structure political, social and economic incentives and interactions between stakeholders. Institutions can be informal (cultural and religious), formal (rules and legislation),

arrangements (contracts and other arrangements between stakeholders) and they occur in the form resource allocation (in exchanges between stakeholders) (Williamson, 2000). One could say that the system is build up by institutions; intended (formal) and unintended (cultural) institutions originated to fit the system. At the same time these institutions reinforce the existing system. This cycle has to be interrupted on behalf of the transition towards a different – circular – economic system.

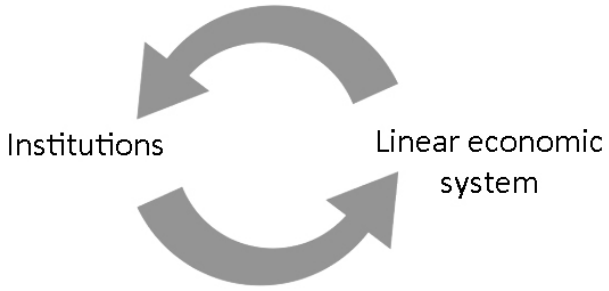

Figure 3. The reinforcing mechanism of institutions and the linear economic system.

1.1. The Dutch textile industry

Globally, the textile industry is a debated industry since it has a severe impact on the environment due to the consumption of an enormous amount of resources and generation of 5% of total waste in the world (textile lab). The two most commonly used resources, cotton and polyester, represent 85% of global fiber production and amounted to a total production of 65 million tons in 2014 (www.circle-economy.com). These numbers are still increasing since consumers are buying 'fast fashion' (Circle Economy, 2015; Circular Textiles Lab, 2015). Fast fashion means low-cost, low-quality garments that are produced in low-wage countries and sold in high volumes on western markets. Examples of companies active in the fast fashion industry are H&M and Primark, who introduce new collections monthly in order to cater to their consumers (CE site). Due to the low quality, garments are disposed of easily and frequently. In the Netherlands, UK and the Nordics it is estimated that 61% of these discarded garments, (from now on referred to as post-consumer textiles) are lost in household waste, ending up in landfill or incineration. From the 39% of textiles, which are collected 84% is reused and 16% is recycled (Massabalans Textiel, 2014).

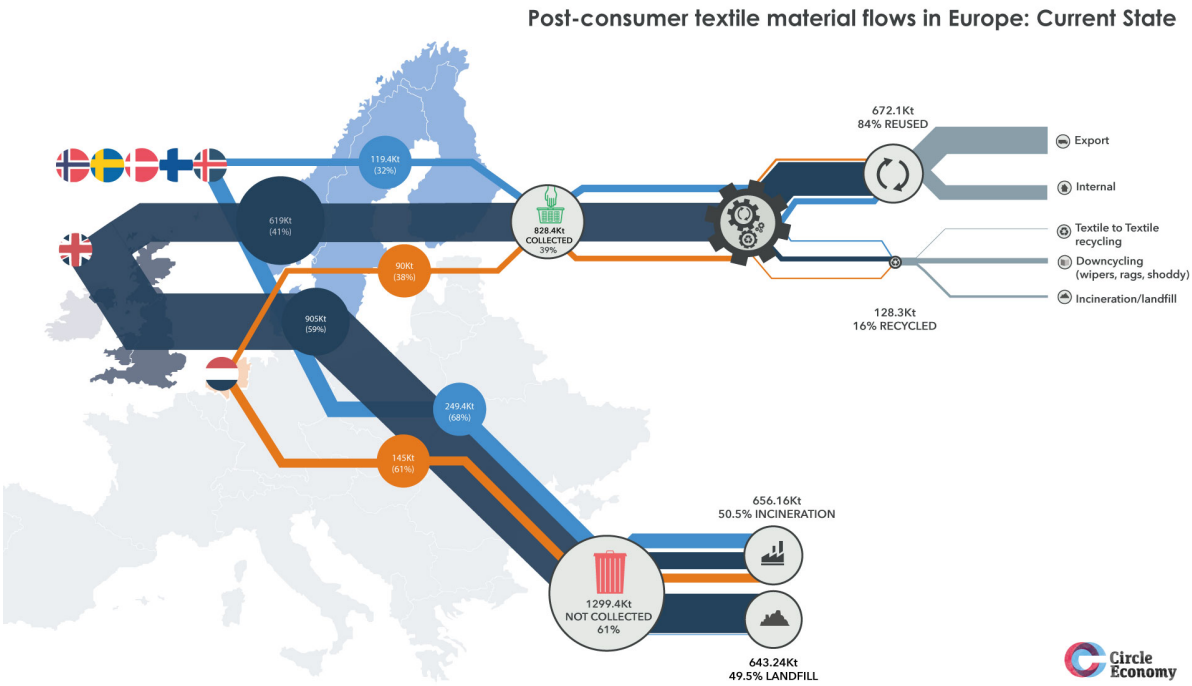

Figure 4. Post-consumer textile material flows in The Netherlands, UK and the Nordics (www.circle-economy.com).

Recycling in reality means down-cycling[3] and after a second life, for example as cleaning towels, textiles are still incinerated or landfilled. Figure 4 visualizes the material flow of collected textile in the Netherlands. This figure shows that post-consumer textiles are partly sold on the second hand market, and partly down-cycled by using the fibers for cleaning towels, or as fuel. It can be concluded that part of post-consumer textiles is recycled, but not al all in a way that creates circular material flows.

[3] Products and materials of lesser quality and reduced functionality (www.wikipedia.org)

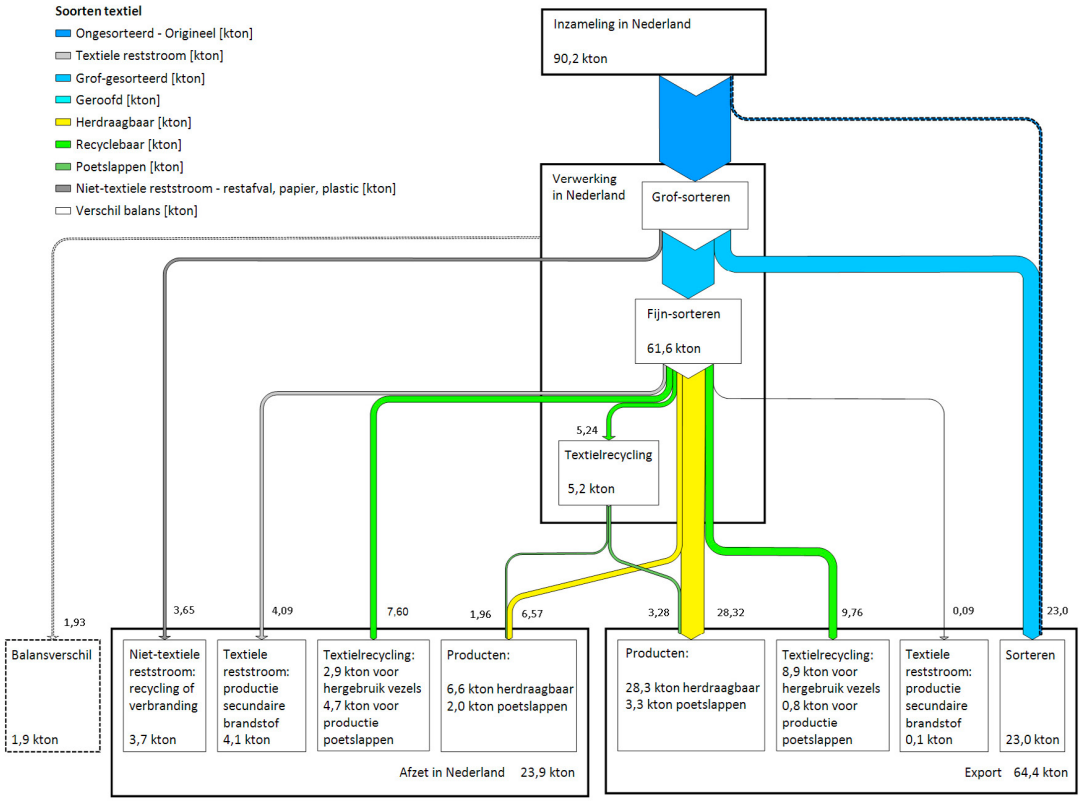

Figure 5. Different uses of collected post-consumer textiles. The lower boxes show down-cycling of fibers (Massabalans Textiel, 2014).

The Netherlands, with different industries starting projects to transition to circular economy, can be seen as a frontrunner country in implementing circular economy. The Dutch textile industry is an example of an industry establishing transition projects. Circular Economy accelerating organizations like Circle Economy and Cradle to Cradle Products Innovation Institute have started programs in collaboration with brands, manufacturers and other stakeholders in textile supply chains. In this research these and other projects in the Dutch textile industry provided insights in how organizations shape institutions for transitioning to circular material flows.

1.2. Research Gap and research question

Circular economy is viewed as a system that can lead to the re-coupling of ecology and economy. The challenge is how to transition to a circular economy when constrained by an institutional system that is aligned with the status quo of linear economy. There is a vacuum of institutions that are coherent with circular economy. The aim of this thesis is to gain insight in how businesses create new institutions in order to align with the circular economy principle 'waste is food' i.e. to create circular material flows. Two strands of literature, one on circular economy and one on institutional analysis, provide the theoretical background for this research.

Currently a clearly formulated and unified theory on the institutions of circular economy is lacking. Therefore this research compares and contrasts empirical evidence form cases and concepts derived from institutional analysis and literature on circular economy to inductively build a cohesive conceptual framework. More specifically institutional analysis has been used to build a theoretical framework on how circular material flows can be established within a linear institutional system.

Research Question

How can circular material flows be established within a linear institutional system?

Sub questions

How do organizations in the Dutch textile industry create institutions in order to implement circular material flows?

What is the role of arrangements in creating circular material flows?

Arrangements are defined as the contracts and other interactions between stakeholders (i.e. organizations) to regulate their economic relations and transactions. Arrangements should not be confused with formal rules such as legislation or legal systems, which are part of the formal institutional environment and are the boundaries within which arrangements between stakeholders can be created and used. Williamson (2000) uses the term 'governance structures', but for the purpose of simplification the term 'arrangements' was found to be more appropriate in the context of this thesis.

Which incentives encourage the transition to circular material flows?

How can institutional changes at arrangement- and incentive level facilitate changes in informal and formal institutions and vice versa?

In the following chapter, theory on the circular economy and institutional analysis are discussed. These concepts are subsequently linked for the purpose of developing new concepts concerning institutions promoting the transition to circular material flows. The choice for inductive research and the decision on cases are explained in the method section. The results of the gathered empirical data are laid out and organized in the analysis chapter, while the discussion section holds debates on the prevailing topics in this research and ends with the formulation of a conceptual framework. In the concluding remarks, implications for stakeholders, limitations of the research and recommendations for future research are provided.

2. Conceptual framework

2.1. Circular Economy

The Ellen MacArthur foundation refers to Circular Economy as an *industrial economy that is restorative by intention and design*, and relies on three principles (*Ellen McArthur Foundation*, 2013, p 14):
1. Waste is Food (Eradicate waste through careful design)
2. No mixing of biological and technical materials
3. Rely on renewable energy

Circular economy (from now on abbreviated to CE) is strongly connected to the earlier concept of cradle-to-cradle. Both concepts are not focused on eco-efficiency but on eco-effectiveness in 'cradle-to-cradle' material flows (Braungart et al., 2007). The cradle-to-cradle concept (from now on called C2C) does not call for minimizing material streams but asks for intelligent design of products and processes in such ways that the materials they are made of maintain their status as a productive resource (Braungart et al., 2007). Products and industrial processes are designed in such a way that materials are nutrients in a perpetual flow in either the biological metabolism or the technical metabolism. Biological nutrients are biodegradable materials and are safe to return to the biosphere to feed biological processes. Examples of biological nutrients are food, cotton, timber and other products that are consumed during the duration of their lifespan and can be safely returned to the biosphere after their lifespan. Technical nutrients are materials that can remain in a closed-loop system of manufacturing, re-use and material recovery. These are often synthetic or mineral materials and are used in a lot of consumer goods (Braungart & McDonough, 2002). The use of toxic materials should be omitted, especially from products that are consumed and return to the bio cycle (*Ellen McArthur Foundation*, 2013).

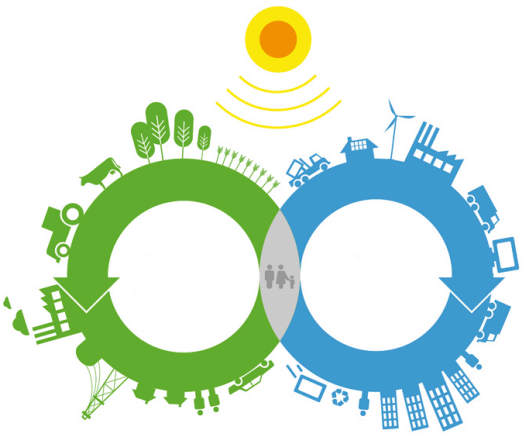

Figure 6. Visualization of circular material flows in biological- and technical metabolisms (Cradle to Cradle, 2015).

In an ideal CE products are designed while taking into account possibilities to re-use products, cascade (parts of) products and to harvest pure materials at the end of a product's lifecycle (*Ellen McArthur Foundation*, 2013). Energy used should always be of a renewable source. The figure below shows the loops in which (parts of) products and materials circulate and cascade. Cascading activities are most valuable towards the inner circle. Activities near the inner circle need the least amount of energy for creating value, since the products only need (minor) alterations. At the same time most of the added value of the product is preserved, since the product or it parts are used again instead of being decomposed into materials (Ellen MacArthur Foundation & McKinsey, 2014).

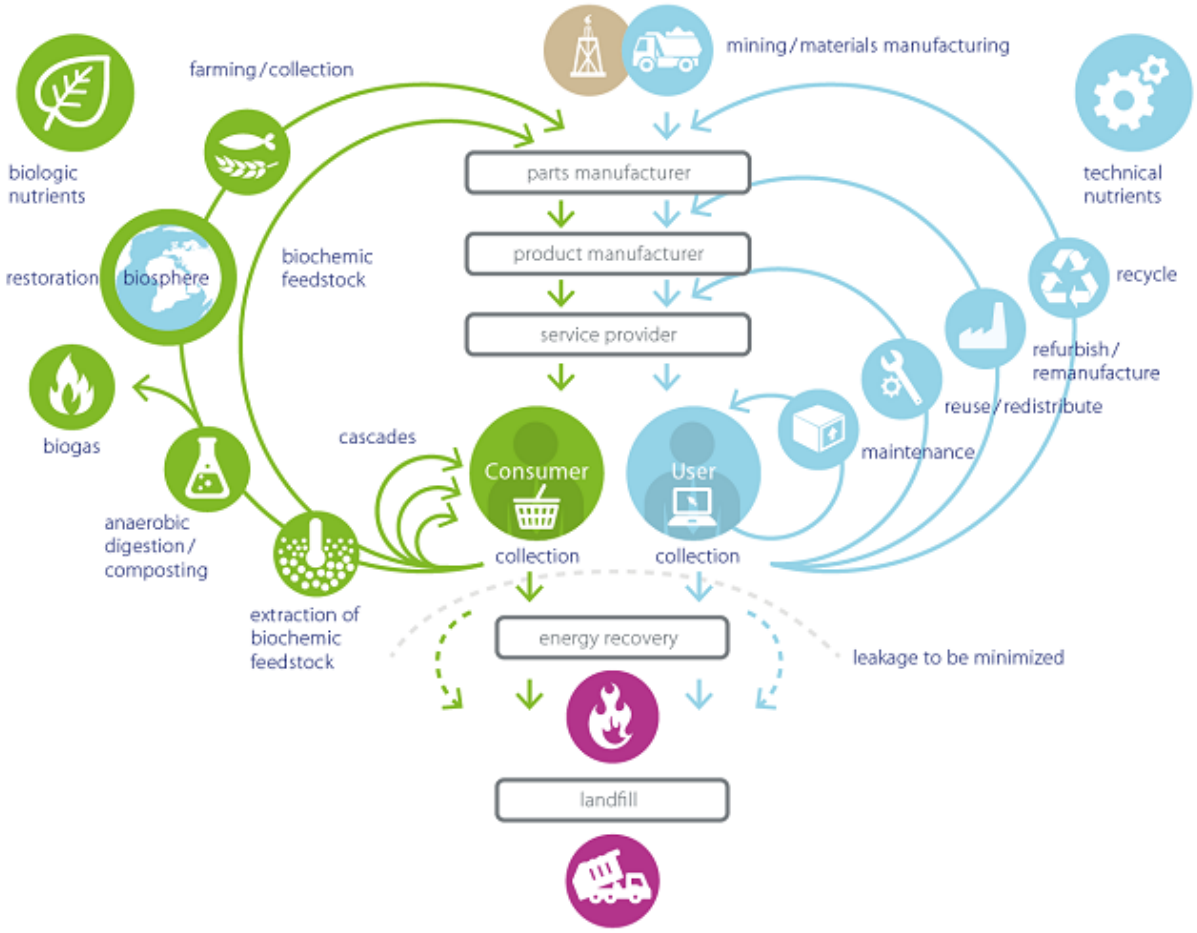

Figure 7. Visualization of cascading in the biological- and technical material cycle (Ellen McArthur Foundation, 2013)

An important feature of CE is that it is not about consuming less, which is a crux in the other sustainability frameworks. Instead it is about emissions being a healthy nutrient for new cycles. This aspect can be seen as a form of 'biomimicry' i.e. mimicking natural phenomena in order to solve human problems (http://biomimicry.net). The natural process that is mimicked in CE is twofold. Firstly, in nature waste functions as food for other organisms, or put differently, waste does not exist (Braungart et al., 2007). Moreover in natural systems excess nutrients are often produced. An example is the blossoms of a cherry tree. Thousands of cherry blossoms are released of which only a few will become cherry trees. The other blossoms serve as food for other organisms (Braungart et al., 2007). If we look at industrial processes trough this lens it implies that the excess materials used and end of life products, which are currently seen as waste streams, should become the input for other production processes.

Being able to use materials over and over again as a nutrient for new industrial cycles implies the capacity to unite a reduction of virgin materials with economic growth and creating growing regenerative abundance. In other words, CE provides a framework that recouples ecology and economy (Ellen McArthur Foundation, 2013; Ellen MacArthur Foundation & McKinsey, 2014).

2.2. Institutional Analysis

North (North, 1990) defined institutions as "*humanly devised constraints that shape human interaction"* and stated that institutions *"structure incentives in human exchange, whether political, social or economic"*. Metaphorically speaking, if we see (social, legal and economic) reality as a game, institutions are the "*rules of the game*". They shape the way actors (inter)act (Anderson & Hill, 2002, 2004). Vice versa actors can also shape these rules. The reason for people or companies to change the rules can be economic, for instance to create more profit, or sociologic, for instance to contribute to a societal cause.

Institutional analysis is concerned with analyzing how institutions are created and function. This field has been developed in two divergent streams of literature: Institutional theory and institutional economics. While institutional theory historically concentrated on the effects of institutionalization on harmonized and isomorphic behavior of organizations (DiMaggio & Powell, 1983) the focus recently shifted towards self-interested agents that shape institutional structures when mobilizing and directing resources with the goal of transforming the institutional environment (Battilana, Leca, & Boxenbaum, 2009). Institutional economics also focus on the role of self-interested agents in changing the institutional environment (Greif, 1998), but explicitly with the aim of exploiting economic opportunities that cannot be obtained in the current institutional system (Anderson & Hill, 2004). In this context another term for a self-interested agent is 'institutional entrepreneur' (Anderson & Hill, 2004). Since the focus of this research is on the content of arrangements created by stakeholders the process of entrepreneurial activity concerning creating arrangements is not further discussed in this research.

Institutional theory and institutional economics approaches both acknowledge that individuals can influence the transformation of institutions. Since institutional theory looks from a sociological point of view, institutional change being driven from a wide range of motivations (Dacin, Goodstein, & Scott, 2002), it has a broader scope than the institutional economics perspective (Pacheco, York, Dean, & Sarasvathy, 2010), which looks from an economic point of view and sees institutional change being driven by a bounded rational individual in search of economic self-interest (Anderson & Hill, 2002).

Both the economic- and sociological background of institutional change are valuable for understanding the reasons for- and ways in which institutions are altered. The question then remains how to categorize institutions. In institutional theory literature institutions are roughly categorized in practices, standards and policies (Pacheco et al., 2010). Institutional economics literature is more dispersed in categorizing institutions. Williamson (2000) categorized institutions in four levels, based on the level of social analysis (figure 8). This categorization leaves room for both economic- and sociological aspects.

1) The first level is 'social embeddedness', and conceives of norms, customs, mores, religion, tradition et cetera. Institutional economists take these deep-rooted societal values and beliefs as 'given'. They can only change over the course of centuries or millennia.
2) The second level is the 'institutional environment', and conceives of formal rules: institutions, property rights and laws (North, 1991). Although change in the institutional environment can occur faster than in level 1, significant changes occur over the course of decades or centuries.
3) Level three is where the structures and institutions of governance are located. Governance aims at crafting *order,* thereby mitigating *conflict* and realizing *mutual gains*. This implies that governance structure reshapes incentives. Optimizing these governance structures is realized at this level. As stated in chapter one, in this thesis these governance structures are called arrangements.
4) Level four is 'resource allocation and employment'. This level is about improving the marginal conditions. Adjustments in price and outputs occur continuously in response to changing market conditions (Williamson, 1998; 2000).
In the figure below solid arrows to lower levels express the constraints that higher levels impose on the lower levels. The dashed reversed arrows signal feedback.

Four levels of institutional analysis (Williamson, 2000)

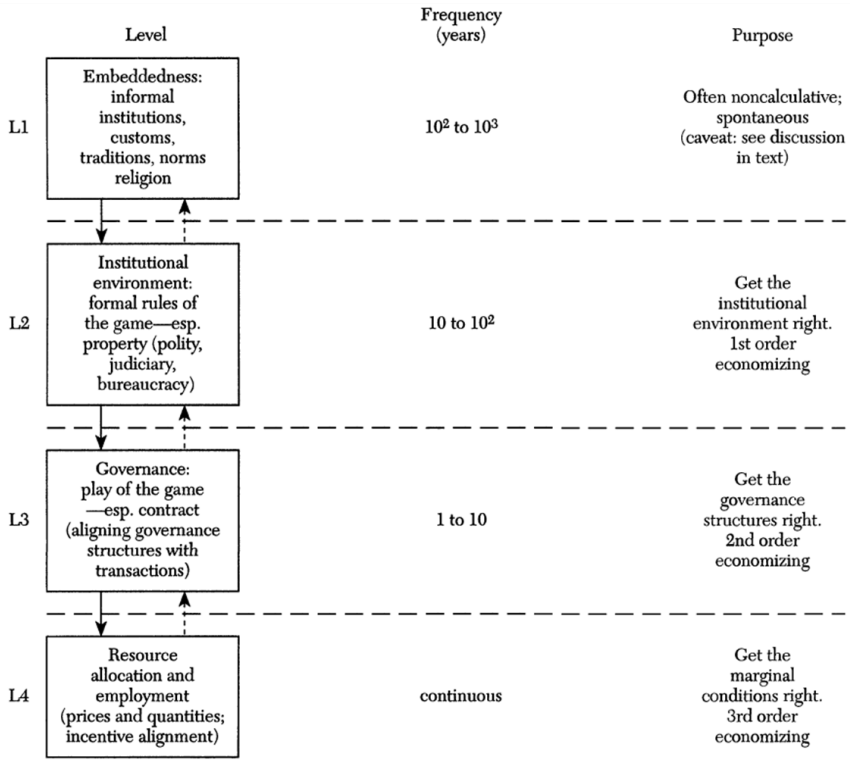

Figure 8. Four levels of institutional analysis (Williamson, 2000)

Categorizing institutions based on the level of social analysis offers the possibility to focus on institutions being created at a certain level. To give an example, institutions concerning cultural habits (level 1) have a different impact and change in different ways than institutions concerning contracts between stakeholders (level 3). These categories provide a clear distinction between different social levels on which institutions can be studied.

2.3. Assessing levels of Institutional Analysis for the transition to Circular Economy

Discouraging the use of scarce virgin materials can be achieved in many different ways. In order to change behavior incentives are needed. The most prevalent idea is that a changing the tax regime - from taxing labor to taxing materials - can provide an incentive to encourage re-use of materials. In the context of Williamson (2000) framework a change in taxation regimes would be a change at level two, the formal rules. Such tax reforms can direct economic activity towards using more labor, while cutting down on consumption (www.theoptimist.nl). This would result in more labor i.e. more jobs close by instead of moving labor-intensive industries to low-wage countries, less transport since products are no longer made in low-wage countries, stronger local economies, more durable products and less waste (www.duurzaamnu.nu). The idea to reform the tax mechanism has been picked up by media and the political arena but has not been applied. Although there are numerous studies presenting the possible advantages, rigorous tax reforms are rejected due to the reigning tax paradigm that is based on labor tax (www.wbs.nl). Besides the fact that tax reforms are not popular in the political arena, the following example shows that taxing externalities in some cases has not proven to be as successful as predicted.

Applying taxes in order to target externalities[4] is an instrument that has been widely used in the transport sector. Approximately 90% of the revenues from environmental taxes consist of motor vehicle ownership and motor vehicle fuels. Taxes have also been installed to target waste collection, water use, pesticides, packaging and fertilizers. The number of taxes on waste disposal and some specific air pollutants has increased in the recent decades (OECD, 2011). However, reasons for implementing such taxes however do not lie in the aim of decreasing emissions and the burden on the natural environment, but lie in the need to increase the income for the state in so-called 'fiscal consolidation strategies' and are purely a substitute for raising taxes on labor or business income (OECD, 2011). Since tax turns appear to be a means to transfer money to the state, which is in a way re-affirming the hierarchic order of the status quo, it is doubtful whether circular economy can genuinely be stimulated by tax measures.

Moreover, the efforts of OECD countries to create such new taxes are aimed at 'green growth'. As stated in a recent OECD document "green growth has been put forward as a new paradigm to achieve simultaneously strong economic growth and a shift towards a cleaner economy, with particular emphasis on low carbon emissions" (OECD, 2010, p.30). The focus is on lowering carbon emissions and on cleaner production, thus on reducing emissions instead of creating positive emissions.

A final problem concerning tax reforms is the minimal positive and sometimes even distortive effect taxes often have on people's behavior (Sipes & Mendelsohn, 2001). Taking a look at the case of gasoline, tax does not provide a convincing incentive. The main policy to reduce the use of gasoline is the use of taxation. A higher tax is expected to reduce the number of cars owned and/or kilometers driven. However, the effect is not a substantial reduction of gasoline consumption (Sipes & Mendelsohn, 2001). Taxation has not proven to be an effective measure to alter behavior. If this example is translated to the case of clothing it is again questionable whether a tax on an environmentally harmful garment would provide an incentive to buy another environmentally friendly garment. Raising prices can make the jeans less available for some people, but more attractive for others, since buying expensive clothing is seen as a status symbol (Tzioti, 2010).

These arguments illustrate that changing tax regimes cannot offer the necessary institutional changes to stimulate the transition to circular economy. Furthermore it is debatable whether changing tax regimes will create a convincing incentive to re-design material flows in a circular way. A more complex

[4] Externalities are the costs (or burden), which are not expressed in the price of a products. For example the burden on the natural environment when extracting natural materials from an ecosystem is not represented in the price of the material

approach in which actual interactions and arrangements between stakeholders (level 3), but also cultural habits and preferences (level 1), are structurally changed is needed. Thus the transition may not primarily lie in alterations of formal rules such as the taxation system (level 2), but may lay in a combination of institutional solutions at all different levels.

For the purpose of this research the focus lies on institutions of level 3 -contract aligning and governance structures (i.e. arrangements) - and level 4 - prices and incentive alignment (i.e. incentives). Ways in which stakeholders create arrangements, such as contracts, in order to create circular material flows are the point of interest. Although these arrangements have to comply with the formal rules of level two, they are created by stakeholders at levels 3 and 4. The last sub-research question (*How can institutional changes at arrangement- (level 3) and incentive (level 4) level facilitate changes in informal (level 1) and formal (level 2) institutions and vice versa?*) focuses on bottom-up and top-down processes between different institutional levels.

3. Methods

As stated in the introduction this research is inductive in nature. The method used is to build theory by using data from multiple cases. The benefits of this research method are explained by Eisenhardt & Graebner (2007). They state that building theory from cases (i.e. based on rich qualitative evidence) is one of the best methods to develop constructs and testable theoretical propositions for mainstream deductive research. Additionally, being deeply embedded in rich empirical data, building theory from cases often generates theory that is testable, accurate and noteworthy (Eisenhardt & Graebner (2007).

In CE theory it is explained why CE is the most effective way to go about material use. However there is no existing theory on how CE can be implemented. Institutional analysis theory so far has not focused on CE. Because of the all-inclusive and paradigm shifting nature of the CE concept changes cannot merely be explained by looking at existing theory of institutional analysis and institutional entrepreneurship. Currently no theory exists that provides an answer to the question 'how organizations create new institutions in order to create circular material flows'. Due to the lack of existing theory on this subject new propositions are needed that provide a testable theory. This is of importance both for CE practitioners and scholars who use institutional analysis to explain the complex and interdependent functioning and change process of institutions in our society, particularly institutional analysis research with a sustainability focus. This inductive research will extend institutional theory on the topic of paradigm shifting institutional changes and the interaction between different institutional layers in case of such changes.

Cases were selected following two criteria: Being a frontrunner and availability. Firstly, the selected cases are organizations that are frontrunners in the transition process to circular material flows in the Dutch textile industry. Secondly, the organizations had to be available for interviews and willing provide information on their activities in creating circular material flows. Selected cases consist of three CE accelerating organizations: Cradle to Cradle Products Innovation Institute, Circle Economy and Turntoo, two organizations in the Dutch textile industry that are transitioning to circular material flows: House of Denim and Lena Fashion Library and a seminar with multiple stakeholders from the Dutch textile industry: the Circular Economy Lab's Textile Edition (from now called Circular Textiles Lab). Interviews with- and documents from these organizations provided rich qualitative data. Interaction with the first organization provided the main sources of information. Following this first cluster of data concepts and ideas were further fine-tuned and compared with data from the other cases. The method of triangulation was used to introduce concepts arising from previous cases in consecutive interviews with other stakeholders. This method allowed for comparing different perspectives on state of the art CE practices and theories. The theory building process existed of this triangulation method and of recursive cycling among the data. This resulted in new concepts that expand existing theory and can be tested in future research.

The inductive process consisted of two conceptualization rounds. The first conceptualization round took place during and after creating the theoretical framework in order to find a method to explain the transition towards CE by using the institutional analysis framework. This conceptualization round provided the main concepts for the in-depth interviews with CE accelerating organizations and other CE practitioners in the Dutch textile industry. The second conceptualization round took place in the discussion section. In this round the findings were discussed and linked with existing theories, which resulted in new themes that were developed in testable concepts. These new concepts are status quo arrangements, material as service arrangements and circular supply ecosystems and will be further explained in the discussion section.

4. Analysis

4.1. Introduction

In this chapter the results of the empirical research are put forward. First the activities of the circular economy accelerating organizations (Cradle to Cradle Products Innovation Institute, Circle Economy and Turntoo) are explained. In the way they approach the transition to circular material flows a dichotomy was found between a 'status quo' pathway and a 'material as service' pathway. The next section elaborates on this dichotomy and provides examples of pioneers in both approaches, followed by a section on the implications of the different pathways for consumers, retail, manufacturing, geographic position, industry structure and business models. The final part of the analysis consists of, contracts, financial arrangements and supply- and demand matching, which are considered as 'tools' that stakeholders can use for shaping the transition process.

4.2. Circular economy accelerating organizations

Cradle to Cradle Products Innovation Institute, Circle Economy and Turntoo contribute to the transition to a CE in different ways and their data gives a valuable insight concerning the transitions towards closed loop material flows in the textile industry. These organizations play important roles as brokers in the process of change that is taking place. First, their role and activities in the transition process is discussed.

4.2.1. Cradle to Cradle Products Innovation Institute

Cradle to Cradle Products Innovation Institute (from now on Cradle to Cradle) is a non-profit organization and certification program that helps organizations to optimize their materials and the design of their products in order to obtain the certificate *Cradle to Cradle Certified*™. The highest standard, a gold-certification level, indicates that products in the textile industry can be up-cycled to new fashion items. No toxic substances are used and no materials from the biological- and technological cycle are mixed (Cradle to Cradle, 2015).

Cradle to Cradle considers blends of materials from the biological- and technological cycle as main bottleneck for the transition towards a CE. It is very complex or impossible to separate blended materials in order to up-cycle them in new fabrics. These blended materials are being down-cycled into products like cleaning towels and lining for the back of cars or in the worst care are landfilled or incinerated. In order to optimize materials and designs to create the necessary material quality for up-cycling, together with brands, Cradle to Cradle moves back in the supply chain. Not only the finished product needs optimization, also at the yarn, colorings, buttons et cetera need to comply with Cradle to Cradle certification standards. Moving back in the textile supply chain is necessary because this often leads to Asian countries where materials are mixed and pollutants are used that are not allowed in Europe and the US. In order to improve these processes these spots in the supply chain have to become visible. In the Fashion Positive initiative Cradle to Cradle, together with large brands like Stella McCartney, G-star and Trigema, try to raise their material standards to a gold-certification level in order to create fabrics and other materials that can be up-cycled after use. One of the partners in the Fashion Positive initiative is Circle Economy (Cradle to Cradle, 2015).

4.2.2. Circle Economy

Circle Economy is a non-profit organization that focuses on changing the system instead of focusing on product innovation. Circle Economy is a non-profit network platform and chain-director. Their activities are two-fold. On the one hand they focus on research and analysis of the circular

economy; to collect data and visualize the situation in order to create awareness and provide insight in the movement towards CE. On the other hand they develop strategies to undertake action and are actively involved in implementing those strategies. In their 'Circular Textiles Program', Circle Economy "*aims to establish a process that ensures the recovery and up-cycling of textiles in a closed loop*" (www.circle-economy.com). The aim is to break the barriers that prohibit scaling up the use of post-consumer textiles in the fashion industry. Part of their circular textiles program, the 'Textile Sorting Project' aims on developing a commercially feasible sorting technology called 'Fibersort' that is able to detect fiber composition of post-consumer textiles (Circle Economy, 2015).

4.2.3. Turntoo

Turntoo introduced the concept 'material as service'. The vision of Turntoo is to treat products as 'storerooms' for re-usable resources. The ownership of products remains with the producer and consumers only pay for using a product (www.turntoo.com, 2015). After the use-period the product returns to the company that can lease it out again, refurbish it or re-use the materials. Turntoo changed its strategy since they started in 2010. Turntoo started out as a platform and intermediary between producers or suppliers and consumers. The focus was material knowledge, but Turntoo soon realized that this knowledge is already present at the companies they work with. Moreover by taking a key position in trying to create a circular chain diminished the incentive for their clients to actively change. Turntoo changed its strategy and shifted focus towards developing creative business models that allow companies to either make their products available as a service or help clients that want to use products by service contract to find companies that want to provide these services (Turntoo, 2015).

4.3. Two pathways for a circular textile cycle

While analyzing case materials two pathways were distinguished for creating circular material flows in the Dutch textile industry. These pathways are divided by either a focus on optimizing up-cycling technologies and infrastructure, promoted by Cradle to Cradle and Circle Economy, or a focus on providing products in service contracts, promoted by Turntoo. These pathways, called *status quo* (from now on abbreviated to SQ) and *material as service* (from now on abbreviated to MAS), are addressed in detail in this section.

4.3.1. Status quo: introduction

The SQ pathway implies optimizing and expanding existing collection systems. The label SQ is chosen because this set of arrangements builds on the existing collection system and industry structure. One way to close the loop of material flows is to use the existing infrastructure. In SQ post-consumer textiles (i.e. textiles that are discarded by consumers) are first collected. This can be done by container collection, which is similar to how glass and paper are collected. Another scenario is to collect textiles by door-to-door collection. Delivery companies can for instance organize this by collecting post-consumer textiles when delivering packages. Here the question arises whether the costs of collection will (at least) equal the value of these post-consumer textiles. The third scenario is to organize post-consumer textile collection in clothing stores in combination with a reward for returning textiles in the form of a discount on a next purchase. This will provide an incentive to return post-consumer textiles (Circle Economy, 2015). Collection containers for old textiles can already be found most cities. Large players in the Dutch textile industry execute the collection, sorting- and up-cycling processes in the current SQ pathway.

After collection textiles are sorted into re-wearable and non-rewearable textiles. The re-wearable textiles are either sold in the Dutch second hand market or transported to other countries. The non-rewearable textiles are further sorted into textiles that are fit for fiberization[5] and textiles that cannot be

[5] Fiberization is the process of breaking up fabrics into fibers

fiberized (which end up in garbage). After fiberization the fibers can be mixed with virgin fibers for creating new fabrics. Fibers harvested from fiberization are shorter then virgin fibers, therefore they are of a different quality and they need to be mixed with virgin fibers in order to create new fabrics. It is currently impossible to create a high quality fabric from purely re-used (fiberized) fibers (Circular Textiles Lab, 2015; House of Denim, 2015, Massabalans Textiel, 2014).

4.3.2. Status quo: pioneers

Cradle to Cradle: Fashion Positive

Companies in the textile industry are currently getting ready to scale up the re-use of materials for new fabrics. Cradle to Cradle states that their Fashion Positive initiative is in a 'leadership phase'. Together with nine renowned brands they are working together to show their customers and the rest of the industry that it is possible to create Cradle to Cradle materials and circular textile flows. When these materials become available at large scale the aim is to expand these practices industry wide (Cradle to Cradle, 2015).

Most of the large textile producers are situated in Asia. These factories produce for many different brands and they are not prepared to change their production processes if only one brand asks for different materials. Collaboration between brands is necessary to create enough weight to convince them to change their materials. When brands collectively ask for optimized materials this creates an incentive for the producer to optimize their materials. Despite the competitive nature of the fashion industry, brands have to work together to create leverage for the transition towards a circular textile industry (Cradle to Cradle, 2015).

To start the transition, together with a brand, Cradle to Cradle creates one product or one collection. Due to the scarce availability of optimized materials in this developing phase it is impossible to change the whole collection of a brand at once. "*Currently there is no producer and no brand that can deliver that kind of material, that is what we are working on at the moment*" (Cradle to Cradle, 2015). It will take a substantial amount of time before using optimized materials can become a common practice.

Cradle to Cradle gave one example of a brand that went back in the chain and asked the yarn producer to optimize their yarn for up-cycling after user life. Together with Cradle to Cradle they succeeded in optimizing the yarn in several colors. This yarn producer sells to different brands and can sell the optimized yarn on a greater scale now, demonstrating that the transition to material reuse consists of a process of going back in the chain in order to optimize materials. After going back in the chain pressure is directed upwards to distribute the optimized products though the chain. In other words, the process of optimizing materials consists of both top-down and bottom-up processes in the textile supply chain (Cradle to Cradle, 2015).

Cradle to Cradle (2015) also mentioned other promising initiatives. One company is currently capable of splitting a blend (for instance cotton-polyester, a blend of biological- and technical nutrients) and another company has succeeded to heat garments in order to release the yarn. These can be a valuable technologies seen the fact that garments with a lot of stitching lines[6] cannot be up-cycled. However, these new technologies are still used on a small scale at the moment and have to be further developed and scaled up. Circular economy accelerating organizations like Cradle to Cradle or Circle Economy can link technologies to brands (Circle Economy, 2015; Cradle to Cradle, 2015).

[6] For example the upper part of jeans have so much stitching lines, due to pockets and zippers, that this part is not fit for up-cycling.

Circle Economy: Textile Sorting Project

The textile sorting project is initiated by Wieland Textiles and Circle Economy and is a joint effort with Valvan Baling Systems, Methrohm, Worn Again and ReShare (Leger des Heils). In this consortium, Valvan Baling Systems is responsible for building a post-consumer textile sorting machine called 'Fibersort', Methrohm for developing scanning technology, ReShare is the collection company, Wieland Textiles is the sorting company, Warn Again the expert and market developer and Circle Economy is the chain director and project manager (Circle Economy, 2015).

Warn Again, based in the UK and currently developing a technology for chemically recycling cotton-polyester blends, joined the consortium because they foresee the need for feedstock for a factory to be built in the near future. At this moment it is still difficult to sort feedstock into what is usable and what is not, a problem that this machine could resolve. However, Warn Again is aware that this technology cannot work efficiently if there is no infrastructure for recycling old garments. The system of the reverse-logistics, sorting, possibly a material library for post-consumer materials, processing into new materials and the demand for those materials is absent at the moment. The companies that work together in the textile sorting project comprehend that they have to cooperate with new stakeholders that to create this infrastructure (Circle Economy, 2015).

ReShare collects old garments and sees its business model change when people are encouraged to throw all their old garment, also non-rewearable textiles, in the containers. ReShare needs a way to valorize these materials with an up-cycling technology and infrastructure whereas at the moment collecting these non-rewearable textiles is costly instead of profitable (this will be further explained in 4.4.6. Business models). Here the Textile Sorting Project exposes a problem caused by the current linear functioning of the textile industry. The problem of costs for collecting non-rewearable textiles has to be dealt with in order to create a profitable business case. Smits (Circle Economy, 2015) calls this problem a 'chain deficit'. One solution can be government subsidizing (Circle Economy, 2015; Circular Economy Lab, 2015).

Warn Again and other companies like Ionica, Renew Cell, Saxion, Evernew and Teijin are all developing textile-recycling technologies. All these stakeholders need the Fibersort technology to handle large volumes of post-consumer textiles, since it is to expensive and time consuming to sort by hand. Moreover, since labels on garments often do not correctly reflect the substances, this technology will function as a quality control system. Circle Economy states that if these various technologies – i.e. the sorting and the recycling technologies – can be commercialized this could be the tipping point in scaling up processing post-consumer textiles and creating circular material flows in the textile industry (Circle Economy, 2015).

House of Denim

Another new initiative is House of Denim, a 'denim lab' that just opened its doors in Amsterdam. House of Denim aims at setting an industry wide standard of using a small percentage (around 3%) of non-rewearable textiles (which they call PCR) in all newly produced fabrics. House of Denim built the denim lab with an investment of their Turkish manufacturer to show their stakeholders the possibilities of quality denim fabrics that are made with a percentage of non-rewearable textiles. The lab is primarily a small scale prestige project to show the possibilities of using non-rewearable textiles in new fabrics. As mentioned above these fiberized fibers are shorter then virgin fibers and have to be mixed with virgin fibers to create a new fabric. The percentage of non-rewearable textiles influences the characteristics of the fabric. They are in the process of establishing a denim-fabric brand to show clothing brands, consumers and other stakeholders that it is possible to create high quality fashion with fabrics with a percentage of non-rewearable textiles. House of Denim is also exploring possibilities to work with a large production factory in Spain that is distinctive since it owns a shredder (i.e. a machine that can make fibers

from non-rewearable textiles) (House of Denim, 2015).

4.3.3. Material as service: introduction

As stated above, MAS is a concept that was introduced by Turntoo. By providing products in service contracts, like for instance a lease contract, ownership of the product remains at the producer or leasing company while consumers pay for using the product for a certain period. When the product returns to the company after use cascading activities like leasing again, re-furbishing or harvesting materials take place (the concept of cascading is further explained in 4.4.5. Supply chain structure).

For Consumers this type of contract has the benefit of guaranteed quality and the possibility to change to another model after the lease period without having to invest a large amount of money at once. For the company the advantage of a lease contract is direct contact with its customers. This way the company can receive direct feedback and establish a durable relationship with its customers, which is also enhanced by the financial advantages of leasing a new product after the contract period (Turntoo, 2015). Since it is in the interest of both the customer and the company to use high quality materials this system will lead to less fast fashion and taking responsibility for the quality and recyclability of materials that are used (Cradle to Cradle, 2015).

Turntoo explains that creating MAS in the textile industry will be more challenging then creating MAS in some other industries due to its business-to-consumer character. When developing a business case with circular material cycles business-to-business contracts are more cost-effective than business-to-consumer contracts. When dealing with businesses, there are fewer parties to keep communicating with. Moreover businesses are rational in the sense that they will change if it is a profitable proposition whereas individual consumers make decisions based on a mix of rational and emotional impulses (Turntoo, 2015). A challenge for MAS is to change the mindset of consumers from owning garments to leasing garmets. Moreover it should be easy for customers to switch garments on a frequent basis.

Another challenge lies in the return logistics. Tracing and collecting the products after the user-period is less costly if products are for instance located in five big companies instead of in five thousand households. Moreover, deals with companies are more likely to result in cost-savings from creating economies of scale. Scale is an important topic when reorganizing logistics around different cascades, like for instance maintenance and return-logistics. For the textile industry, "*there is a bigger challenge for a smaller scale*" (Appleton, Turntoo, 2015).

4.3.4. Material as service: pioneers

Lena the Fashion Library

Lena the Fashion library is a new material as service business model. It is both a store where people can buy clothes and a library where clothes can be rented. Their collection is a mix of upcoming designers, old collections of eco labels and vintage. All garments in Lena are of high quality, which is a necessity when garments are worn by different customers. Lena exposed a divide between brands that do not want to be on display at Lena out of fear to be associated with 'second hand' garments and brands that explicitly do want to be on display at Lena because they perceive the concept as a new sustainable business model for fashion. They take this latter role serious and collaborate with motivated brands in order to make their processes more sustainable.

Figure 9. Impression of Lena the Fashion Library.

A subscription costs €20 per month which is worth hundred points. All garments in are assigned a certain amount of points (for example a dress can be 50 points and a top 30 point) and people can always borrow their hundred points worth of garments. When they exceed this amount they can pay extra. The owners of Lena had to invest their own capital in the project since banks did not want to finance their business model. Although this was a disappointment at first it allowed the owners to fully remain in control of their business. The project turns out to be successful since their client base has increased to exceed their forecast (Lena the Fashion Library, 2014).

Mud Jeans

MUD Jeans is the first brand that created a business case of leasing jeans. In their business model customers can lease a jeans for €5 per month and an entrance fee of €20. After one year the customer can either decide to pay €7,50 to switch to another jeans or pay another €20 to keep the jeans. When the jeans is too old to wear MUD jeans refunds €20 as a deposit to spend at a new MUD Jeans garment for returning the jeans and will use the materials to up-cycle into new fabrics by blending them with organic virgin cotton. Since MUD Jeans always remains responsible for its jeans they offer a repair service free of charge (www.mudjeans.nl, 2015).

4.4. Implications of status quo versus material as service

In the previous section the emerging dichotomy between SQ arrangements and MAS arrangements was introduced by using case examples. From the distinction between the SQ pathway (4.3) and the MAS pathway (4.4) the following can be concluded.

In case of the Fashion Positive initiative materials are optimized so they can be up-cycled after user life, i.e. the focus is on the technological aspects of up-cycling. The Textile Sorting project is about creating a sorting machine that will allow economies of scale in the sorting stage and about collaborating with supply chain partners in order to close material cycles. This can enable a business case for up-cycling post-consumer textiles into new fabrics. Both these projects focus specifically on the material aspect. The aim is to improve materials and facilitate large scale processing of post-consumer textiles in order to create momentum in using these fibers in new fabrics. Besides the aim of creating a new industry standard of using a certain percentage of post-consumer fibers in fabrics these projects do not debate the ways

garments are sold or bought. The aim is for a new industry standard within the current way the textile industry is organized, i.e. they build on the status quo.

The MAS concept of Turntoo does not focus on technologies for collaboration within the chain, but proposes a holistic approach in by focusing on providing material as service and remain added value by using as many as possible cascades before harvesting materials for a new cycle. In this approach materials are one aspect, but optimizing materials is seen as a process that will evolve, since every cycle will provide new feedback about what aspects of a products can be improved i.e. it is not the main goal. This concept of material as service is not a concept that will work within the current textile industry, it includes a paradigm shift in the way garments are sold and bought. In the case of textiles MAS means that garments are leased or rented in the form of service contracts (like Mud Jeans) or libraries (like Lena the fashion library).

Following one of these pathways in the transition to circular material flows will have different implications for stakeholders and supply chains. In the this section these consequences of the SQ pathway and the MAS pathway are compared. From now on SQ arrangements and MAS arrangements are comprehended as sets of arrangements that facilitate respectively the SQ pathway and the MAS pathway to circular material flows.

The following table provides an overview of the implications of SQ arrangements and MAS arrangements. The implications are compared topic-wise in the following paragraphs.

Implications for:	**Status quo (SQ)**	**Material as service (MAS)**
Consumer	- No change Garments are bought; (container) collection of post-consumer garments No implications concerning quality	*Lease garments* Garments are leased and returned to the owner (brand) after use Quality of products is high
Retail	- No change No implications for retail business	*Threatened* Retail business redundant because of contract between brand and consumer
Manufacturing	- No change Responsibility can increase due to new legislation, but not due to CE system	*Full responsibility for product* Products return to the company after use; High quality and safety of material is in the advantage of the company
Geographical	*Manufacturing in Europe and/or Asia* Depending on costs/benefits of creating post-consumer up-cycling plants in Asia versus Europe	*Cascading systems in Europe* Cascading system results in local hubs
Supply chain structure	*Collaboration and new chain actors* New stakeholders entering the supply chain and increased collaboration	*Cascades* Stakeholders will specialize in certain cascades (i.e. maintenance, re-use, refurbish, material harvesting)
Business models	*Same business model* Collaboration with (new) chain actors	*MAS business models* CE business models and collaboration with chain actors for different cascades

Table 1. Overview of the implications of SQ and MAS.

4.4.1. Consumers

SQ arrangements imply expanding the container collection systems and to stimulate consumers have to bring their old garments to these collection facilities. However, communication concerning what should be thrown in these containers has been poor. The prevailing idea amongst consumers is that these garments are sent to poor countries and therefore people only throw in quality garments that can be worn again. In order to capture all post-consumer textiles consumers have to be educated about the new possibilities to up-cycle these textiles. Moreover consumers have to be motivated to throw all their old textiles in the container, which can be done by providing an incentive in the form of a free item or a discount on a new purchase (Circle Economy, 2015; Cradle to Cradle, 2015).

MAS arrangements imply that garments are leased instead of bought. This asks for a change in mentality from consumers. Consumers will benefit from MAS since the quality of garments will improve, because the manufacturer remains responsible for- and is owner of the material (Turntoo, 2015).

4.4.2. Retail

SQ arrangements will not have a substantial effect on retail. Retail locations may be used not only for selling garments but also for collecting post-consumer textiles after user life and may provide some education and/or rewards for returning post-consumer textiles (Circle Economy, 2015).

MAS arrangements can have severe effects on the retail sector. This is for instance shown by the example of the fear of electronic retailers that retail will become obsolete when electronics are provided as service by the brand (Turntoo, 2015). Likewise Mud Jeans does not need retail shops. Customers can order jeans and try them at home before deciding which jeans to keep and which jeans to send back. MAS challenges retailers to rethink their reposition in the supply chain.

4.4.3. Manufacturing

SQ arrangements are affecting manufacturing in the sense that new technologies for sorting, fiberizing and up-cycling post-consumer textiles are implemented. This may result in a new industry standard of using a percentage of post-consumer fibers in new fabrics (Circle economy, 2015; House of Denim, 2015; Circular Textiles Lab, 2015).

MAS arrangements will affect manufacturing in the sense that manufacturing companies will become increasingly responsible for their products and materials. This increased responsibility is caused by the shift of ownership from consumers towards manufacturers. The fact that products and materials return after user life provides an incentive to make products of the highest possible quality and safety (Turntoo, 2015).

4.4.4. Geographic position

Due to globalization and labor costs the textile manufacturing industry largely moved to Asia in the past decades. The quality of textiles produced in large volumes in Asia is often low. Materials and garments produced in Europe are of higher quality, but are also more expensive. In the current linear textile chain products are manufactured in Asia and shipped to Europe where they are sold (Cradle to Cradle, 2015). The current geographical separation between manufacturing and consumption cause two problems. In the first place technologies and know-how concerning up-cycling post-consumer materials are situated in Europe. These technologies need to be transferred to manufacturing plants in Asia in order to scale up the process of closing material cycles (Circle Economy, 2015; Cradle to Cradle, 2015). Second, the question arises if- and how post-consumer textiles can be transported back to manufacturing sites in Asia in order to up-cycle the fibers in new fabrics (Circle Economy, 2015).

SQ arrangements find solutions in building manufacturing facilities in and around Europe again, specializing in processing and up-cycling post-consumer textiles (Circle Economy, 2015). Another option

is to transfer post-consumer technologies to Asian manufacturing sites. Then the question arises whether transporting post-consumer textiles back to Asia can be made cost-effective. Moreover, competition on price impedes investments in new technologies to create materials that can be up-cycled after use. Investments from the revolving fund[7] of Cradle to Cradle in collaboration with several manufacturers can be an incentive for optimizing technologies for up-cycling post-consumer textiles (Cradle to Cradle, 2015).

MAS arrangements imply more local hubs (Turntoo, 2015). When creating cascades activities for re-using (parts of) products and materials local hubs will develop and will specialize in certain cascading activities like for instance refurbishing or maintenance. This way a market is created for local initiatives that can cater to the needs that arise from creating circular material flows with MAS arrangements. Appleton foresees small local businesses developing their own business models, contracts and collaborations with other stakeholders (Turntoo, 2015).

4.4.5. Supply chain structure

SQ arrangements imply increased collaboration and new stakeholders entering the supply chain. Examples are collaboration with competitors to create mass to develop and implement technologies, like in the Fashion Positive initiative. Examples of new supply chain partners are the software designer entering the textile supply chain for creating the Fibersort machine (Circle Economy, 2015).

MAS arrangements will effect the supply chain structure more drastically in the form of cascading activities. Cascading is an important concept for MAS. Since the majority of the value of a product is captured in its function and design whereas the raw materials portray only a small percentage of the value, the profit is the highest in the cascades closest to the center. In these cascades most of the value is preserved while using the least amount of energy since (parts) of products are re-used, saving the energy needed to harvest materials and transform them in completely new products. Not many companies can take care of all these cascades themselves, resulting in the need for partners for the other cascading activities (Turntoo, 2015). This can be clarified by the example of Dutch Spirit, a company that uses long yarn in their suits in order to re-use materials and is interested in applying the lease concept. Dutch Spirit stated if they would have to do all these cascades themselves they would eventually turn into a material processor, while their goal is to make suits from good quality fabrics and to have close contact with their customers (Turntoo, 2015). This shows that companies have to find partners for cascading activities. They have to re-define what steps are necessary to use products and materials most effectively and they have to decide which cascading activities to outsource and which activities to maintain or develop in-house. This shows a changing supply chain structure (Turntoo, 2015).

This transition is creating the urge to make the supply chain visible, to redefine where value can be added along the chain and possibly reposition the company. How the supply chain will change, what cascades become important and which activities become redundant will likely differ per industry or industry segment (Turntoo, 2015). This process of changing supply chains has taken off but will take substantial time to develop. The first signals arise of chain actors that are realizing that their position is endangered by this chain transition. This concerns wholesalers and retailers that see their position threatened by the new service contracts between brands and consumers (Turntoo, 2015). There is an advantage for the companies that actively look at their position in the chain and are in the position to choose their role in the changing supply chain, whereas companies that hang on to the status quo may be forced to change in a later stadium (Turntoo, 2015).

[7] Cradle to cradle possesses a revolving fund that is used for investing in optimizing technologies and materials (Cradle to Cradle, 2015).

4.4.6. Business models

In transition to CE new business models will arise. In SQ the structure of business models is not likely to change. Since SQ focuses on optimizing materials and technologies for up-cycling, a concern in this model is whether technologies can be up-scaled and supported in a way that creates a profitable business case (Circle Economy, 2015).

Until recently this has been convenient for the collection companies since they made a profit selling these re-wearable textiles to the second hand market. Currently, non-rewearable textiles can only partly be sold and for a relatively low price (Circular Textiles Lab, 2015). These textiles are fiberized and used in the interior of car trunks or in cleaning towels i.e. they are down-cycled. The non-rewearable textiles that cannot be fiberized due to poor quality or mixing of materials are landfilled or incinerated (Massabalans Textiel, 2014). Collection of these non-rewearable textiles costs collection companies money, since the costs of collection are not compensated. For this reason, collection companies benefit from a high percentage of re-wearable textiles followed by non-rewearable textiles that can be fiberized (Circle Economy, 2015). This has led to poor communication towards people concerning the possibility to throw all textiles in containers, not only re-wearable items (Circle Economy, 2015).

When consumers are educated about- and motivated to throw all their old textiles in the container the amount of non-rewearable textiles increases, resulting in lower revenues for the collection companies. In France the collection companies were losing money due to the high amount of non-rewearable textiles resulting in a strike. The French government was forced to subsidize post-consumer textile collection (Circle Economy, 2015). This example shows the threat of a supply chain deficit. It is debated whether governments should be held responsible for creating an incentive to close textile cycles, for instance by subsidizing container collection, or whether responsibility on the part of brands and/or producers should be extended (Circular Textiles Lab, 2015). Lack of responsibility can result in 'cherry-picking' behavior of collection companies, meaning re-wearable garments are selected and the rest ends up in garbage (Circle Economy, 2015).

Currently the situation shows a paradoxal state where stimulating people to throw all there post-consumer textiles in collection containers will lead to a problem for collection companies. Nevertheless, joint venture projects like the circular textiles program will soon need a large feedstock of non-rewearable textiles for scaling up the up-cyling of textiles into new fabrics (Circle Economy, 2015). The value that has to be generated to cover the costs cannot be generated this early in the transition process. There is an immediate necessity to subsidize non-rewearable textiles either by the sales of re-wearable garments or government subsidizing. The challenge is to generate enough value to make a business case (Circle Economy, 2015; Circular Economy Lab, 2015). Creating economies of scale in collecting and processing post-consumer textiles asks for large investments.

Appleton (Turntoo, 2015) states that "*the reality of a declining market with more and more competition persuades companies to always look out for new business models* (nl: verdienmodellen)". MAS business models will be about cascading activities and providing a service instead of selling a product. The fact that materials will return and will be cascaded in cascading activities like re-use, re-furbish, re-use of parts and material re-use will create new possibilities for business models that explore and exploit one or more if these cascades. As stated above partners are needed for certain cascading activities (Turntoo, 2015). The evolving networks of business models for different cascades will likely happen in small and medium sized entrepreneurial organizations.

4.5. Tools for creating Status quo- and Material as service arrangements

Besides sets of SQ arrangements and MAS arrangements influencing stakeholders and supply chains there are also arrangements that can be used as practical 'tools' for creating circular material flows. These tools consist of contracts, financial arrangements and supply- and demand matching. In the following paragraphs these three tools will be analyzed concerning the way they enable SQ arrangements and MAS arrangements. This is also summarized in table 2.

Tools	**Status quo (SQ)**	**Material as service (MAS)**
Contracts	*Normal contracts* Contracts for Pilot projects for up-cycling materials	*Service contracts* Creating contracts for MAS, contracts with cascading partners
Financing	*Normal financing* Investments in technologies for optimizing materials and up-cycling post consumer materials	*New financing models needed* Cash flow based financing, dynamic earning models
Supply- and demand matching	U*p-cycled fabrics* Link supply- and demand for fabrics with percentage up-cycled fibers	*MAS and Cascading* Help clients to source MAS and collaborate in cascading activities

Table 2. Tools for creating the transition to circular material flows in SQ arrangements and MAS arrangements

4.5.1. Contracts

Due to the competitive nature of the fashion industry cooperation and collaboration are very limited. Collaboration primarily takes place in the holding[8] that brands are part of (Cradle to Cradle, 2015). However, making optimized materials more widely available requires some form of open source sharing of new production methods. By sharing the ways of producing brands can still protect their specific designs and success formulas. As long as their formula is protected brands are willing to cooperate in order to improve material production processes. An example of this is the development of a machine that makes buttons from optimized materials. The machine can be calibrated to different designs of buttons for the different brands, which safeguards the designs of brands (Cradle to Cradle, 2015).

An example of a SQ contract is Cradle to Cradle's Fashion Positive Initiative. In this project there are clear contracts with the brands about large collections of garments and investments of millions of euros. These contracts are the basis for working together in pilot projects in order to create products that can entirely be up-cycled after use. In order to protect the brands' confidential information, like business processes, formulas, strategies, financial information et cetera, a non-disclosure agreement is part of the contract. These contracts lack specific outputs since it is often unclear what outputs can be expected (Cradle to Cradle, 2015). Manufacturing companies are stimulated and guided in their transition instead of punished by rigid contracts. The starting point is to optimize one product or one collection followed by up scaling throughout the whole collection. The more fabrics and other materials are optimized, the larger the amount of garments that can be used for up-cycling into new garments. Vissers calls this the '*growing material library'* (Cradle to Cradle, 2015).

[8] A holding refers to a company that does not produce goods or services itself; rather, its purpose is to own shares of other companies to form a corporate group.

Whereas Cradle to Cradle moves back in the supply chain with brands to optimize materials, Turntoo has a different approach focusing on service-based (MAS) contracts. Closing the loop for Turntoo starts with the current situation of the client company. When Turntoo receives a question for producing or buying products on a service basis or for creating a whole unit – they have taken upon projects like creating a circular train station and a circular polyclinic – they help the client to determine the position they wants to have within the circular economy and they start to sketch a vision and roadmap. Subsequently they will look how the business model should function, what the consequences are when a service model is created with that product, what the contract should look like, who is the target market et cetera. A pilot is set up in which the company runs through the circular cycle once. During and after the run through the processes and products can be fine-tuned in order to improve the circular process for the generation of products in the next cycle (Turntoo, 2015). This implies that Turntoo is action-focused and uses pilots to learn by doing. The start of a project is a question from a company, which Turntoo translates into a vision and a roadmap, than a pilot and finally the learnings. The contract is always loosely set up; a company can always stop the project or put it on hold if there is a budget problem or when focus has to be shifted (Turntoo, 2015).

4.5.2. Financial arrangements

In SQ financing is needed to invest in creating new technologies, scaling up technologies and possibly building new factories for up-cycling processes (like for instance sorting and fiberization) (Circle Economy, 2015). Investments in specific up-cycling technologies like the fibersort machine[9] may be seen as a risky investment for banks since banks lack the specific knowledge about return on investment and possible risks of these investments (Circle Economy, 2015). Cradle to Cradle's revolving fund and the investments of the different stakeholders collaborating in the circular textiles project are examples of stakeholders in the textile supply chain co-financing these projects for up-cycling technologies (Cradle to Cradle, 2015; Circle Economy, 2015).

Small-scale entrepreneurs with MAS business models often do not have extensive financial resources. A problem arises from the way banks decide which business plans to grant financing. When businesses apply for a loan the bank uses a checklist to check whether the business is likely to be successful. However, this checklist is based on linear success features resulting in asset based financing. In CE where companies provide a service financing based on assets is inapplicable (Circle Economy, 2015). This is problematic since new business models do not receive the required investments. An example of the mismatch between new business models and financing models of banks is Lena the Fashion Library (Circle Economy, 2015; Lena Fashion Library, 2015). Lena has a certain amount of members and is assured of a monthly income i.e. cash flow. However, since the garments are not necessarily bought or sold banks declined the request for an investment. Financing models consist of rules that are based on linear business models. This causes severe barriers for start-ups that try to break trough with a circular business model. This problem can be solved when constructing financing models based on cash flow instead of assets (Circle Economy, 2015).

A promising way to divide benefits and risks fairly in collaboration projects is to apply a dynamic earning model, which also motivates companies to be more innovative (Turntoo, 2015). Turntoo gives an example for light as a service, which could be a collaboration between the designer, producer and installer. Another example is the collaboration of a rental housing organization that collaborated with Bosch for providing a laundry machine and refrigerator included in the rent. This collaboration resulted in improved contact with consumers and enhanced information about consumer preferences, which were used to improve products. Moreover providing home appliances in a service contract established a long-term relationship with consumers. This model can speed up the transition to circular material cycles since

[9] The sorting machine created by Circle Economy's textile sorting project.

successful improvements to products and processes will benefit all partners, resulting in high levels of trust, reciprocal behavior and continuous innovation (Turntoo, 2015). A bottleneck at the moment is the juridical difficulties concerning dynamic earning models. Due to legislation these models are currently applied by a distribution code (nl: verdeelsleutel) and therefore reduced to a very simple mechanic form (Turntoo, 2015).

4.5.3. Supply- and demand matching

SQ supply- and demand matching is about matching technologies with brands. At this pilot stage it is often not clear what quality can be expected from fabrics made with post-consumer materials. There are misconceptions concerning quality, price and availability and suppliers and buyers fail to get in contact. Even in the textile industry people are not aware of the possibilities and quality of post-consumer fabrics (Circle Economy, 2015; House of Denim, 2015). At fabric fairs, like Premiere Vision, these fabrics are not showcased and therefore invisible for brands. For brands that actively want to source post-consumer fabrics supply-demand matching is required. Vice versa suppliers believe there is no demand for these fabrics, since brands do not yet ask for them. Circle Economy actively links supply and demand one on one and trusts that when the number of examples grows it will take off and supply and demand for post-consumer fabrics will grow (Circle Economy, 2015).

MAS supply- and demand matching is a more local process. Turntoo links supply and demand by helping their client to buy products in the form of services. When a certain service does not exist they talk to stakeholders to help them create MAS. Turntoo actively looks for partners for different cascades. Turntoo has built enough experience with choosing products and materials so they are able to select the right products that can function as a service model. These products are qualitatively suitable to be modular i.e. they can be reused and the used materials can (generally) be up-cycled (Turntoo, 2015). It must be noted that Turntoo currently does not have clients in the textile industry. Moreover the focus lies primarily on technological nutrient cycles whereas textiles are largely biological nutrients. The reason for focusing on technological nutrients has been the initial interest for this cycle since these technological materials are often valuable, scarce materials (Turntoo, 2015).

4.6. Summary of results

Analyzing the case materials from CE accelerating organizations and pioneers in the Dutch textile industry resulted in a dichotomy of SQ arrangements - in which industry standards may change, but the industry structure will remain the same – and the MAS arrangements - in which the paradigm of ownership of products may change. MAS arrangements were found to have more extensive consequences and may be able to change institutions at all four institutional levels.

The implications of SQ arrangements and MAS arrangements were analyzed for consumers, retail, manufacturing, geographical position, supply chain structure and business models. Notable differences were found for consumers, manufacturing and the supply chain structure, since in case of SQ arrangements the situation does not change significantly. In case of MAS arrangements consumers have to adjust to using garments as service instead of owning them, manufacturing will become increasingly responsible for products and the supply chain structure will change because of cascading activities. This will also imply a geographical shift to more local hubs. Cascading activities imply new business models in case of MAS, whereas business models in SQ arrangements will stay the same.

Finally, contracts, financial arrangements and supply- and demand matching were analyzed as tools that stakeholders use for transitioning to circular material cycles. These tools are differently used depending on aiming at following the SQ path or the MAS path. The most significant difference concerned financial arrangements, which urgently need to be developed in order to finance MAS business models. For SQ arrangements financial arrangements were less important since financing can be asset based. Moreover, the revolving fund of Cradle to Cradle is used for investments in up-cycling technologies. Contracts are relatively flexible in both SQ- and MAS arrangements, although MAS activities will likely result in more collaboration between cascading partners. Lastly, supply- and demand matching focuses on creating a market for up-cycled fabrics in SQ arrangements whereas focus lies on creating a market for providing products in service contracts and cascading activities in MAS arrangements.

5. Discussion

5.1. Introduction

Analyzing the case materials resulted in different arrangements stakeholders use for creating circular material flows. These were divided in the two sets of SQ- and MAS arrangements on the one hand and a set of tools on the other hand. In this chapter these tools and their implications for SA- and MAS arrangements are discussed, followed by a discussion on the interconnection of institutional levels and the mechanism by which different institutional levels can influence each other. In the following section strengths and weaknesses of- and complementary aspects of SQ- and MAS arrangements are discussed. Finally, based on the set of MAS arrangements a new conceptual model for circular supply ecosystems is introduced.

5.2. Tools for creating circular material flows

When looking at arrangements between stakeholders in the context of Williamson (2000) five types of arrangements have been analyzed that are used to create circular material flows. SQ and MAS are sets of arrangements whereas contracts, financial arrangements and supply- and demand matching are the practical arrangements or 'tools' used by stakeholders to create change. First the three practical arrangements and their implications for SQ and MAS will be discussed.

5.2.1. Contracts

The legally binding aspect of contracts ensures stakeholders that contractual agreements will be kept. Although the form of the contract is used as an arrangement to create circular material flows, the content can be different from the content in a contract for linear economic transactions. Whereas linear economic transaction contracts consist of (a variation on) the agreement: stakeholder A delivers X for stakeholder B delivering Y in return', contracts for transitioning to circular material flows are often set up in a less explicit manner. Since arrangements to developing circular material flows consists of activities like optimizing materials, re-designing products, creating cascading activities and collaboration between different stakeholders contracts are aimed at creating mutual trust, collaboration and room for new processes and structures that may evolve during the collaborative project. For this reason these contracts do not explicitly state expected outputs, but the goal of improving materials and processes for the transition to circular material flows. This type of contract corresponds with the concept 'relational contracting' (Slangen, Loucks & Slangen, 2008). Relational contracting is a way of contracting in which gaps in the agreement are overcome by the identity, commitment, reputation and trustworthiness of the stakeholders. These contracts are effective when stakeholders collaborate for a longer period of time and when the goals are modified over time as a result of unfolding events (Slangen et al., 2008). Relational contracting is a tool for aligning stakeholder goals and creating collaborative projects for the transition to circular materials flows.

Both SQ and MAS contracts have elements of relational contracting. SQ contracts are about long-term collaboration for optimizing materials and technologies. The competitive nature of large-scale textile industry, protection of company formula's and high-capital investments in new technologies may result in less trust amongst collaborating stakeholders in comparison to MAS contracts.

MAS contracts on the other hand are about collaboration for cascading activities and creating service contracts. The complementary nature of MAS collaboration (i.e. different cascading activities are fulfilled by different stakeholders) is more likely to increase trust since a cluster is formed in which risks and gains are ideally distributed over multiple collaborating stakeholders. Moreover, the requirement in

case of MAS to receive materials back in good shape is a shared goal that will contribute to increased trust.

Proposition: *In collaboration to establish circular material flows the requirement to receive materials back in good shape is a shared goal and will likely increase trust amongst stakeholders.*

5.2.2. Financial arrangements

Financial arrangements are specifically important for MAS. As stated in the analysis *Dynamic earning models* are a way for organizations to work together in creating circular material flows that allows risk spreading and stimulate innovation (Turntoo, 2015). Providing MAS in collaboration by using dynamic earning models provides an incentive for improving materials and products since this benefits all stakeholders. Since it is legally impossible to construct dynamic earning models a change in legislation will be necessary. Until this legal aspect is changed simple distribution codes have to be installed, which are simpler and create less incentive for innovation and collaboration (Turntoo, 2015). When stakeholder can collaborate in dynamic earning models this can result in MAS in a win-win-win situation for collaborating stakeholders and consumers.

In order to finance MAS business models *Circular Financing models* are needed. Currently the development of MAS business models is hampered by the banks' investment criteria. Current asset-based financing, in line with linear business models, is not suitable for financing MAS business models. Circular financing models are urgently needed to support entrepreneurs with MAS business models. Cash flow based financing was appointed as an appropriate financing model, since providing MAS in lease contracts generates a continuous cash flow (Circle economy, 2015). CE accelerating organizations may play an important role as broker between banks and entrepreneurs creating MAS business models with the goal of developing circular financing models. This is an important barrier to overcome for accelerating the transition to circular material flows in MAS arrangements.

For SQ new financial arrangements are less important. Since SQ arrangements concern investments in technology and machinery asset based financing can be applied. Moreover Cradle to Cradle has a revolving fund that can invest in these optimization processes if needed (Cradle to Cradle, 2015).

Proposition: *The lack of dynamic earning models and circular financing models are barriers to overcome in accelerating the transition to circular material flows.*

5.2.3. Supply- and demand matching

As explained in the analysis supply- and demand matching is a tool to link stakeholders that provide CE products or services to organizations that want to buy CE products or services (Circle Economy, 2015). This is an important arrangement for creating a market for circular products or services. At this moment there is not yet a functioning CE product- and service market, which makes it difficult for supply and demand to find each other. Supply and demand matching in SQ implies linking organizations that sell fabrics with a percentage of up-cycled post-consumer materials with organizations that want to buy these up-cycled fabrics. Supply and demand matching in MAS is about linking organizations that want to buy- with organizations that sell material as service and linking organizations that fulfill complementing cascading activities.

Proposition*: Supply- and demand matching creates a market space for up-cycled fabrics (in SQ), material as service and cascading activities (in MAS).*

The 'toolset' consisting of contracts, financial arrangements and supply- and demand matching is an important transition mechanism at the institutional level of arrangements between stakeholders i.e. at level 3 (Williamson, 2000). However, these arrangements influence other institutional levels as well. Leading to the 'higher order' sets of SQ institutions and MAS institutions. This is further elaborated in the next section about the interconnection of institutional levels. Although the concepts were created based on empirical evidence from the studied cases in the Dutch textile industry from this point onwards the focus shifts to creating concepts for the transition to circular material flows by using institutional analysis. Therefore conceptualization goes beyond the Dutch textile cycle.

5.3. Interconnected institutional levels

One of the sub-questions for this thesis was how institutional changes at arrangement- (level 3) and incentive level (level 4) can facilitate changes in informal- (level 1) and formal (level 2) institutions and vice versa.

In the analysis a dichotomy between two sets of SQ arrangements and MAS arrangements and a set of tools in the form of contracts, financial arrangements and supply- and demand matching arrangements were revealed. Since these tools can be used to create new incentives they directly affect the incentive level (level 4). For example, when a new contract is created in which all stakeholders benefit from the highest material quality (which is the case for MAS contracts) this will create an incentive for stakeholders to improve material quality. Therefore the contract, created at level 3, results in a new incentive at level 4.

When more of these contracts are developed in the same direction, the incentives start to change on a larger scale. This implies that materials and products will be improved on a larger scale, since a growing amount of stakeholders receives the benefits (as explained above benefits are increased added value in high quality products and cascading activities as well as better relationships with consumers through MAS contracts). This may again increase the adoption of MAS business models and contracts. At a certain point the number of MAS business models passes a threshold where the formal rules, still aligned with linear economic processes, become a visible obstacle for the substantial amount of stakeholders engaging in MAS business models (think about entrepreneurs in multiple different cascading activities and the consumers that use products in service contracts). This is the moment where formal rules (level 2) can be altered since it makes sense for a substantial part of the economic activity in the form of MAS business models.

During this entire process, which will take some time, simultaneously the cultural habits and beliefs of people (level 1) are transformed from owning products to buying the service of a product. This bottom up influence from arrangement- (level 3) and incentive level (level 4) on the cultural- (level 1) and formal (level 2) level is visualized in the figure below.

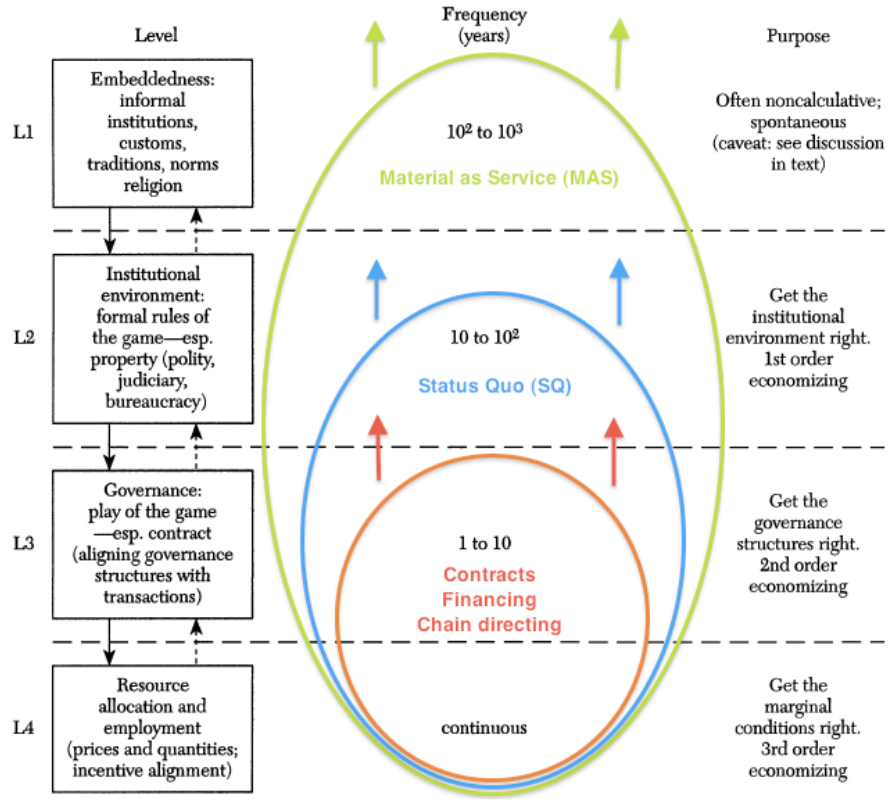

Figure 10. The influence of the five arrangements at different institutional levels. Upward arrows signal bottom-up feedback processes that can effect higher level institutions.

In reality, supply chains and industries practices have to change before the formal rule set will be adjusted. Moreover, interaction with national- and European policy makers is necessary to develop the necessary legal boundaries in order to facilitate circular material flows. In order to align the formal rules (level 2) with creating circular material flows obstructing legislation has to be overcome and new legislations have to be created. Identified obstructing legislation is legislation on waste transport, BWT (tax), labor tax (instead of material tax), international laws and trade agreements. Non-existent legislation that could encourage circular material flows is legislation on reducing excessive production, material safety, environmental legislation (should be stricter), material tax (instead of labor tax) and legislation on dynamic earning models. In the appendix a concise explanation of obstructing- and lacking legislation is provided.

Figure 10 also visualizes the difference in reach between the 'tools' and the 'sets' of SQ- and MAS arrangements. Whereas the tools are arrangement between stakeholders at level 3 and create incentives at level 4, the set of SQ arrangements is capable of changing industry standards and legislation on material (re)use and MAS arrangements are capable of changing both legislation and cultural beliefs about using products in service contracts and cascades.

5.4. Discussing Status quo and Material as service

In the analysis the findings were presented in a table that show the implications for different stakeholders and processes when CE develops in a set of MAS arrangements versus a set of SQ arrangements. The strengths and weaknesses of these sets and complementary aspects are discussed below.

5.4.1. Status quo: Strengths and weaknesses

An advantage of SQ arrangements is the fact that they build on a (collection) system that is already in place. Therefore SQ arrangements are relatively easy to install. If SQ arrangements are broadly applied this means a higher percentage of post-consumer textiles is collected and up-cycled into new fabrics. Growing demand for fabrics with a certain percentage of post-consumer fibers can result in a new industry standard of using post-consumer fibers in new fabrics. Since returning old textiles is an extra effort for consumers a reward is needed to create an incentive. Without a reward there is little incentive and this system cannot guarantee 100% of old textiles being collected for up-cyling. It can be questioned whether the SQ path will in the end lead to 'positive emissions' or just to 'less bad emissions', in which case circular material flows will be partially applied. In other words, there is no incentive to fundamentally change the way of thinking about material use since responsibility for the products or materials still evaporates after garments are bought.

Another issue concerning SQ arrangements is the large investments that are needed for developing new technologies and post-consumer textiles processing facilities. Moreover collection costs may be higher than the returns when the majority is collected textiles are low value, non-rewearable textiles. As stated in the analysis stakeholders are struggling with creating a viable business case and collecting and up-cycling post-consumer textiles still has to become profitable for the system to work. If not, this system will need support from government subsidies.

Proposition: *SQ arrangements will at best result in a new industry standard of using a certain percentage of post-consumer fibers in new fabrics.*

5.4.2. Material as service: Strengths and weaknesses

When products are used in service contracts this means ownership is moved back in the supply chain. Where ownership will be re-located can be contemplated; companies can for instance specialize in providing service contracts and function as intermediaries between brands and consumers or even more directly between manufacturers and consumers. Another possibility is for manufacturers to develop their own service departments and provide service contracts themselves. The fact that products and materials return after use provides an incentive to produce products of the highest possible quality. What can be expected is that manufacturers will become increasingly responsible for the products and materials they (prod)use and therefore have an incentive to produce products of higher quality that will last longer and that can be cascaded after user life. Since MAS arrangements create an incentive for returning products and after use since ownership is relocated from consumers to service providers circular material cycles can be guaranteed.

A difficulty concerning MAS is the newness of the concept. It is unclear whether consumers will accept garments as a service, since buying a service instead of owning a product is a new idea that needs

embedding in cultural habits and beliefs (level 1). A paradigm shift is needed from owning products to using products by means of service contracts. However, MAS arrangements can be capable of transforming formal rules (level 2) and cultural beliefs (level 1) concerning materials and property rights.

Proposition: *MAS arrangements are promising for transitioning to circular economy in higher institutional levels.*

5.4.3. Status quo and Materials as service: Complementary sets of arrangements

In reality, both sets of arrangements are to a certain extent complementary. SQ arrangements can be used to develop technologies for up-cycling materials and can raise industry-standards by mainstreaming these technological improvements. MAS arrangements are necessary in order to safeguard circular material cycles because they provide an incentive to create high quality products and cascading activities that keep materials cycling in an ongoing process. Whereas SQ arrangements are a potential set of arrangements in order to up-cycle materials, MAS arrangements are crucial for assuring circular material flows. This necessity of MAS arrangements follows from the lack of incentive in SQ arrangements to create completely circular material flows.

Moreover, in case of MAS the transition can take place at all different levels and through all sorts of organizations. Small-, medium- and large organizations can offer a service with a MAS business model or provide cascading activities. Trough SQ arrangements large investments are allocated for optimizing materials and technologies. The necessity for large-scale investments indicates that this set of arrangements will result in a less diverse ecosystem of organizations. The typical linear economic pull towards economies of scale will not change in case of SQ. MAS arrangements promote a more versatile ecosystem of entrepreneurial organizations, creating a bottom up transition.

Proposition: *Although SQ- and MAS arrangements have complementary aspects, MAS arrangements comprehend the crucial incentives for creating circular material flows.*

Given the promising nature of the set of MAS arrangements for creating circular material flows by influencing multiple institutional levels, the following section conceptualizes the metamorphose of supply chains into circular supply ecosystems in the context of expanding cascading activities.

5.5. Circular supply ecosystems

Developments in MAS arrangements are likely to transform supply chains because of the new cascading activities and the relocation of ownership, resulting in increased responsibility for materials and products. In the following figures the evolution of the supply chain, when creating circular material flows according to MAS arrangements, is visualized and explained.

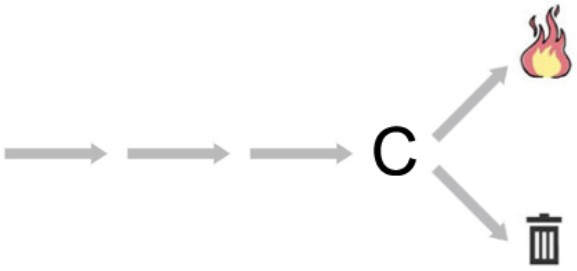

Figure 11.a. Starting point of a linear supply chain
C = Consumer

In figure 11.a. the current linear supply chain is visualized. In this supply chain C stands for the consumer and the arrows leading to C are the nodes before, like retail, manufacturing et cetera. After the consumer has used the product it ends up in landfilling or incineration.

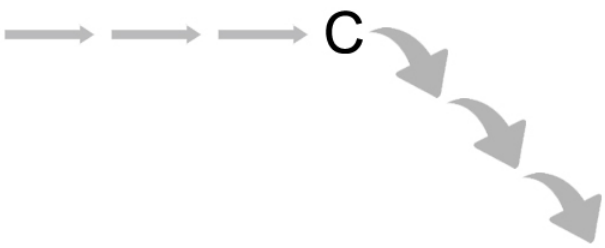

figure 11.b Supply chain continued in cascading activities
C = Consumer

In figure 11.b. the first cascading activities are visualized. After the consumer has used the product it continues in cascading activities, for instance re-use, re-manufacturing, parts re-use, material re-use et cetera.

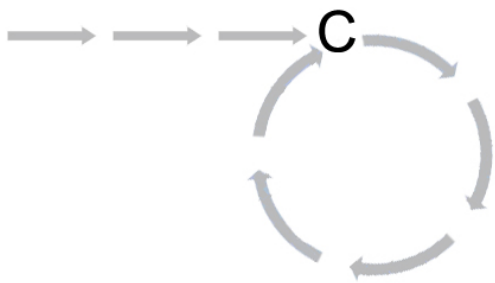

figure 11.c Supply chain with cascading activities that form a circular material cycle
C = Consumer

In figure 11.c. the circular movement of materials through cascading activities is visualized. This is the first visualization of a circular material flow. In this situation cascading activities are more advanced in the sense that not only the more obvious primary cascading activities like re-manufacturing and part re-use, but also cascading activities that yield less but are crucial for closing the cycle, are accomplished. The closer these latter cascading activities are to biological- or technical nutrients (i.e. raw-material) harvesting, the more energy is needed since parts have to be disentangled and materials separated and the more costly the process for relatively low remaining added value (since value is added by design and technology in products, whereas raw materials do not possess this added value) (Turntoo, 2015).

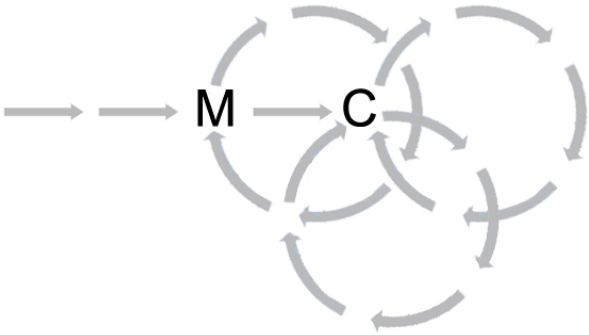

figure 11.d More advanced circular supply cycles with interconnections
C = Consumer, M = Manufacturer

When cascading activities are indeed successful in creating circular material flows, these circular material flows do not only occur after the consumer has used a product, but also occur at other locations in the supply chain. In other words the supply chain evolves to a circular- instead of a linear process. For example, cascading activities that take place after the consumer will also consist of (re)manufacturing

processes (C → M), and after a few cascades nutrients will be harvested to begin a new cycle in a new manufactured product (M → C). The origination of circular movements of materials through cascading processes is visualized in figure 11.d.

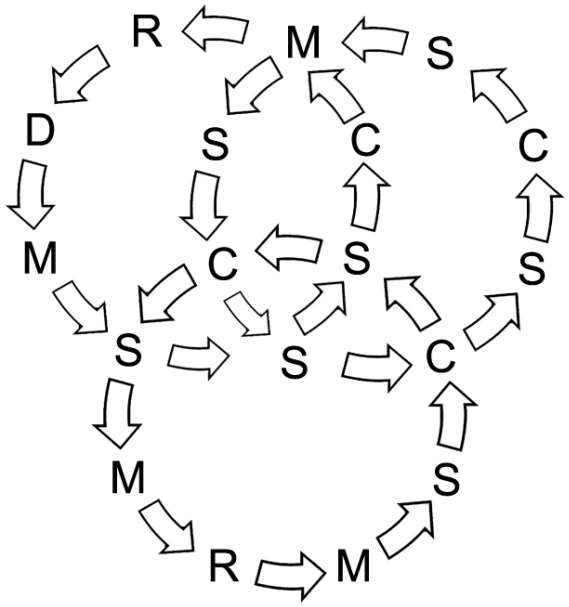

figure 12. Circular supply eco-system in which all material cycles are circular and interconnected
C = Consumer, M = Manufacturer, S = Service provider, D = Material depot , R = Raw material (nutrient) harvesting

Figure 12 is a more detailed visualization of circular material flows in which the linear supply chain structure is completely evolved to a 'circular supply ecosystem'. The term ecosystem was chosen since materials flows are aligned in the most effective way, resembling the metabolism of an ecosystem. In this circular supply ecosystem MAS business models fulfill the different cascading activities.

To clarify the processes of circular supply ecosystems the letters in the figures stand for different consecutive usages of materials (consuming, (re)manufacturing, providing material as service, material storage and raw material harvesting). As an example the lower cycle is further explained, starting at the M (manufacturing activity) at the bottom. After manufacturing a product, the product continues to a service provider (M → S). The service provider creates a contract to lease it to a consumer (S → C). After the consumer is done with the product the product goes back to the service provider (C → S). When the product is still in good shape the service provider will lease the product to another consumer (S → C), after which the product is again returned to the service provider (C → S). This time the product needs to be re-manufactured (S → M). At manufacturing some parts are re-manufactured, but some parts are to old and are disassembled for material harvesting (M → R). The raw materials start a new cycle when they are manufactured into a new product (R → M).

The ecosystem however works in more complex ways than isolated cycles. This is visualized by interconnecting the cycles. An example can be given starting from the left-most M in the figure. After this manufacturing process the product go to a service provider (M → S). This service provider not only received the product from this manufacturer, but also received a used product back from a consumer after

the lease term (C → S). Whereas the used product goes back to be re-manufactured (as stated in the above example) the new product that came from manufacturing is linked in a package deal with a product from another service provider (S → S), before being leased to a consumer (S → S → C). An example of such a package deal can be to lease Jeans from company A in a package deal with a leather belt from company B. This example shows that there are infinite material flows and connections possible in the circular supply ecosystem. Note that these are just some examples of cascading activities in a simplified scheme. In reality many more activities may develop that cater to demands that are non-existent yet but will evolve in the transition to circular material flows in circular supply ecosystems.

In these circular supply ecosystems the current divided nature of sectors (like for instance the textile sector, paper sector, food sector) will cease to exist since the same resources and materials can be used for different kinds of products and will become available for other products after cascading. It can be theorized that an immeasurable number of supply ecosystems can arise that are connected since ecosystems clustering around certain (groups of) materials may share nodes with ecosystems clustering around other (groups of) materials. For instance the ecosystem clustering around cotton may share nodes with the ecosystem clustering around metal, since buttons on cotton jeans are made from metal. This possibility can be visualized by a spirograph[10] figure (figure 6) with multiple connections between the lines (i.e. the nodes) that can take all sorts of shapes as long as all movements are circular (i.e. there is no begin and no end). The metaphor of a spirograph was chosen since the different geometric circles display all possible supply chain shapes. Implicit in this abstract visualization of circular supply ecosystems is the notion that all processes are circular. Within each circle both biological- and technological elements may be used (for products and processes can be created with both), as long as biological- and technological materials are only united for the purpose of creating a product and can be separated again, for that is the only way to guarantee circular material flows and to prevent mixed materials that cannot be up-cycled ending up being incinerated or landfilled.

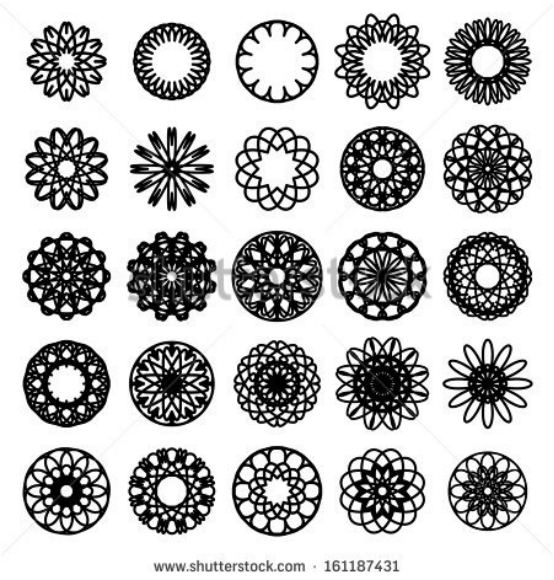

Figure 13. Spirograph figures visualizing infinite possibilities for circular supply ecosystems.

[10] A spirograph is a geometric drawing instrument that produces mathematical roulette curves.

Finally, it must me noted that figures 11, 12 and 13 only visualize the movement of materials. Where ownership is situated in circular supply ecosystems remains a question to be answered. As stated earlier in the discussion section balancing the power that comes with ownership is important. Dividing ownership amongst multiple small- or medium scale stakeholders instead of a few large stakeholders can safeguard this balancing.

6. Conclusion

6.1. Conclusion

Using case materials to create new concepts for the transition to a circular economy resulted in discovering a dichotomy between SQ- and MAS arrangements. Contracts, financial arrangements, and supply- and demand matching were discovered as tools for creating the transition. SQ- and MAS arrangements, while created by organizations, can have consequences at multiple institutional levels. Whereas SQ arrangements may have implications at the level of formal rules (level 2) in creating a new industry standard of using up-cycled fabrics, MAS arrangements may have implications for all four institutional levels by relocating ownership in service contracts and creating cascading supply chain activities. This not only shows the way institutional levels are connected but also shows the possibility to change the institutional system in a bottom-up way. Both SQ- and MAS arrangements aim at creating circular material flows. However, MAS arrangements offer a more convincing incentive for closing material cycles. The possibility of MAS arrangements is further developed in the conceptualization of circular supply ecosystems.

6.2. Implications and recommendations for stakeholders

The difference between SQ arrangements and MAS arrangements holds important implications for stakeholders. Since it is questionable whether SQ arrangements can lead to circular material cycles stakeholders have to decide whether this set of arrangements, aiming at raising industry standards for up-cycling post-consumer textiles in new garments, is a virtuous path to follow. Although is may be worthwhile to collaborate with chain partners in order to address the technological side of up-cycling materials, stakeholders have to realize that the true nature of circular economy is found in circular material flows. These circular material flows cannot be achieved by mere technological solutions. Therefore, supply chain collaboration should not only be used to improve up-cycling of fibers, but also to think about the next step, the future of the supply chains in MAS arrangements.

MAS arrangements activate changes at multiple institutional levels. Providing products as service in service contracts shifts responsibility for materials, property rights and the cultural aspect of ownership. Moving ownership back in the supply chain, for instance to the manufacturer or service provider, will result in increased responsibility for materials and will create an incentive for improving quality of products in order to keep products cycling longer before cascading and cascading longer before harvesting the (raw) materials for creating new products. It is a legitimate question whether the benefits of MAS business models, like Mud Jeans and Lena Fashion Library, will convince consumers to participate in MAS propositions. If a critical mass of MAS propositions becomes available and is embraced by consumers this will have disruptive effects on the supply chain structure. As shown by the example of retail stores becoming redundant in case of MAS, at stakeholder level this means repositioning may be needed in order to fulfill activities that are required in the new MAS situation. At supply chain level the long-term effects of MAS and cascading can be the transition from linear supply chains to circular supply ecosystems in which products, parts of products and materials can circulate in multiple sectors and industries. The implication is the vanishing of barriers between industries and the clustering of cascading activities around a specific material instead of a specific industry. To give an example, clustering of cascading activities around wood can occur instead of the separate supply chains for the building industry, furniture industry, paper industry and other industries that use wood. In other words, the focus of organizations will shift from relative positioning in the supply chain (connections with chain partners) to the relative positioning in materials cycles. Then the question becomes: 'How can I add value to this material? In what form do I

need the material i.e. do I need a raw material, or a part of a product that is cascading, i.e. in which cascade do I position my business model?' Note that this is a simplification since many products use multiple materials. This question needs to be answered for all materials coming together in the product. As should de question arise 'how can I get most value out of my product?' Firstly cycling longer (i.e. the highest possible quality is assured since this allows for multiple service cycles with the same product) and afterwards finding stakeholders that can use your castoff products in their product while keeping maximum of the (parts of) products intact (i.e. remaining added value as much as possible).

These consequences of MAS arrangements can be an incentive for stakeholders to actively change their position and alter their business models for stakeholders changing business models early on in the transition process can benefit from a first-mover advantage. Moreover, from the perspective of increased competition due to the saturated market, new business models and repositioning can distinguish stakeholders from their competitors.

A question arising in case of MAS arrangements is what the effects are of ownership moving back in the supply chain. As explained in the section on circular supply cycles it is unclear where ownership will be located, since this conceptual model only shows the movement of materials, not ownership. Chances are that ownership will remain at the manufacturing company, the service provider, a raw material depot or any other stakeholder. Since materials are the focal point of a MAS system ownership of materials implies power. Stakeholders should keep this in mind and should find ways to introduce checks and balances in order to circumvent a situation of inequality due to large amounts of materials being owned my one single stakeholder. Shared ownership models and/or collaboration between multiple small- or medium sized material owners in networks can be a more balanced solution than accommodating large amounts of materials at a few large stakeholders, for example a material bank or multinational.

Another issue is the way service contracts are formulated. When looking at the example of existing service contracts in the telecom sector, consumers often pay more in a two-year subscription with 'free' mobile device then for a sim-only contract (i.e. without a mobile device included). In that sense consumers are in a way deceived by service contracts. Moreover telecom service providers have been accused and fined for forming cartels and pushing up prices (www.rtlnieuws.nl). More small- and medium sized stakeholders instead of a few large stakeholders can be a solution to create fair competition and fair prices for consumers.

Finally, issues to overcome are how to cope with obstructing legislation and the lack of adequate financing models. If stakeholders can create arrangements that circumvent these barriers they may become examples for other stakeholders to transition to MAS business models. Turntoo (2015) mentioned an example of such an arrangement by formulating contracts in such a way that obstructing legislation is omitted. A short-term solution for financing issues can be to do crowd funding instead of turning to banks for financing. When the amount of MAS business models grows the success of these business models will become more apparent. This may lead to alteration in the asset-based financing models of banks. Moreover, more MAS business models may have bottom up effects on the formal institutional level, resulting in alteration of- and creation of formal rules that are in line with MAS business models.

6.3. Limitations

Limitations of this research lie in the pioneering nature of this study. Firstly, due to a lack prior knowledge on transition mechanisms for circular economy, an institutional analysis perspective was selected in order to create new concepts for transition mechanisms in the form of arrangements created by stakeholders.

For the aim of this inductive research multiple cases in the Dutch textile industry were studied which led to the development of new concepts about the ways organizations shape institutions for the transition towards circular material flows. Triangulation was used to introduce concepts from previous cases in interviews with new cases. However, the concept of circular economy itself is still new and being developed. This hindered the triangulation process since respondents did have different ideas of which extent of circular material was desired. At times data appeared in a more anecdotal way then aimed at with the triangulation method. This also resulted in two clearly different sets of arrangements, one focusing on optimizing materials and raising industry standards (SQ) and another focusing on cascading and shifting ownership (MAS).

It can be questioned whether the concept for cascading in circular supply ecosystems can be applied to other sectors and countries. Based on the reasoning that MAS will provide an incentive to take responsibility for material (re)use and opportunities for new MAS business models it is probable that the mechanisms of cascading and circular supply ecosystems are likely to emerge in a similar pattern as has been conceptualized in this research. However, the inductive nature of this research leaves this question for future deductive research.

6.4. Future research

As the saying goes 'the proof of the pudding is in the eating', the value of circular economy for society has to be proven by a functioning circular economy. Fist recommendations for future research are given concerning the content, followed by recommendations concerning research methods.

In this research concepts were created for the transition towards cascading in circular supply ecosystems. The five types of arrangements that were identified in this research should be closer examined in future research. Firstly contracts and the concept of relational contracting (Slangen et al., 2008) in circular economy is an important topic for future research. Research in increased trust, long term collaboration and open-end contracts can provide insight in how stakeholders relate to each other and establish long-term qualitative material cycles. More specifically, in case of MAS all stakeholders benefit from creating high quality products and receiving products and materials back in good shape in order to maximize added value through cascading. Correlating this shared stakeholder incentive with increased trust and relational contracting can be the starting point for future research.

Supply- and demand matching is another arrangement that is vital for generating a market for buyers and sellers of products, materials and/or services in circular material flows. Since the circular economy accelerating organizations can be seen as brokers of circular material flows their activities and networks can reveal significant aspects of changing institutions. Embedding this research in institutional entrepreneurship theory (Anderson & Hill, 2004) can provide an effective framework.

Financial arrangements are also an important subject for future research. On the one hand the legal difficulties to overcome in creating distribution codes when multiple stakeholders collaborate and on the other hand creating cash flow based- or other circular economy enabling financing models are important topics. Circular economy accelerating organizations may again play a role as broker between

financial organizations and entrepreneurs. For this reason institutional entrepreneurship theory seems a promising perspective.

Future research should also focus on the progression of SQ- and MAS arrangements. It is important to get a better understanding of how both sets of arrangements relate to one another. Future research questions should specifically focus on ways in which they strengthen each other and ways they hinder each other. Moreover, further conceptualizing on the lack of incentive for circular material flows in case of SQ arrangements and the creation of incentive in case of MAS arrangements is needed. This can help circular economy scholars and practitioners to construct a unified understanding of which arrangements will lead to circular material flows and which arrangements will have less optimal outcomes.

Another perspective to shed light on the transition process is by using transition theory. Using this framework circular economy can be viewed as being developed in a niche environment. When circular economy has gained strength and momentum it can 'compete' with the existing linear economic regime (Kemp & Loorbach, 2006). While this thesis has taken a stakeholder (i.e. organizational) perspective, transition theory can provide a policy perspective on the transition to circular economy.

A major point to be addressed in future research is the last cascade of the biological cycle i.e. to return biological matter to the earth to serve as nutrients for a new cycle of biological materials. Although this is the last, necessary step in order to close the biological material cycle it has not been addressed in any of the analyzed cases, nor did this cascade explicitly come up in other circular economy materials.

The lack of theory indicates the need for more inductive research to build a comprehensive theoretical framework on the transition mechanisms for circular economy. As proven in this research, a (multiple) case study is an effective method for obtaining rich data to derive new concepts from. Another method that can contribute not only to valuable insights, but also to societal change is transformational research. This is a dynamic research method that involves interplay between phases of reflection and action, and learning by doing (http://srmo.sagepub.com). Deductive research for testing the concepts that were developed in this thesis asks for carefully developed proxies[11] for cascading activities and circular movements of materials and products. This research should be qualitative in nature, since the examples of such cascading activities are currently occasional. Only if MAS business models and cascading activities become more widely represented quantitative research may be suitable to show certain tendencies.

[11] An entity or variable used to model or generate data assumed to resemble the data associated with another entity or variable that is typically more difficult to research (www.thefreedictionary.com).

References

Anderson, T. L., & Hill, P. J. (2002). Cowboys and Contracts. *Journal of Legal Studies*, *31*.

Anderson, T. L., & Hill, P. J. (2004). *The not so wild wild west: Property rights on the frontier*. Stanford CA: Stanford University Press.

Barker, T. (2007). Climate Change 2007 : An Assessment of the Intergovernmental Panel on Climate Change. *Change*, *446*(November), 12–17.

Battilana, J., Leca, B., & Boxenbaum, E. (2009). How actors change institutions: Towards a theory of institutional entrepreneurship. *Academy of Management Annals*, *3*(1), 65–107.

Braungart, M., McDonough, W., & Bollinger, A. (2007). Cradle-to-cradle design: creating healthy emissions - a strategy for eco-effective product and system design. *Journal of Cleaner Production*, *15*, 1337–1348.

Braungart, M. & McDonough, W. (2002). *Cradle to Cradle; Remaking the Way We Make Things*, New York

Circle Economy. (2015). H. Smits. Interview March 18th 2015

Circular Economy Lab: Textiel. (n.d.), *Utrecht*.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., … van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*.

Cradle to Cradle. (2015). R. Vissers. Interview March 3rd 2015

Dacin, M. T., Goodstein, J., & Scott, W. R. (2002). Institutional theory and institutional change: Introduction to the special research forum. *Academy of Management Journal*, *45*, 45–46.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationallity in organizational fields. *American Sociological Review*, *48*, 147–160.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges, *50*(1), 25–32.

Ellen McArthur Foundation. (2013).

Ellen MacArthur Foundation & McKinsey, (2014), *Towards the Circular Economy: Accelerating the scale-up across global supply chains,* Rapport, World Economic Forum, Switzerland

Greif, A. (1998). Historical and comparative institutional analysis. *American Economic Review*, *88*, 80–84.

Groot, R. S. De, Wilson, M. A., & Boumans, R. M. J. (2002). A typology for the classification , description and valuation of ecosystem functions , goods and services, *41*, 393–408.

House of Denim. (2015). J. Veenhoff. Interview April 9th 2015

Kemp, R. & Loorbach, D. (2006) *Transition management: a reflective governance approach*, chapter in 'Reflexive governance for sustainable development. UK

Lena the Fashion Library, (2014) S. Smulders, Interview April 4th 2015

Library, L. F. S. Smulders (2015).

Massabalans van in Nederland ingezameld en geimporteerd textiel, (2014), raport, FFact Strategy and Implementation, Delft,

Matthews, E. et al. (2000). *The Weight of Nations: Material Outflows From Industrial Economies, World Recources Institute, Wahington D.C.*

North, D. (1990). *Institutions, institutional change, and economic performance*. Cambridge UK: Cambridge University Press.

North, D. (1991). Institutions. *Journal of Economic Perspectives*, *5*(1), 97–112.

OECD. (2010). *Economic Policy Reform; Going for Growth. Economic Policy Reform; Going for Growth* (pp. 17–48).

OECD. (2011). *Towards Green Growth*. Retrieved from http://www.oecd.org

Pacheco, D. F., York, J. G., Dean, T. J., & Sarasvathy, S. D. (2010). The Coevolution of Institutional Entrepreneurship: A Tale of Two Theories. *Journal of Management*, *36*(4), 974–1010.

Sipes, K. N., & Mendelsohn, R. (2001). The effectiveness of gasoline taxation to manage air pollution. *Ecological Economics*, *36*, 299–309.

Slangen, L.H.G., Loucks, L.A. & Slangen, A.H.L. (2008), *Institutional economics and economic organization theory; An integrated approach*, Wageningen

Turntoo. (2015). D. Appleton. Interview March 17th 2015

Tzioti, S. C. (2010). *PhD Thesis: Let Me Give You a Piece of Advice: Empirical Papers about Advice Taking in Marketing*. Erasmus Research Institute of Management (ERIM).

Verfaillie, H.A. Bidwell, R. (2000). Measuring eco-efficiency: A guide to reporting company performance. *World Business Council for Sustainable Development*, (June).

Vissers, R. (2014). *Presentation: Cradle to cradle products innovation institute*. Wageningen, Netherlands.

Williamson, O. E. (1998). Transaction cost economics: how it works; where it is headed, (1), 23–58.

Williamson, O. E. (2000). The New Institutional Economics: Taking Stock, Looking Ahead. *Journal of Economic Literature*, *38*(3), 595–613.

Websites:

http://srmo.sagepub.com, retrieved May 28th 2015

http://biomimicry.net, retrieved February 10th 2015

www.circle-economy.com, retrieved April 20th 2015

http://www.duurzaamnu.nl/archives/176-Belasting-als-sturingsinstrument.html, retrieved May 6th 2015

www.mudjeans.nl, retrieved April 20th 2015

http://www.rtlnieuws.nl/economie/nma-geeft-boetes-voor-oude-kartelvorming-aan-kpn-vodafone-en-t-mobile, retrieved May 30th 2015

http://www.theoptimist.nl/een-duurzame-vrije-markt, retrieved May 6th 2015

http://www.wbs.nl/platform/debatten/4431/start-eerst-eens-met-een-hervorming-van-het-belastingstelsel, retrieved May 6th 2015

Appendix: Legislative issues

It is the role of the government to create legal rules i.e. laws. When these laws stimulate circular material cycles this will accelerate the transition towards a circular economy. An example from the construction industry shows a highly structured system of material recycling. Re-using building materials was initially a reaction to high costs of building materials. Legislation followed when the government created a policy for reusing materials in new buildings. Governmental legislation is one of the most effective incentives for businesses to re-use materials (Cradle to Cradle, 2015). However, the cases exposed that the legal system is reinforcing the linear economy due to some legislative gaps on the one hand and obstructing legislation on the other hand.

Legislative gaps

Since legislation is currently directed to benefit linear (economic) processes there are legislative gaps seen from a CE perspective.

Brands rather have surplus- than insufficient inventory. The result is that 20-40% of inventory never reaches store shelves. These materials currently cannot be up-cycled and are down-cycled, landfilled or incinerated. Vissers (Cradle to Cradle, 2015) states legislation is needed to reduce excessive production.

Moreover there are no sufficient rules concerning material safety. When treating materials in order to reduce inflammability, be colorfast, be water resistant et cetera, producers often use substances containing carcinogens, heavy metals, endocrine disruptors, teratogens, mutagens and/or that are persistent[12]. Although most of these substances are forbidden in the EU they are used on large scale in production processes in Asia. Since there is no control on imported products these materials enter our environment in large numbers (Cradle to Cradle, 2015).

Environmental legislation was mentioned not to provide a substantial incentive to transition to circular material cycles and should be strengthened in order to activate more circular material flows (Cradle to Cradle, 2015).

A recurring subject in the context of the circular economy is labor tax. Closing material cycles means that materials can be used in smarter ways. This will result in more cascading, more manufacturing industry close by instead of in Asia and more labor. Therefore, taxing labor is in a way punishing smart use of materials. A solution can be to tax (virgin) materials instead of labor. This would create an incentive for reusing materials and provide a monetary advantage for organizations that are already closing material cycles (Circle Economy, 2015; Turntoo, 2015). A company like Mud Jeans For instance would benefit from that (Turntoo, 2015).

Finally, Appleton explained the difficulty of creating dynamic earning models. A distribution code for contributing stakeholders is an intermediate solution, but dynamic earning models can only be created when legislation on this topic is altered (Turntoo, 2015).

Missing Legislation on:
Reducing excessive production
Material safety
Stricter environmental legislation
Material tax (instead of labor tax)
Dynamic earning models

[12] See next page for the explanation of these concepts.

Obstructing legislation

Besides the lack of legislation some existing laws that obstruct the transition to circular material flows. Firstly, legislation concerning waste and transport of waste is prohibiting using waste as a resource. Transport is costly because materials classified as waste have to be transported in a specific way. This might be necessary for harmful substances, but when it concerns empty PET-bottles for instance the costs for specialized transport can be unreasonable (Circle Economy, 2015).

For the concept of lease there can be other legal obstacles. Although not defined for the textile industry yet an example mentioned by Turntoo is accession (nl: natrekkingsrecht) - An object that is connected to a building legally becomes part of the building and can be sold by the bank when the company goes bankrupt. If this object, for instance a lamp, was leased there is a problem since the leasing company is not able to recollect the lamp for legally it is part of the building (Turntoo, 2015). Although this example is not applicable to the fashion industry it is a clear example of an obstructing law that becomes visible in the transitioning process. Turntoo hired a specialist in fiscal law in order to develop contracts around obstructing laws.

For the concept of leasing garments tax (BTW) that has to be paid at once forms a problem. This would be no problem if a product is sold at once and the selling company receives the money for the product immediately. However, if a product is leased the money is received in terms (Turntoo, 2015).

Finally, problems can arise from international laws and trade agreements. For instance Veenhoff (House of Denim, 2015) explains that import duties have to be paid when importing non-rewearable garments to Turkey in order to up-cycle them in new fabrics. Although these garments are not wearable anymore and cannot be sold as garments, the import duties still have to be paid. A solution could be to make fibers of the garments first and send the fibers to Turkey, but at the moment there is no fabric in the Netherlands able to do this. If this issue is solved demand for these materials is likely to increase because they become financially attractive (Circle Economy, 2015).

Obstructing Legislation on:
Waste management
Accession
Tax (BTW) has to be paid at once
Labor tax (instead of material tax)
International laws and trade agreements

Explanation of concepts

Bioaccumulation:
The process by which substances are stored and accumulated in the tissue or organs of humans or animals.

Carcinogen:
A causal relationship has been established between exposure to the agent and human cancer

Endocrine disruptor:
A substance that mimics, blocks, or interferes with hormones and their production, metabolism, and excretion causing malfunction of the endocrine system which can lead to malfunction of the reproductive, nervous, and immune systems.

Heavy metal:
The term "Heavy Metals" is generally interpreted to include those metals from periodic table groups IIA through VIA. The semi-metallic elements: boron, arsenic, selenium, and tellurium are often included in this classification.

Mutagen:
This is a substance that may cause hereditary disorders in the offspring due to mutations in the chromosomes of the male or female reproductive cells. These mutations can be alterations in the structure or number of chromosomes, or nucleotide substitutions known as point mutations.

Persistence:
This is a measure of a substance's ability to remain as a discrete chemical entity in the environment for a prolonged period of time. A common measuring tool for persistence is "half-life" (t1/2), which is the amount of time required for half of the substance to breakdown. If half-life is greater than 30 days in the air, or if half-life is greater than 50 days in soil, water, or any other media the substance is considered to be persistent.

Teratogen:
A substance shown to cause damage to the embryo or fetus through exposure by the mother (MAK-list: Pregnancy risk group, category A).