Master's Degree Thesis

Be in the Loop: Circular Economy & Strategic Sustainable Development

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Abstract:

Current human activities have a significant impact on the socio-ecological system, endangering this system's capacity to support human civilization and biodiversity. Today's linear industrial model can be seen as a main driver of this challenge, which implies a need for a model that uses less raw material and is more aligned with the cyclical nature of Earth. A concept that claims to provide such a model is Circular Economy (CE).

This study analyses CE for its potential contribution to strategic sustainable development, and explores the barriers and enablers companies face in its implementation process. The main methodologies used for this research include the analysis of the concept by means of a conceptual framework and a Framework for Strategic Sustainable Development, as well as interviews with experts in related fields.

The research exposed several gaps between CE and strategic sustainable development. The main barriers were found on a technological, legal, economic level, and at the behavioural level, i.e. the difficulty to change mindsets. Leadership, collaboration, the CE concept itself and customer behaviour were identified as important enablers. These results show that the concept is difficult to implement and that there is a need for a refined approach, which is easier to apply while leading closer towards sustainability.

Keywords: Sustainability, Circular Economy, strategic sustainable development, barriers, enablers, closed loop

Statement of Contribution

Throughout the five months of the thesis period, the thesis team worked well together and experienced very good group dynamics. The team started the process by defining a shared vision for the thesis project and outlining each member's personal expectations for working together as a group. As a result, everyone brought in one's individual perspectives, strengths and humour to the process, contributing to a dynamic working atmosphere.

The thesis was carried out in a collaborative manner - all group members contributed equally to all parts of the thesis, namely: research design, data collection, analysis, writing, presentation of results and project management. In the division of the work the group did not only consider the strengths of each team member, but also aspects that the members would like to improve on. In this way, opportunities for personal learning were provided, instead of only drawing upon existing strengths and capabilities.

Although the whole team in total contributed equal amounts of work, in the course of the thesis each of the members had adopted a certain role: Roman as the hero of facilitating meetings (especially in guiding brainstorm- or planning meetings) and critical systems thinker, Ronja as the rockstar of writing, proofreading and phrasing, and Nicola as the superwoman of organisation, formatting and layout. Moreover it can be said that in the writing process Ronja was more responsible for the formulation of the introduction, Nicola for compiling the methods part and Roman for presenting the results part.

Throughout the whole thesis period, meetings were held on a near-daily basis and, besides some very few exceptions, always the whole group was present. The roles of the facilitator and the note-taker rotated for each meeting: the same was applied to the roles of the interviewer, second interviewer and note-taker during the interview phase. Decisions were made consensus-based and everyone reviewed and revised each other's work.

The thesis team took on a systematic and purposeful approach, meaning that the work was continuously reviewed and questioned critically in order to make sure that the group is still going into the right direction and everyone is on the same page.

Overall, without each team member's individual contribution, the quality of this work would never have been achieved. At all times, all three members worked together exceptionally well and made this process an unforgettable experience. The learning experience was significant - individually as well as collectively.

Nicola Bechtel　　Roman Bojko　　Ronja Völkel

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Nicola, Roman & Ronja

Executive Summary

Introduction

Current consumption and growth patterns are leading society on a highly unsustainable path, which is increasingly damaging the ecosystem and endangering the provision of resources and ecosystem services. The consequence of living beyond the Earth´s means is that resources are being depleted, pollution is increasing and biodiversity is endangered. This sustainability challenge can be visualized by the funnel metaphor: The walls of the funnel represent society's growing demand for natural resources and ecosystem services on the one hand, and the decreasing capacity of the Earth to provide these resources and services on the other hand. As the area within the funnel shrinks, the risk of 'hitting the walls' increases and the room to manoeuvre diminishes.

The current industrial model, which is also described as a 'take-make-waste' approach, can be seen as one of the main drivers of this challenge. Businesses - and due to their size, specifically multinational companies (MNCs) - have a high influence on today's resource flows and unsustainable manufacturing practices that are not aligned with the way the Earth functions. A concept that claims to be more in line with the cyclical nature of Earth and acknowledges the interconnectedness of economy and environment is Circular Economy (CE). Therefore, this concept can potentially address the sustainability challenge by reducing resource extraction and waste streams, and support businesses in moving towards sustainability. However, given the complexity of today´s challenges, a strategic approach for working towards full sustainability is needed.

The purpose of this research is therefore to assess whether Circular Economy does provide such a strategic approach towards full sustainability and is aligned with strategic sustainable development (SSD). Furthermore, this study aims to explore the key factors that either hinder or help the implementation of CE. The motivation behind this research is to understand how the concept can be used to foster strategic sustainable development.

Following the outlined purpose, this thesis is based on the subsequent research questions:

1. To what extent is Circular Economy aligned with a strategic sustainable development approach?

2. What are the key barriers and enablers multinational companies face in the implementation process of Circular Economy?

The focus of this research lies on multinational companies that are active in Europe and are therefore subject to European laws and regulations, as this allows basing the research on a common ground.

Methodology

The structure of this study is based on Maxwell's Model for Qualitative Research Design, as it allows for an interactive, flexible approach to research. Different methods were used to answer the outlined research questions.

The data collection for the first research question was achieved by means such as desk research, case studies and interviews. Methods used for the analysis of the data included the generic Five Level Framework (5LF) and the Framework for Strategic Sustainable Development (FSSD), which both share a set of five levels: systems, success, strategic guidelines, actions and tools. While the 5LF helped to conceptualize and format the CE concept for analysis, the FSSD - with its unique principle-based definition of sustainability - was used to explore the concept´s gaps and contributions to strategic sustainable development. The outcome of the interviews, which were mainly conducted for answering the second research question, helped to support the information for the 5LF and FSSD analysis.

Approaches used for collecting data for the second research question included the reviews of case studies and desk research, but mainly exploratory interviews as a primary source of data. In total, 27 interviews were conducted with both representatives from MNCs (9) and academic experts (18). The data analysis was achieved by reviewing transcriptions of each interview and clustering the obtained information based on common topics. The key barriers and enablers were selected according to their frequency.

Results

Research Question 1: To what extent is Circular Economy aligned with a strategic sustainable development approach?

Once a structured overview of the concept has been established by means of the 5LF, it was analysed through the lenses of the FSSD to identify and describe the role that Circular Economy can play in moving towards sustainability. The following gives an overview of results to the first research question:

The analysis of contributions and gaps to SSD shows that the concept of CE could support companies in moving closer towards sustainability. However, it does not ensure a sustainable industrial model; not all dimensions of sustainability are considered as for instance the social perspective is neglected, and the concept lacks in strategic guidance.

At the systems level, the concept sufficiently acknowledges the existence of the sustainability challenge and the interconnectedness of the economy and the socio-ecological system. However, explicit information about basic natural laws and principles is limited, and further elaboration on these would be helpful for practicing organizations to get a better understanding of how the Earth functions. Furthermore, no widely agreed upon definition of the CE concept exists.

The importance of closing material flows, of substances either extracted or produced by society, and the need for dematerialization is aligned with certain Sustainability Principles of the FSSD at the success level. Several gaps, speaking to the fact that the concept does not fully eliminate the demand for extracting virgin materials and not sufficiently covers the mechanism of substitution, were identified. Furthermore, the concept currently does not adequately address environmentally-friendly management routines or agricultural practices, and the social side of sustainability is neglected.

At the strategic level, CE does not provide further means for the decision-making process, which creates a need for additional guidelines informed by a definition of socio-ecological sustainability. Furthermore, the concept does not suggest specific actions and is currently more focused on building an understanding of the foundations of the concept. However, it should be noted that the recommendation of concrete actions is only possible to a certain extent, as specific actions highly differ based on the products or the industry of the practicing organisation.

The results indicate the need for informing the CE concept by the FSSD, in order to close the identified gaps and move strategically towards sustainability.

Research Question 2: What are the key barriers and enablers multinational companies face in the implementation process of Circular Economy?

Based on the conducted interviews, 165 barriers and 56 enablers were identified. By organizing them around common topics, these factors were then grouped into categories. In this way, a total of ten clusters was established for the barriers and eight clusters for the enablers. The four key barriers MNCs face in the implementation process of CE, based on their occurrence in the interviews, can be described as the following:

- *Technological:* Barriers connected to specific technologies (e.g. recycling technologies) and processes (e.g. product design) that hinder companies to fully adopt the concept.
- *Legal:* Complexity of regulations, discrepancies between international regulations, and their often outdated or rigid characteristics, can unintentionally create additional barriers during the transformation.
- *Economic:* Businesses experience difficulties in defining the business case for adopting the CE concept, which is even more intensified by the current economic situation.
- *Change in mindset:* A reluctance to acknowledge that the current way cannot proceed and a change to a more long-term perspective is necessary, can hinder the implementation of CE.

For the enablers, the four key categories include the following:

- *Leadership:* Leadership that appreciates the new strategic direction, understands its benefits but also its risks, and is able to establish a common understanding in the business, can be a powerful enabler during the transformation process.
- *Collaboration:* A company can never achieve full circularity on its own: It is dependent on a network of collaborating organizations to enable the adoption of the concept. Fostering internal as well as external collaboration can therefore be a powerful factor.
- *Motivation through the concept itself:* The concept of Circular Economy unleashes creativity and improves morale by getting the idea that being sustainable, and at the same time benefiting economically, is possible for companies.

- *Customer behaviour:* Customers are increasingly demanding environmentally friendly products and by this are putting more pressure on businesses to adopt more environmentally cautious practices; this can be as significant enabler.

During the research additional barriers and enablers were identified, which - although their frequency was somewhat lower during the interviews - can be important in the implementation process.

Discussion

The findings show that there is not only a gap of the concept towards sustainability, but as well a gap regarding strategic guidance and support in the implementation process. This lack in guidance relates to an absent common definition of Circular Economy, missing strategic guidelines to assist the decision-making process and lacking concrete actions and tools that can be used to apply CE.

Furthermore, the exploration of barriers and enablers revealed a significantly higher number of hindering factors, than of such that help the implementation process. Apart from that, the obtained results indicate that there are no single most critical barriers and enablers, but that it is rather a combination of these that either hinders or helps the implementation process.

Additionally, the key barriers identified are rather seen as external factors, whereas the most important enablers are rather of an internal character. This might be related to the degree to which they can directly be controlled or influenced by a company.

Moreover, the comparison of the clusters of barriers and enablers has shown many common themes: technology, legal issues, customer behaviour, governmental support, the concept of CE itself, leadership and collaboration are all seen - depending on the context - as both hindering as well as helping factors. Except for leadership and collaboration however, which are nearly equally seen as a barrier and an enabler, the common themes are rather perceived as being hindering factors in the implementation process.

These findings indicate that Circular Economy is a concept difficult to implement, which can also be seen as a reason for its low diffusion. This shows that there is a certain need for a refined CE approach, which would not only bring companies closer towards sustainability, but also offer more guidance and strategic support and would therefore be easier to implement.

The conducted research indicates the possibility for advancing the CE concept with the help of the FSSD as well as the detected barriers and enablers, in order to address those weak points. Based on this, first recommendations were presented that could be utilized to start off the implementation of a circular model.

Relevance of the Research

By defining the concept's gaps and contributions to strategic sustainable development, this research has contributed to a better understanding of the role that Circular Economy could play in addressing society´s need for a more sustainable industrial model. Furthermore, the exploration of key barriers and enablers pointed out which factors can negatively or positively influence the implementation of CE, and shed light on the currently low diffusion of the concept. Both, defined gaps as well as key barriers and enablers, could be utilized for the establishment of a refined approach, enabling a more strategic implementation process and offering more guidance.

Strengths and Limitations of the Research

The high number of conducted interviews, as well as the variety of backgrounds and experiences of the interviewees can be seen as a strength, and positively contributed to the overall validity of the results. However, it is important to acknowledge that the implementation of the concept, and therefore the related barriers and enablers companies experience, might vary based on geographical and cultural contexts.

Areas for Future Research

Deviations of the implementation process based on geographical or cultural differences, the analysis of the role of small and medium sized companies in the further diffusion of CE, or the integration of a social perspective into Circular Economy are potential areas for future research. Furthermore, the possibility of developing a refined CE approach based on this study's findings could be explored and tested.

Conclusion

Research has shown that the implementation of Circular Economy can support companies in improving their environmental and economic performance, but exhibits certain gaps in regard to a principle-based definition of sustainability of the global socio-ecological system. Additionally, a missing common definition as well as a lack of strategic guidelines and concrete measures were emphasized. This, as well as the fact that during the research significantly more barriers than enablers were identified, indicates that the implementation of CE is a rather difficult process and could be a reason for its low diffusion.

These results indicate the need for a refined approach to CE that simultaneously addresses the gap towards strategic sustainable development, and provides companies with more guidance in the implementation process. Several recommendations were presented based on these findings.

Glossary

Backcasting: A strategic approach, frequently used for sustainability planning, of building a vision of success in the future and planning backwards from this, by looking at the current reality and considering options how the envisioned state can be reached (Holmberg and Robèrt 2000).

Barrier: In the context of this study, the term is used as a factor that limits or hinders the implementation of the Circular Economy concept.

Biological material cycles: A material cycle of biological nutrients, including non-toxic and biodegradable substances, that can safely be "returned to the soil by composting or anaerobic digestion" (EMF 2013, 26).

Circular Economy (CE): Describes "a development strategy that maximises resource efficiency and minimises waste production, within the context of sustainable economic and social development" (Green Alliance 2012).

Closed loop: In the context of this study, the term refers to the closure of material cycles in (production) processes. In a closed loop, materials are used again and again, and both the need for the extraction of virgin resources and the creation of waste is decreased (Preston 2012).

Downcycling: A process of "converting materials into new materials of lesser quality and reduced functionality" (EMF 2012, 25).

Enabler: Refers to a factor that is already present in the system, and simplifies or clears the way for other things to happen. This study uses the term for an aspect that can enhance the pace of the transition from a linear to a circular model, or helps to simplify this transition.

Funnel Metaphor: This metaphor is based on the funnel paradigm and refers to the "systematic degradation of the ecosphere's functions and biodiversity, and thereby to its ability to sustain society with its growing demands on services and resources" (Robèrt 2000, 246).

Five-Level Framework (5LF): A conceptual framework that was developed to assist planning in complex systems and serves as a neutral mental model for planning and analysis. It consists of five interconnected levels: system, success, strategic guidelines, actions and tools. (Robèrt 2000)

Framework for Strategic Sustainable Development (FSSD): Application of the 5LF for the purpose of planning in complex systems that aids societal transformation towards a sustainable mode of operation (Robèrt et. al 2010).

Leverage Point: A place within a complex system "where a small shift in one thing can produce big changes in everything" (Meadows 2009, 1).

Multinational Corporation or Company (MNC): A corporation which has operations (produces and sells goods) in various countries. In this thesis the authors also refer to MNCs as companies, businesses or corporations (UN 1973).

Paradigm Shift: Refers to a change in the way of perceiving, framing and thinking. In this study the authors therewith also refer to a shift from a short term to a rather long term perspective of thinking.

Remanufacturing: A process of disassembling and recovering products and materials at the module and, eventually, at the component level. “Functioning, reusable parts are taken out of a used product and rebuilt into a new one” (EMF 2012, 25).

Socio-ecological system: A combined system of biosphere and society that interacts in complex ways (Robèrt et. al 2010).

Strategic Sustainable Development (SSD): A process of planning and decision making, promoting a transition of the current unsustainable society towards a sustainable society based on the Sustainability Principles (Robèrt et. al 2010).

Substitution: Refers to “exchange of type/quality of flows and/or activities” (Robert 2002, 200).

Sustainability: A state of society in full compliance with the four Sustainability Principles - in which the socio-ecological system and the ability of future generations to meet their own needs is not systematically undermined by society.

Sustainability Principles: “In a sustainable society, nature is not subject to systematically increasing:

1. concentrations of substances extracted from the Earth‘s crust;
2. concentrations of substances produced by society;
3. degradation by physical means;

And in that society...

4. people are not subject to conditions that systematically undermine their capacity to meet their needs “ (Ny et al. 2006, 64).

Systems Thinking: “Systems Thinking is based on understanding of a system by examining the linkages and interactions between the components of the entire system” (Koca 2012).

Systems Perspective: A perspective which is taking all behaviours and feedbacks of a system as a whole into account. In the context of this study, the system in focus is the socio-ecological system.

Technical material cycle: A material cycle of technical nutrients which are durable materials, as plastics or metal, which can be reused again and again for various purposes (EMF 2013).

Trade-off: A scenario of reducing or losing a desirable outcome or quality of something in return for gaining another desirable outcome or quality.

Waste: Refers to residuals “for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose” (UNSD 1997).

List of Abbreviations

4SPs	Four Sustainability Principles
5LF	Five-Level Framework
B2B	Business to Business (transactions)
B2C	Business to Consumer (transactions)
BTH	Blekinge Tekniska Högskola
C2C	Cradle to Cradle Concept
CE	Circular Economy
EMF	Ellen MacArthur Foundation
EU	European Union
FSSD	Framework for Strategic Sustainable Development
IEA	International Energy Agency
IAEA	International Atomic Energy Agency
MNC	Multinational Company/Corporation
MSLS	Masters in Strategic Leadership towards Sustainability
PSS	Product Service System
SME	Small Medium Enterprise
SP	Sustainability Principle
SSD	Strategic Sustainable Development
ROI	Return On Investment
RQ	Research Question
UN	United Nations
UNEP	United Nations Environment Programme
UNSD	United Nations Statistics Division

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1 Introduction

"Oh, let's go back to the start
Running in circles, coming up tails
Heads on a science apart.
Nobody said it was easy…"

The Scientist - Coldplay

The awareness that business need to change in order to retract society from its current unsustainable path has strongly increased in recent years. Yet, most changes made by companies are only of an incremental nature. Nonetheless, a small but growing number of enterprises have taken on the challenge to truly transform the way they make business and become more sustainable by designing their processes in a more circular way. A concept inspiring and trying to bring forward this conversion is Circular Economy (CE). But can CE lead companies to sustainability? If yes, why have not more companies adopted it so far? Those are two of the questions that this research tries to answer.

1.1 The Sustainability Challenge

Since the industrial revolution in the middle of the 18th century, economic growth and countless innovations have led to an increased living standard and high improvements in fields such as education, medicine and technology. However, this "high standard of living in industrialized countries is based on high annual resource consumption": In the same period more natural resources than ever before throughout history have been depleted through human activities (Stahel 2010, 3; Steffen 2004). Among others, consequences of this degradation include depletion of the ozone layer, shortages of clean water, climate change, destroyed landscapes or biodiversity losses (Stockholm Resilience Centre 2009). Negative impacts on the ecological system are so high that the system's capacity to support human civilization and biodiversity is endangered (Steffen 2004).

This sustainability challenge can best be visualized by the funnel metaphor. The walls of the funnel represent society's growing demand for natural resources and ecosystem services on the one hand, and the relatively decreasing capacity of the Earth to provide those resources and services on the other hand. As the area within the funnel shrinks, the risk of 'hitting the walls' increases and the room to manoeuvre diminishes. (Robèrt 2000)

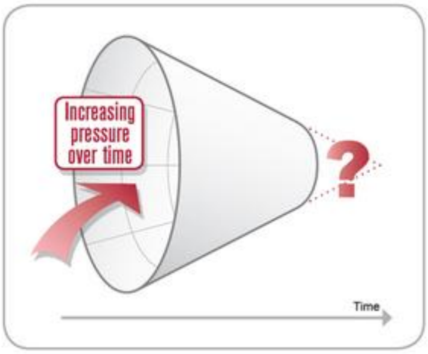

Figure 1.1 The Funnel Metaphor (Robèrt et al. 2010)

1.2 The Market Economy as a Driver of the Challenge

According to the UN "the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production"(UN 1992, 18). Therefore, it is essential to take a look at the economy when addressing today's sustainability challenges. Economic decision making today is mainly based on neoclassical economic thoughts. The neoclassical economic theory believes in the market's power to distribute resources in the most efficient way, satisfying both businesses and consumers by rational price setting. It welcomes little governmental interference and the privatization of property rights (Nicholson and Snyder 2008). The neoclassical theory is based on several assumptions: Among others, externalities - describing unintended consequences of economic decisions as for instance pollution - are seen as being separate from the market and such an environmental degradation is considered to be reversible by compensatory measures at a later stage (Taylor and Weerapana 2009). This worldview also assumes that the three main production factors, namely capital, labour and natural resources, could be replaced by one another (e.g. a lack of resources could be replaced by more capital) (Robèrt et al. 2010).

As it is one of the most dominant economic schools of thought, neoclassical thinking had a great influence on the characteristics of today's markets. A market can be anywhere where producers and consumers meet and exchange goods. Although it can be centrally steered by the government, deciding what, who and how products are produced, in our current society the model of a market economy predominates. In a market economy, producers decide themselves what and how to produce it, and how prices are set. Compared to the state-directed economy, in this decentralised model the government does not have a controlling function here, but rather attempts to level the playing field in terms of rules and regulations. Therefore, producers have a significant influence on the flow of resources and finished products. (Taylor and Weerapana 2009)

The original purpose of the market is to serve the society and satisfy consumers, by distributing scarce resources in the most efficient way (Taylor and Weerapana 2009). However, the current system sees the economy virtually as separate from the environment and does not accredit the dependency on it. Resource limits are not respected, as the rising consumption leads to a systematic overuse of resources (Robèrt et al. 2010).

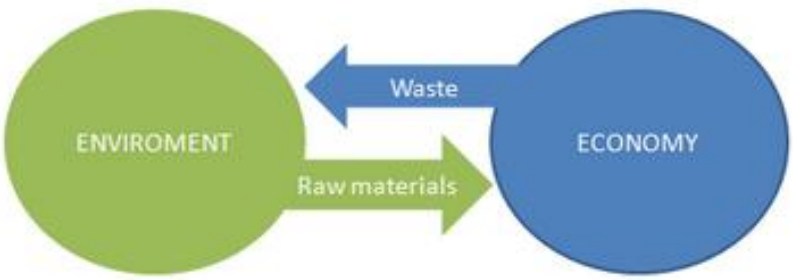

Figure 1.2 Neoclassical Economics Worldview (Robèrt et al. 2010)

According to numerous studies, for some resources, as for instance oil, we are likely to reach the peak global production soon (Hubbert 1956; MacKenzie 1998; IEA 2010). In the meanwhile, new extraction methods are required to keep the high extraction rate up - both at a higher cost for consumers and the environment (JP Morgan 2011). This in turn has a negative impact on the market, as resource prices keep increasing and fewer consumers can afford products and may be excluded from the market. Since the beginning of the new century, commodity prices have increased by 147%, reversing the trend of price declines during the last century (McKinsey Global Institute 2011, 4f). However, by 2030 three billion additional consumers are expected to join the middle class, desiring to consume more (McKinsey Global Institute 2011, 5). Simultaneously, “recent increases in food prices pushed 44 million people into poverty in the second half of 2010” (McKinsey Global Institute 2011, 7).

On the other hand, the increasing consumption causes the amount of waste to skyrocket: A report of the Worldbank estimates that by 2025 solid urban waste will increase by up to 70% globally (Hoornweg and Perinaz 2012). In turn, this waste contributes to an increased pollution of the socio-ecological system[1] which again endangers the provision of ecosystem services, leading to ever more scarcities (Persson et al. 2010).

1.3 The Role of Businesses in the Sustainability Challenge

As in a market economy businesses have a significant influence on resource flows, transforming the current market model to a more sustainable one heavily depends on their contribution. Especially multinational corporations (MNCs), defined as “enterprises which control assets - factories, mines, sales offices and the like - in two or more countries”, which account for approximately “two-thirds of world trade”, are an essential factor on today’s markets (UN 1973, 4; Johnson and Turner 2010, 212). Therefore, firstly it is important to understand their influence on the sustainability challenge and how products are actually manufactured. “The awareness of socio-ecological problems has grown [...] and numerous initiatives to support and facilitate sustainable development have been developed” (Lindahl 2013, 13). However, in today’s market economy the so called linear industrial model still predominates. In this study the term industrial model is used to refer to the way companies structure their operational business, including processes from procurement until the end-of-life phase of the product. In the linear model, resources are mainly extracted from the Earth’s crust or harvested from ecosystem services, are manufactured into a product and disposed at the end of the product’s lifetime. This process is often referred to as ‘take-make-waste’, as a large part of the resources cannot be recovered after the product’s disposal and ever new resources need to be extracted (Ellen McArthur Foundation 2012). Though, this pattern is slowly shifting and - not least due to rising resource prices - an attempt by businesses to reuse materials and lower their resource intake can be observed (Clark 2013). However, a methodical change of the system is missing (Nasr 2013).

[1]Combined system of interactions between the biosphere and society (Robèrt et al. 2010).

1.3.1 The Current Industrial Model in Conflict with Earth´s Natural Laws

To better understand why this linear approach cannot be pursued forever and a systematic transition needs to happen, it is necessary to take a step back and explore how the Earth system functions. The Earth is a closed system: essentially all matter remains in the system, whereas energy, however, is exchanged (Robèrt et al. 2010). This characteristic of a closed system defines natural limits to resources and ecosystem services, as Boulding described in his 'Spaceship Earth' theory (Boulding 1966). In order to survive in the long-term, society has to regard those resource limits.

The Earth, as part of a bigger system, functions in cycles. Just as e.g. carbon dioxide or water move in cycles, life on the planet is characterized by cycles as well. Plants transform matter into biomass, which serves as food for animals: the animals' waste again serves as nutrients for the soil, enabling the plants to grow and produce more biomass (Robèrt et al. 2010). The engine behind those natural cycles and enabling the system's self-sustainment is photosynthesis, a chemical process in plants powered by the sun (see e.g. Robèrt et al. 2010).

Several natural laws govern the Earth system: according to the Law of Conservation of Energy and Matter (the first Law of Thermodynamics), energy (and matter) cannot be created or destroyed. The second Law of Thermodynamics states that energy and matter naturally diffuse from a state of concentration to entropy. Those laws imply that firstly, although waste and pollutants resulting from such linear industrial models may be broken down to a certain level, the matter they consist of will remain in the system. Secondly, as matter naturally spreads, this applies to pollutants as well: Although pollution could only be a local problem, there is always the possibility that it spreads, as greenhouse gas emissions or cases of radioactive pollution show (Akimoto 2003; IAEA n.d.).

Furthermore, society contributes to the creation of entropy by consuming the "concentration, structure and purity" of material and leaving dispersed residuals behind (Robèrt et al. 2010, 35). An example would be paint on buildings that weathers away with time and spreads in nature. Sustainability, however, "relies on a systematic re-creation of concentration, structure and purity that at least equalizes the consumption of such value into dispersed waste" (Robèrt et al. 2010, 35). This is what a sustainable industrial model should aim for.

1.3.2 Vision of a Sustainable Industrial Model

A sustainable industrial model is one that respects the cyclical nature of Earth. First of all, products are manufactured in a way that does not exceed the natural limits of resources and ecosystem services. It is in balance with the Earth's bio-geochemical cycle and makes use of the Earth's renewable energy sources, as e.g. solar power. Accounting for the laws of thermodynamics, harmful substances that cannot degrade safely are phased out of the manufacturing process or prevented from entering the ecological system. Furthermore, the purity of resources is recreated at the same rate as resources are being consumed. From a social perspective, a sustainable industrial model does not contribute to unfair or unhealthy working conditions across the whole value chain. Such an industrial model could in turn support the market economy in decreasing its contribution to the sustainability challenge.

1.4 The Need for a New Industrial Model

Society's need for a vital industrial model using radically less raw material and energy, which decouples economic growth from an erosion of the socio-ecological system, gets more conspicuous and urgent (Hawken 2000). Today's sustainability challenges have not gone unnoticed, and attempts to find more sustainable alternatives are underway.

1.4.1 The Concept of Circular Economy

A concept that is gaining more and more attention is Circular Economy (CE). It could potentially help to resolve the sustainability challenge and support organizations moving towards sustainability by reducing resource extraction and waste streams, leading to decreased environmental impairment (Stahel 2010). As the term indicates, CE aims for a redesign of linear processes and flows of "materials, energy, labour and information" to more circular ones, thereby rebuilding natural and social capital (EMF 2013, 26).

The notion of CE and the thought of using nature as a teacher for industrial models are not new; the concept has been evolving since the 1960's. In 1966 the American economist Kenneth E. Boulding introduced the *Spaceship Theory* - a representation of an early Circular Economy. Boulding was aware of the resource challenge society might face in the future: "Earth has become a single spaceship, without unlimited reservoirs of anything […], therefore, man must find his place in a cyclical ecological system" (Boulding 1966, 7). The publication *Limits to Growth* from 1972 can be seen as a further important step towards the development of the CE concept: It also addresses the problem of resource limits and states that products need to be produced in a way that enables efficient re-use and recycling (Meadows et al. 1972; Li 2010). In the late 1980's, Walter Stahel as well as Michael Braungart and William McDonough revived the idea of an economy functioning in loops and discussed its impact on economic competitiveness, resource savings, job creation and waste prevention. All three claim that in an ideal closed-loop system waste would not exist as it would be feedstock for other processes (McDonough and Braungart 2002; Stahel and Reday-Mulvey 1981). In the 1990's, David Pearce, known in the field of environmental economics, was one of the first to coin the term 'Circular Economy' (Andersen 2006). Concepts such as Cradle-to-Cradle or Biomimicry, which were inspired by nature as well, also had an influence on the development of the Circular Economy concept (Sherwin 2013). Those various influences that were combined in the concept throughout the last four decades can be seen as a reason for the current lack of a common definition and clear explanation of the concept.

Although the wording of its principles might differ due to those multiple influences, Circular Economy generally aims to close material loops and treat them in two separate cycles: Biological nutrients, which can safely re-enter the biosphere since they are non-toxic and biodegradable, and technical nutrients which can be reused again and again (McDonough and Braungart 2002). The creation of waste, as referring to residuals "for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose", is avoided by the redesign of products and processes (UNSD 1997). The (re-)manufacturing process thereby relies on renewable energy, especially by harvesting solar power (EMF 2013).

1.4.2 Moving towards Circular Economy – Win-Win-Win Situation

Adopting a circular business model that seeks to sustain the planet could present an attractive win-win-win situation for society, the environment and the company itself. In the long-run, this transformation could offer an essential competitive advantage as CE claims to create more value from resources, support companies in meeting changing market requirements, lowering environmental costs, increasing consumer convenience and securing supplies (Preston 2012). Despite of that, companies adopting a CE could also benefit from savings in material and energy costs, a decrease in resource dependence (e.g. through reusing and re-marketing goods), an improvement in customer interaction and a reduce in warranty use by switching to longer-lasting products (Preston 2012). According to Willard, "the business case for sustaining the planet is stronger than the business case for trashing it." (Willard 2012, 18)

In addition to economic benefits for the individual company, CE could make a significant contribution to the sustainability challenge and the ecological system in general. Treating resources in closed loops may significantly lower the need for resource extraction, alleviating the problem of resource scarcity. Designing out the concept of waste and reducing toxic substances from the value chain could help to prevent today's massive pollution and furthermore contribute to a healthier society. (EMF 2012; Stahel 2010)

Regarding today's challenges, companies that will excel are those that best combine their knowledge and collaborate among other sectors in order to use resources as efficient as possible and thereby "help[...] restore the economic, ecological, and social health of the planet." (Willard 2012, 18)

1.4.3 Circular Economy Today

As CE is still a rather theoretical construct, research mostly focuses on the business case and how to implement it in companies (EMF 2012). Currently, "the term 'Circular Economy' is applied inconsistently by governments and companies – and awareness of the concept is relatively low." (Preston 2012, 3) This makes it difficult for companies to implement the concept and explains its current low diffusion. However, the dissemination of the concept is picking up speed and also politicians are becoming more and more aware of the limits of our current industrial model (Hermine 2013). Realizing that the 'take-make-waste'-practice cannot proceed for much longer, various laws and regulations aimed at making a shift towards a Circular Economy possible are being implemented.

The European Commission is an important driver for new policies regarding resource usage: The concept of CE is an essential component of the resource efficiency initiative of the EU 2020 strategy (The Parliament 2012). In 2008 for instance, the European Commission presented the 'Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan' which is supposed to lead to an improved environmental performance of products and increase the demand for more sustainable production technologies (European Commission 2012). Furthermore, a 'Cradle-to-Cradle-network' has been established in 2010, providing a platform for cooperation of EU regions for sharing their knowledge and experiences "in the areas of innovation, the knowledge economy, the environment and risk prevention" (C2C Network n.d.).

Besides the European Union, there are examples of other countries where laws and regulations fostering the transition towards a Circular Economy have already been implemented; China and Japan are two leading examples (Heck 2006).

1.5 Need for Strategic Sustainable Development

Although Circular Economy has the ambition to transform the current industrial model to the better and work towards sustainability, CE alone is not sufficient for society to be sustainable. The magnitude of today's challenges call for a strategic approach to sustainability that takes all - intended and unintended - consequences into account. The increasing number of sustainability methods and tools available often only focus on separate aspects of sustainability and whose role and contribution is difficult to understand, and thus exacerbate planning towards sustainability for organizations. As the ecosphere is a complex system, the whole system and its interrelations have to be examined instead of studying only individual parts of system (Capra 1985). A lack of such systems thinking could lead to difficulties in dealing with trade-offs or to unfavourable effects in other parts of the system, for example when the focus rather lies on dealing with concrete symptoms (e.g. climate change, biodiversity loss) than taking the overall picture into account (Robèrt 2000). An example of such a trade-off could be that even if one manages to reduce the consumption of fossil fuels for energy generation, this might lead to the unfavourable consequence of increasing the dependence on scarce metals, used for the provision of renewable energy solutions.

As a response to these challenges, there is a need for an "open-ended and non-prescriptive" definition of sustainability - a principle-based definition that supports us to deal with such complexity and addresses the entirety of unsustainable practices (as illustrated by the four categories in Figure 1.3) (Byggeth 2001, 702).

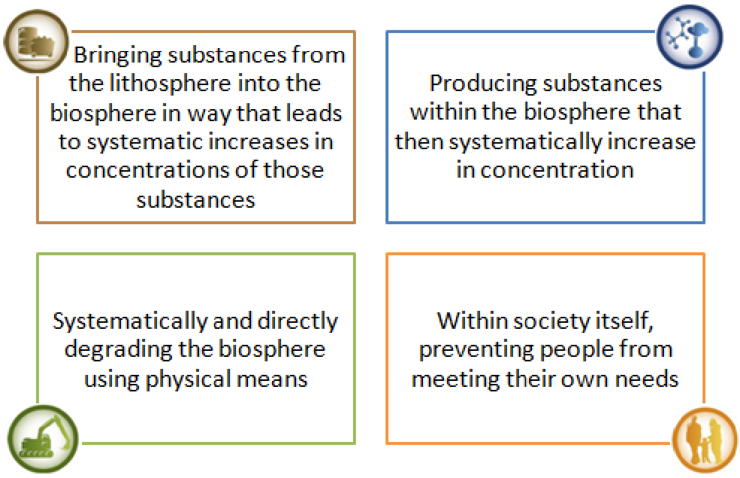

Figure 1.3 Categories of unsustainable practices framing the sustainability challenge (Robèrt et al. 2010)

The ‘Framework for Strategic Sustainable Development’ (FSSD), a unifying approach for planning towards sustainability, makes use of such a principle-based definition of sustainability that is “science-based, necessary and sufficient for sustainability, general but concrete enough and distinct” (Ny 2006, 5). Because of its characteristic as an overarching framework for sustainability, the FSSD will be used to assess the eligibility of Circular Economy to lead to strategic sustainable development.

1.6 Outline of the Research

1.6.1 Purpose

The first aim of this research is to analyse the concept of Circular Economy to understand and concisely describe the tool’s intended purpose and particularly its contribution to strategic sustainable development. Although the concept possibly has the potential to reform the market economy, only a few companies have adopted it so far. Therefore, the second aim of this study is the exploration of factors that either hinder or help the implementation of CE, as a potential reason for its low diffusion.

The motivation behind this research is to understand how the concept can be used to foster strategic sustainable development.

1.6.2 Research Questions

Following the outlined purpose, this thesis is based on the subsequent research questions:

1. To what extent is Circular Economy aligned with a strategic sustainable development approach?

2. What are the key barriers and enablers multinational companies face in the implementation process of Circular Economy?

1.6.3 Research Scope and Delimitations

Instead of taking on a global perspective, the study is concentrated on multinational companies (MNCs) that are active in Europe and therefore are a subject to European laws and regulations, as this allows basing the research on a common ground.

The scope of this study does not take small and medium sized enterprises (SMEs) into account, although there are a number of examples of SMEs having adopted a circular approach. The underlying rationale is that MNCs have a comparatively higher impact on the biosphere, with large amounts of resources being used and waste and pollution being created. Aiming for a more sustainable future and therefore a new economic approach, the researchers believe that MNCs have a significant potential in supporting and finally making the transition from the current take-make-waste economy to a Circular Economy happen. Therefore, by using their influence in a positive way and being a role model for their value chain and the whole market, those companies could act as a leverage point.

The emphasis will be on business to consumer trade, as those companies are considered to be more approachable as well as more attractive for a broader audience. Furthermore, this study targets companies that either have adopted CE already or are in the process of doing so. Here, the focus lies on the barriers and enablers of the implementation process and not on the aspects that are hindering or helping companies to improve their circular model even more and move towards 100% circularity.

Based on this scope, the primary audience for this thesis includes decision makers in MNCs of any industry, as well as organizations or sustainability practitioners interested in the field of Circular Economy.

2 Methodology

In the following, the design of the research and the methodologies used to answer the two research questions are outlined.

2.1 Research Design

Maxwell's Qualitative Research Design was chosen to structure the research. With its five interconnected levels of goals, conceptual framework, research questions, methods and validity (see *Figure 2.1*) it allows for a systematic, interactive research approach (Maxwell 2005). This approach enabled a continuous evolvement of the research, where new knowledge was constantly incorporated into the research process and the iterative process of data collection and analysis was ideally supported.

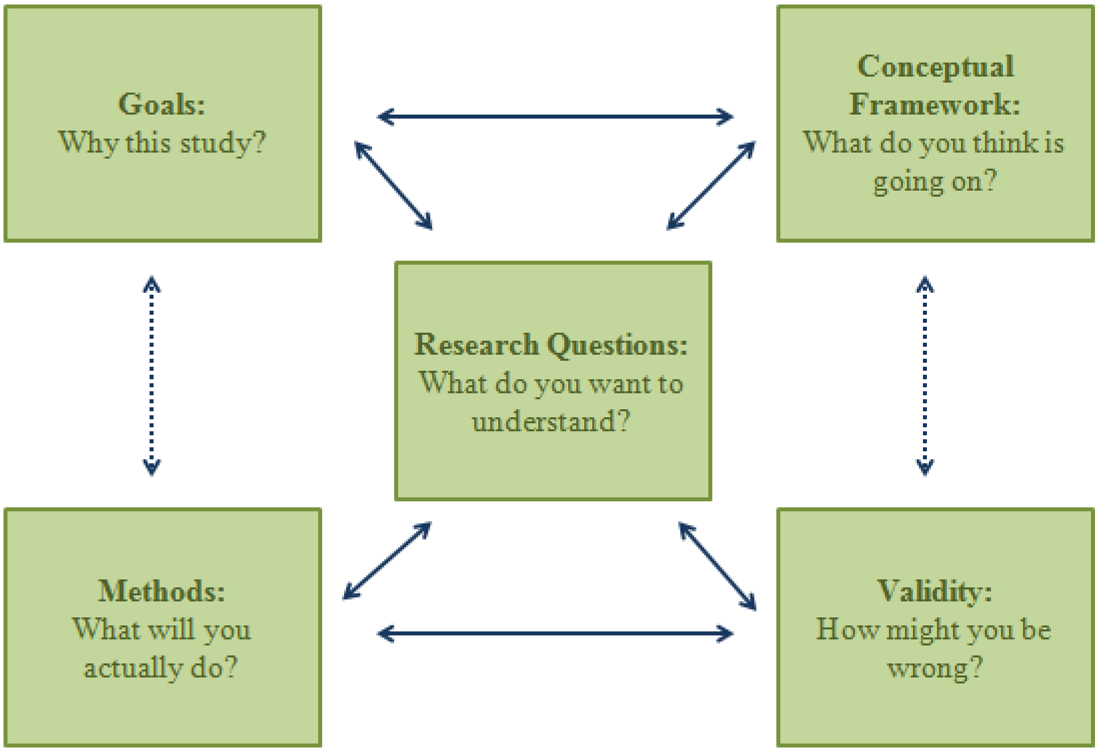

Figure 2.1 Maxwell's Model of Research Design (Maxwell 2005)

2.2 Research Question 1

To what extent is Circular Economy aligned with a strategic sustainable development approach?

The data collection for this research question was achieved by means such as desk research, case studies and interviews. Methods used for analysis of the data included the Five Level Framework (5LF) and the Framework for Strategic Sustainable Development (FSSD). Each of these are elaborated below.

2.2.1 Data Collection

The first period of the research served as a foundation for the whole study, and the collected information informed and influenced the general objectives and finally the two research questions. Published information such as books, journals, reports, articles, as well as online resources, as websites, were reviewed. Especially regarding the first research question, published research on the subject of sustainability and strategic sustainable development was utilized extensively. Besides, case studies were screened for first clues on the potential of CE moving towards sustainability. Advisors, peers and interviewees also were a helpful source for indicating further literature. Key research topics included: 'circular economy' 'closed-loop economy', 'linear model', 'industrial economy', 'cradle to cradle' and 'performance economy'. New literature was regularly discussed and evaluated during team meetings. In order to avoid research overlaps, a shared online database, where new literature findings were posted, has been established. Also, the outcome of the interviews, as described in section 2.3.3, helped to support the 5LF and FSSD analysis. For this purpose, specifically information about gaps of the concept and possible improvements or recommendations was extracted from the interviews.

2.2.2 Analysis of Gaps and Contributions to SSD

In order to assess whether CE leads towards sustainability, the Five Level Framework for planning in complex systems and the Framework for Strategic Sustainable Development were used.

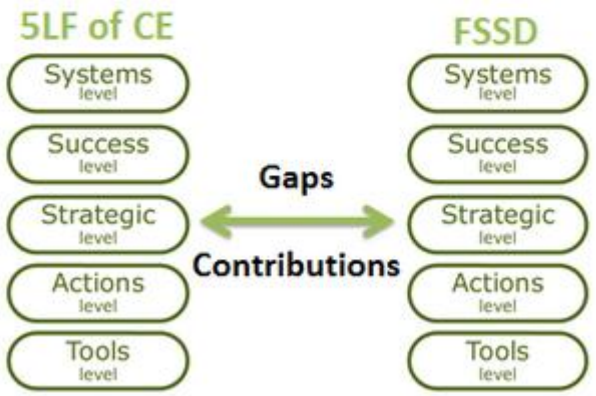

Figure 2.2 Analysis of gaps and contributions using 5LF and FSSD

The Five Level Framework

The 5LF is a conceptual framework that was developed to assist planning in complex systems and serves as a neutral mental model for planning and analysis, thus it can be used to structure any type of information. The relevant information that the CE concept provides – i.e. its assumptions, principles and guidelines - was categorized into the five levels the framework provides: systems, success, strategic guidelines, actions and tools. (Robèrt 2000)

The use of the 5LF to analyse the CE concept "facilitates clear analysis by clarifying both the distinctions and interrelationships between the levels of strategic planning (the system, success, etc.)" and further helps to create a shared definition (Robèrt et al. 2010, 29). To categorise information according to the five levels, a set of questions for each of the levels was used (see Appendix A) (Robèrt 2000).

The Framework for Strategic Sustainable Development

However, to analyse the CE concept's suitability for strategic sustainable development the 5LF is not sufficient. Instead, the FSSD was used to identify any gaps and contributions of Circular Economy in regard to sustainability. The FSSD serves as a variation of the generic 5LF and takes on a sustainability perspective - focused on the global socio-ecological system - with a clear principle-based definition of sustainability. Those principles are based on scientific consensus which was reached in a learning dialogue between policy makers and scientists in politics and business. It is designed to structure information in a strategic way and support decision making without losing the sight of the bigger picture. This allows organizations to improve their effectiveness and strategically plan actions contributing to the process of sustainable development. (Broman et al. 2000)

It shares the same structure of five levels:

<u>1. The Systems Level</u>

The FSSD focuses on the socio-ecological system as the system to be sustained. On this level, fundamental characteristics of the society within the biosphere and the interrelationship between the ecological and social systems are explored. This involves for example the bio-geochemical cycles, the laws of thermodynamics and society's dependence on natural resource flows and eco-services provided by the Earth (as outlined in chapter 1.3.1).

<u>2. The Success Level</u>

On the success level a principle-based definition of sustainability is introduced. "The Sustainability Principles are basic conditions, underpinned by scientific knowledge, for the successful continuation of the socio-ecological system." (Robèrt et al. 2010, 41). These principles (see *Figure 2.3*) were established based on the categories of societal unsustainable activities (see *Figure 1.3*).

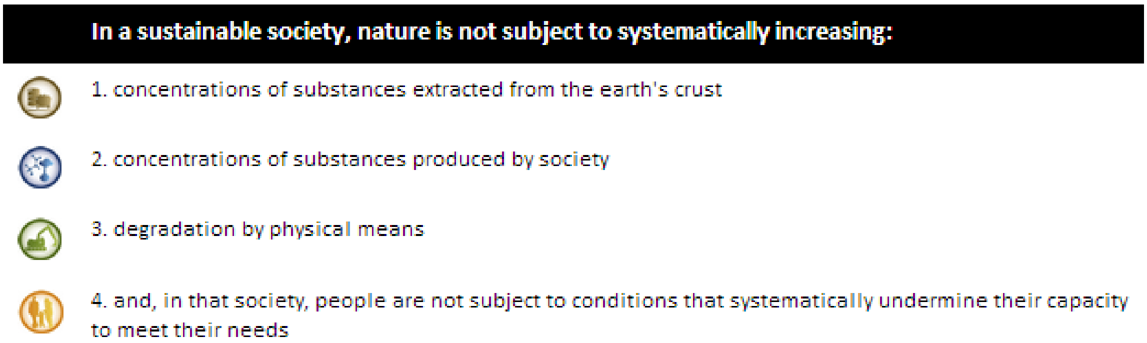

Figure 2.3 Sustainability Principles (Holmberg and Robèrt 2000)

<u>Sustainability Principle 1</u>
The first Sustainability Principle (SP) addresses society's influence on the socio-ecological system by systematically accumulating substances in the biosphere that were extracted from the lithosphere. The balance of flows between the biosphere and the lithosphere is not only affected by extraction activities, which are larger than natural flows, but also by the management and storage of such substances. Due to the complexity of the ecosystem it is difficult to define acceptable levels of concentration for different substances: This is why society at least has to avoid the systematic increase of such substances. (Ny et al. 2006)

<u>Sustainability Principle 2</u>
The second SP is connected to substances created by society. Such substances have to be produced in a way that allows their integration into natural cycles, either by managing them in closed loops or designing them in a way that they can safely be deposited in the atmosphere. In any case, their concentration in the biosphere should not systematically increase. (Ny et al. 2006)

<u>Sustainability Principle 3</u>
Society's impact on the biosphere by physical means as for instance "over-harvesting, mismanagement or displacement" is covered by the third SP (Broman et al. 2000, 12). Such measures have a negative impact on resources or the provision of ecosystem services, as e.g. the quality of soil, the availability of fresh water or as well biodiversity (Broman et al. 2000).

<u>Sustainability Principle 4</u>
The fourth SP addresses the social dimension of sustainability. It requires the elimination of conditions that hinder people from meeting their basic needs, while respecting the first three ecological Sustainability Principles. (Missimer et al. 2010)

<u>3. The Strategic Guidelines</u>
The strategic level introduces the concept of backcasting: Backcasting is a suitable "methodology for planning under uncertain circumstances" (Holmberg and Robèrt 2000, 3). In this context, backcasting refers to "start planning from a description of the requirements that have to be met when society has successfully become sustainable", and then defining what needs to be done today in order to reach this vision of future success (Holmberg and Robèrt 2000, 3-4). As there may be many potential actions to close the gap between the

current, unsustainable reality and the principle-based vision of sustainability, three prioritisation questions can be applied to aid selecting those actions that strategically move an organisation towards sustainability. They serve as strategic guidelines for aligning actions with the four Sustainability Principles, and can be extended and adapted by an organisation's individual prioritisation criteria. (Holmberg and Robèrt 2000)

The three prioritisation questions are as follows:

> a. Is this action leading in the right direction in regard to sustainability?
> Some measures might be in alignment with some of the SPs, but simultaneously disregarding others. This question helps to identify possible consequences of the proposed measures. (Holmberg and Robèrt 2000)
>
> b. Does the measure serve as a flexible platform for future actions?
> In order to avoid blind alleys, measures to be implemented need to allow for future steps to be taken towards success with respect to sustainability. (Holmberg and Robèrt 2000)
>
> c. Does the measure generate sufficient return on investment?
> This question is focused on the effective management of investments. Actions that allow for an early return on investment should be taken first (so called low hanging fruits), as they can generate additional resources for later, higher investments for sustainability. (Holmberg and Robèrt 2000)

<u>4. The Actions Level</u>
The fourth level of the FSSD includes potential measures moving the socio-ecological system closer towards sustainability, which have been selected using the three prioritisation questions of the strategic level.

<u>5. The Tools Level</u>
This level defines tools and concepts that support efforts to achieve global sustainability. Tools can typically be divided into strategic tools that aid planning, measurement tools to assess the progress and capacity building tools such as educational measures. As the FSSD is a framework that does not offer specific guidelines or steps to take, it is dependent on additional tools to support an organisation's sustainability work. (Robèrt 2000)

2.3 Research Question 2

What are the key barriers and enablers multinational companies face in the implementation process of Circular Economy?

Approaches used for collecting data for the second research question included the reviews of case studies and desk research, but primarily the information was gathered through exploratory interviews. The data was analysed by clustering the information based on common topics and selecting the key barriers and enablers according to their frequency.

2.3.1 Data Collection

A focused desk research was undertaken to set a foundation for the second research question. In order to get a first overview on potential barriers and enablers of a circular transformation, case studies were sifted. Hereby the focus was on organizations that adopted a more circular model already. Both, desk research and case studies additionally supported the compilation of a list of possible interview partners.

2.3.2 Interview Sampling

The first step in the process of identifying the main barriers and enablers of a CE approach was to determine who could contribute to the research. To include both practical and more theoretical knowledge in the research and increase the validity of the data, practitioners from companies as well as academic experts were consulted. Potential companies were chosen based on the following criteria:

- The company is a manufacturing company
- It is a multinational corporation with more than 250 employees
- Its focus is on business-to-customer (B2C) transactions
- It is in the process of implementing a CE approach

The sample list of potential interview companies was compiled by means of desk research and case studies, as those companies publicly communicate their involvement in the Circular Economy approach (e.g. through their membership of the CE100 group, an initiative by the Ellen MacArthur Foundation).

Academic experts were chosen based on their contribution to books, journals, reports and articles connected to the research topic.

Based on those criteria a sample list of 38 companies and 29 academic experts was created. These potential contacts were screened more in depth to explore whether they could possibly contribute to the answering of the second research question (e.g. by researching their background and level of experience). In the end, 25 out of the sampled 38 potential companies and all 29 sampled academic experts were assessed as being relevant for the research.

In case no direct contact for the potential interviewees was available, connections were tried to be established using the network of current students of the Master program in Strategic Leadership towards Sustainability (MSLS), the MSLS Alumni and the MSLS staff. Besides providing contact details for the requested companies and academic experts, additional suggestions for possible interviewees were gathered.

All 67 potential interviewees were contacted via email to request an interview. The initial contact email included a one page document outlining the MSLS program, the research objectives, the planned timing of the interview phase (between March 19th and April 19th 2013), and the interview duration (30 to 60 minutes depending on availability of the interviewee).

2.3.3 Interviews

The design of the interview questions was based on the desired outcome, defined through the query "What needs to be found out to be able to answer the research questions?" To structure the interview in a strategic way, the 5LF was used to formulate the interview questions (see Appendix C). In regard to the varying duration of interviews, an additional list with fewer questions (containing the most relevant ones) was established. Furthermore, the phrasing of questions was adapted depending on whether a corporate practitioner or an academic expert was interviewed (see Appendix C). As the knowledge of Circular Economy was deepened in the course of the research, the list of questions evolved simultaneously. The first interviews therefore helped to get a more general overview, whereas during the last interviews additional questions were asked to gain more in-depth information (see Appendix C). To ensure its effectiveness, the list of questions was pretested before the interviews with both primary and secondary advisor, as well as an external advisor from a previous MSLS class.

A total of 27 interviews were conducted with both MNCs (9) and academic experts (18) (see Appendix D). Before each interview a short overview of the organisation or company, and the background of the interviewed person were compiled. This was achieved by online research, e.g. through reviewing the organizations' websites, and made it possible to ask more in-depth questions based on the interviewee's background. Furthermore, the list of questions was sent to the interviewee a minimum of three working days in advance, to make it possible for the interviewed person to prepare.

During the interviews, the three authors rotated through different roles: the person who established the contact to the interviewee took the role of the first interviewer and led the interview. A second interviewer supported the first interviewer by asking additional follow-up or clarifying questions. The third author was appointed as the note taker and had the responsibility to transcribe the interview.

All interviews - except for one in-person interview (MRT) - were conducted online via Skype or web conferences (WebEx). With permission of the interviewees, all interviews were digitally recorded using the Amolto Call Recorder to support the transcription process and increase data reliability.

2.4 Data analysis

2.4.1 Transcription

All 27 interviews were transcribed by the note taker, with the help of the interview recordings. Upon completion, the transcription was sent to the interviewee for approval and to avoid any misunderstandings. In a few cases, interviewees added additional notes or comments to the document. This process additionally increased the validity and accuracy of data.

2.4.2 Coding

To process and analyse the transcribed data to make it possible to answer the second research question, it was coded in several steps. Firstly, based on the predefined desired outcome that was at the bottom of the interview questions, the following coding categories were defined:

- Barriers of the transformation process
- Enablers of the transformation process
- Most critical implementation steps
- Drivers of the transformation process
- Final vision of the CE concept

Secondly, the acquired data was sorted according to those categories. To avoid bias and therefore increase the validity of the analysis, the coding of data was divided among the three authors and all the interviews were sorted separately. Finally, the accuracy of information in each coding category was tested in a common discussion: If necessary, the data was shifted to a more suitable category until consensus was reached and a final set of coded data for each category was defined.

2.4.3 Clustering of Information

In a first step, the categories of 'key implementation steps' and 'drivers of implementation' were screened for additional, implicit barriers and enablers, which were then added to the according categories. Secondly, the categories of barriers and enablers were searched for common, recurrent themes (e.g. technological barriers). Finally, the identified hindering or helping factors were clustered into those identified common themes. To allow for a better overview and avoid reductionism, rather broad clusters were created that contain more specific information on a deeper level.

In the clustering process no distinction was made between information obtained from companies or academic experts, as the meaning of a potentially resulting divergence of results would have been impossible to scientifically assess.

2.5 Validity of Data

Throughout the research process, assumptions as well as results and conclusions were thoroughly discussed by the researchers and their advisors in order to ensure a high validity of the research. Different sources of data collection were used throughout the research process to allow for a rich diversity of data and perspectives.

Especially regarding the interviews, as a primary source of data, special arrangements - including recordings, transcriptions and approval of the information by interviewees - were taken to ensure their validity.

3 Results

In this chapter, the two research questions are answered, using the upfront outlined methodologies.

3.1 Research Question 1

To what extent is Circular Economy aligned with a strategic sustainable development approach?

To answer this research question, a structured understanding of the Circular Economy concept was established and its gaps and contributions to strategic sustainable development were explored.

3.1.1 Five Level Framework Analysis

In the following, the relevant information provided by the concept - i.e. its assumptions, principles and guidelines - are categorized into the five levels of system, success, strategic guidelines, actions and tools.

Systems Level
At this level of the 5LF it is described how the system works, what its most basic functions and its boundaries are (Robèrt 2000).

The origin of the current industrial model of 'take-make-waste' dates back to the Industrial Revolution. It is a model where "resources are extracted, shaped into products, sold, and eventually disposed of in a 'grave' of some kind, usually a landfill or incinerator" (McDonough and Braungart 2002, 27). This behaviour has contributed to challenges such as climate change, mass species extinctions and clean water shortages (The Worldwatch Institute 2008). Circular Economy acknowledges that it is not sufficient to approach these problems with a linear way of thinking and aim for quick fixes: a different perspective needs to be taken on considering the root of problems (The Guardian 2013). Based on this, CE "takes nature as an example and considers that our systems should work like organisms, processing nutrients that can be fed back into the cycle" (EMF 2012b).

CE is not limited to the macroeconomic level of how whole nations or markets can use the concept as an economic model, but considers the microeconomic level of individual companies and the interaction of businesses (e.g. in food webs or industrial parks) as well (UNEP n.d.). Even more, it stresses the importance of collaboration among organizations across the whole value chain, as the realisation of "such [an] approach […] requires systemic changes that go beyond the individual firm" (Preston 2012, 8). Circular Economy can therefore be seen as a design tool that serves a wide range of different actors, as for instance product developers, decision-makers in companies or political actors.

Success Level

In this level the overall goal of the concept is defined. Ideally, to ease the implementation, the concept's definition of success is based on principles that later on can be used to guide the decision-making process (Robèrt 2000).

The vision of Circular Economy on a business level can be described as developing an industrial model that uses radically less raw material and energy, thereby not only creating a competitive advantage by reducing expenses, driving innovation and making the organisation more resilient to risks, but also reducing its negative impacts on environment and society (EMF 2012). The concept emphasizes the need of moving away from the current linear manufacturing model and making a transition to a model that "seeks to optimize all flows in the economy" (Wallace and Raingold 2012, 5). This change in the way things are made has in turn "profound implications for society", as it influences our way of working, purchasing, thinking and living as well (Preston 2012, 2).

Due to the diverse influences of various schools of thoughts, no universal guidelines for a Circular Economy exist (see e.g. EMF 2012c). However, there are certain aspects that are shared by most of the different approaches, which shall be taken into account for a successful implementation of the concept.

<u>1. Closed-loop thinking</u>

The central idea of Circular Economy is that resources shall be kept in a closed loop, meaning that linear processes are redesigned into circles that have "no beginning and no end" (Stahel 2012). Materials are therefore used again and again and both the need for the extraction of virgin resources and the creation of waste is decreased (Preston 2012).

<u>2. Distinct technical and biological material cycles are maintained</u>

Building on the idea of closed loops, Circular Economy requires materials to be treated in two separate flows: one exclusively for biological nutrients, the other for technical nutrients. Biological nutrients include non-toxic and biodegradable substances that can safely be "returned to the soil by composting or anaerobic digestion", as for instance degradable packaging (EMF 2013, 26). Technical nutrients are durable materials, as plastics or metal, that can be reused again and again for various purposes (McDonough and Braungart 2002).

<u>3. Manufacturing cycle is extended</u>

In order to keep technical materials in a closed cycle, new ways of manufacturing are needed. Not only the manufacturing process itself might need to be changed to ensure a higher quality and durability of the product, but moreover new manufacturing steps need to be added (see *Figure 3.1*). A first step would be maintenance of products to conserve their original condition for as long as possible. Furthermore, the repairing or reusing of broken products allows a big share of otherwise wasted goods to be returned to consumers. Also, the refurbishment and remanufacturing of old, outdated products by "little enhancement or change" allows keeping products in the cycle for longer (EMF 2013, 32). A last step would be the recycling of products at their end of life. A smart recycling system enables the retrieval of valuable resources without diminishing their quality, so that materials can be reused to manufacture new products. (EMF 2012; Green Alliance 2011; Preston 2012)

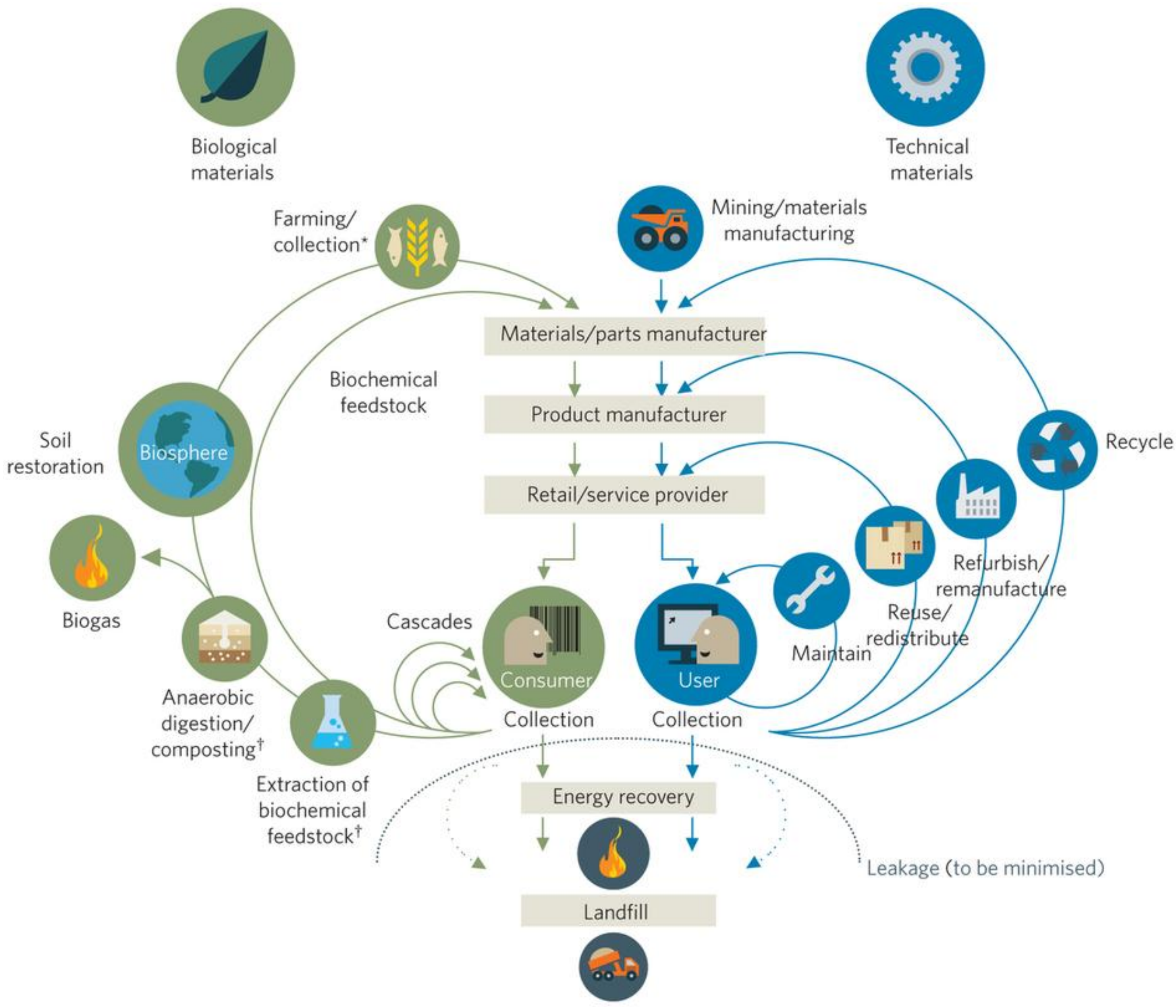

Figure 3.1 The material flow within CE - Biological and technical nutrients (EMF 2012, 24)

<u>4. No waste is created</u>

However, the prolongation of the use phase of products by additional manufacturing steps is not sufficient to realise the idea of keeping materials in closed loops. Moreover, the implementation of a Circular Economy requires waste to be completely eliminated from the economy. This asks for a new approach to product development and design respecting the following criteria: "product durability, to keep valuable materials in use for longer; design for disassembly and remanufacture; design for recycling" (Green Alliance 2011, 23). This also includes designing product components to fit in either the biological or the technical material cycle.

<u>5. Use renewable energy</u>

This principle relates to society's dependence on fossil fuels as a main source of energy. By choosing an industrial model that aims for a sustainable economy, also the energy system requires a redesign as the use of fossil fuels as scarce resources is hardly consistent with the essential principles of CE. As Davis puts it, "the first Industrial Revolution developed through the interaction of scarce fossil fuels with rocks bearing scarce, inorganic elements. The second will depend increasingly on renewable sources of energy processing renewable resources." (Davis 1994, 188). Using natural and renewable sources of power is therefore an important part of the CE concept (Preston 2012).

Strategic Guidelines

This level of the 5LF contains specific guidelines that help organizations to prioritise actions for moving towards success as defined in the previous level (Robèrt 2000).

The concept of Circular Economy does not provide specific criteria to support the selection of actions, such as guidelines of how to implement the concept. This might be due to the fact that the implementation of Circular Economy "var[ies] significantly for different products and markets": Each business requires a highly individualized approach, so general guidelines can hardly be given (EMF 2013, 33; Bey and Bjørn 2013). However, the concept describes four ways of how value in a Circular Economy can be created.

<u>1. Design small circles</u>

Circles should be designed as tight as possible, so that products and materials can quickly and easily re-enter the market: "The smaller the loop (activity-wise and geographically) the more profitable and resource efficient it is" and "the higher [are] the potential savings on the shares of material, labour, energy, and capital embedded in the product." (Stahel 2012, 3; EMF 2012, 32). Therefore, fewer changes have to be made to the product and the less it has to be transported, the more economic it is. Moreover, retaining the ownership of materials can enhance time-to-market and cost benefits, as "re-use, repair and remanufacture without a change of ownership save[s] double transaction costs." (Stahel 2012, 3)

<u>2. Increase retention time</u>

Keeping resources in the cycle for longer "can be done by either going through more consecutive cycles or by spending more time within a cycle", e.g. through the means described in the section 'Extension of the manufacturing cycle' (EMF 2012, 32). Prolonging the retention period can increase resource productivity, as the same amount of input is used to create a higher output, and costs can be reduced as e.g. material and waste costs are diminished (Stahel 2010). Here as well, "'product service systems', where the consumer is provided with a good as a service, […] with the materials remaining the property of the company, are […] being proposed as a possible route to greater longevity." (Green Alliance 2011, 21)

<u>3. Cascade material usage</u>

Using materials for other than their original purpose at their end of lifetime makes economic sense when it is technologically or economically not feasible to restore the resource to its original condition. In spite of this, those resources can then be used "as a substitute for virgin material inflows and their embedded costs (labour, energy, material) as well as externalities" for different processes (EMF 2012, 31). IKEA for example transforms old PET-bottles into shoe cabinets (Pripp-Kovac 2013).

<u>4. Maintain resource quality</u>

The economic potential of the above levers can further be improved by ensuring a certain quality and purity of materials, especially in the technical cycle, as this "typically extends longevity and thus overall material productivity" (EMF 2012, 31). Here, important starting points are the product design, e.g. designing products for better disassembly, and the whole reverse cycle that is needed to get materials back and prepare them to enter the market again, as e.g. establishing a smart collection system that keeps various materials separate (EMF 2012).

Actions Level

The action level contains the concrete, prioritized actions that are finally implemented and support the move towards the overall goal (Robèrt 2000).

Implementing a Circular Economy requires current business models to be reshaped. A paradigm shift is needed, meaning "putting closed-loop thinking at the heart of business models and industrial organisation" (Preston 2012, 2). In order to make this happen, one of the important first steps is to communicate the adoption of CE internally as well as externally and highlight its benefits (Bey and Bjørn 2013). Especially "consumers will need to understand and value what the concept represents" as they will be the ones buying the new product (Preston 2012, 15). Raising consumer awareness requires actions such as marketing in general or even specific product labels and certifications (Preston 2012).

According to Stahel a shift towards a service-based business needs to happen: "Selling goods as service, or performance, is the most profitable and resource efficient business model of the Circular Economy" (Stahel 2012, 6). As moving towards selling performance requires a shift in the way products are produced, organizations are asked to improve their product development processes through "designing products for easy disassembly, reuse and recycling, and by creating tight reclaim and refashioning chains" (Link2Portal n.d.). Besides, the extraction processes need to be changed in order to reduce waste and at the same time gain more control over by-products as they shall "become food for another cycle" (Green Alliance 2011; EMF n.d.). Also, switching to renewable energy sources is an essential action to be taken to make the shift (Preston 2012). In general, companies need to ensure access to remanufacturing skills as well as improve different technologies that will help and at the same time support redesigning products and chains vertically (Preston 2012).

However, to successfully adopt a Circular Economy approach, changes within the company are not enough: Businesses need to "embed […] [their endeavours] in partnerships and networks of companies operating at different points in the supply chain" (Preston 2012, 8). This shows the importance of using Systems Thinking, an approach that helps companies seeing the whole picture and the relationships among the single parts of the system (Capra 1985).

Tools Level

This level presents tools that support the implementation process to reach the overall vision of success (Robèrt 2000).

The CE concept draws upon and encompasses principles from the following concepts (described below), among others:

- Performance Economy
- Industrial Ecology
- Biomimicry
- Product Service Systems
- Cradle to Cradle
- Eco-Efficiency
- Recycling
- Circularity Calculator

(EMF 2013; Robèrt 2013)

The *Performance Economy* describes how to improve manufacturing processes, product service sales[2] and performance over time. It introduces business models that turn knowledge into better performance, more jobs and greater value (Stahel 2010).

The concept *Industrial Ecology* also focuses on changing the business model. It emphasizes the need of companies to collaborate vertically as well as horizontally across the industry to become successful. Furthermore, it can be seen as an important concept that helps getting a big-picture understanding of the entire industrial system, as it studies the material and energy flow within this system as well as its interaction with the global ecosystem. (Graedel and Allenby 2002)

Biomimicry is a concept that tries to find solutions to current challenges of society by looking at nature's systems, processes and elements (Benyus 2002). Organizations moving towards CE can use Biomimicry especially during the product development and the manufacturing phase.

As the implementation of a Circular Economy requires gaining control over material flows and a switch to services instead of products becomes more and more relevant, the concept *Product Service System (PSS)* gains in importance. It supports companies in changing their business model and retaining the ownership of their products, or in providing an additional service component along with products, such as maintenance contracts (Tukker and Tischner 2004).

Cradle-to-Cradle is a supporting tool that organizations can use at the product level. Analogous to the nutrient cycle of nature where the waste of one organism is used by another, material streams in the production process should be planned in a way that avoids waste the ineffective use of energy (McDonough and Braungart 2002). A major focus of Cradle-to-Cradle lies on eco-effectiveness, which is an "an alternative design and production concept to the strategies of zero emission[3] and eco-efficiency" (Braungart et al. 2006). It requires ensuring from the beginning that a product has no negative impacts on the ecological system. This means "working on the right things - on the right products and services and systems - instead of making the wrong things less bad." (McDonough and Braungart 2002, 76) In comparison, *Eco-Efficiency* seeks to reduce the negative impacts production processes have on the environment (e.g. eco-efficient techniques that help minimizing toxicity within the material flow) (WBCSD 2000).

As the term indicates, *Recycling* is a tool that enables materials to be kept in a cycle and used again and again. This does not only help to reduce overall resource and energy usage, but also avoids the generation of waste. Recycling requires the establishment of adequate infrastructure, as for instance take-back or collection systems, and the availability of suitable recycling technologies (WRAP 2013).

Apart from those concepts that support capacity building for a Circular Economy, CE does not involve specific strategic or systems tools. Regarding system tools, there is a clear lack of measurement possibilities: Although the Ellen MacArthur Foundation developed the *Circularity Calculator*, a tool that enables the comparison between material inputs needed in a linear or a circular manufacturing process, this tool is not publicly available yet (Ellen

[2] Product services refer to services that are sold as an add-on to a product (Stahel 2010).

[3] Focuses on "the intake of natural resources within renewable limits and final emissions within acceptable limits" (Robèrt et al. 2010, 75).

MacArthur 2012). However, the standardization of measurement approaches is a topic that currently gains a lot of attention from experts in the field (Tuppen 2013; Hermine 2013).

3.1.2 Framework for Strategic Sustainable Development Analysis

Based on the structuring of Circular Economy according to the 5LF, in the following the concept is now analysed through the lens of the FSSD to explore its gaps and contributions to strategic sustainable development. For this purpose, as for the 5LF, a set of specific questions was asked for each level (see Appendix B). As the focus of this analysis is exclusively on Circular Economy, it is limited to the first four levels and does not include a deeper investigation of related tools in the 'Tools Level'.

Systems Level

Circular Economy primarily looks at organizations' interactions from a business and environmental perspective (e.g. scarcity of materials, volatility of prices), acknowledging the existence of the sustainability challenge, and the interconnectedness of the economy and the socio-ecological system (EMF 2012). Research has shown that implementing CE and adopting 'closed-loop thinking' enhances the awareness of the sustainability challenge and the comprehension of how the socio-ecological system functions even more (Hazell 2013). However, the concept lacks a more elaborated description of the social dimension of sustainability (e.g. the fulfilment of human needs) to achieve a complete systems perspective at this level (Villa 2013). Furthermore, no widely agreed upon definition of the concept exists.

CE is based on scientific knowledge as system dynamics, the bio-geochemical cycles and the laws of thermodynamics. However, the explicit information given about the basic laws and principles that govern natural and human systems is limited: For instance, the law of entropy is mentioned without further explaining which impacts it has (see e.g. EMF 2012). Providing more knowledge about the scientific foundation would be essential for organizations to see the bigger picture and better understand the concept of CE and its benefits. This should include for example the law of conservation of energy and matter and the law of entropy, and how these define the need for a Circular Economy with zero waste, the fact that society only consumes the "concentration, structure and purity" of materials and that CE aims to restore these, and an explanation of the sun being the driving engine of the Earth, offering a huge potential for renewable energy in a Circular Economy (see chapter 1.3.1) (Robèrt et al. 2010, 35).

Success Level

Circular Economy is a concept that is especially designed for planning towards sustainability. The concept's aim is to create a sustainable economy framed by its principles (see chapter 3.1.1). However, as mentioned in the 5LF-analysis, these criteria are not necessarily shared by all approaches to the concept, and there is no common vision of a Circular Economy. Although they were defined to address the sustainability challenge, the principles are primarily formulated from a business point of view and strive equally for environmental and economic benefits. For example, Circular Economy aims to protect the environment by reducing the primary consumption of natural resources, thereby also decreasing organizations' dependence on those materials and lowering accompanied risks.

As described in the methods chapter, the FSSD defines sustainability through four principles, regarding both ecological and social aspects:

"In a sustainable society, nature is not subject to systematically increasing...
1. concentrations of substances extracted from the Earth's crust;
2. concentrations of substances produced by society;
3. degradation by physical means;

and in that society...
4. people are not subject to conditions that systematically undermine their capacity to meet their [basic human] needs" (Robèrt et al. 2010, 39)

Being "science-based, non-overlapping, general, necessary and sufficient" principles, the four Sustainability Principles (SPs) are specifically designed for a backcasting planning process (Ny 2006, 5). Although the CE principles are general enough to be used in various contexts, they are not necessarily sufficient to achieve global socio-ecological sustainability (i.e. a company could successfully adopt the concept without becoming fully sustainable). On the other hand, they are framed in a way that is easily understood and therefore easy to communicate. As they are not defined too narrow, the CE principles leave more room for inspiration and creativity in the implementation process. In the following, it is explored to what extent the Circular Economy principles cover the SPs.

Ecological Sustainability Principles 1-3

Circular Economy speaks to the importance of closing material flows – of substances either extracted or produced by society - within society in order to both limit or even stop the extraction of virgin materials as well as the accumulation of waste in the biosphere. This balance of flows between society, biosphere and lithosphere is targeted by all of CE's success criteria, which brings them in line with Sustainability Principles 1-3.

Although the closing of material loops could significantly contribute to a reduction of resource extraction and a decrease in discarding materials that could potentially still be reused, several constraints concerning the reconditioning of materials appear. Firstly, Circular Economy works with a static model of reality that does not take the continuous growth of economy and population into account. Thus, even fully applying its principles and establishing material cycles does not eliminate the demand for extracting virgin materials, due to the strong correlation between direct material consumption per inhabitant and income (Bjørn and Strandesen 2011; Bjørn and Hauschild 2011).

Additionally, the concept argues that closing the loop of technical nutrients is feasible and downcycling of those materials avoidable, when biological nutrients are isolated (EMF 2012). However, as the second law of thermodynamics states, "all spontaneous processes irreversibly disperse energy (and as a consequence, matter) into ever more chaotic states" - resulting in loss of quality and quantity of substances and prohibiting a complete closure of loops (Robèrt et al. 2010, 35). Based on this law, another challenge might appear: In today's recycling processes impurities of used materials can only be removed to a certain extent. Low concentrations of impurities will still persist in recycled resources, as "the work required to separate ideal mixtures of two or more substances increases without bounds as the separation process proceeds" (Gutowski in Bjørn and Hauschild 2011, 7). Therefore, it might only be possible to increase the retention time of certain materials in the cycle, but impossible to recycle them infinitely: In this case, unless a substitution of the specific material is feasible, the extraction of new resources is required. Besides a high level of energy, recycling processes might also call for problematic chemicals (e.g. solvents) that cannot necessarily be kept in a closed loop - this would not be in alignment with SP 2 (Bjørn and Strandesen 2011).

Circular Economy mainly addresses the mechanism of dematerialization (i.e. reduction of material flows), but in some cases it is also necessary to substitute (i.e. exchange of type/quality of flows and activities) certain substances. The process of dematerialization versus substitution largely depends on the characteristics of the substance and differing critical concentrations (Holmberg and Robèrt 2000). In some cases, the concentration of extracted materials in the biosphere has already exceeded natural flows and those materials should be substituted and phased out completely (e.g. mercury or copper), in order to keep the natural balance. For some materials (e.g. aluminium or titanium), the situation is the opposite, as the flows caused by human activities are below natural flows: These abundant substances could then be used to replace phased-out materials (Robèrt 2012). To sum up, in designing circular processes a more comprehensive analysis is needed to understand where the substitution of material is necessary, and where it is not environmentally beneficial (Green Alliance 2012).

This in turn is as well connected to the handling of harmful substances: The principles of Circular Economy do not explicitly prohibit the use of such, as long as those are kept in a closed loop (see e.g. Stahel 2010). Although this does not contradict SP2, if the context allows it, the elimination of harmful substances should also be taken into account in the decision making process.

Regarding the shift to an energy system based on renewable sources that is promoted by CE, further aspects need to be taken into account. On the one hand, this shift would contribute to a decrease of society's dependence on fossil fuels as well as the connected accumulation of waste in the biosphere (e.g. through emissions or particulate matter), which aligns it with SP1-3. On the other hand, it is important to acknowledge that for the expansion of renewable energies - at least using today's technologies - more scarce resources are needed and thus "without effective usage of produced energy, [it] might also further increase the resource scarcity" (Bjørn and Hauschild 2011, 9). Therefore, it is important to take on a long-term perspective and use current available technologies as stepping stones on the way of identifying future solutions that do not lead to such trade-offs.

As following a zero waste strategy is at the core of Circular Economy and e.g. waste streams to landfills are avoided, the SP3 is at least partly addressed as well. CE promotes the use of biodegradable materials and as well as renewable energy, but in this regard it does not address the need for more environmentally-friendly management routines connected to agricultural practices (e.g. growing crops with a high water demand in areas with water scarcity) or spatial planning (e.g. the need to switch to less area-consuming activities) (Robèrt 2002). Therefore, CE does not necessarily avoid physical degradations of ecosystems, as caused for instance by over-harvesting, clear-cutting natural habitats to increase the supply of biodegradable resources, or establishing extensive infrastructure.

Social Sustainability Principle 4

Circular Economy puts a strong focus on environmental sustainability; however, in terms of social sustainability it does not provide concrete principles (Villa 2013). Though, designing circular processes often requires more mental work than following a standard linear approach, and therefore it could offer a chance for a more intensive encouragement of the human talent available in the company, hence utilizing capacities, competences, and experience from an inside perspective (Schreiber 2013; Bauer-Leeb 2013).

Moreover, additional manufacturing processes in a Circular Economy - e.g. refurbishing or recycling - demand more human labour as such processes can often not be standardized. Both due to legislation (e.g. regulations restricting transports of waste across borders) and to economic reasoning (e.g. buying materials locally to save transport costs), the importance of the local economy increases and supply chains get more localised. Altogether, pursuing a CE model can benefit the local community and create employment opportunities. (Hermine 2013)

However, people's basic needs around the world are further undermined by, among others, abuses of power, unhealthy or unfair labour and living conditions or a disrespect of human rights; Circular Economy does not explicitly work to abolish such conditions. Also, the origin of utilized resources is currently not targeted by the CE's principles: Therefore, procuring materials from sources with weak social standards (e.g. conflict zones) is not actively prohibited (Thies and Alting Sibert 2013). Furthermore, the increase of renewable energy and materials that CE promotes, could potentially lead to a conversion of (productive) lands in favour of non-food plants used for the generation of renewable energy or the production of biodegradable materials. Therefore, it could potentially affect global food production and biodiversity in a negative way (Bjørn and Strandesen 2011; Smil 2006).

Strategic Guidelines

As CE argues mainly from a business point of view, the cost-benefit analysis is one of the strategic tools mostly used[4]. However, apart from this economic prioritisation support, CE does not provide further means for the decision-making process. This can be a challenge when it comes to decision-making in specific scenarios, as for instance the assessment of trade-offs between durability and recyclability in product design (Hazell 2013). Considering the selection of materials, CE principles might exclude not fully recyclable materials; nonetheless, the environmental benefits of certain materials (e.g. lightweight components, less corrosive materials) could outweigh the disadvantage of non-recyclability (Schmidt et al. 2004). In comparison with CE, which does not provide sufficient guidance to deal with such trade-offs, the FSSD allows for a strategic management of such by means of backcasting from a principle-based definition of success (Robèrt 2002).

Therefore, additional guidelines that are informed by a definition of socio-ecological sustainability, as the three prioritisation questions of the FSSD, would support the concept in moving companies closer to sustainability. Furthermore, practitioners might need to supplement these broad principles with further decision criteria adapted to their company, to derive suitable actions for implementation and decrease the risk of running into blind alleys of innovations. For instance, for a car manufacturer it is not sufficient to build an environmentally-friendly car, unless it is safe as well.

[4] as demonstrated by the four ways of value creation described in the 5LF analysis

Actions Level

As the concept does not suggest specific actions, no general statement can be made whether the prioritized actions lead into the right direction with respects to the SPs, are a flexible platform for further actions, or provide a sufficient return on investment.

Nevertheless, a company cannot achieve full circularity on its own, but is dependent on a network of collaborating organizations (as e.g. recyclers or capacity-building institutions) (Dortwegt 2013; Bey and Bjørn 2013). The need for collaboration however is not sufficiently addressed by CE in an explicit way when it comes to the selection and prioritisation of actions.

In general, taking actions based on the CE principles can support organizations in improving their environmental performance. However, rather than defining actions to be taken into practice, Circular Economy seems to be more focused on building an understanding of the foundations of the concept (Clift 2013). But as each implementation strategy needs to be tailored to the individual company, in any case the recommendation of concrete actions is only possible to a certain extent (Bey and Bjørn 2013).

3.2 Research Question 2

What are the key barriers and enablers multinational companies face in the implementation process of Circular Economy?

In the following, the barriers and enablers that were discovered through the interviews with corporate practitioners and academic experts in the field of CE are described. As the research was focused on the key aspects hindering or helping the implementation of the concept, the four most important barriers and enablers - based on the number of times mentioned - are explored in more detail. It follows a short description of additional barriers and enablers that were mentioned less often.

3.2.1 Barriers

In the context of this research, a barrier can be described as a factor that is limiting or hindering the implementation process of Circular Economy. The research has shown that there are significant barriers of the transformation from a linear model of ‘take-make-waste’ to a more circular model. During the interview process a total of 165 barriers were compiled. Within those, ten common topics were identified according to the method described in chapter 2.4.3. *Figure 3.2* displays these topics based on the number of times the according barriers were mentioned in the interviews.

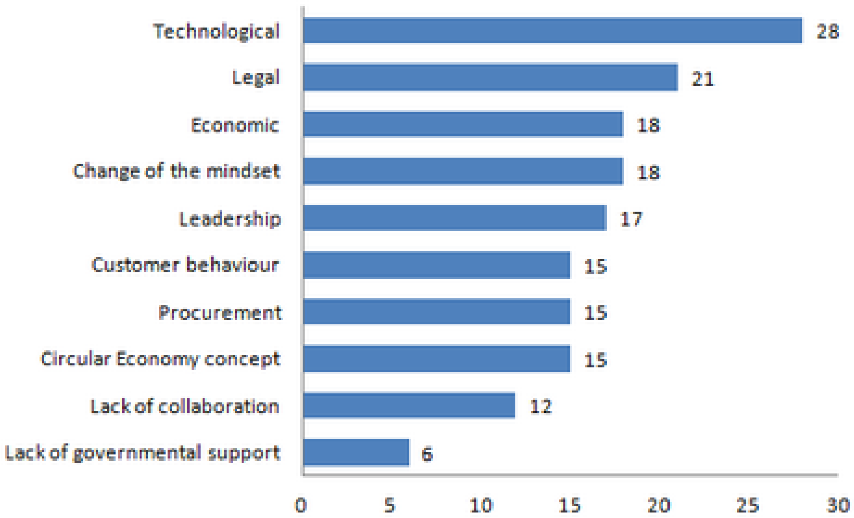

Figure 3.2 Barriers in the implementation process of Circular Economy

Key barriers

Technological barriers

Technological barriers refer to processes and technology needed to establish closed-loops, create technical and biological material cycles, and to extend the manufacturing cycle. Interviewees pointed out significant barriers connected to specific technologies (e.g. recycling technologies) and processes (e.g. product design) that hinder companies to fully adopt the concept (Villa 2013). Currently, businesses are well equipped with *"know-how of dealing with products in a linear approach, [but] they don't know how to deal with products in closed-loop system"* (Nasr 2013). Additionally, insufficient knowledge about recyclable materials creates concern of how to replace certain materials with other substances, without compromising the quality of the final product (Jacono 2013). Interviewees emphasized the fact that not a lot of design specifications for the purpose of designing products for reuse and remanufacturing are known (Clift 2013). Simultaneously, adopting a CE approach requires alterations in infrastructure *"to allow products to flow through value circles, allowing products and materials to remain in the economic cycle for longer and the quality of the material input is preserved"* (Harris 2013). Infrastructure for the capturing of technical nutrients is either completely missing or recycling rates are too low for a full closure of the loop (Duggan 2013; Tuppen 2013).

Legal barriers

Legal requirements, connected to the management of products, materials and waste, were another frequently mentioned barrier. The complexity (e.g. regulations connected to packaging), international discrepancies and the often outdated status of regulations can unintended create additional barriers to the transformation (Thies and Alting Siberg 2013; Pripp-Kovac 2013; Bey and Bjørn 2013). Furthermore, the CE concept strongly relies on the ability to process waste, which in various countries is only collected at a fraction and difficult to be transported across borders due to impeding laws (Clark 2013; Pripp-Kovac 2013). Further issues arise from traditional accounting methods *"which are not flexible enough in accounting different values created in a reusing or remanufacturing process"* and hinder companies from taking full advantage of the new circular system (Nasr 2013). In addition, barriers connected to property issues were emphasized, as they can hinder businesses from disassembling or remanufacturing components that they do not own (Nasr 2013). Besides that, *"the Circular Economy depends on strong business partnerships, but current anti-competitive legislation can hinder businesses from establishing those crucial partnerships"* (Oberhuber 2013).

Economic barriers

Many interviewees acknowledged difficulties in defining the business case for a CE concept, which is being intensified by the current economic situation (Fisher 2013; Clark 2013). "*Economics play a major role and a positive return on investment is required"* for a company to consider reshaping the current model (Nasr 2013). Additionally, interviewees underscored the fact that the required re-organisation of processes, the acquisition of new technology, and the training of involved employees generate significant costs and risks, which hinder corporations from adopting the concept (Villa 2013; Schreiber 2013). Furthermore, these additional investments and "*material limitations are also translated into higher product prices"*, which might have a negative response of customers as an effect (Seidel 2013).

Change in mindset as a barrier

A change in mindset, from a short to a longer term perspective and acknowledging the fact that the current development path cannot be continued, was named as another significant barrier (Hermine 2013). A successful transformation to a circular model involves a *"new way of thinking, acting, plus communicating with others in the chain"* (Cramer 2013). However, there is an *"internal reluctance to move away from business as usual"* and to challenge current paradigms in the corporation (e.g. products are continued to be designed in a linear way, as this is often cheaper than designing it as a recyclable product) (Fisher 2013; Clift 2013). A lack of systems thinking inside the business often hinders it from seeing the whole value chain perspective, and only leads to an "*optimization and [assuming] responsibility of [a company's] part of the value chain and misses the overall possibilities"* (Cramer 2013). *"Most organizations can see that society cannot go on behaving as it is doing today",* however it is very difficult to translate this "*into the micro-economic reality of business"* and short-term measures (Tuppen 2013). Additionally, resistance to change created by previous, negative experiences with similar transformation approaches was also mentioned as a reason that slows down the speed of the implementation process of CE (Hazell 2013).

Additional barriers

Leadership as a barrier

Barriers connected to the leadership in the company appear once *"the management does not stand behind the learning process and does not sufficiently support it"* (Schreiber 2013). Interviewees underscored the importance of *"[business] leaders to be aware and understand the sustainability agenda and its importance on the operational level"* (Castren 2013). There is also a danger that the motivation and focus of employees decrease after the initial introduction of the concept, due to their other responsibilities in the business (Giner and Popham 2013). Moreover, it was emphasized that a failure of creating a common understanding at the beginning of the process could generate misunderstandings of the concept, and hinders a company from taking off the implementation (Seidel 2013; Thies and Alting Siberg 2013). Furthermore, it was mentioned that there is a certain reluctance of companies to take on leadership and bring change forward, unless their competitors are making changes as well (Fisher 2013).

Procurement as a barrier

A number of interviewees mentioned issues connected to the purchase of suitable materials and difficulties to establish appropriate supply chains that meet the company's requirements (Clark 2013; Metzke and Smit 2013). The current volume and quality of recycled or reused materials available on the market is highly limiting businesses to close their resource loops (Pripp-Kovac 2013). Currently, the access to virgin materials is still much easier and the demand for recycled materials is often exceeding its actual supply (Rydén 2013; Pripp-Kovac 2013).

The Circular Economy concept itself as a barrier

Certain barriers might be caused by the concept itself, as it might be perceived as being *"too radical to be fully adopted"* (Fisher 2013). The language of the concept is rather complex, and the definition and interpretation of the term needs to be worked out by the users of the concept themselves (Fisher 2013). Additionally, the lack of measurement tools makes it difficult to assess the progress of the implementation process (Tuppen 2013).

Customer behaviour as a barrier

The success of a transformation to a more circular model also depends on the behaviour of customers and their cooperation (e.g. their ability to dispose products properly) (Bauer-Leeb 2013; Metzke and Smit 2013). Furthermore, "*consumers, who are responsible for consumption decisions and to a certain level also for creating the demand",* often value products from recycled materials less, even if quality and product properties remain constant[5] (Bauer-Leeb 2013; Nasr 2013). Additionally, a lack of a recycling culture, *"especially in countries where recycling is just evolving",* makes it difficult for businesses to get their materials back and close their loops (Castren 2013).

Lack of collaboration as a barrier

A lack of collaboration, not only between different companies but sometimes also inside the company, and the failure to work on a common objective of establishing closed loops was a recurring topic (Cramer 2013). For instance, often a gap can be observed between the requirements product designers have for a product and those of salesmen or recyclers (Rydén 2013). In such cases, internal as well as external cooperation is missing to support processes (Bey and Bjørn 2013).

Lack of governmental support as a barrier

A lack of governmental support, in terms of "*steering and facilitating the process*" of assisting businesses in becoming more circular, was also emphasized (Cramer 2013). National agencies should play "*a more active role and recognize their responsibility in the process"*, especially through economic incentives and using the taxation system (Clark 2013). Such an approach could increase the motivation to overcome the mentioned barriers and enable a faster transformation process (Nasr 2013).

[5] Note: Although customer behaviour is important, their responsibility is limited by the goods and services provided by companies. Furthermore, it is not only the customers' ability to dispose waste properly, but companies should also be encouraged to provide information and means to allow customers returning products to the companies (Bauer-Leeb, 2013).

3.2.2 Enablers

In this research, an enabler is described as a factor, which is already present in the business itself or the system it is part of, and can support or simplify the transition from a linear to a circular model. A total of 56 enablers were identified through the interviews and, similarly to the barriers, clustered according to the common topics they were speaking to. In this way, eight clusters could be defined and are presented in *Figure 3.3* based on the frequency in which they were mentioned.

Figure 3.3 Enablers in the implementation process of Circular Economy

Key enablers

<u>Leadership as an enabler</u>
Research has shown that leadership within the company can be a powerful enabler for the transformation in case it *"appreciates this strategic direction (i.e. moving towards Circular Economy), and understands its benefits but also its risks"* (Nasr 2013). Such dedicated leaders, who "*see the big global picture and drive change within their corporations, are making a significant difference to their companies' long viability and success. It is this vision and execution that excites employees and involves parties to believe in the feasibility of the transformation."* (Harris 2013) Additionally, the ability of leaders to translate the concept in practical terms and into small, tangible steps - ideally achieving quick wins - therewith making it more applicable to all levels of the corporation, can be a significant enabler (Bauer-Leeb 2013). Furthermore, it is important to acknowledge that the whole implementation is a learning process and requires everyone to be involved and to contribute (Schreiber 2013). Companies that have such *"enlightened board members thinking strategically and long-term"* are believed to be more successful in overcoming barriers in the process (Fisher 2013).

<u>Collaboration as an enabler</u>
"At all levels of the company it is important to think about the implementation process, the whole company needs to find possible solutions together" (Schreiber 2013). A significant number of interviewees also highlighted that *"a company can never achieve full circularity on its own, but is dependent on a network of collaborating organizations"* (as e.g. recyclers or capacity-building institutions), which enable it to adopt the concept (Dortwegt 2013). The transformation process is easier when a corporation is able to *"look on the life cycle of*

products and define possible beneficial relationships, even with companies that you normally would not think about" (Clift 2013). Interviewees emphasized that it is essential *"to communicate with those that are providing the company with certain materials (i.e. suppliers), and those using the product (i.e. consumers), involving them in setting up the agenda working towards closing the loop"* (Dortwegt 2013). Additionally, collaboration could decrease potential economic risks and costs connected to required investments (Bey and Bjørn 2013).To conclude, instead of seeing themselves as isolated entities and only taking responsibility for their part of the product chain, companies need to recognize themselves as part of a bigger operating network and cooperate along the chain (Cramer 2013).

<u>The concept of Circular Economy as an enabler</u>

Although by some interviewees certain aspects of the CE concept itself were perceived as a barrier, it can also play an important role as an enabler, as *"it creates a lot of energy, enthusiasm and unleashes a positive attitude because it aligns sustainable business concepts with fundamental business interests."* (Oberhuber 2013) Also, the fact was highlighted that the creation of a "*common understanding of the concept and its benefits*" is highly beneficial and is paid back by an easier implementation and communication of the transformation process (Thies and Alting Siberg 2013). Additionally, in the past years a strong trend towards the increasing awareness of the concept, not only in terms of businesses but also among customers, governments and academic experts, could be observed, which is believed to have a positive impact on the further diffusion of the concept (Fisher 2013; Metzke and Smit 2013).

<u>Customer behaviour as an enabler</u>

Changing customer behaviour and preferences, *"looking out for environmentally friendly products",* are an important factor supporting the circular transformation (Schreiber 2013). The pressure from the side of customers, criticizing the current linear model, is intensifying and MNCs are increasingly willing to respond by adopting more environmentally cautious practices (Fisher 2013). Retailers, which "*can trigger that change thanks to the powerful position, are very conscious of consumer needs, and they can force changes in a way that e.g. non-profit organizations will struggle to do"* (Clark 2013). The further education of customers, informing them about the importance of such a shift to a circular model, was also mentioned as a potential enabler (Clark 2013).

Additional enablers

<u>The resource crisis as an enabler</u>

Acknowledging the *"inability of the planet to sustain these human activities over the long-term"* and understanding that the "*system simply cannot go on as it is and the economic growth, being driven by high consumption, cannot sustain"* is also positively contributing to the fact that an increasing number of companies are adopting a circular model (Tuppen 2013). Although such a crisis certainly leads to barriers in other areas, in this context the understanding of businesses that they "*do not have another chance in the long-term than using resources in a more efficient way"* contributes to the adoption of CE (Thies and Alting Siberg 2013).

Legal enablers

The evolvement of "*some regulations (e.g. within the EU) are also forcing MNCs to do more",* in order to be in compliance with law or making it possible to benefit from certain legislation connected to resource efficiency (Thies and Alting Siberg 2013). Examples can be found in policies regarding recycling and waste management (e.g. WEEE, EPR), which require companies to take more responsibility for the development and management of products during the whole life cycle (Thies and Alting Siberg 2013; Hermine 2013).

Technological progress as an enabler

The increasing amount and availability of data about materials (e.g. their origin or their composition), was also mentioned as an enabler. This also refers to data provided by customers, which enables the organisation to design flows of products and materials in a smarter way. Additionally, it was mentioned that costs of reverse logistics could be decreased, as better information and data is available to enhance recycling technologies for certain materials. (Metzke and Smit 2013)

Governmental support as an enabler

In some cases, governments (e.g. in the United Kingdom) have already taken first steps to support businesses in their ambition of adopting the concept of CE (Villa 2013). This is done for example by "*removing risks of innovations by covering the connected costs"* or *"incentivizing research programs encouraging companies to move in that direction"* (Fisher 2013; Clark 2013).

4 Discussion

In this section, a discussion of the key findings in support of both research questions is presented, forming the basis of the recommendations provided. Furthermore, it is reflected on the overall relevance of this research, and strengths and limitations of the study are pointed out. Finally, areas for further research are indicated.

4.1 Key Findings and Interpretation of Results

4.1.1 Gaps Regarding Sustainability and Guidance of the Concept

The analysis of contributions and gaps to strategic sustainable development has shown that the concept of Circular Economy could support companies in moving closer towards sustainability. However, the concept is not to be equated with achieving sustainability: Although CE can support companies in improving their environmental and economic performance, it does not lead to full sustainability as it exhibits several gaps in regard to a principle-based definition of global socio-ecological sustainability.

Moreover, the FSSD analysis not only emphasized gaps regarding the sustainability perspective, as framed on the success level, but also certain gaps that contribute to a lack of guidance in the implementation process of Circular Economy. Concerning the systems level for instance, a missing common definition of CE makes it difficult to establish a shared understanding, and thus complicates internal and external collaboration in this field. The strategic level revealed a lack of strategic guidelines to support and ease the decision-making process, as for instance how to deal with trade-offs. Additionally, this missing guidance, in terms of absent concrete measures or tools recommended to take for the transformation process, could also be identified on the actions and tools level.

4.1.2 Barriers Exceeding the Number of Enablers

The research of factors influencing the implementation process revealed a total of 165 barriers and 56 enablers. Although the investigation was not of a quantitative, but rather of a qualitative character, the number of barriers significantly exceeds the number of enablers. Based on these results, it is assumed that a company faces considerably more factors hindering the implementation process of Circular Economy, than such that are supporting it.

However, regarding the specific clusters within the categories of barriers and enablers, the quantitative difference between these clusters is rather modest. On the side of barriers, the cluster of technological barriers is the one standing out. However, seven other clusters were mentioned with a similar high frequency. For the enablers, leadership and collaboration were rated the highest. No significant variations in frequency could be observed for the remaining clusters of both barriers and enablers. The obtained results indicate that there are no single most critical barriers and enablers, but that it is rather a combination of these that either hinders or helps the implementation process.

4.1.3 Degree of Influence on Factors

Taking a closer look at the key barriers and enablers, it can be seen that the highest ranked barriers (technological and legal) were rather perceived by interviewees as being external factors. On the other hand, the enablers of leadership and collaboration were rather seen as internal factors. The external or internal nature of these factors might be related to the degree to which they can directly be controlled or influenced by a company. For example, it might be easier to take over leadership or fostering collaboration in a business, than setting up required infrastructure systems (technological barrier) or influencing regulations (legal barrier).

4.1.4 Recurring Common Themes

When comparing the clusters of barriers and enablers, many common themes can be observed. Themes that occur on both, the hindering as well the helping side, include technology, legal issues, customer behaviour, governmental support, the concept of CE itself, leadership and collaboration. *Figure 4.1* shows, based on the relative number of hits, whether these themes are rather perceived as being hindering or helping factors in the implementation process.

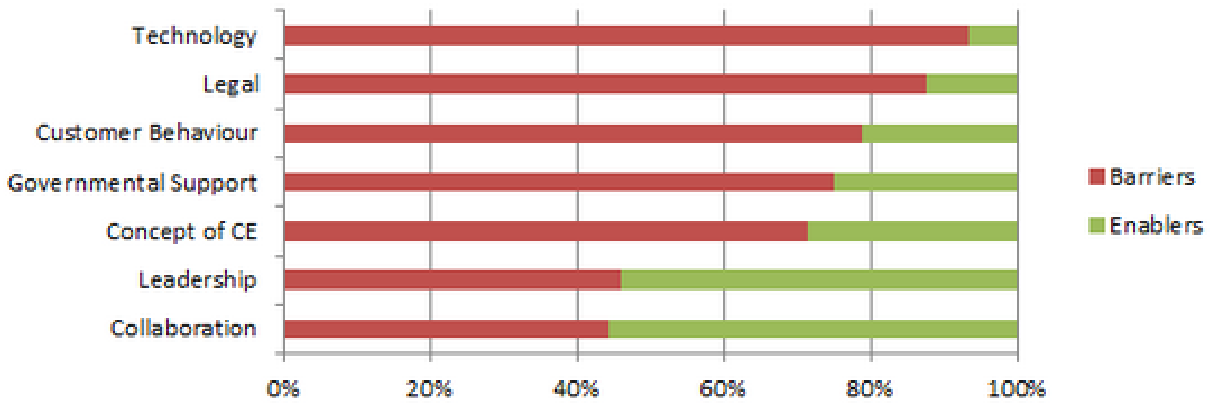

Figure 4.1 Perception of common themes as barriers or enablers

As *Figure 4.1* shows, nearly all of the clusters are rather perceived as barriers in the transformation process. Only the themes of leadership (to 46% seen as a barrier and to 54% seen as an enabler) and collaboration (to 44% seen as a barrier and to 56% as an enabler) are more or less equally perceived as being both a barrier and an enabler to the implementation.

However, is has to be acknowledged that within these themes that occur on both sides, in each case different aspects are seen as being either of a hindering or a helping nature. Regarding the technological level, the missing infrastructure as well as insufficient knowledge about product and process design play a key role on the side of barriers. On the other hand, the availability of better recycling technologies and more data are perceived as enablers.

On the legal level, the complexity and discrepancy of certain regulations hinder the implementation process. However, some few regulations also have an enabling effect on the transformation, by pressuring companies to take over more responsibility.

The lack of governmental support in facilitating this process makes it difficult to use CE. On the other hand, if governments actively assist businesses in the process, this can be seen as an enabler.

Customer behaviour is as well strongly viewed as a barrier, which is connected to insufficient waste disposal and customer preferences that disadvantage environmentally-friendly approaches. However, these preferences seem to undergo a change and customers putting pressure on companies to employ more sustainable practices can act as an enabler; this tendency could further be supported through additional information and education of customers.

Lacking of a common definition and guidance, the concept of Circular Economy itself is rather perceived as a barrier. Though, if a shared understanding can be established in the system, the concept can also serve as an enabler and a source of inspiration.

Regarding the aspect of leadership, especially the failure of establishing a common understanding of the company’s new circular approach, and not managing to raise the awareness for it, can turn into a barrier. On the other hand, achieving management buy-in can serve as an important enabler. If a company therefore manages to overcome these hindering aspects and utilizes the supporting factors, leadership can serve as a significant leverage point in the transformation process.

Missing internal and external collaboration can exacerbate the implementation process. However, if a company acknowledges this dependency and actively fosters collaboration, as for the leadership, this factor can serve as an important leverage point.

All in all, the high number of barriers - of which the most important ones are rather perceived as external factors - and the lacking guidance of the concept show that the implementation of Circular Economy is a rather difficult process. This can also be seen as a reason for the currently low diffusion of the concept. On the other hand, if a company manages to strategically use those aspects, it can possibly turn hindering factors into enablers, as the examples of leadership and collaboration show.

These results show that there is a need for a refined CE approach that does not only bring companies closer towards sustainability, but also offers more guidance and strategic support and is therefore easier to implement. The conducted research however indicates the possibility for advancing the CE concept with the help of the FSSD and the detected barriers and enablers, in order to overcome those weak points.

4.2 Recommendations

Whereas developing such a refined and more widely agreed upon concept would require more research and testing, in the following some first recommendations - based on the gap to SSD as well as the barriers and enablers - are given. These recommendations can be seen as a first starting point for companies that want to implement a circular model from scratch, and address - amongst others - prerequisites, prioritisation criteria, and actions as well as tools that can be used.

4.2.1 See the Big Picture

Given the lack of a common definition, the creation of a shared understanding of Circular Economy would be one of the most essential first steps. This is best be done by using a language that is comprehensible to the entire company as well as its stakeholders.

Besides, it is recommended to start off by analysing the larger system the company is part of. Usually, companies represent just one entity of a whole network of other actors including suppliers of raw materials or parts, retailers, distributors and customers. For one company alone it is therefore hardly possible to become circular - it is dependent on the collaboration and support of its larger network. Therefore it would be beneficial to first explore all relevant entities in the company’s system, as well as their interrelations. Following this analysis, it should be explored whether it would theoretically be possible to close all material loops within this network and move the current system towards a Circular Economy. A first assessment of whether the actors within the system are playing rather a helping or a hindering role in the implementation and whether any higher level barriers (e.g. legal or infrastructural) exist, could be beneficial in this regard. Finally, it is recommended to investigate who is not part of the system yet, but would be needed to overcome those barriers and realise the implementation. Such entities could for instance be cooperating recycling companies or organizations enabling capacity building within the system.

4.2.2 Strategically Select Actions

Once the company explored its larger system, it is recommended to both create a vision of future success that it wants to achieve as well as to analyse its current situation. From there, the business will then be better able to strategically select next steps that empower it to bridge the gap between the present and the vision.

To select concrete actions that will help to realise this vision, prioritisation guidelines are needed. First of all, for businesses it is of course essential that those actions bring the required return on investment. For this, the different ways of value creation that the CE concept describes (see chapter 1.4.2) are well suited.

Apart from that, it is also important that selected actions lead into the right direction regarding the vision of a CE, while being aware of its gap to strategic sustainable development. In addition, the question should be asked whether the action can serve as a flexible platform in the future, to avoid lock-in effects or investing in blind alleys.

Based on the fact that technology is one of the major barriers to the implementation of a Circular Economy, the technological feasibility of each action should be assessed beforehand. This does not mean that actions that are not technologically feasible today should not be taken, but that actions should at least be likely to be feasible in the nearer future.

4.2.3 Get Active

The following set of actions, based both on the barriers and enablers as well as key implementation steps investigated through the interviews, could serve as a first step to implement CE from the start.

> Raise awareness for the need of change
Leaders should take on the task to create awareness within the whole company that a shift towards a more sustainable approach is needed. In order to overcome the resistance to change, it is essential to communicate the benefits that the company can derive from the transformation to a circular model. Besides the creation of internal awareness, it is also important to communicate the need for a transformation among all stakeholders.

> Adapt the business strategy and set targets
Once awareness and a shared understanding of the concept have been created, it is recommended to adapt the business strategy of the company with regard to the concept's principles. Additionally, in order to strengthen the profitability and decrease potential financial risks especially at the initial stage, further easy-to-achieve short term targets should be defined to utilise so-called low-hanging fruits. These short term benefits can then be used to finance long-term investments that might be required.

> Foster collaboration
It is essential to analyse whether the targets set can be achieved alone, or only in cooperation with additional organisations. At this stage, the need for collaboration along the entire value chain should be assessed and any missing entities, that would need to be involved to realise the transformation, identified. Besides external support, it is equally essential to concentrate on internal collaboration and communication between different departments (e.g. product design and sales). To foster collaboration, certain *capacity tools* could be valuable to use: One possible way could be through creating a network for knowledge-sharing, which brings different companies together and capitalises on good practices and experiences in implementing a CE approach.

> Rethink product design
Circular Economy requires a more efficient usage of resources in order to decrease the company's dependence on raw materials. To ensure this, one of the most important steps is to analyse current product design and explore the potential for disassembly or remanufacturing. Furthermore, one important criterion to be considered should be the substitution of substances, where human flows have exceeded natural flows. The so called *Template for Sustainable Development* is a tool that "captures overall sustainability aspects of the life cycle of certain product categories", facilitates discussion between product developers and sustainability experts and could thus be beneficial to use in the product development process (Ny et al. 2008, 619).

> Change to less land area-consuming and sustainable management practices
Connected to the environmentally conscious manufacturing of products, also a company's practices and processes should not contribute to a physical degeneration of the environment.

Therefore it is recommended to avoid the usage of materials whose production required clear-cutting of natural areas for farming, substantial use of harmful chemicals as pesticides or fertilisers, over-harvesting of crops or ecosystem services, or contributed to a considerable degradation of the soil. Also, resources that require less transportation should be prioritised wherever possible, and a localisation of the supply chain should be attempted to reduce the dependency on extensive transportation infrastructure. (see e.g. Robèrt 2002)

<u>> Take social responsibility for all actions</u>
In respect to the social dimension, for companies it is especially important to consider the labour conditions in its system. It is therefore recommended that companies introduce fair conditions regarding working hours and salary, health and safety concerns, and the respectful handling of employees. Also, child labour should of course be prohibited. It is recommended to not only bring those labour conditions forward in one’s own company, but also in the company’s value chain. To support this development, companies could make use of the *ISO 26000* standard, as it provides additional guidelines for social responsibility. Furthermore, *Social Life Cycle Assessment* is a potential tool that could help to analyse and assess the social impacts of products throughout their whole life cycle.

In the attempt to move companies closer towards sustainability, these recommendations can provide businesses with some first concrete measures to start off the implementation of a more circular model.

4.3 Relevance of the Research

Given today´s complex sustainability challenge, a new industrial model using radically less material and energy is needed. This research is focused on assessing Circular Economy as a concept that could potentially satisfy this need and support companies in moving towards sustainability.

This research has shown that CE alone does not suffice for constructing such a sustainable industrial model: In order to bring the concept more in alignment with strategic sustainable development, it would need to be informed by the FSSD, as a systematic decision-making framework ensuring that steps taken by companies are strategic from a systems perspective of sustainability. Additional to this gap, significant barriers make the implementation of the CE concept difficult, which partly explains why its current diffusion is rather low.

Therefore, utilising the results of this research to establish a refined approach to Circular Economy informed by the FSSD and the key barriers and enablers, would address a considerable need of businesses. Such an approach could not only enable a more strategic approach to sustainability, but could as well provide additional guidance in the implementation process of CE and enable companies to further leverage the benefits that the CE concept provides.

Overall, the significance of the research was confirmed by the wide interest of corporate practitioners and academic experts to contribute to this study. Circular Economy is an approach that is observed to gain more and more importance and is one of the burning topics in the business world.

4.4 Strengths and Limitations of the Research

One strength of this research is the diversity of the data, which in turn contributed to the overall validity of the results. A total of 27 interviews were conducted with 9 multinational companies and 18 academic experts. Thanks to the combination of these two different standpoints, the authors were able to include practical corporate as well as rather theoretical expert knowledge in the research. The information provided by the interviewees was of high value to the research and the diversity of their experiences and backgrounds was essential for answering the research questions. Furthermore, this allowed the authors to see the implementation process from different perspectives, and also to get more insights in important topics related to Circular Economy.

There is a possibility that the results of this research could have varied slightly, if a distinction between the information obtained from companies and academic experts would have been made. However, the authors believe that, in terms of validity, the chosen approach did not limit the results, as the majority of the interviewed academic experts collaborated with various companies and could therefore as well exhibit practical experiences on this field.

The research was mostly based on the input of multinational companies based in the EU and active in business-to-consumer transactions. The implementation of the CE-concept and the related barriers and enablers companies could face during this process, might vary based on geographical and cultural contexts. However, the authors believe that, within the chosen scope of this study, the results provide valuable insights.

4.5 Areas for Future Research

For future research, it would be interesting to take on a global perspective and analyse how the implementation process might differ in other regions. Furthermore, the scope of this study intentionally excluded small and medium sized enterprises (SMEs) from the research. However, as a high percentage of businesses are defined as SMEs, an analysis of how SMEs could support the diffusion of the concept is considered to be valuable. On the other side, it could be interesting to research the drivers for business-to-business companies to transform to a more circular model, and analyse how their implementation process of CE differs from B2C-companies.

As the dissemination of the concept is picking up speed, it could be relevant to explore which industry sectors are usually adopting a circular model, and on the other hand which - and why - certain industry sectors are missing in the transformation process.

Additionally, research could be undertaken to further integrate the social perspective in the concept of CE, e.g. by putting more emphasis on human needs in the product design process. Designing new solutions that efficiently satisfy people's needs instead of improving the environmental performance of current solutions, can further help the dematerialization of resource flows and thereby support the concept of Circular Economy and its alignment with strategic sustainable development.

5 Conclusion

The purpose of this research was to analyse the contribution of Circular Economy (CE) to strategic sustainable development, particularly with regard to the transformation towards a sustainable industrial model in multinational businesses. Additionally, factors that either hinder or support the implementation of CE in a multinational company were explored. The underlying motivation behind this research is to understand how the concept can be used to foster strategic sustainable development.

Research has shown that the implementation of Circular Economy can support businesses in improving their environmental and economic performance. However, based on an analysis through the lenses of a Framework for Strategic Sustainable Development (FSSD), the concept exhibits some gaps in regard to a principle-based definition of sustainability for the global socio-ecological system. Therefore, the implementation of CE cannot be equated with strategic sustainable development.

Furthermore, certain barriers were detected that hinder the transformation to a more circular model. The key barriers, referring to the ones mentioned most often in interviews with company representatives and academic experts, can be found on a technological, legal and economic level, as well as at the behavioural level, i.e. the difficulty to change mindsets. These barriers slow down the process of the transformation and hinder companies from fully adopting the concept. On the other hand, several factors were identified that have an enabling effect in the implementation process. The key enablers included taking up leadership, fostering collaboration, motivation through the concept of Circular Economy itself and changing customer behaviour. Making use of these factors can simplify or enhance the pace of the transition to a circular model.

However, the FSSD analysis not only emphasised a gap to sustainability, but also concerning a common definition, strategic guidelines as well as concrete actions and tools in the implementation process.

Regarding the factors that could hinder or help the transformation, the identified barriers by far exceeded the number of enablers. In case of the key barriers, those are rather seen as being external factors and therefore could possibly be harder to influence. Furthermore, the research indicated that there are no single most important barriers or enablers, but the combination of these is what influences the implementation process. These results emphasise that Circular Economy is a concept that is difficult to apply: This can be seen as a reason for the currently low diffusion of the concept.

The research indicated that there is a need for a refined CE approach, which does not only lead closer towards sustainability, but it is also easier to implement. Based on these findings, some first recommendations were given to start off the implementation process.

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Appendices

Appendix A: List of questions for analysis of Circular Economy by using 5LF

Level	Aim of level	Set questions to be asked at each level
System	How does the system (any system under study within which the planning is to occur) work? What are its boundaries? Especially, what are its most basic functions, flows, laws, mechanisms, feedback loops, etc. that are needed to inform what defines success and strategy, as well as potential actions and tools (see levels below)?	Who did develop the concept? Why was it created? Who should use the concept? Does the concept state any explicit or implicit assumptions about the system? What is the concept designed for?
Success	Describe how the concept defines Success.	What is the concept's stated purpose? What is it intended for?
Strategic	Describe the overall guidelines which help users prioritise actions to move strategically towards success.	Does this concept help planners prioritise actions towards the overall goal? How does the concept recommend that decisions be made? What criteria are used to decide on actions?
Actions	Describe specific actions that the concept recommends taking	What are the various suggested actions and the stated rationale for them?
Tools	Describe complementary tools that are suggested by the concept you are analysing	Does the concept suggest complementary tools (measurements, monitoring,management approaches)?

(BTH 2012)

Appendix B: List of questions for assessment of the Circular Economy using the FSSD

Level	Questions to identify contributions:	Questions to identify possible gaps:
System	Does the concept help users understand more about the system of study and how it relates to society within the biosphere? Does it offer, describe, or measure further information to understand more about the system?	How does the concpet describe its boundaries to the environment and society globally? When it states or implies assumptions about the system, are those assumptions actually accurate?
Success	Does the concept offer or further elaborate on a definition of success i.e. sustainable society? Does this definition cover the full scope of sustainability i.e. the Sustainability Principles?	Given what the concept is designed to do, are there any 'blind spots,' or areas where it cannot help users achieve success in relation to the Sustainability Principles? What sustainability aspects are not addressed by this concept?
Strategic	Does the concept offer any guidelines, processes for planning, or further information for prioritizing strategic moves? How, if at all, does it integrate sustainability in overarching strategic guidelines?	Does the concept suggest a limited view of a strategic approach, such as focusing too narrowly on making decisions based on cost-benefit analysis alone? Does it specifically contradict any of the other guidelines? Does it utilise a backcasting approach, or does it solely rely on forecasting?
Actions	Does the concept suggest actions which are in line with strategic guidelines for decision making and will help move the organisation towards sustainability?	Does the concept broadly suggest concrete actions without contextualising whether those actions are appropriate for that organisation at that given time?

(BTH 2012)

Appendix C: Structure of Interview Questions

(Part 1 of 3)

Part	***Goal***	***Questions Companies (60 minutes)***	***Questions Academic Experts (60 minutes)***
Practical information	*Collect information to help us understand the context*	1) What is your position in the organisation? (Focus on responsibilities, level in the hierarchy) 2) What has been your role in the implementation process of CE?	1) What is your background? 2) How are you involved in the topic of Circular Economy?
System	*Create a common understanding, the context and set system boundaries /focus of interview)*	3) What is your organisation's understanding of CE and its principles? 4) In which parts of the (processes, products, etc.) has CE been applied? 5) Do you cooperate with specific departments regarding the implementation process? 6) In which timeframe did the implementation process take place?	3) What is your understanding of CE and its principles?
Success	*Understand the motivation/driver behind transformation*	7) Why did you decide to use the concept of CE? 8) What is the final goal (vision) for implementing CE? How do you know you achieved this goal? 9) How did you implement it? How did the process of implementation look like?	4) Why do you think companies decide to use the concept of CE? What are the main drivers? 5) In your view, what would be the final goal (vision) for implementing CE in a company? When could you call a company "circular"? 6) Can you imagine how the implementation process in a company could look like? What would be the first and the critical steps to take?

Structure of Interview Questions (Part 2 of 3)

<table>
<tr><th>Part</th><th>Goal</th><th>Questions Companies
(60 minutes)</th><th>Questions Academic Experts
(60 minutes)</th></tr>
<tr><td>Strategic, Actions</td><td>Understand the process of implementation, discover the key B&E and their interrelations, is CE a suitable tool for sustainable development</td><td>Barriers and Enablers :

10) What were the internal barriers and enablers you faced?
11) What were the external barriers and enablers you experienced on a political, economic, social, technological, legal and environmental level? (PESTLE)
12) Do you expect to experience any further barriers/enablers in the future?
13) Among those, what are the most important barriers/enablers you faced?
14) To what extend can you influence those?
15) Can you identify any interrelations between those barriers and enablers? Do they influence each other?

Practicability of the Concept:

16) Would you say that CE is an approach that provides you with sufficient flexibility for future actions?
17) Did the implementation of the concept provide you with sufficient return on investment(revenue, cost reduction, employee motivation, etc.) or do you expect it in the future?</td><td>Barriers and Enablers :

7) In your experience, what are internal and external barriers a company might face in the transformation process? What evidence do you have to support that?
8) In your experience, what are the internal and external enablers a company might face in the transformation process? What evidence do you have to support that?
9) Among those, what do you consider to be the key barriers and enablers?
10) To what extent might companies be able to influence those? Why?
11) Can you identify any interrelations between those barriers and enablers? Do they influence each other?
12) Regarding those barriers and enablers, how do you think the Circular Economy approach will develop in the future?

Practicability of the Concept:

13) Would you say that CE is an approach that provides companies with sufficient flexibility for future actions?
14) Do you think the implementation of the concept provides companies with sufficient return on investment (revenue, cost reduction, employee motivation, etc.)?</td></tr>
<tr><td>Tools</td><td>Find out if the successful implementation of CE is dependent on additional tools</td><td>18) Did you use any specific tools to implement the approach? If yes, which ones did you use (e.g. cradle-to-cradle, eco-efficiency, product-service systems)?</td><td>15) Can you think of any tools and concepts that are frequently used to implement the approach?</td></tr>
<tr><td>Additional Information</td><td>Collect further information that could be important for our research (e.g. gain new insights)</td><td>19) Is there anything else that you think would be important for us to know?</td><td>16) Is there anything else that you think would be important for us to know?
17) Can you name any key references or case studies that have been insightful for you?</td></tr>
<tr><td>30 minutes interview</td><td></td><td>Following questions were not asked: 5, 6, 8, 12, 16, 17</td><td>Following questions were not asked: 4-6; 12-15</td></tr>
</table>

Structure of Interview Questions (Part 3 of 3)

Questions being asked in the later stage of interviews
1) To what extent can a company actually become circular? Is 100% circularity possible?
2) How do you actually measure how circular you are?
3) Do you think that when CE is fully implemented, it does lead towards sustainability?
4) To what extend does CE lead us towards sustainability? Are there any gaps? Can the concept be improved?
5) To what extend does CE cover the social part of sustainability? Do you see there any gaps?
6) Does the CE require a shift from short-term to long-term perspective?
7) To what extend does collaboration happen between companies implementing CE?
8) What if companies do not pick up this concept for economic reasons - whose role will it then be (also in the future) to drive the companies being more sustainable and make them change?
9) Changing the Business Model and e.g. instead of selling the products, companies remain ownership - how does the accounting then look like?
10) Why is it not happening that product designers design the products in a way that they are lasting longer and are fully recyclable?
11) In your view, does circularity mean that you have to bring back all your own products and recycle them again or is it enough to create a recyclable product and purchase recycled materials?
12) Do you think that on the technological level it is possible to completely recycle material and at the same time remaining the same quality level?
13) Do you think that in a CE economic growth is still possible (e.g. talking about material flows)?

Appendix D: List of interviewed practitioners

Multinational companies (MNCs)

Organisation	Industry	Name	Position
BT Group	Telecommunications	Gabrielle Giner; William Popham	Environmental Sustainability
Cisco	Networking equipment	Neil Harris	Head of Sustainability, Europe (covers all EMEAR)
Ikea Group	Retail	Lena Pripp-Kovac	IT Sustainability Manager
Nokia	Telecommunications equipment	Helena Castren	Senior Environment Manager
Philips	Electronics	Robert Metzke; Eelco Smit	Senior Director Philips EcoVision Program; Senior Sustainability Manager
Puma	Sports goods	Stefan D. Seidel	Deputy Head PUMA Safe Global
Renault	Automotive	Jean-Philippe Hermine	Vice President Strategic Environmental Planning
Ricoh	Digital imaging, Photography, Electronics	Kerstin Thies; Louis Alting Siberg	Chief Manager CSR; Recycling Business Expert
Tarkett	Flooring	Roberto Jacono	Environmental Director

Academic Experts

Institute	Country	Name	Position
Advancing Sustainability LLP	United Kingdom	Chris Tuppen	Senior Partner
B.A.U.M. e.V. Reutlingen	Germany	Dr. Detlef Schreiber	Representative of B.A.U.M. Reutlingen
Biomimicry 3.8	USA	Chris Allen	Founder and Senior Partner
Cradle to Cradle Products Innovation Institute	USA	William Duggan	Strategic Communications at Cradle to Cradle Products Innovation Institute
EPEA Hamburg/Copenhagen	Germany/Denmark	Michael Braungart; Douglas Mulhall	Representatives of the Academic Chair, Cradle to Cradle for Innovation and Quality Rotterdam School of Management, Erasmus University, as well as EPEA Internationale Umweltforschung
Green Alliance	United Kingdom	Jonny Hazell	Policy Assistant
MRT	Sweden	Claes Rydén	CEO
New Energy Docks / Green Metropole Amsterdam	Netherlands	Peter Dortwegt	Director “New Energy Docks”; Business incubator “Green Metropole”
Rochester Institute of Technology	USA	Dr. Nabil Z. Nasr	Assistant Provost for Academic Affairs & Director
Technical University of Amsterdam	Netherlands	Niki Bey; Anders Bjørn	Associate Professor; PhD student
The Good Tribe	United Kingdom	Michael Bauer-Leeb	Project Manager, Consultant, Researcher
Turntoo	Netherlands	Sabine Oberhuber	Managing Partner
UNEP	USA	Garrette Clark	Programme Officer Business and Industry Outreach
University of Cranfield, Sustainable Production and Consumption	United Kingdom	Dr. Raffaella Villa	Lecturer in Bioprocess, Technology and Associate Dean
University of Surrey	United Kingdom	Professor Roland Clift	Distinguished Professor of Environmental Technology President-elect, International Society for Industrial Ecology
University of York	United Kingdom	Professor James Clark	Professor and Director of the Green Chemistry Centre of Excellence for Industry
Utrecht Sustainability Institute	Netherlands	Jacqueline Cramer	Director of Utrecht Sustainability Institute
WRAP	United Kingdom	Gerrard Fisher	Special Advisor (Electronic Products)

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