Circular Transformation: Creating Business Models and Ecosystems for a Circular Economy

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I have been involved in various environmental protection initiatives to the best of my capacity since I was sixteen, as creating an impact through my thoughts and actions has always been important to me. Thus, this dissertation was a perfect thematic fit for me and allowed me to pursue my interests and achieve practical benefits.

My supervisor and I wished to create an impact outside of academia as we believed that transforming academic work into practice requires the targeted use of varied communication channels and an allowance for knowledge flow

across the board. For this purpose, we created practical tools and publications derived from this dissertation.

First, we created a deck with 40 cards called *Circular Economy Pattern Cards*, that serve as an ideation tool in workshops and development processes, including an in-depth description of each pattern and inspiring use cases. The logic behind the cards is based on Paper B (Chapter 4: *Circular Ecosystems: Business Model Innovation for the Circular Economy*). The elaboration and production of this handy card deck would not have happened without Richard Stechow, and I extend my heartfelt gratitude to him.

Second, we successfully published a shortened version of Paper B titled *A Step Toward Making Your Company More Sustainable* in the *Harvard Business Review* at the beginning of 2021. This enabled us to reach a broad spectrum of readers who are interested in research, whom we could inspire with the concept of a circular economy. I thank Prof. Dr. Karolin Frankenberger for her perseverance and essential contributions that made the long road to publication traversable.

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Executive summary

Since the Industrial Revolution, humanity has risen to become a geological force through economic activities. The consequences accumulated over time are severe: global exploitation of finite and renewable resources, serious waste production, and the climate crisis being accelerated. Humanity and the biosphere are increasingly threatened by these consequences. Different approaches, both in research and practice, exist to counteract this overshoot of planetary boundaries, one being the circular economy. It offers a socially acceptable, ecologically necessary, and economically thrilling potential for change, and aims to close material loops efficiently and reduce negative externalities as much as possible. It is achieved through systemic, business, and personal changes.

This cumulative dissertation focuses on the business implementation of a circular economy. To this end, this dissertation presents three standalone papers and a comprehensive introduction to the circular economy. The introduction explains why adopting different perspectives is pivotal while analyzing the complex problem of environmental degradation currently faced. Furthermore, it introduces different concepts and definitions. Based on a dataset of 59 interviews with Swiss small and medium-sized enterprise managers, Paper A identifies possible barriers to the entrepreneurial implementation of a circular economy. The barriers are related to each other and are embedded in a holistic and multilevel framework. Paper B explores the link between business models and circular ecosystems conceptually and based on existing literature. To this end, it presents a comprehensive framework for designing circular ecosystems based on pattern logic, which draws on a comprehensive literature review and over 200 business cases identified in practice. This is enriched by presenting an innovation process and analyzing a thriving textile ecosystem in which eight partner companies were interviewed and evaluated. Finally, Paper C approaches the driving factors of the transformation into a circular economy from a management perspective. The

identified drivers are linked to the dynamic capabilities approach, which helps to explain the driving factors for the entrepreneurial implementation of business models in a circular economy. Finally, a conclusion is drawn, and the potential for further research is presented.

Zusammenfassung

Seit der Industriellen Revolution stieg die Menschheit durch ihre ökonomischen Aktivitäten zu einer geologischen Kraft empor. Die Konsequenzen, welche sich über die Zeit akkumulierten, sind gravierend: Weltweite Ausbeutung endlicher und erneuerbarer Ressourcen, massive Abfallproduktion und zunehmende Beschleunigung der Klimakrise. Die Biosphäre und die Menschheit selbst werden dadurch immer mehr in ihrer Existenz bedroht. Unterschiedliche Ansätze existieren, um dieser Überreizung der planetarischen Grenzen Einhalt zu gebieten. Ein Ansatz, der in der Wissenschaft und Praxis momentan frequentiert diskutiert wird, ist die Kreislaufwirtschaft. Sie bietet sozial verträgliches, ökologisch notwendiges und ökonomisch interessantes Veränderungspotential. Ziel der Kreislaufwirtschaft ist das effiziente Schliessen von Materialkreisläufen und die Reduktion von negativen Externalitäten auf die Umwelt. Erreicht wird dies durch systemische, betriebswirtschaftliche und individuelle Veränderungen.

Der Fokus dieser kumulativen Dissertation liegt auf der betrieblichen Umsetzung der Kreislaufwirtschaft. Dazu präsentiert die Dissertation drei Artikel und eine umfassende Heranführung an den Themenkomplex der Kreislaufwirtschaft. Die Einleitung zeigt, warum die Einnahme unterschiedlicher Perspektiven bei der Problemanalyse zentral ist, und sie definiert die relevanten Begrifflichkeiten. Artikel A identifiziert – basierend auf einen Datensatz von 59 Interviews mit Vertreterinnen und Vertretern von Schweizer Kleinen und Mittleren Unternehmen – mögliche Barrieren bei der unternehmerischen Umsetzung der Kreislaufwirtschaft. Die Barrieren werden zueinander in Relation gesetzt und in einem holistischen, multi-level Framework eingebettet. Artikel B eruiert – konzeptuell und abgestützt auf der Literatur – die Verbindung von Geschäftsmodellen und zirkulären Ökosystemen. Dazu präsentiert der Artikel ein umfassendes Framework zur Gestaltung zirkulärer Ökosysteme, das auf einer Pattern-Logik basiert, welche auf einer umfassenden Literaturanalyse und auf über 200 in der Praxis

identifizierter Unternehmensbeispielen abgestützt ist. Angereichert wird dieser Artikel zudem durch die Präsentation eines Innovationsprozesses und die Analyse eines erfolgreichen Textilökosystem, bei welchem acht Partnerfirmen interviewt und ausgewertet wurden. Artikel C nähert sich abschliessend aus einer Managementperspektive den antreibenden Faktoren in der Transformation hin zur Kreislaufwirtschaft. Die identifizierten antreibenden Faktoren werden dabei in Verbindung zu den dynamischen Fähigkeiten von Unternehmen gesetzt. Dies ermöglicht ein Verständnis für die antreibenden Faktoren bei der unternehmerischen Implementierung von kreislauffähigen Geschäftsmodellen. Zuletzt wird eine Konklusion vorgenommen und auf weiterführende Forschungsfragen verwiesen.

“Strictly speaking, the humans of the age of affluence are surrounded not so much by other human beings, as they were in all previous ages, but by objects.” (Baudrillard, 1998, p.25)

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BM business model

CBM circular business model

CE circular economy

DC dynamic capability

SME small and medium-sized enterprise

SSM sustainable strategic management

Preface

Implementing a circular economy (CE) is probably the last chance for the current economic system to heal itself and prevent an unprecedented ecological collapse. A CE provides a clear perspective on how the interplay of market forces can be steered along ecological lines by offering opportunities to successfully internalize the negative externalities of business activities. Thanks to closed material loops, innovative business models (BMs), the development of ecosystems, and the necessary regulatory guidelines, today's economic system could recover sustainably. A CE fits a sufficient lifestyle and supports materially saturated societies in formulating ideas for the frugal management of natural resources.

The concept of a closed material loops cannot be viewed as novel, as it has existed for millennia. It was displaced in the last century by an economic system of fast life, fast profit, a throwaway mentality, and planned obsolescence. The damage caused is immense, and the ecological catastrophe resulting from the exploitation of resources is massive. If we manage to implement a CE sustainably and do not use it as another greenwash instrument, it will buy some time for nature to pause, and replenish. Although the social aspects of sustainability are not the focus of this dissertation, they should be part of circular solutions.

A CE can be implemented at various levels in today's economic systems. Policymakers can exert their influence through regulatory levers, consumers can contribute to a circular transformation through their consumption pattern, institutional actors provide guidelines, and companies can shape innovative value propositions and BMs. This dissertation focuses primarily on the entrepreneurial implementation of a CE. Accordingly, it addresses managers and employees willing to create products, implement services, and innovate BMs in a sustainable and resource-saving manner.

I am convinced that modern Western cultures, in particular, see themselves as detached from natural processes, dependencies, and logic. I consider the successful implementation of sustainable change highly dependent on whether the people involved perceive themselves as an integral part of nature. The price to be paid for anthropogenic separation from the logic of the biosphere is high, making corrective human reintegration in natural processes difficult. Thus, sustainable change always appears to be a personal confrontation with one's own perspectives, needs, and feelings. Therefore, the question is whether we, as humans, consider ourselves as part of the whole natural system and if we are willing to pay the psychological price for deviating from today's paradigms.

A CE will not be able to solve all the environmental problems caused by humans, but it will help to incorporate nature-related viewpoints into today's market-dominant line of thoughts in two ways: by incorporating the logic of circularity into the logic of businesses and by supporting people in finding ways to realize the need for sustainable activities in their personal and professional lives.

“Look deep into nature, and then you will understand everything better.” (Albert Einstein)

1. Introduction

1.1 Thematic embedding of the phenomenon under study

A historically incomparable number of objects surround modern humans. A glance into children's rooms, storage cupboards, or landfills supports this finding. In today's consumer society, the relationship between people and objects has changed fundamentally, creating a system of constantly increasing quantities of goods and needs (Trentmann, 2004). Often, products are no longer used for a specific function, but serve as symbols of prestige, status, and comfort (Baudrillard, 1998). Moreover, the utilization period of products has decreased, and their life cycle has been shortened over the past decades. This can be observed in almost every industry, such as textiles (Ellen MacArthur Foundation, 2017) or electronics (Wilhelm, 2012).

Excessive consumption, short life cycles, and a growing number of products are the central pillars of modern capitalist societies and their cultures. In many economies, along with this flourishing consumerism and throwaway culture, there has also been a steady growth in gross domestic product. Counterintuitively, it is noteworthy that life satisfaction has stagnated in recent decades, despite this growth in many Western societies such as Switzerland (Frey and Stutzer, 2009).

Behind this consumerism lies a complex interplay between different actors, such as companies, consumers, and institutions. Simply put, companies produce products as a response to the needs expressed by consumers for which they are willing to pay. Institutions set framework conditions and interact with other actors. Companies need labor, resources, and energy, among other things to manufacture these products. This process generates jobs, income, and purpose for the people involved. Due to various factors, since the second half of the 20th century, companies have become increasingly aware of the negative consequences of these economic activities on the environment.

Therefore, it is not surprising that an increasing number of companies want to take their corporate responsibility seriously and invest in sustainability reporting, initiatives, and sustainable measures, and try to reduce their ecological impact. Company leaders are increasingly emphasizing the advantages of being sustainable. Cost savings, risk reduction, and brand reputation are highlighted as essential drivers of sustainability (Dyllick and Muff, 2016a; Kiron et al., 2013). Recent developments, the rise of *green* products and marketing campaigns exhibit potential.

Unfortunately, a closer look reveals a striking discrepancy between the actions propagated at the corporate level and the deterioration of the planet. This *big disconnect* (Dyllick and Muff, 2016a; Whiteman et al., 2013) is reflected by a lack of progress regarding environmental sustainability and achieving the sustainable development goals (*SDGs*) set by the United Nations (Sachs et al., 2019). Additionally, we see an increasing risk of social conflicts and irreversible damage to nature, all of which are mutually dependent (Arpe, 2012).

One of the most evident signs of deterioration in global sustainability is the concentration of greenhouse gases in the atmosphere, accompanied by an increase in annual temperature (NASA, 2019; Steffen et al., 2015). The Intergovernmental Panel on Climate Change (IPCC) warns that if radical and extensive changes do not occur quickly, the international goal of limiting global warming to 1.5°C cannot be achieved (IPCC, 2018a). The subsequent years will witness varied climate tipping points being reached, and the aftermath will cause irreversible damage to ecosystems (Stockholm Resilience Centre, 2020). It must be noted that the way we exploit resources accounts for 70% of global greenhouse gas emissions (Circle Economy, 2021).

The amount of waste produced daily—a significant part of which ends up as municipal waste in waters and oceans—is estimated to grow from 3.5 million tons per day in 2020 to 6.0 million tons per day in 2025 (Hoornweg and Bhada-Tata, 2012). At the current pace, one million species will face extinction in the

following decades. The global rate of species extinction, which is already ten to hundreds of times higher than the average in the past ten million years, will increase exponentially (Díaz et al., 2019). Animals that are not yet extinct but have been pushed back lack adequate space in terms of habitats. Viruses that previously existed only in the animal kingdom have begun to cross the species barrier and infect humans (Centers for Disease Control and Prevention, 2020). The probability that this will occur correlates with the destruction and reduction of natural ecosystems. This pattern was observed in the cases of diseases like Ebola, bird flu, and other highly infectious diseases, and now the current COVID-19 pandemic (Shah, 2020; Vidal, 2020).

This overview highlights the urgent need to transition to a more sustainable and resource-conserving economy. Here, a CE offers an alternative to the current linear-functioning economic system. CE is a concept that aims to close resource loops, optimize the use of resources, and minimize waste (Blomsma and Brennan, 2017; Ellen MacArthur Foundation, 2013). It is about transforming the linear value chain, that is, one that works in a take-make-use-dispose pattern, to a circular value chain that works in a take-make-use-recover pattern (Ellen MacArthur Foundation, 2015a). The idea of a CE is to maintain the biophysical capacity of the planet (Desing et al., 2020).

Even though closed resource loops mechanisms have existed for millennia in everyday practices, the academic perspective on CE is a new phenomenon that has only been analyzed and discussed for two decades (Ghisellini et al., 2016). Interest in the subject has also increased as more political initiatives and resolutions have been implemented, such as in the EU, the Netherlands, and China (Ellen MacArthur Foundation, 2013; Lehmann et al., 2014; Potting et al., 2017). Additionally, an increasing number of researchers are addressing CE, as reflected by the rising number of publications on the topic (Geissdoerfer et al., 2017).

As a research subject, CE cannot be assigned to a single research field, as it is relevant to different fields such as business administration, material science,

jurisprudence, and design. This dissertation chooses an entrepreneurial point of view, and focuses on implementing CE in business reality. For this purpose, it builds as a cumulative dissertation on three papers (Chapters 3–5), that are thematically held together and accompanied by an introductory, key definitions, and concluding contribution (Chapters 1 and 6). Chapter 2 presents the scope of this dissertation and relates the individual papers (A, B, and C).

1.2 Intrusion in complex systems demands the conflation of different perspectives

The present interglacial period that began about 10,000 years ago, the Holocene, enabled humanity to settle and farm, develop complex societies, and invest in the natural environment. This was enabled by the relatively stable state of the natural geological epoch (Rockström et al., 2009b). Until recently, humanity had little or no influence on the functioning of the Earth's systems. If at all it did, it was only regionally and with a limited range and low magnitude (e.g., through hunting or the use of fire) (Steffen et al., 2007).

With the advent of the Industrial Revolution and the invention of the steam engine by James Watt in 1784, fundamental changes took place. Excessive mining and use of fossil fuels, first coal and later oil and gas, promoted the development and prosperity of modern economies and initiated a new chapter in Earth's history: the Anthropocene (Crutzen, 2006). It is assumed that the Holocene condition would have continued to be maintained for thousands of years without human stress on Earth's systems (Berger and Loutre, 2002). The previously prevalent energy shortage in civilization was thus overcome by using fossil fuels, an energy reserve of solar energy from millions of years of photosynthesis (Steffen et al., 2011). Humans have become a geological force through resource extraction, usage, and consequences. From the second half of the 20th century onward, this process has intensified, and human influence on Earth's systems can no longer be overlooked (Crutzen, 2006, 2002).

The state of the civilization directly affects the energy required, as industrial societies need up to five times as much energy as agricultural ones, which in turn consume up to four times more energy than the hunting and gathering societies that existed before them (Steffen et al., 2007). The increase in energy use has been accompanied by growth in various other areas of society. Agriculturally used land areas increased from 16% in 1850 to 50% worldwide in 1990 (Goldewijk, 2001). During the same period, the global population grew from less than two billion to over six billion, partly because of inorganic nitrogen fertilizers (Smil, 1999). Parallelly, the burning of fossil fuels and agricultural production caused an enormous increase in the concentration of CO_2 in the atmosphere by more than 30% and methane by more than 100% (Crutzen, 2002). Similar growth curves can also be visualized for freshwater use, for the extraction of metals, or for the use of pesticides.

Humanity has increasingly interfered with a complex natural system through its activities. It is necessary to take a higher level of abstraction to understand this intrusion and the resultant environmental and societal problems. For this purpose, the economic–entrepreneurial perspective central to this work is enriched from a CE perspective, thereby enabling the understanding of reality as causal, and thus reciprocal cause–effect, conditional, and dependent. The four main explanations for the current state of the environment, economy, and society are presented below. These can be derived from the central work in CE.

Bocken et al. (2016) defined a cornerstone of CE research with the three dimensions of sustainable CE (slowing, narrowing, and closing resource flows). The chapters on linearity, efficiency, and temporality build on this knowledge. The chapter on complexity and technology is inspired by Bauwens et al. (2020), which attempts to forecast the future of closed resource loops. Chapter 1.2.1 focuses on the logic of resource exploitation in today's economic system, and facilitates the explanation of the prevailing pattern of linearity. Chapter 1.2.2 deals with the influence of efficiency efforts and examines the potential effects without a holistic view. Chapter 1.2.3 discusses the factor of time, and how it

is perceived by people, involving central aspects of a sociological view of the problem complex. Chapter 1.2.4 deals with the influence of complexity and technology on a product and systemic level.

These four chapters are not exhaustive, but they build on core conceptual considerations in the CE literature and condense them into four perspectives. This introduction highlights the importance of observing high levels of interconnectedness and interdependencies. It allows the identification of the central roots of current environmental problems and enables a potential path toward practical solutions.

1.2.1 Linearity: the logic of how we produce unwanted materials and invented waste

The wasteful use of resources is a modern phenomenon, both globally and historically. With the onset of industrialization, humanity has developed a linear relationship between the steps of resource usage, known as the take-make-use-dispose pattern (Bocken et al., 2016; Ghisellini et al., 2016). Before that, economic and technical conditions usually did not allow people to waste resources. The consequence of this linear logic is the production of unwanted material at the end of a product's lifetime and the acceptance of other negative externalities, such as greenhouse gas emissions or biodiversity loss, along with all steps of a value chain (Bell et al., 2013; Lieder and Rashid, 2016). Waste has become an inescapable part of our industrialized consumer society (Ellen MacArthur Foundation, 2013). To this day, the basic assumptions about the way resources flow in this linear logic and the consequences of business activities on the environment remain unchallenged (Schulte, 2013).

Two dominant factors stimulated the development of linearity in the 20th century. First, the industrial use of fossil fuels, especially oil, to produce plastics and their use as a cheap source of energy, allowed the production of inexpensive products. This caused sales volumes to shoot up and increase greenhouse gas emissions (Steffen et al., 2015). Second, the ongoing development of raw material extraction methods has become increasingly

accessible and cheaper than labor costs. The cheap energy from fossil fuels has stimulated the rapid mining industry. Subsequently, centuries-old methods, crafts, skills, and traditions, such as maintaining product quality or preserving reusability, were made obsolete in favor of new production (Allwood et al., 2011).

Many highly sustainable activities, such as the production of long-lasting items, subsistence strategies, and methods for preserving food, are in danger of being lost as knowledge repositories for societies. Losing this accumulated knowledge can be understood as a loss of cultural heritage and a decrease in societal resilience, thereby reducing the capacity of the socio-environmental system to continuously change and adapt to new circumstances (Folke et al., 2010; Holtorf, 2018). The potential damage through economic linearity must be considered not only from the viewpoint of the resource waste it triggers, but also through indirect consequences such as the loss of techniques and cultural traditions (Jigyasu, 2013).

Before the paradigm of linear mass production commenced on a grand scale in the 20th century, the creation of products took place as a vertically integrated model in which the same person or group of people simultaneously undertook tasks of design, manufacture, repair, and recovery. This model lacked scalability and led businesses to fragment the necessary process steps into many small, replicable, and tangible ones to achieve higher production volumes through efficiency gains. A drawback of mass production was that it reduced the level of holistic, cross-process knowledge regarding the product, dispersed information about the product among various actors, and deprived product design of its integral role (Terzi et al., 2010). In the current linear economy, product design is often focused on cost-efficient assembly and short-term profitability, resulting in significant material diversity and complex assemblies. From a sustainable resource perspective, it would be more sustainable to have (integral) design configurations that push repairability,

limit material wear, or allow disassembly without damaging the material contained therein (Alting and Legarth, 1995).

The shift from a domestic craft to a linear economy, driven by the industrial manufacturing and advertising industries, led to a massive increase in materials, products, and packaging that were declared waste without any other purpose. The more waste this created, the more society focused on it as a distractor (Cooper, 2010). Initially, no one cared much about the waste, and nature became a catch basin for the growing mountain of waste. It was not until the 1960s and the 1970s when environmental problems intensified due to the accumulation of waste, that society's perspective on the subject changed, particularly in Western countries, and triggered political measures to make waste invisible. With the rise of waste management systems in the 1980s, reuse and recycling rates have also increased; so did the proportion of waste shipped to developing countries due to a lack of regulation and political practicality, where similar problems awaited people (Barles, 2014).

In summary, a complex, linear system of production and use exists today, dependent on fossil fuels, which largely determines the logic of resource use.

1.2.2 Efficiency: the problem of sustainability efforts that are not holistic

Efficiency-oriented concepts in sustainability, also called eco-efficiency (Ayres et al., 1997), have been discussed and applied since the 1970s. They are characterized by viewing the value created by a company, that is, the added value, in relation to the resultant ecological burdens, thus achieving a relative weighting (Figge and Hahn, 2004). Among the first to explore eco-efficiency were McIntyre and Thornton (1978), who examined eco-efficiency in countries of the Soviet Union and Western market economies. However, the concept did not become widely known until Schmidheiny's (1992) book *Changing Course* that was written on behalf of the World Business Council for Sustainable Development (WBCSD), which was defined as the following:

"eco-efficiency is achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the Earth's estimated carrying capacity." (WBCSD, 2006, p.3)

The difficulty in measuring eco-efficiency lies in determining the impacts that should be considered and the boundaries that must be included (Ehrenfeld, 2005). In addition to efficiency measures in the manufacturing of products, energy can also be used more efficiently, for example, using better machines or vehicles (Allwood et al., 2011). It is not surprising that the last few decades of corporate sustainable engagement have mainly focused on efficiency measures as they are often practical, can be implemented directly in the company, lead to cost savings, and require a relatively straightforward business case. Often, these efficiency gains are side effects of lucrative efforts and come with a per-unit efficiency focus on incremental efficiency gains (Bocken et al., 2016).

Eco-efficiency is reflected, for example, in efforts to make computers thinner or cars more fuel-efficient. Such aspirations are still an uncontested thrust for many companies and states, and investments are made accordingly in applications and technologies to increase efficiency (Chakravarty et al., 2013). Such measures might be useful from a sustainability perspective, but only if they are perceived holistically. Otherwise, hidden consequences, such as rebound effects (Figge et al., 2014; Polimeni et al., 2008) or boomerang effects (Mayer et al., 2005), can occur. Different studies have demonstrated these effects in various areas: cost savings from more energy-efficient cars led to additional transportation (Yu et al., 2013), and energy efficiency in cooling or heating systems resulted in an increase in energy usage (Greening et al., 2000). The focus of per-unit analysis is only on relative efficiency and not on absolute efficiency, which ignores the overall availability and global limitations of the resources (Desing et al., 2020; Hobson, 2016).

If products require less material to manufacture and are more efficient to operate, they might be cheaper to offer and use. This stimulates the demand for more products, which, in turn, requires more resources. Eco-efficiency efforts, which were initially classified as sustainable, became even more damaging to the environment afterward. In the event of the link between the micro and macro perspectives on sustainability being missing, such unintended effects may result (Dyllick and Muff, 2016a).

In summary, it can be said that eco-efficient sustainability efforts must always be considered in their entirety and include all possible impacts and inherent risks from unforeseeable consequences over time.

1.2.3 Temporality: the influence of acceleration and the valuation of time

Humans are temporal beings who perceive and evaluate the progression of time (Bell, 2003). The experience of time relative to the past, present, and future, and the speed of time, is a valuable starting point to analyze environmental degradation and the state of society. Based on the conception of Sztompka (1993), which distinguishes between qualitative (individually perceived, not uniformly flowing time) and quantitative time (unified interpretation of time units), the focus here is on time as a temporal dimension concerning resource usage, and as a resource itself, which is perceived through its availability and perception (Huy, 2001).

First, we can observe in quantitative terms that since the beginning of the 20th century, the utilization time of products, and thus, of resources, has changed measurably. Innovations, a growing division of labor, and new requirements have accelerated the production of goods. In the 1930s, triggered by the financial crash, the self-sustaining loop of demand-supply-income came to a temporary standstill in the U.S. This development caused profound changes in product design and marketing to stimulate decreased consumption, resulting in the emergence of planned obsolescence (Andrews, 2015). Planned obsolescence, typical of a linear economy, is aimed at rapidly aging products

and causes them to become nonfunctional within a shorter period (Satyro et al., 2018).

After the 1930s, various markets began to show increased symptoms of saturation and a decline in consumption, which further accelerated the deliberated short lifespans. In the 1950s and the 1960s, when planned obsolescence was extensively established in all Western countries, the modern consumer and throwaway society took root with the help of fast-moving fashion trends. Rapidly recurring purchase of new products became the new normal, triggered by a change in the temporal and qualitative perception of a standard product lifespan (Whiteley, 1987).

The trend of ephemerality and time-reduced use has continued to date. Obsolescence, as a "key issue for sustainability" (Andrews, 2015, p. 306), affects consumers through different channels: either through the functionality and condition of the product (e.g., technical defects), intentionally managed by companies via product design and material selection, or through the mental attitude of the consumer toward the product (e.g., fashion awareness), stimulated by marketing activities (Packard, 1960).

The accurate interpretation of planned obsolescence is challenging because it is subject to reciprocal relationships between entrepreneurial activities and customer behavior. A helpful distinction can be made between relative obsolescence (a scenario where the product is no longer used, even though it is functional) and absolute obsolescence (a scenario where the product is no longer functional and defective) (Cooper, 2004). Companies can intentionally promote absolute obsolescence so that products break sooner or are consumed faster, for example, through practices such as design adjustments for faster consumption in shampoos through a larger dispenser size or software update difficulties in mobile phones (Satyro et al., 2018). Relative obsolescence is linked to users' psychological perceptions of the attractiveness and satisfaction of a product over time (Fels et al., 2016). This perception is related to customer evaluations, time perceptions or attitudes, and companies' marketing activities

(Spinney et al., 2012). It is no secret that marketing has dealt extensively with the question of the best time span of product use, depending on the desired sales volume, demand-stimulating activities, and waiting costs, to achieve the highest possible product sales over time (Levinthal and Purohit, 1989).

A reason for planned obsolescence is the link between entrepreneurial success and dependence on sales (Ghisellini et al., 2016). Driven by entrepreneurial rationales, a company can be incentivized to design a product in such a way that it will function just long enough that consumers will not refrain from buying new products from the same company. When the optimum between perceived quality and product lifespan has been reached, the product is rendered obsolete so that the consumer is forced to replace it. The underlying strategy manifests itself in various design standards, such as limited repairability or death dating, that directly influence consumer throwaway behavior (Guiltinan, 2009). The environmental consequences of intentionally shortening usage time are clear: new resources are needed to create new products for those that have become useless.

Second, in qualitative terms, time can be viewed as an intangible resource that is perceived and valued individually and collectively in varied ways. Time is possibly the most fundamental and profound budgetary restriction of human existence; activity possibilities in life are exhausted along with the exhaustion of the lifetime budget. This circumstance makes two questions regarding the temporal structure central: What is the relationship between people and time in modern societies? How does this influence consumer behavior and environmental degradation?

Various sociologists and historians note that modernity can be characterized by a sense of accelerated time and increasing time scarcity (Rosa, 2014a). While it is debatable whether the sense of accelerated time stems from technological or social change (Wajcman, 2016), the perception of acceleration is almost undisputed. It has become deeply etched into the contemporary zeitgeist of consumer societies. This is not a recent phenomenon, but one that

has been ongoing since the Industrial Revolution (Koselleck, 1985). The acceleration of time permeates the most diverse areas of modern life, such as technical, economic, social, and cultural processes. This aspect should be considered in the analysis of the current state of the consumer society and the environment, similar to trends such as individualization, differentiation, and rationalization (Rosa, 2003). In everyday life, this intensification of time can be seen very concretely in the organization of leisure time, learning, or work practice (Hayes and Jandric, 2017; Rosa, 2014a). Time constraints in a company context are related to this (Rosa, 2014b) and are similar to those in the everyday lives of consumers (Folkers and Paech, 2020).

The core purpose of many products and technological innovations is to save time. This applies to the washing machine just as much as to a mobile phone; centuries ago, one still had to wash at the river and possibly cross long distances by foot to communicate. The growing perception of accelerating time thus recurrently calls for novel technological solutions to reduce the perceived scarcity of time. On the one hand, more available technologies, products, and applications stimulate *utilization competition*, while time availability remains the same (24/7), thereby creating a perceived time scarcity (Folkers and Paech, 2020; Paech, 2012). On the other hand, especially in societies with relatively higher wages than resource prices, this leads to a "rebound effect with respect to time" (Binswanger, 2001, p. 119). Technologies with a time-saving character are in greater demand because they reduce time loss, which is more significant due to higher wages and, therefore, higher opportunity costs. However, increased time-saving technologies require more energy and resources in most cases. This can be visualized using the metaphor of a train: The faster the train should go, the more (disproportionate) energy and infrastructure improvements are needed. The ratio of energy required to save time is not linear, and this increases energy consumption (Binswanger, 2001).

In summary, it can be said that temporal acceleration at the individual and business levels results in (accelerated) adverse effects on the environment.

Thus, the factor of time allows a critical explanatory angle at both the individual and business levels in describing the worsening environmental problem. The changing relationship to and handling of time affects the impact of human activities on the environment.

1.2.4 Complexity: the role of technology and path dependency in a constantly evolving system

"What is perhaps most intriguing in the evolution of human societies is the regularity with which the pattern of increasing complexity is interrupted by collapse—by episodes when societies change rapidly to a lower level of complexity." (Tainter, 1995, p.399)

No further effort is required to realize that in the course of modern history, products, and the associated technical and institutional systems have become more sophisticated, comprehensive, and, above all, more interconnected, as illustrated by production, communication, or mobility systems. For instance, in the past, carriages were used for transportation, but technicians are capable of designing self-driving cars today; tables were previously painstakingly made by hand, but today, a single click can deliver a customized table.

It seems reasonable to state that since the beginning of the Industrial Revolution, not only have products become more complex in their design but they also involve entire economic systems with all their actors and institutions, in their creation and maintenance. Anthropologist and historian Tainter (1995) described this development as an adaptive, socio-economic process in which societies designate complexity as an investment in solving prevailing problems.

Today's economic system has been created by humans through the interaction with the environment for centuries. It is a product of human thoughts, actions, and forecasts, characterized by networking structures and aggregations through actors at and across various levels (e.g., markets or regulations) that are much more complex than a microeconomic production function might lead one to believe (Foster, 2005). In extremis, the *world economy* is characterized by an

aggregated global interconnectedness of political, economic, technical, and social systems, and generates a complexity that is incomparable (Arpe, 2012). Additionally, in contrast to natural systems, economic actors change and react with strategy and foresight that consider possible outcomes resulting from their own behavior, which adds reciprocity to the complexity itself.

What underpins the complexity of the economic system is the fact that technological innovation and the accompanying institutionalizations create path dependencies with locked-in standards (Arthur, 1999). Therefore, the development of more sustainable technologies may be prevented due to the predominant and systemically embedded technology logic (Arthur, 1989; Barnes et al., 2004). This complexity seems to be difficult to disentangle, and it is perilous to discern what made problem solving even more demanding and provide an explanation for environmental degradation. Path dependency is challenging, and increases complexity, as many problems in linear value chains arose at a time when sustainability was not yet an issue, luring economic actors into existing systems that are inherently unsustainable. Breaking free from these path dependencies is challenging for individual actors, as they must work against existing incentive mechanisms and logic that may be more supportive of actors who are compliant with the system.

At the product level, these dependencies and complexities can be well visualized (Bakker et al., 2014a; SITRA, 2016). The more complex the design and components of a product, the more challenging it is to find sustainable solutions (Baxter et al., 2018; Franco, 2017a). The way a product is designed and its degree of complexity influences the opportunity to recover materials post usage and cause consumer behavior (Andrews, 2015). Complexity that leads to more materials in products, bonding of product components, or reduced ability to disassemble materials specifically reduces the possibility of durable usage and a closed-loop system. Complexity in product design influences the entire value chain, and thus the economic and social systems (Novak and Eppinger, 2001). While there are many explanations for an

increase in complexity at the product level, such as protection against imitation or specialized customer requests, or at the systemic level due to globalization trends or the need for interacting digital technologies (Arpe, 2012), research only marginally addresses the impact of this increase in complexity at the product and systemic levels on the environment.

Technologies play a key role in the formation of today's state of the environment, and are characterized by ambiguous relationships with nature. Technologies are both the root of environmental problems and a tool for remedying them. However, even if nearly every environmental problem is based on some form of technological application (except for environmental disasters such as volcanic eruptions or earthquakes), the issue is not that simple, as technology can have multiple manifestations, create ambiguous values, and depict different diffusion channels (Berkhout, 2002).

Technology has made it possible to raise the standard of living in many regions while simultaneously putting human actions on par with natural influences, as shown in the excursus of the Anthropocene. It is not surprising that technology is seen as both a blessing and a curse from an environmental perspective, which is also depicted in the history of science as the attitude toward technology being subject to fluctuations ranging from enthusiastic to skeptical (Kerschner and Ehlers, 2016).

The focus on technology and complexity is central, as the predominant paradigms in sustainability and CE research rely heavily on technological innovation (Ellen MacArthur Foundation, 2016; Kristoffersen et al., 2020; Lacy et al., 2014). Bauwens et al. (2020) identified two clusters of CE-driven entrepreneurial innovators regarding their attitude toward the influence of technology in sustainable change: high-tech and low-tech innovators, with the former being techno-optimistic with the aim of maintaining a growth-oriented consumer society but decoupling it from environmental impact with the help of technological innovation, and the latter being techno-pessimistic with the aim of moving away from resource-intensive lifestyles, consumption, and

resource use. Techno-skeptics argue that technologies always create some form of negative impact on the environment and disrupt natural systems (Cohen, 2006).

Inspired by Binswanger (2001), Kerschner and Ehlers (2016) note that technologies exist to overcome certain limits, such as time or space, as described in Chapter 1.2.3, about temporality, and this would directly or indirectly cause negative impacts on the environment. To stay within the planetary limits, a trend toward a degrowth movement has emerged among researchers and environmental activists, which foresees not only a rethinking of the growth-dependent economy (Binswanger, 2012), but also a turning away from an economy that relies only on technology (Schneider et al., 2010). The techno-optimistic paradigm assumes that harmful products and processes can be replaced by sustainable alternatives, which makes them highly dependent on innovation and the development of new, previously untested technological and institutional interrelationships.

The economist Paech explained that the risk of technology modernization lies in the uncertainty about the result, that is, whether the sum of all benefits from the innovation outweighs all intended and unintended disadvantages (Folkers and Paech, 2020). It is therefore not surprising that techno-optimists assume that "modern society has transcended nature, that, sustained by human ingenuity, it is inherently sustainable" (Rees, 2002, p. 250). The element of risk in this perception is that a reversal and change after the full implementation of new technologies could be simple, ignoring the effects on economic and societal systems that have already been unleashed, defining path dependency (e.g., behavioral change of consumers, adjustments of entire value chains, or BMs).

In summary, it can be stated that it is central to observe the impact of technological innovation on the intensification of complexity. This means understanding how path dependencies emerge and how actors trapped in complexity can overcome them. The somewhat naive but legitimate question

here would be: Would humanity still develop and approve the use of combustion engines if we knew their consequences on climate?

1.3 The path toward sustainable resource loops

The debate on sustainability has long been a tradition. Even ancient Romans were concerned with the question of the sustainable use of agricultural land (Pfister et al., 2016). In the Middle Ages, researchers increasingly began to study the interaction of humans with substances found in nature; the dose-response relationship for therapeutic substances emerged, along with concerns about the side effects of economic activities in the mid-16th century. For example, Paracelsus discussed the externalities of mining activities, such as lead exposure (Gallo, 1996; Zapp and Doull, 1993) in his work *On the Minders' Sickness and Other Diseases of Miners* (1567). Galileo Galilei used old (recycled) brass, which was cheaper than new, for the manufacture of his telescope in the beginning of the 17th century. It was common to collect pre-used materials such as iron, cannonballs, and old cordage, and use them to manufacture new products. The complexity of the procedures varied and went from melting old iron to complicated improvement of the color quality of ink by using broken galls as additives in manufacturing (Werrett, 2013).

It was not until the 18th century that the concept of sustainability was put into writing by Hans Carl von Carlowitz in his work *Sylvicultura oeconomica*. The German nobleman dealt with sustainable deforestation and the cultivation of forests (von Carlowitz, 1732). As industrial activities intensified in the 18th and 19th centuries, there was an increase in observed diseases related to those activities (Gallo, 1996), such as cancer. Subsequently, the idea of sustainability was only sporadically discussed, until in the mid-20th century, interest increased massively due to the increasing consequences of industrialization. An increasing number of scientific disciplines have begun to address questions about toxins, pollution, and diseases triggered by economic activities.

In her book *Silent Spring* (1962) the biologist Carson drew attention to the connection between pesticides and insecticides like dichlorodiphenyltrichloroethane (DDT) and the suffering of various animals, such as birds of prey, as well as the development of human cancer. Socio-economic scientists were increasingly interested in sustainability, as seen in the publication *Tragedy of the Commons* (Hardin, 1968) or *The Economics of the Coming Spaceship Earth* (Boulding, 1966). The second work introduced the expression *open cowboy economy*, which became popular as a metaphor for the use of the limited resources on planet Earth. Boulding advocated a cyclical economic system based on ecological principles and available resource capacity, calling it a *closed spaceship economy*.

Shortly afterward, the Club of Rome published its widely discussed work, *The Limits to Growth* (Meadows et al., 1972). Almost simultaneously, *Principe I* of the 1972 *Stockholm Declaration* was established and agreed upon by the United Nations (UN) Conference on the Human Environment:

> "Man has the fundamental right to freedom, equality, and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations […]." (United Nations, 1972)

This was later followed by the famous definition of sustainability by the World Commission on Environment and Development in the *Brundtland Report*:

> "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". (Brundtland, 1987)

The key message was that future generations should be able to live in conditions that are the same as those in the present, or more abstractly, ensure intra and intergenerational equity (Desing et al., 2020). Simultaneously, the discovery of the ozone hole boosted discussions on sustainability, which

culminated in 1992 at the first environmental summit, the *United Nations Conference on Environment and Development (UNCED)* in Rio de Janeiro. Nearly annual climate conferences followed, and in December 1997, legally binding targets for emission levels in industrialized countries were set up in the *Kyoto Protocol*.

At the beginning of the 1970s, the discourse was still dominated by relatively reversible forms of environmental pollution, such as hazardous waste, but by the end of the century, the discourse shifted to more irreversible and interrelated destruction and global issues, such as climate change or the loss of biodiversity (Bodansky, 2001). The 1990s saw an intensifying connection between business reality and sustainability. One of the most famous links was provided by Elkington's (1997) work *Cannibals with Forks: The Triple Bottom Line of 21st Century*. This book was crucial for the examination of the subject of sustainability from a business perspective. It brought together the three spheres of sustainability relevant to modern societies: social, environmental, and economic, or in short, people, planet, and profit.

Parallel to the climate conferences of the 1990s, the first schools of thought were developed around the concept of a CE. The two environmental economists, Pearce and Turner (1989), were among the first to develop the principles of closed resource loops, based on Boulding's (1966) thoughts to think in terms of limited availability of resources and in line with the physical logic of thermodynamics. Impulses also came from the research field of industrial ecology, that aims to restructure the economic system into one that is compatible with the functions of the natural ecosystem (Erkman, 1997) and develop new ways of dealing with waste (Frosch, 1992). In the following years, in addition to industrial ecology, various ideas regarding CE emerged, building on a material, practical, or performance perspective (Desing et al., 2020; Ghisellini et al., 2016). Some concepts have also transitioned from purely academic consideration to business practice, such as cradle-to-cradle efforts

(Braungart et al., 2007) or biomimicry driving design innovation (Benyus, 1997).

It is important to note that the discussion about CE has long consisted of a fragmented collection of varying ideas from different scientific disciplines (Korhonen et al., 2018b). The concept of a CE, conceived as a comprehensive model for (re)designing the economy, has recently become widely accepted with political, business, and consulting aspirations in Europe and Asia. This originated from political initiatives, such as resolutions of the EU, the Netherlands, and China (Ellen MacArthur Foundation, 2013; Ghisellini et al., 2016; Lehmann et al., 2014; Potting et al., 2017), and due to the growing interest of large consulting firms (EY, 2015; Hannon et al., 2016; Kirchherr et al., 2017a; WBCSD and BCG, 2018).

The most influential contribution and attempt to harmonize these concepts came from the Ellen MacArthur Foundation, which united many stand-alone methods and ideas under one roof: A CE aims at a regenerative industrial economy, (re)capturing the enormous volume of finite and renewable resources to use them again and again (Ellen MacArthur Foundation, 2013). This indicates a reduction in the negative impacts of human activities on the environment. The general goal is to maintain the maximum utility and value of products, components, and materials (Bocken et al., 2017). To achieve this, products and materials must be kept in the loop with CE measures such as product reuse, repair, remanufacturing, or recycling. This idea will be elaborated on in Paper B (see Chapter 4).

1.4 An overview: circular economy, business models, and ecosystems

In the literature and in practice, there are different concepts and definitions of what a CE entails and how it can be designed and implemented in a sustainable way (Ghisellini et al., 2016; Kirchherr et al., 2017b). This chapter provides an introductory overview of the basic components of a CE, defines them, and

addresses the interface between BMs and ecosystem research. This allows for a holistic and interconnected understanding of the subject matter. Therefore, the following chapter will address the main findings from the first research output of the LACE project (Laboratory for Applied Circular Economy).

1.4.1 Circular economy: conceptual construction, resources, and the concept of entropy

In the following section, the key elements of the paper, *A Circular Economy Within the Planetary Boundaries: Towards a Resource-based, Systemic Approach*, published in the journal *Resources, Conservation and Recycling* (Desing et al., 2020) are presented. These ideas enable the embedding of a CE in the sustainability discourse. Text sections from the paper are presented in *italics*.

Physical reality is conditioned by the Earth's system that surrounds us with its natural laws, such as the distribution of energy in space and time:

These principles limit the possibilities for all natural, but also all technical processes. The Earth system provides vital ecosystem services to humanity but has a limited resilience against anthropogenic stressors. These boundaries of the planet and the physical limits combined should be considered as the overall frame for human activity, in order not to trigger unintended anthropogenic changes in the Earth system. To design a sustainable CE, two fundamental engineering problems need to be addressed: i) How to quantify the sustainable resource base and make sure that, despite all uncertainties, the Earth system can sustain the socioeconomic metabolism in the long run? ii) How to utilize these limited resources best within the socio-economici system?

The socio-economic system must find itself in this logic of conditions. It is, so to speak, the playground in which all kinds of actors, such as those who form institutions, society, or the economy, strive for their interests. The given compelling, environmentally relevant conditions require a deductive approach that allows socio-economic action over time only within these conditions. This provides a normative framework for human, social, and economic behavior. Under the necessary assumption that economic activities serve and support the existence of humans, our holistic view results in a cascaded, three-layer framework (see Figure 1):

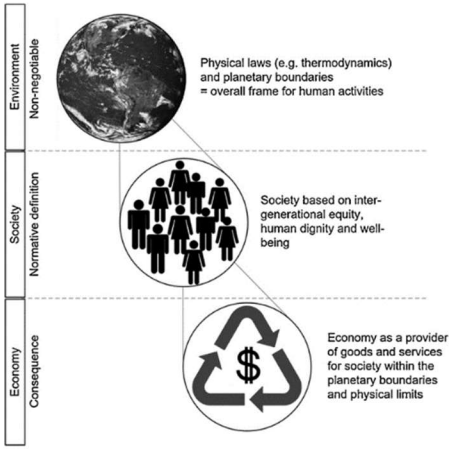

Figure 1 Holistic integration of the economic system, by Desing et al. (2020)

The layer of the environment forms the overall frame for human activities. The latter can be described as the "society", which is part of the biosphere, as depicted in the second layer. To be sustainable in the long run, human activities should integrate the nature-given, non-negotiable, physical, and environmental restrictions from the first layer. The society is organized along normative definitions. The economy as a third layer is understood as a constellation of actors and entities providing goods and services for the society. The deductive approach implies that economic actors have to operate within the environmental constraints.

The idea is to create a holistic, top-down, and ideal framework, so that the potential efforts toward CE are contextualized, reflected on, and understood within a normative framework. The concrete implementation of a CE at the

entrepreneurial level then serves as a practical guide to overcome the linearity of today's economy that is embedded in the holistic understanding of sustainable resource use:

Developing a concept of CE that would allow, if completed, to stay within the bio-physical capacity of the planet is of great macro-societal importance. Keeping an eye on the global resource base is useful to ensure that initiatives towards CE do not turn out to be counter-productive from the environmental point of view (rebound effect) or phagocytosed by the current "linear" paradigm that CE expressly aims to overcome, by confusing the means (e.g., implementation of strategies improving eco-efficiency at the micro level) and the ends (staying within the planet's bio-physical capacity); such considerations can be useful for policy-makers and institutions to design environmentally effective strategies related to CE (top-down approach). On the individual and company level, an ideal-typical definition, and the normative criteria derived from it, can be used by businesses as a benchmark aiming at improving their environmental performance; by consumers to evaluate their choices (bottom-up approach).

The framework assumes that humans are aware of their impact on the planet and implicitly want to undertake measures that ensure the viability of their species. Following the definition of sustainability by Brundtland (1987) that was presented earlier, a goal of environmental sustainability is that future generations can find equal conditions on this planet, making intra and intergenerational equity central. This makes the identification of a sustainable resource base and the best way to use it essential for a CE.

On a limited planet, the total amount of any resource is limited. […]. For management and design of technical and socio-economic systems, it is however important to make choices and decisions not based on mean values, but on those values, which guarantee system functioning with a high confidence. This logic is the underlying principle in engineering, i.e., designing

systems with a very small probability of failure, despite uncertainties, simplifications, and limitations in available models.

Considering the global scale of human operations, the Earth's resources and emission absorbing capacity can no longer be approximated as infinite. On the contrary, it is necessary to apply the precautionary principle when describing the planetary capacity and designing environmental loads. This is to ensure that, despite all uncertainties there is a high probability that the ecosystem can sustain the socioeconomic system for generations to come. Following this logic, planetary capacities need to be determined at the lower end of the uncertainty range, as it is done, e.g., in the planetary boundaries framework (Rockström et al., 2009b; Steffen et al., 2015) and environmental loads on the upper end of the uncertainty range […].

The concept of planetary boundaries (Rockström et al., 2009b) serves as the basis of this approach, as it relates the resilience of natural ecosystems to human activities and economic externalities. It estimates a "safe operating space for humanity with respect to the functioning of the Earth System" (Rockström et al., 2009, p. 473). Therefore, it presents critical thresholds along nine different categories of boundaries (such as biodiversity loss, chemical pollution, freshwater use, and climate change) and their link to each other. We must assume that, today, six of the nine planetary boundaries have already been critically crossed. This pushes the biophysical capacity of Earth to its limits (Steffen et al., 2015). The logical consequences of this are described as follows:

Human activities need to be designed in a way that they do not compromise, ideally even advance Earth system functioning, also after intentional (e.g., abandoned building) or unintentional (e.g., dispersion (Geyer et al., 2017)) discharge of its material and energy flows. The appropriation and discharge of resources is thus limited by the biophysical capacity of the Earth system and have to be evaluated regarding the availability upstream and potential harm downstream. A CE can be considered sustainable, if it is built exclusively on the sustainably available resources, i.e., products and services

utilize the ecologically available material and energy mix, and a management system needs to ensure that globally resource needs don't exceed availability.

To ensure effective resource utilization, a CE must be viewed as a system in which resource inputs are used as effectively as possible and outputs are reduced as much as possible, because there are physical limits to resource utilization. To illustrate this, it is necessary to include the thermodynamic variable of entropy, as described below.

A high state of order (e.g., a crystal structure) is less likely than a low state of order (e.g., random distribution of molecules in gases). Thus, the entropy is low when the order is high and vice versa. It is possible to increase the order in a specific part of the system, such as in the refinement of iron ore to steel. However, this requires useful work (i.e., exergy) and in the overall system the orderliness decreases. In a production process, raw material with high entropy is refined through the employment of exergy into a product with low entropy (i.e., high order). In the use phase of the product, the entropy increases and, to restore the initial order, it again requires exergy (see Figure 2). Every change in the entropy level in a product leads to entropy production in the overall system and thus decreases the usefulness of its resources.

The first fundamental requirement for a CE is derived from this variable:

(1) The CE aims to minimize entropy production.

The consequence of this is reflected, among others, in the waste hierarchy of the EU (European Union, 2008) and the different frameworks known as RE-strategies, that divide CE measures into reuse, recycling, refurbishment, repair, and similar. The framework developed here deconstructs this idea into its essential components and connects it to the entropy in the following manner:

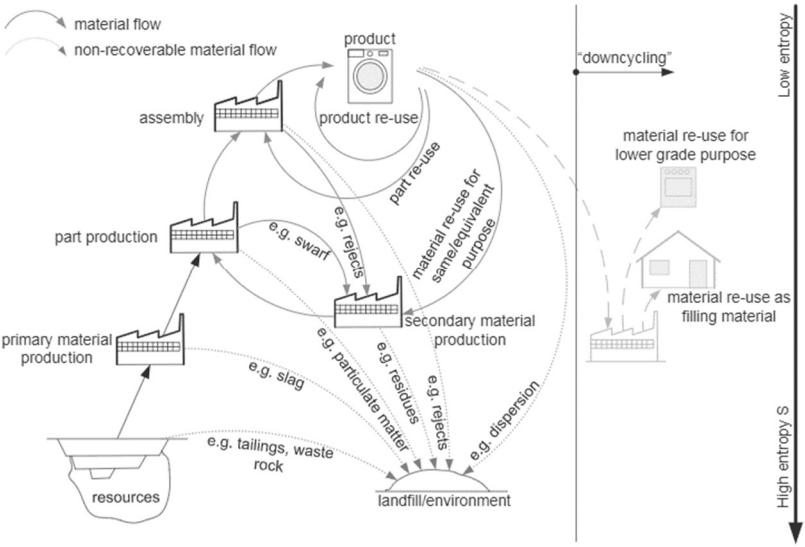

Figure 2 Schematic representation of entropy changes (Desing et al., 2020)

Reuse of parts or products without any changes requires no change in the entropy level of the material, whereas refurbish and recycle result in increasing entropy changes. Production out of raw material and disposal in a landfill (i.e., "linear economy") results, in most cases, in the largest changes of entropy in the material and is thus the least preferable option. However, the principle of minimizing entropy is not limited to end-of-life strategies, but has to be applied to all lifecycle steps, e.g., material selection.

Theoretically, materials can be cycled indefinitely as long as sufficient exergy is available (Ayres, 1999). Since available exergy is limited, materials need to be kept at a low level of entropy for as long as possible. However, many different mechanisms, such as dispersion, dilution, contamination, degradation, and process losses, inevitably transform materials into a state of high entropy, where it is essentially lost for technical

use and thus material cycles cannot be fully closed (see Figure 2). For example, material can be dispersed as fine particles in the environment, with no practical means of recovery. In general, every process step and exposure to ambient conditions, eventually leads to a loss or degradation of the material. To utilize the materials as long as possible, it is essential to build "clean cycles" (Kral et al., 2013), minimize losses to the environment and design product cycles for longevity (Allwood et al., 2011). The faster a product needs to be replaced, the more often a cycle is needed to provide the same service again and the more material is lost per functional unit.

The second fundamental requirement for a CE is derived from this framework:

(2) Durability is key to preserving material value ("slow cycle").

As explained in the beginning, since materials and energy are only available to humans in limited quantities for technical applications, it is necessary to use them for as long a time, as effectively as possible.

The third fundamental requirement for a CE is derived from this:

(3) Optimizing output per-unit input for all resources (i.e., efficiency) best utilizes a sustainable resource base.

1.4.2 Two definitions of a circular economy

Based on the conceptual elaboration presented in Chapter 1.4.1, we derived a definition of CE that brings together the two levels of physical and socio-economic perspectives.

The CE is a model adopting a resource-based and systemic view, aiming at taking into account all the variables of the system Earth, in order to maintain its viability for human beings. It serves the society to achieve well-being within the physical limits and planetary boundaries. It achieves that through technology and BM innovation, which provide the goods and services required by society, leading to long term economic prosperity. These goods and services are powered by renewable energy and rely on materials which

are either renewable through biological processes or can be safely kept in the technosphere, requiring minimum raw material extraction, and ensuring safe disposal of inevitable waste and dispersion in the environment. CE builds on and manages the sustainably available resources and optimizes their utilization through minimizing entropy production, slow cycles, and resource and energy efficiency.

The strength of this definition lies in its comprehensive nature, which is not specifically tailored to a particular CE measure (e.g., recycling), but leaves room for practical application. Thus, it serves as a holistic understanding and guideline for the implementation a CE. It was used in Paper B as a guideline for the development of the conceptual content of the Circular Canvas and the identification of the patterns.

In Papers A and C, the definition of a CE by Kirchherr et al. (2017b) was used for practical and time lag reasons. This definition has similarities to the one above but incorporates two practical aspects that promoted understanding and fostered dialogue in the semi-structured interviews with company representatives. This refers to the different levels on which a CE can be implemented, and has stimulated an understanding of what exactly can be done at the business or system level to implement CE and helped to design the interdisciplinary multilevel framework in Paper A based on the considerations of Stead and Stead (2008).

This definition of CE is as follows: "A CE describes an economic system that is based on BMs which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production /distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and be-yond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations." (Kirchherr et al., 2017b, p.224)

1.4.3 Business models and a circular economy

With the rise of the Internet in the mid-1990s, business studies have experienced a strong focus on the core of entrepreneurial activity, thanks to the increasing popularity of BM research (Amit and Zott, 2001; Gassmann et al., 2014; Magretta, 2002). Even today, there is no consensus on what exactly a BM consists of (DaSilva and Trkman, 2014), or on a common definition (Bigelow and Barney, 2020) of it. Various authors have conducted empirical research and meta-studies on BMs, providing a comprehensive overview of existing definitions and applications. The definitions provided are often based on the phenomena studied by them and are thus fragmented (e.g., focusing on e-business or innovation management) (Zott et al., 2011).

For certain authors, BMs serve to execute strategy (Casadesus-Masanell and Ricart, 2010; Richardson, 2008), while for others, the relationship between BMs and strategy remains controversial (Bigelow and Barney, 2020; Massa et al., 2017). To understand the business implementation of a CE, it is essential to understand the idea of a BM, comprehend how BMs work, and clarify the logic behind the model. To facilitate this, a short overview of the existing concepts of BMs is presented. Based on this, the central concept for this paper is elaborated upon, and applied directly and indirectly in the individual papers in the following chapters.

Amit and Zott (2001, p. 494) were one of the first to propagate the BM as a "unifying unit of analysis that captures the value creation arising from multiple sources." A successful BM is therefore characterized by a heuristic logic that links the technical potential to the realization of economic value and thus shows how a company can maintain and survive in the market (Chesbrough and Rosenbloom, 2002). It is a representation of factors relevant to a company, such as products, information flow, business actors, and sources of revenue and benefits (Timmers, 1998). The implementation of BMs is not simply the imitation of successful cases from the Internet boom, but rather, the recurring testing of business hypotheses, which must be subjected to a reality check

(Magretta, 2002). It is important to recognize that BMs emerge implicitly from operational activities, but also explicitly through entrepreneurial intentions (Teece, 2010).

BM research has moved in several directions over the last 20 years, wherein there have been variations not only in the definitions and descriptions of a BM, but also differences in the classification of the different scientific perspectives on the subject matter. Numerous attempts have been made to show varying ranges of altitude and definition spectra. According to Lambert and Davidson (2013), BMs serve to classify companies by providing an explanation for their performance and innovation. Zott et al. (2011) illustrate the relevance of BMs in explaining competitive advantage by looking at networks, activity systems, and technological innovations as drivers of value creation. Foss and Saebi (2017) illustrate the importance of considering BMs as antecedents of heterogeneity in firm performance, and as units of innovation that can be altered and adapted willingly.

Massa et al. (2017) divided BM research into three relevant fields: first, as a representation of real and observable attributes of companies, such as BM archetypes; second, as a cognitive schema abstracted by members of organizations useful in decision making; and third, as a formal concept and model to reduce the complexity of existing phenomena. Amit and Zott (2001) highlighted the relevance of transactions and exchange mechanisms that span company and industry boundaries. In their view, BMs serve as a design for transaction, structure, and governance to create value owing to the exploitation of opportunities.

BM research tries to answer the question of what the “basic sense” of it is (Chesbrough and Rosenbloom, 2002, p. 533) and how they influence company performance (Zott and Amit, 2007), and in turn, the profitability of a company (Chesbrough, 2007; Teece, 2010). A clear aim of BMs is to create value for a company (Bigelow and Barney, 2020). Johnson et al. (2008) defined four components as central to a successful BM, including a customer value

proposition, profit formula, key resources, and process. Gassmann et al. (2014) reduced the complexity of BM to four dimensions, including *what* as the value proposition, *who* as the target customers, *how* as the supply chain to create the value, and *why* as the value capture mechanisms. One of the most widely cited descriptions of a BM comes from Teece (2010), who described it as the design or architecture of entrepreneurial value creation, value delivery, and value capture mechanisms.

However, BMs do not have to be static. They can be innovated continuously and adapted (Mitchell and Coles, 2003). In particular, the invention of new technologies or other types of changes shifts the familiar set of constraints and opens a new scope of action and possibilities to innovate existing BMs (McGrath, 2010). BMs can therefore be seen as transmitters of ideas and technology to markets and customers (Chesbrough, 2010). This is relevant to the innovation potential of BMs (Zott et al., 2011) and makes BM innovation a promising "pathway to competitive advantage if the model is sufficiently differentiated and hard to replicate for incumbents and new entrants alike" (Teece, 2010, p. 173). Uncertainties in change processes can result in the success of experiments involving new BMs within and between companies (McGrath, 2010). We also perceive this in the context of a CE, where iterative learning in experimentation processes can be an advantage to innovating a BM (Bocken et al., 2018).

What is striking when looking at attempts to describe BMs is that they often have a strong focus on internal company. Factors beyond the company's boundaries are considered only when it comes to customer needs, boundary-spanning transactions, or partners (Osterwalder and Pigneur, 2010; Zott and Amit, 2007). However, every BM has an impact on its surroundings, regardless of whether the company actively considers it. Through the purely economic view of BMs, the possible externalities caused by business activities have been largely ignored in research until recently. Sustainability considerations often only come into play in relation to sustainable growth, corporate development,

and economic prosperity (Chesbrough and Rosenbloom, 2002; Teece, 2010). This detachment of the BM from its environment is pointed out by Dyllick and Muff (2016, p. 161) as the "friedmanian fallacy of business seeing itself and being disconnected from society" (Dyllick and Muff, 2016, p. 161). It seems that the absence of a research focus on the possible environmental consequences of running BMs gave businesses the legitimacy to practically negate them.

Over the last decade, a small but significant stream of research has addressed the question of how to make BMs sustainable and circular. Based on pre-established discussion surrounding sustainable strategic management (SSM), closed material loops, and toxic-free products, research has intensified its efforts regarding the intersection of CE and BMs, also known as circular business models (CBM) or sustainable BMs (Bakker et al., 2014a; Bocken et al., 2014; Geissdoerfer et al., 2018; Lüdeke-Freund et al., 2018b). Expanding the horizon of BM and integrating sustainability often results in the incorporation of the triple bottom line approach (Bocken et al., 2014). The following factors are relevant to this dissertation from the BM perspective:

First, the BM concept serves as a heuristic complexity reduction in business reality and thus helps simplify the dialogue about operational structures, activities, and products, which in turn helps to solve environmental problems at the business level. This is incorporated in Paper B as an underlying assumption and is used to design, elaborate, and innovate BMs in circular ecosystems. Likewise, the triple bottom line is integrated, and the economic dimension of the BM is enhanced by environmental and social dimensions. In doing so, this paper relies on the simplification of business reality, in which BMs can be divided into individual patterns that can occur in combination (Gassmann et al., 2014). This modular thinking draws on a morphological approach and helps represent complex reality in a simple way (Ritchey, 2006).

Second, knowing that BMs do not emerge organically, but can be created and changed explicitly and intentionally, creates tremendous potential for a CE to

have an impact on solving environmental problems. This is relevant in Paper B, where BMs, ecosystems, and sustainability are conceptually and practically combined, and in Paper C, where the design and development of CBMs depend on the development of dynamic capabilities (DCs) triggered through organizational and managerial drivers within the company, analogous to the views of Foss and Saebi (2017).

1.4.4 Ecosystems and a circular economy

In biology, an ecosystem is defined as the unity of all organisms interacting in an area, consequently generating energy flows that manifest themselves in structures and material cycles (Matthews et al., 2011). In such an ecosystem, organisms build an interactive system (O'Neill et al., 1986) that functions together to stay alive (Moll and Petit, 1994). Ecosystem perspectives come into play not only in relation to biological organisms and entities, as in the case of forests and lakes (Waring and Running, 2007; Wetzel, 2001), but also in a broader social science sense. In the 1980s, the term *ecosystem* emerged in the context of society to describe the interdependencies in a population that enabled it to function as a unit (Hawley, 1986).

Business research has altered the term ecosystem into a socio-economic construct with similar aspects as those in biology. The construct (business) ecosystem involves a perspective on cross-company value creation and capture (Adner, 2017). There are relevant differences when compared to other constructs of inter-firm cooperation, such as alliances, networks, or supply chains (Jacobides et al., 2018; Kapoor, 2018). Adner (2017) distinguished between two basic types of ecosystems: ecosystems as affiliations or structures. The first type is characterized by a community of associated actors, with (sometimes loose) network connections, interdependencies, and symbiotic relationships, which can increase their system value; the Microsoft ecosystem serves as an example (Iansiti and Levien, 2004). Viewing ecosystems as a structure offers a complementary approach, starting from the value proposition,

building on it, and identifying the actors and the configuration of activities necessary to create this.

Viewing ecosystems as a structure fits the focus topic here, as it highlights the intersection of BM and ecosystem research regarding cross-company activities (Zott et al., 2011), which is also relevant in the context of CE (Lüdeke-Freund et al., 2018b). Following this, Kapoor (2018, p. 2) defined it simply as "an ecosystem encompasses a set of actors that contribute to the focal offer's user value proposition." The way a set of partners can materialize this value proposition together is what matters (Adner, 2017). An ecosystem is, therefore, a type of organizational form that is vitalized by coordinated collaboration across different actors (Müller-Stewens and Stonig, 2019).

Moore (1996) highlighted the relevance of collaborative development in terms of capabilities, roles, and orientation toward a shared vision. There is often one actor, also called the orchestrator, focal firm, or lead organization, who plays a central role in an ecosystem and who is responsible for the development of shared value propositions and steering the ecosystem through rules (Müller-Stewens and Stonig, 2019). Different authors highlight not only the relevance of the complementary characteristics of an ecosystem, but also its modular architecture (Gawer and Cusumano, 2014; Jacobides et al., 2018), applicable to the organizational form and technologies.

Modularity as a system concept (Schilling, 2000) is becoming increasingly important, especially because of the increasing complexity of organizations and technology, as described below:

> "By breaking up a complex system into discrete pieces—which can then communicate with one another only through standardized interfaces within a standardized architecture—one can eliminate what would otherwise be an unmanageable spaghetti tangle of systemic interconnections." (Langlois, 2002, p. 19)

In this way, modular technical characteristics enable different actors to produce interdependent components of a system under coordinated effort. A focal actor can define the necessary overarching design parameters and thus enable coordinated and aligned actions (Jacobides et al., 2018). This is illustrated in platform ecosystems, where complementors produce complements and use the platform as an interaction-supporting architecture, thereby increasing their own value and that of the platform. The focal actor can thus provide the platform and increase the value for all, owing to a common and standardized architecture, specification of interfaces, and guiding interactions (McIntyre and Srinivasan, 2017). This enables complementors to develop and distribute their own suitable products and technologies (Gawer and Cusumano, 2014).

The following considerations suggest that looking at ecosystems in the context of CE and BM innovation can be fruitful.

First, designing a product that allows for its full or partial recovery at the end of its lifetime requires close collaboration with all partners along a circular supply chain, as it is unlikely and often inefficient for a single firm to realize all the different activities (production of parts, take back, disassembly, etc.) on its own. Cross-company collaboration with partners plays an important role in the development process (Konietzko et al., 2020). The companies involved need to collaborate to create an overall shared value proposition that meets the requirements of each step in the loop. This is very challenging, as companies typically do not interact with other companies in the loop of a CE, but are focused on direct supplier or customer relationships.

Second, product design in a CE involves different factors such as modularity and standardization (Lewandowski, 2016; Parida et al., 2019) that enable the resource-reduced closing of the loop. In particular, when dealing with increasing technical complexity at the product and system levels, a coordinated ecosystem, where all actors focus on smart product design, seems practical. The ecosystem construct allows the coordination of different actors and helps create a shared value proposition that may be subject to technical, operational,

and business factors. The multilateral interdependencies prevailing in an ecosystem (Adner, 2017) can help mobilize external competences and thus overcome technical barriers (Li and Garnsey, 2013).

Third, BM and ecosystems can be coupled in conceptually interesting ways, as shown in Paper B. Bigelow and Barney (2020) point to the boundary-spanning characteristics of BMs, that can be understood in interaction as networks connecting firms and industries. Value creation in its novel form is to be considered as a product of the successful interaction of networked partners (Zott et al., 2011). This is consistent with the studied phenomenon of sustainable circular solutions. Therefore, Paper A proposes the formation of a circular ecosystem as a strategy to overcome potential barriers.

2. Scope of the dissertation

This chapter comments on the three papers associated with this dissertation, gives an overview of their authors, abstract, and keywords, and mentions where the papers were published. Furthermore, compact information is given about the core elements of the papers, and in the second part, they are placed in relation to each other.

2.1 Paper A: Barriers toward a circular economy

Title: Barriers to a circular economy in small and medium-sized enterprises and their integration in a sustainable strategic management framework

Authors: Fabian Takacs, Dunia Brunner and Karolin Frankenberger (2021)

Abstract: A sustainable CE limits the consumption of virgin resources, fosters cleaner production, and promotes the efficient utilization of resources. Thus, companies have a responsibility to apply sustainable and closed resource loops. Hence, this study explores the barriers companies encounter when implementing circular economy measures from the small and medium-sized enterprise (SME) perspective. Prior studies primarily focus on company-external barriers, such as technology or the market, ignoring company-internal barriers. This study conducted 59 interviews with Swiss SME managers from three industries—namely, food and beverage, textile, and logistics—and identifies six internal barriers, thereby revealing four levels of company-external barriers. Accordingly, the study develops a holistic and interdisciplinary multi-level framework, largely inspired by sustainable strategic management, and comprises a company-internal and four company-external levels: technology, market, legislation, and society and consumers. Illustrating and discussing the embeddedness, influence, and reciprocal interaction between the different barriers offers a comprehensive representation to capture the complexity of different factors hindering the transition to a CE and enhancing the ability to identify different levels of strategic responsibility.

Keywords: Circular economy, Implementation barriers, Corporate sustainability, Sustainable strategic management, SME

Publication: published in the *Journal of Cleaner Production* (20.05.2022); here, original version before final revision

Understanding the barriers that arise when implementing CE in business practice is central to this study. Characterizing and contextualizing these barriers helps companies address solutions to circumvent them in their environments. This study focuses on SMEs, which are quantitatively dominant in the economy, and are vital to the implementation of CE. This study identifies three fundamental points.

First, it identifies and classifies the key barriers within companies and those that are external to the company. It relies on a qualitative research design based on 59 interviews with Swiss SME managers. The data analysis was inductive and based on the grounded theory method (Corbin and Strauss, 1990; Gioia et al., 2012). This creates a basic understanding and elaboration of CE in a broader business context.

Second, to make the barriers for companies as practical as possible and to promote the internalization of corporate responsibilities, they were conceptually incorporated into a multilevel framework. This framework allows a systemic view of the interaction between barriers and actors on different levels (company, technology, market, regulations, and society). Based on this, the interactions between the barriers within these levels and between these levels were conceptualized and described.

Third, strategic recommendations were formulated on how these barriers could be prevented or circumvented for companies. Thus, this study bridges the gap between the inductive, data-driven first part, and the practical relevance for companies that implement CE.

2.2 Paper B: Pattern of business models in circular ecosystems

Title: Circular ecosystems: business model innovation for the circular economy

Authors: Fabian Takacs, Richard Stechow, Karolin Frankenberger (2020)

Abstract: A growing number of companies are focusing on sustainability. However, a closer look reveals a big disconnect between the actions propagated at the corporate level and the deterioration of the state of our planet and global society. By design, waste and other negative environmental impacts have become an integral part of our industrialized consumer society. The CE is a way to move away from the linearity of our current industrial and economic systems. The aim of a CE is to keep products, components and materials at their maximum utility and value at all times. The present article provides an actionable path for companies to design, validate, and implement a circular ecosystem with suitable BMs that enable sustainable solutions that are beyond the reach of single companies. Our easy-to-navigate framework consists of seven steps.

Keywords: circular economy, business models, ecosystems, sustainability, transformation

Publication: on the research platform Alexandria (23.01.2020); Institute of Management & Strategy, University of St. Gallen

This paper aims to provide an understanding of the business implementation of a CE based on theory, literature, and practice and has three core elements. First, we identified a comprehensive set of patterns for creating circular ecosystems based on morphological analysis. This allowed us to embed business model logic and ecosystems conceptually and integrate existing insights from the literature. Second, we developed a navigator process that serves as a practically oriented management tool in implementing CE in an entrepreneurial context. Third, we analyzed a circular textile ecosystem called

wear2wear™ and conducted semi-structured interviews with all involved partners. This allowed us to gain insight into a circular ecosystem and apply the pattern logic tangibly.

2.3 Paper C: Managerial and organizational drivers toward a circular economy

Title: Managerial and organizational antecedents of business model innovation for a circular economy

Authors: Fabian Takacs (2021)

Abstract: Today's economic system and the companies operating within it are strongly oriented toward a linear pattern of value creation in which raw materials are extracted from the earth, products are manufactured, sold to customers, and end up as waste. This economic linearity causes material waste, global warming, and other environmental degradation. There is increasing pressure being put on companies to implement sustainable, material-conserving BMs. An economical alternative is a CE in which companies focus on closed material loops implemented with so-called CBMs. Although some research has been done in this field, there is still a significant research gap regarding the company-internal driving factors that facilitate the implementation of CBMs. This current study involved conducting interviews with 59 Swiss managers of SMEs from three industries: food and beverage, textile, and logistics. Helped by an inductive grounded theory approach, five managerial and five organizational drivers were identified and analyzed first. In the second step, the concept of DCs was used to explain the possible influence of drivers on the creation of CBMs conceptually and with reference to data. This study shows which company-internal drivers can act as antecedents of CBM innovation in the entrepreneurial context and how they can affect the higher-order DCs of sensing, seizing, and transforming, according to (Teece, 2007). This current study contributes to the analysis of factors that stimulate economic transformation toward a CE from a company perspective.

Keywords: circular economy, drivers, dynamic capabilities, SMEs, entrepreneurship

Publication: on the research platform Alexandria (21.12.2021); Institute of Management & Strategy, University of St. Gallen

This study focuses on the internal factors that drive the operational implementation of a CE through BMs, and has two core elements. First, using a grounded theory approach based on the dataset of Paper A, it identifies ten different company-internal drivers. These drivers can be categorized into five managerial and five organizational factors. This identification and analysis enrich entrepreneurship research, as they enable the identification of driving factors that may be suitable for the implementation of a CE from a managerial perspective. This understanding allows conclusions about managers' attitudes, perspectives, and behaviors, as well as the design of organizational structures and measures to stimulate a transition toward a CE.

Second, building on the drivers identified, a conceptual link was drawn to the DC approach based on the data fragments, thus explaining how the drivers could impact the implementation of CBMs. The DC approach is theoretically anchored in the resource-based view of the firm and attempts to explain how companies display different performances despite the same environmental factors. This approach offers insight into the interrelationships between company management and successful implementation of a CE in the business context. This study bridges the gap between sustainability-dominated research on driving factors toward CE and relationship-oriented research on possible DCs for implementing entrepreneurial change.

2.4 Interplay of the three papers (A, B, and C)

This dissertation aims to take a holistic look at the corporate implementation of a CE. This includes a better understanding of the impact, interdependencies, and relations between internal and external factors from a company's perspective. This dissertation focuses on the conceptual and empirical

understanding of how companies and their BMs are embedded in a CE and enable closed material loops. The three papers ideally complement each other and adopt different perspectives in dealing with a CE in a corporate context.

Paper A takes a systemic perspective (macro-level) in its overall orientation and examines the factors that hinder the transformation toward a CE for companies from different angles. For this purpose, these hindering factors are integrated into a holistic framework, and their relationships are elaborated upon conceptually. Paper B works on the level below, analyzing the BMs and their interactions in ecosystems to reach a CE (meso-level). It presents solutions for how the identified barriers can be circumvented by establishing BMs in circular ecosystems. Paper C focuses on the individual management level and considers the implications for the company's managers (micro-levels) aiming to implement CBMs. Paper B analyzed the driving factors that facilitated the achievement of a CE in the business context. Similar to Paper A, Paper C inductively analyzes a rich dataset using a grounded theory approach. The identified drivers build the entrepreneurial answer to the internalization idea presented in Paper A, which, as an implicit goal, offers companies a range of possibilities to push circular solutions forward through entrepreneurial efforts. Paper A delivers a systemic framework and classification to provide a basic understanding of the interconnected and interdependent reality businesses face in practice. Paper B links the systemic level of Paper A to the internal entrepreneurial implementation of a CE in Paper C, thanks to its focus on BMs and ecosystems. Paper C uses the DC approach to conceptually answer the research questions. This procedure makes the transformation toward a CE in companies tangible for managers and allows for an outlook on further research possibilities in entrepreneurship literature. The three papers show that, in addition to a purely material-scientific view of CE, existential organizational factors can be decisive in achieving a CE. These include culture, behavior, leadership, and an understanding of interconnectedness and systemic interactions.

3. Paper A: Barriers to a circular economy in small and medium-sized enterprises and their integration in a sustainable strategic management framework

Status: published in *Journal of Cleaner Production* (20.05.2022), here, original version before final revision

Abstract: A sustainable CE limits the consumption of virgin resources, fosters cleaner production, and promotes the efficient utilization of resources. Thus, companies have a responsibility to apply sustainable and closed resource loops. Hence, this study explores the barriers companies encounter when implementing CE measures from the SME perspective. Prior studies primarily focus on company-external barriers, such as technology or the market, ignoring company-internal barriers. This study conducted 59 interviews with Swiss SME managers from three industries—namely, food and beverage, textile, and logistics—and identifies six internal barriers, thereby revealing four levels of company-external barriers. Accordingly, the study develops a holistic and interdisciplinary multi-level framework, largely inspired by sustainable strategic management, and comprises a company-internal and four company-external levels: technology, market, legislation, and society and consumers. Illustrating and discussing the embeddedness, influence, and reciprocal interaction between the different barriers offers a comprehensive representation to capture the complexity of different factors hindering the transition to a CE and enhancing the ability to identify different levels of strategic responsibility.

Keywords: Circular economy, Implementation barriers, Corporate sustainability, Sustainable strategic management, SME

3.1 Introduction

A CE is broadly a regenerative industrial economy that recaptures the enormous volume of resources for repeated use while, ideally, positively impacting the surroundings (Ellen MacArthur Foundation, 2013). It aims to keep products, components, and materials at their maximum utility and value at all times, reduce waste, and minimize the extraction and processing of virgin resources (Bocken et al., 2017). CE unites different aspects of environmental sustainability as a sustainable *umbrella concept* (Blomsma and Brennan, 2017) and internalizes the negative externalities emergent over the life cycles of products through company activities (Grafström and Aasma, 2021). Thus, manufacturing, distribution, use, and recovery systems are designed to keep resources in the loop and minimize energy use (Wells and Seitz, 2005; Winkler, 2011), inducing cleaner production in society. CE has become increasingly popular in recent years, and while various initiatives and declarations favor it, the transition remains in its infancy (Ghisellini et al., 2016). Currently, less than 9% of the global economy is circular (Circle Economy, 2021).

Many studies have endeavored to explain this discrepancy by identifying barriers to CE implementation (Bocken and Geradts, 2020; Kirchherr et al., 2018; Ormazabal et al., 2018), mainly focusing on company-external barriers (de Jesus and Mendonça, 2018; Grafström and Aasma, 2021). Accordingly, an in-depth understanding of why and how company-internal barriers prevent CE implementation is lacking. Prior studies show that internal barriers are largely hidden in cultural (Kirchherr et al., 2018), financial (de Jesus and Mendonça, 2018), or cultural-cognitive factors (Ranta et al., 2017). Grafström and Aasma (2021) underline the importance of identifying barriers from a company perspective to mitigate business risks for companies implementing a CE. Moreover, prior studies primarily focus on different barriers and largely ignore their interrelations (Bening et al., 2021). Thus, a holistic framework that integrates CE barriers at the company's internal and external levels and explains how they interact and relate is missing (Tura et al., 2019). Finally, prior studies

do not formulate clear strategic recommendations for companies regarding their potential to influence and overcome CE barriers. Hence, this study bridges the noted gaps in the literature. First, it identifies the internal barriers to CE implementation. Second, it furnishes a better understanding of external barriers and how they can be structured. Third, it investigates how internal and external barriers interrelate. Finally, it draws from the derived insights to develop strategic management recommendations for company leaders who wish to implement a CE in their organization.

The research objectives are particularly salient in the context of SMEs, as SMEs are indispensable in transforming linear economies into circular ones (Garrido-Prada et al., 2020; Rizos et al., 2015; Zamfir et al., 2017). First, SMEs shape the core of economies worldwide; in the EU, SMEs account for more than 99.8% of all companies in the non-financial business sector (Muller et al., 2017). Consequently, while the environmental impact of an individual SME is almost negligible, SMEs are highly relevant in the aggregate, accounting for approximately 60% to 70% of all industrial pollution in the EU (Miller et al., 2011). Second, from a political economy perspective, the EU provides considerable financial support for SMEs in the CE transition (European Commission, 2019a). Third, CE transformation often requires the interplay of various companies in a circular supply chain, and SMEs often take on the role of connecting companies (Lüdeke-Freund et al., 2018b; Takacs et al., 2020). Hence, the research questions are as follows:

(1) *What company-internal barriers exist for SMEs seeking to implement a CE?*
(2) *What company-external barriers exist for SMEs, and how can they be categorized?*
(3) *How are company-internal and external barriers related, and how can they be integrated into a holistic, sustainable strategic management framework?*

Thus, this study employs an inductive, grounded theory approach (Corbin and Strauss, 1990; Strauss and Corbin, 1994), interviewing 59 company managers, owners, and founders of Swiss SMEs in three industries (food and beverage, textile, and logistics). Switzerland is a suitable study setting because its SMEs have strong economic power, and CE implementation is high on top managers' agendas (Bocken et al., 2021). The three industries represent a broad spectrum of SMEs in Switzerland and qualify for CE implementation. They comprise important CE perspectives, such as transportation, packaging, supply chains, and product design. The data analysis identified company-internal and external barriers and their relationships. It then integrated the identified barriers into a broader framework, building on the SSM concept of Stead and Stead (2008) with an open-system perspective. Hence, we formulate strategic recommenddations for SMEs to address CE barriers.

3.2 Concept and theory

3.2.1 Barriers to implementing a circular economy

Many CE barrier studies have attempted to identify and categorize the factors that hinder CE implementation, from which three main strands of barrier categorization have been established. The first strand categorizes barriers into thematic levels, making no distinction between internal and external barriers. According to Grafström and Aasma (2021), the following four levels emerge most frequently from their comprehensive literature review: technological, economic, cultural, and institutional. Others process this categorization with minor adjustments to the thematic levels, adding, for example, policy, regulation, financial, or customer levels (Araujo Galvão et al., 2018; Ghisellini and Ulgiati, 2020; Hart et al., 2019; Kirchherr et al., 2018). De Jesus and Mendonça (2018) condense the categorization into a hard versus soft factor division, classifying technical and economic barriers as hard factors (forcing change) and institutional and culture as soft factors (enabling change by attracting through values). Ranta et al. (2017) apply an institutional perspective and identify regulatory, normative, and cultural-cognitive barriers. Govindan and

Hasanagic (2018) show barriers in an unstructured mode but offer a multi-perspective framework, inspiring this study; they distinguish between organizational and external perspectives, focusing on government, society, consumers, and suppliers. Regarding internal barrier findings, Ritzén and Sandström (2017) come closest to this study. They conduct interviews in two large manufacturing companies and do not report internal barriers; however, they identify two thematic levels (*attitudinal* and *financial*) with an internal focus.

The second strand classifies barriers along specific types of economic actors (e.g., SMEs), economic structures (e.g., networks), and specific industries. Rizos et al. (2015) theoretically examined CE barriers for SMEs comprehensively but conceptually unstructured. They report *upfront investment costs* and *lack of knowledge of CE*, both classifiable as internal barriers, in addition to various other barriers, such as government barriers; the results are confirmed descriptively in a survey-based case study with 30 Spanish SMEs (Rizos et al., 2016). Ormazabal et al. (2018) divide barriers into two categories in the SME context: *hard* (e.g., lack of financial support) and *human-based* (e.g., lack of customer interest) *barriers*. Garcés-Ayerbe et al. (2019) discover that different barriers occur per firms' CE proactivity. Other studies address specific industries, such as the coffee industry (van Keulen and Kirchherr, 2020), examining value, technology, business cases, and governmental barriers, and the packaging industry (Bening et al., 2021), using causality networks (Gue et al., 2020).

The third strand categorizes barriers regarding CE measures, such as material efficiency in manufacturing (Shahbazi et al., 2016) or energy savings in supply chain practices (Zhu and Geng, 2013). Some studies further present possible ways to circumvent the barriers (i.e., so-called drivers) (Agyemang et al., 2019; Moktadir et al., 2018; Pheifer, 2017). Nonetheless, the literature ignores the company-internal perspective, yet there are various calls in the literature to close this gap and identify barriers derived from practice for companies and

across sectors (Grafström and Aasma, 2021; Kirchherr et al., 2018; Ormazabal et al., 2017). In sum, prior research shows that barriers to CE implementation represent a pertinent research topic, but this research lacks a detailed analysis of internal barriers and their relationship to external barriers.

3.2.2 Business models as core mechanisms to realize circular economy in organizations

The most common way for SMEs to implement a CE in their organization is to transform the underlying business model from linear to circular (Brendzel-Skowera, 2021; Frankenberger et al., 2021; Geissdoerfer et al., 2020; Rizos et al., 2016; Ünal et al., 2018). Business models broadly describe how a company generates value, the value proposition it offers, and how it captures value (e.g., Gassmann et al., 2020; Casadesus-Masanell and Ricart, 2010). Following the triple bottom line approach (Elkington, 1997), researchers are increasingly focusing on sustainable business models that extend the traditional business model research by combining the environmental aspects of sustainability with the well-being of people and the economic dimensions of the company. Sub-forms of sustainable business models are circular business models that describe how organizations must design their underlying business models to realize a CE. They are "business models that are cycling, extending, intensifying, [or] dematerializing material and energy loops to reduce the resource inputs into and the waste and emission leakage out of an organizational system" (Geissdoerfer et al., 2020, p.7). Designing and implementing circular business models can lead to cost advantages for the focal company (Christmann, 2000; Ranta et al., 2018) and enable organizations to create and capture new value and gain a competitive advantage (Simpson et al., 2004; Stewart and Gapp, 2014). However, research on business models and circular ones lack insight into the main antecedents of designing and implementing business models (Foss and Saebi, 2017). Studies on company-internal antecedents of business models design remain rare (e.g., Frankenberger and Sauer, 2019). Thus, analyzing CE barriers contributes significantly to this growing research field.

3.2.3 SMEs in the circular economy

As notes, SMEs are indispensable in transforming economies into circular ones. However, the characteristics of SMEs differ from those of larger companies (Zahra et al., 2006). First, the owners and founders of SMEs are often managers; thus, management and ownership are in the hands of the same person or group of people, especially in family-run businesses. Many SMEs lack formalized structures and specialized managers and have personalized leadership and management styles (Jenkins, 2006; Rizos et al., 2015). Second, the strategic management of SMEs strongly focuses on investment decisions on direct returns and benefits from the core businesses, which are then strongly linked to a business case evaluation (Dex and Scheibl, 2001). Third, SMEs demonstrate high degrees of flexibility and agility in the market, adapt quickly, and compete well in niches (Jenkins, 2006; Koirala, 2018). Fourth, SMEs are strongly anchored in the analog world, maintaining good relationships in their networks rather than using digitally sophisticated solutions for operational development. Fifth, SMEs usually have a rather low level of knowledge of the concepts and opportunities of a CE (Ormazabal et al., 2018; Rizos et al., 2015). Hence, a study on CE barriers in the context of SMEs is worthwhile.

3.3 Methodology

Given this study's exploratory nature a qualitative research design is suitable to answer the research questions (Yin, 1994). The design is driven by an inductive, grounded theory approach (Corbin and Strauss, 1990; Gioia et al., 2012), allowing for developing a theory from the data (Strauss and Corbin, 1994). The study builds theory while performing social research as two aspects of the same procedure (Glaser, 1978).

3.3.1 Sampling and data collection

3.3.1.1 Industry selection

We conducted 59 interviews with (top-level) managers, owners, and founders of Swiss SMEs from three industries—*food and beverages, textile,* and *logistics*—between September 2018 and January 2019. These industries

represent a broad spectrum of SMEs with relevant characteristics for a CE. The food and beverage industry has expandable circular potential, which can be seen in its packaging (Agamuthu and Visvanathan, 2014; Geueke et al., 2018), single-use plastic waste (Foschi and Bonoli, 2019), water usage, land degradation, and greenhouse gas emissions (Pagotto and Halog, 2016). The textile industry, principally the garment sector, is among the most polluting industries worldwide, with a recycling rate of only 1%, massively driving the overutilization of resources (Ellen MacArthur Foundation, 2017). Hence, the circular potential of the textile industry is enormous, as it involves product (re)design and material selection (Franco, 2017b), closing resource loops (Ashby, 2018), and sustainable production methods to reduce emissions or water pollution (Alkaya and Demirer, 2014; Angelis-Dimakis et al., 2016; Jia et al., 2020). The logistics industry, with its task of transporting goods, is central in the CE (van Buren et al., 2016) for covering a wide range of activities, such as distribution of resources for production, reverse logistics after product usage with incentive take-backs (Abdulrahman et al., 2014; Govindan et al., 2015; Klausner and Hendrickson, 2000), or waste disposal logistics (Seroka-Stolka and Ociepa-Kubicka, 2019).

3.3.1.2 Company selection

This study is tailored to SMEs with 8–250 employees. It aligns with the official EU definition of SMEs, where small (medium-sized) companies have 10–50 (50–250) employees (European Commission, 2003). We also include companies with eight or nine employees because they offer interesting cases and are sufficiently large to represent a company with different CE measures. Regarding firms with a non-Swiss subsidiary, we consider only the part of the firm in Switzerland.

3.3.1.3 Data collection

We employ a judgment (purposeful) sample—a non-randomized sample of respondents (Marshall, 1996)—according to the company and the interviewees positions therein (Kirchherr et al., 2018). We first used various lists provided

by official Swiss bodies (e.g., Federal Statistics Office, regional commerce chambers) and created a unique list containing companies that met the SME and industrial sector criteria. We extended it by including additional companies during the data-gathering process using snowball sampling (Noy, 2008). Ultimately, we contacted 341 companies and conducted 59 interviews, with a 17.3% response rate. An interview was, on average, 30–60 minutes; we conducted approximately 50 hours of interviews. The interviews were mostly in German (89%) and the rest, French (11%), as per the main language of the interviewees.

Table 1 shows the interview schedule with an overview of the participants, industries, and products. The study aimed to create the largest possible sample to ensure theoretical saturation when processing the data (Bowen, 2008).

Table 1 Overview of interviewees

No.	Company description	Number of employees	Company foundation	Consumers (b2b/b2c)	Position of the interviewee	No.	Company description	Number of employees	Company foundation	Consumers (b2b/b2c)	Position of the interviewee
1	work wear	150	1826	b2b	managing director	31	transportation of building materials & machinery	12	1969	b2b	management/ subdivision
2	breakfast & snacks	195	1954	b2c	product development	32	transportation of wood & timber related goods	22	1983	b2b	managing director
3	storage & distribution	55	1992	b2b	management/ subdivision	33	mill: grain processing	10	1847	b2b	managing director/ owner
4	high quality clothing (women)	30	1988	b2c	founder/ management of subdivision	34	mixed spices	10	1982	b2b	managing director
5	soup & dressing	65	1974	b2b	managing director	35	food import & processing	40	1926	b2b	managing director
6	pastry & confectionery specialties	25	1948	both	managing director/ owner	36	transportation & logistics	70	2004	b2b	managing director/ owner
7	pastry & confectionery specialties	8	1956	b2b	managing director/ board of directors	37	spices & sauces	12	1978	both	management/ subdivision
8	mineral water	30	1986	both	managing director	38	transportation & logistics in construction	10	1994	b2b	management/ subdivision
9	soft drinks & fruit juices	250	1909	both	management/ subdivision	39	meat processing	60	1896	both	managing director/ owner
10	zippers	13	1957	both	managing director	40	bread & cake	54	1976	both	managing director/ owner

11	logistic coordination	16	2001	b2b	managing director/ board of directors	41	transportation & logistics	30	1992	both	managing director
12	protection work wear & consulting	80	1932	b2b	management / subdivision	42	sustainable fashion	8	2014	b2c	managing director
13	knitwear	25	1909	b2b	president of the board of directors	43	fabrics processing	10	1900	b2b	owner/ president of the board of directors
14	specialized textile production	9	2001	b2b	managing director/ owner	44	butchery & meat processing	11	1879	both	owner/ management
15	coffee processing & roasting	9	1994	both	management/ subdivision	45	transportation & logistics in construction	10	1989	b2b	owner/ management
16	food from insects & consulting	8	2015	both	management/ subdivision	46	transportation of building materials & recycling concrete	55	1973	b2b	management/ subdivision
17	fruit juices	26	2002	b2b	managing director/ owner	47	knitwear, fabrics, textiles	12	2008	b2b	managing director/ owner
18	bakery (bread)	30	1988	b2c	management / subdivision	48	butchery & meat processing	28	1945	both	managing director / owner
19	high-quality textiles for interior decoration	170	1886	b2b	managing director/ owner	49	beer	20	2001	both	managing director/ owner/ founder
20	olive packaging	30	1975	b2b	managing director	50	fruit & vegetables processing	200	2002	b2b	management/ subdivision
21	organic fruit juices	54	1957	b2b	managing director	51	butchery & meat processing	200	1871	b2b	management/ subdivision

22	uniforms	30	1988	b2b	managing director	52	fruit & vegetables processing	190	1980	b2b	managing director
23	work wear & service provider	70	1967	b2b	managing director/ owner	53	wool shoes	29	2013	both	management/ subdivision/ founder
24	bread & cake	12	1931	b2c	managing director	54	various textile products	18	1999	both	managing director/ owner
25	transport service for pianos	14	2004	both	managing director / owner	55	urban fashion	13	2006	b2c	managing director/ owner
26	high-quality fabrics for shirts	18	1918	b2b	management/ subdivision	56	work wear fabrics	208	1868	b2b	managing director
27	transport of fossil fuels	18	1927	b2b	managing director	57	beer	96	2014	b2b	managing director/ founder
28	processing fruit/vegetables for convenience	100	1998	b2b	management/ subdivision	58	e-commerce womenswear	23	1978	b2c	managing director
29	transport, storage and logistics	25	1972	b2b	managing director	59	shoes	50	1947	both	management/ subdivision/ founder
30	ice cream production	12	1995	both	managing director/ founder						

The study employed semi-structured interviews. We carefully constructed the interview guide to generate different types of information and avoid inconsistencies or ambiguities (Bogner et al., 2014). First, the interviewers ascertained the exact business model of SMEs. Second, interviewers presented a comprehensive definition of CE (Kirchherr et al., 2017b). They ensured the interviewees understood this definition well and, thus, explored the kind of CE measures the company had already implemented. Third, the interviewer explored implementation barriers. The interviewees were then asked about mitigating actions and what barriers arose subsequently. Finally, the interviewers checked the company data (e.g., number of employees, etc.) to ensure that the sampling was correct. All interviews were conducted by telephone, recorded, and transcribed verbatim.

3.3.2 Data analysis

We followed the grounded theory approach of Gioia et al. (2012) and Corbin and Strauss (1990) to develop a conceptual framework from the data. Methodologically, it is crucial to evaluate the interviews in detail (coding and classification), *semi-ignorant* of prior studies (Gioia et al., 2012). This approach requires a data-based elaboration of categories and concepts, which does not induce hypothesis bias through literature knowledge; of course, no one can act completely detached from prior research (Bogner et al., 2014). We started with a first-order analysis and coded it close to the text in open coding, not to generate categories directly but summarize the essence of the excerpts. This descriptive coding method generated numerous codes (Saldana, 2009). Next, we determined the similarities and differences between codes (axial coding), reducing the number of codes. In the second-order analysis, themes were formed from the codes. These theoretical themes were then labeled as informatively as possible and equipped with phrasal descriptions; rearrangements and reclassifications were performed when necessary (Gioia et al., 2012; Saldana, 2009). We then employed selective coding to form core categories, visualized as aggregate levels, to get closer to the theoretical level.

We subsequently examined all emerging themes in the different categories to determine whether they explained the phenomena under study (Corbin and Strauss, 2008, 1990). We reached theoretical saturation before analyzing the 59th interview; that is, no more new categories and themes emerged from the data (B. Glaser and Strauss, 1967). Figure 3 shows the data analysis process.

Further, to elaborate on the emerging theory, one researcher collected the data and worked closely with the data, while two other researchers with sufficient distance supported the analysis. This approach strengthened the findings. The two distant researchers acted as critical, questioning voices and, thus, improved the theorizing (Bocken and Geradts, 2020). The recurrent back and forth regarding the theory, data, and analysis enabled the formation of elaborate categories and relationships (Flick, 2009).

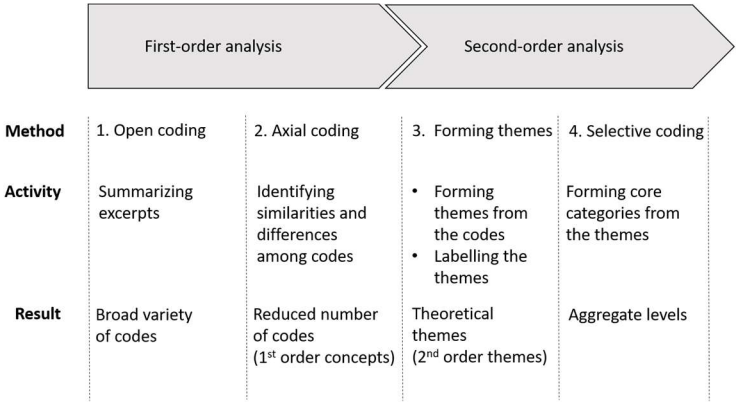

Figure 3 Data analysis

Finally, to answer the third research question, we developed a holistic framework to illustrate the interrelationships and interdependencies of the identified barriers. We built on the framework of Stead and Stead (2008). This framework highlights the embedded and interrelated nature of a company, being in constant interaction with the following levels: technology, markets, legislation, society and consumers, and the environment. That is, the SSM

framework considers human beings, organizations, society, and other systems embedded in the ecological environment (Starik and Kanashiro, 2013). For instance, Neumeyer and Santos (2018) note the importance of embedding companies and their sustainability-driven business models in their environment to enhance understanding and make relationships visible. Thus, we developed a holistic framework and integrated the identified barriers.

3.4 Findings

We present the findings in line with the research questions. First, we present the company-internal barriers comprising six main themes (3.4.1). Second, we describe the company-external barriers comprising 12 themes and four categories (3.4.2). As per Tracy (2010), we created a visualization of the relationship between raw data, first-order concepts, second-order themes, and aggregate levels (Figure 4), displaying the results on the identified barriers. Finally, we developed a holistic framework integrating the identified barriers and described the interrelations between different levels of barriers (3.4.3).

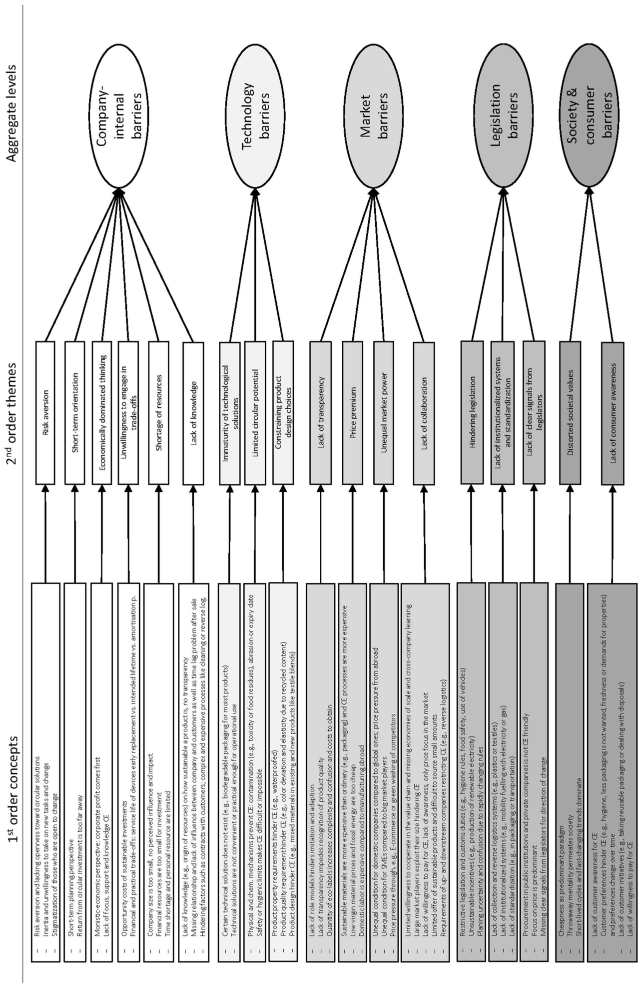

Figure 4 Visualization of the data structure. Adapted from Gioia et al. (2012)

3.4.1 Company-internal barriers

Table 2 Company-internal barriers

Barrier theme	Description of how the barrier functions	Representative quotes
(I1) Risk aversion	Risk aversion and a lack of openness to new solutions among management and employees act as barriers; fear of suffering financial losses and leaving familiar paths; inertia in the face of change processes and a basic desire to keep things as they are; stigmatization of those who are willing to change	*Skeptical attitude; leaving the comfort zone; critics call you a dreamer with illusions; it is better to wait for the right time to come; how much risk are we willing to take?*
(I2) Short-term orientation	The role of time and how it is viewed by management in planning and investment decisions determine how companies respond to environmental issues; short-term perspective on planning and payback periods can act as a barrier; implementing CE measures can be time-consuming, resulting in intertemporal decisions, complicated by a strong preference for the present	*Lack of focus on long-term planning, which would cover three or five years; management thinks in short[-term] dimensions; we do it differently than our competitors who always focus only on one quarter or another*
(I3) Economically dominated thinking	Economic value creation as an end in itself and its omnipresence in entrepreneurial decisions act as barriers; lack of understanding of environmental relationships and	*Economic sword of Damocles; ecologists rarely sit at the top, [but] economists do, we need ecological thinking for the*

	negation of one's impact on the environment; lack of focus on CE	*future; corporate profit is elementary*
(I4) Un-willingness to engage in trade-offs	Various forms of business trade-offs act as barriers (e.g., operating times of machines and defined payback periods vs. replacement by more sustainable options, or sustainable investments vs. the availability of financial resources); trade-offs are predominant in opportunity cost discussion; no guidance on how to address trade-offs	*Cost benefit ratio was not good enough; running out of payback time; destroying room energy of existing machines; waiting until the old system is replaced*
(I5) Shortage of resources	Three types of interconnected resources can act as barriers if they are limited or their availability is considered too low: company size (e.g., turnover and market share), financial resources, and human resources	*We thought about heat recovery, but we are too small, and so is the utilization effect; Awareness-raising among customers is extremely cost-intensive; we do not have the personnel resources;*
(I6) Lack of knowledge	Lack of knowledge becomes apparent in questions about different stages of the value chain (e.g., origin of raw materials and product handling of customers after usage); lack of effort can be seen in CE measures, such as reverse logistics processes, or when there is a lack of contact with customers	*We only have an indirect influence and insight into the production of these articles; trouble returning the product; lack of experience with recycled materials; washing, chemical use, and logistics for return is far too complex*

Table 2 lists internal barriers, briefly describes each barrier, and displays representative quotes from the interviews. The following describes the barriers in more detail. ***(I1) Risk aversion***: Managers' risk aversion is an important barrier to CE implementation. For example, when managers assess the business risk associated with implementing a CE (e.g., profit loss) as higher than the environmental risk of not implementing it (e.g., resource scarcity or climate collapse), the CE will probably not be implemented. A strong orientation toward low risk, security, and stability induces status quo preservation. A high level of risk aversion narrows the manager's view, distorts information gathering, and reduces the focus on business opportunities (Bleicher and Abegglen, 2017). ***(I2) Short-term orientation***: A short-term orientation runs counter to the CE implementation goal—that is, achieving the longest possible use of resources. CE implementation requires upfront investments, diminishing a company's short-term financial performance. Previous research shows that companies with long planning periods have a higher sustainable innovation potential (Haugh et al., 2019; Longoni and Cagliano, 2018). ***(I3) Economically dominated thinking***: Economic factors are given greater importance than environmental or social factors. Hence, economically dominant thinking means business calculations include only short-term economic factors, ignoring environmentally and socially relevant issues (Bleicher and Abegglen, 2017). It stems from companies perceiving their value creation as detached and separate from society (Dyllick and Muff, 2016b), resulting in a lack of understanding of environmental relationships, thereby negating one's impact on the environment, also known as low *ecoliteracy* (Tilley, 1999). ***(I4) Unwillingness to engage in trade-offs***: Trade-off situations demand sacrificing one area to gain an advantage in another (Byggeth and Hochschorner, 2006). If companies want to apply the triple bottom line, trade-offs arise, and managers must address those conflicting dilemmas. The multi-faceted nature of a CE (Hahn et al., 2010) suggests that the simultaneous achievement of economic, environmental, and social aspects is rather illusory in the short run. A win-win in environmental decision-making is a rarity (Walley and Whitehead, 1994) if

market price signals do not account for negative externalities. Typically, these trade-offs arise between a company's different stakeholder groups, and studies focus more on synergy issues than trade-offs (Dyllick and Hockerts, 2002; Pagell and Shevchenko, 2014). ***(I5) Shortage of resources***: Three types of resources can act as barriers. An SME's size could be considered too small; thus, its influence is perceived as too limited, especially regarding CE measures, such as reverse logistics or energy savings. Financial resources are often low to provide scope for new, innovative solutions; this goes hand in hand with limited time and human resources. CE measures such as recycling or monitoring products require additional effort along the whole product life cycle, which often occurs with research and development (R&D) efforts and investment of financial capital (Kalmykova et al., 2018). Many SMEs are limited in their design of marketing campaigns and introduction of a new revenue model, such as leasing, as these may incur high investment costs, which they may not bear on their own (Rizos et al., 2016). ***(I6) Lack of knowledge:*** In SMEs, lack of knowledge often hinders CE implementation. It can regard the value chain—that is, SMEs do not know the raw material source or what customers do with the products after usage. Moreover, a lack of knowledge of existing technologies can bar CE implementation, especially when SMEs strongly focus on knowledge of their immediate surroundings, which remain in the same bubble (Hoevenagel et al., 2007). Employees' lack of ecoliteracy can build or reinforce a culture where CE is perceived with skepticism or stigmatization.

3.4.2 Company-external barriers

Table 3 shows the external barriers identified, including the name, short description, and representative quotes. Following prior research, we clustered them into the following levels: technology, market, legislation, and society and consumers.

Table 3 Company-external barriers

Barrier theme	Description of how the barrier functions	Representative quotes
(E1) Immaturity of technological solutions	Certain technical solutions for CE are not yet practical enough for operational use or do not exist in a marketable form (e.g., biodegradable packaging for moist products)	*Not tested enough and suitable for everyday use*; *problem with material, it dissolves*; *technology and infrastructure of electric cars are in their infancy*; *shelf life in a compostable bag with moist content*
(E2) Limited circular potential	Physical and chemical mechanisms reduce the CE potential of a product; various mechanisms can increase a product's entropy level and reduce its usefulness for CE per the rules of thermodynamics (e.g., degradation or dispersion)	*After 30 wash cycles, a textile loses its luminosity*; *filter must, of course, be thrown away; contaminated with food residue, which is a challenge for recycling*
(E3) Constraining product design choices	Product and property requirements (e.g., waterproof) can make CE measures impractical and challenging; design, application, and functionality considerations (e.g., color) and adding alternative materials and components to pure materials in the manufacturing processes can induce impurities that hinder CE (e.g., additives or pigments)	*Weight reduction means a thinner film, if we have weak films, then the packaging opens; mixed fibers; if the finesse, the resistance, the tear strength is not right, we do not have a product that will be successful on the market*

(E4) Lack of transparency	Lack of transparency about the real quality and ingredients of products and materials (e.g., organic) impedes recognition of product quality; eco-labeling can provide a remedy, but many labels can be overwhelming and challenging to evaluate properly; lack of CE role models hinders imitation and adaptation	*Organic coffee from Brazil: not certified organic because the hurdles with all the effort are immense for a small business*; *can we check if it is only greenwashing? Only a few companies are shining examples that are really carrying this to the outside world and convincing the consumers and ultimately the politicians*
(E5) Price premium	Prices of sustainable materials, products, and CE measures are often more expensive than ordinary ones (e.g., packaging); virgin materials and fossil energy are cheap	*Recycled cotton: it is simply more expensive than cotton on the open market, although the price of raw materials is rising*; *sustainable packaging is expensive*; *price of boat transport too cheap*
(E6) Unequal market power	Competition between large companies and SMEs, incl. e-commerce, is challenging, as large competitors can charge lower prices through economies of scale or cross-financing less lucrative products; greenwashing of competitors; unequal conditions between domestic products relative to global ones	*Wholesalers lure customers with fresh bread at low prices, and they subsidize these breads by selling other stuff, and we cannot do that; cheap water from discounters, imported at low prices from abroad, increases the price pressure, and this is not conducive to a CE; CE costs money; We have*

		competitors who make PET collections and say it is from the sea. That is pure communication. Nothing is gained from that
(E7) Lack of collaboration	Limited willingness to co-operate in the value chain and missing economies of scale and cross-company learnings; large market players exploit their size, hindering CE measures in SMEs upstream (e.g., no offering of reusable containers) and downstream (e.g., demand more packaging than necessary); lack of awareness	*Competitors or colleagues are not open to a CE at all, we tried to buy shared machines to create a common database to avoid waste, but no one is willing to do it; recycled materials not available in small quantities; [they are determined to be] bound to bulk [buying]; possible transport load on trains is prescribed*
(E8) Hindering legislation	Negative incentives for CE investments; restrictive regulations (e.g., hygiene rules, food safety, use of vehicles) and customs duties; planning uncertainty and confusion given rapidly changing rules; bureaucratic burdens	*Package it in a special way or we are not allowed to re-distribute it; very foolish and inconvenient with the food laws that forbid to cleanly wash out and reuse a plastic container, so I have to throw them away; more and more time-consuming and administrative effort*
(E9) Lack of institutionalized systems and standardization	Lack of collection and reserves logistics systems (e.g., plastics or textiles); lack of institutionalized systems (e.g., in mobility with renewable	*Gas vehicles have proven to be economical, but the range with gas has not been as good and gas stations have been a bit scarce; a lot*

	energy sources); lack of standardization (e.g., packaging)	*of things we can only use once, like the pallets on international deliveries that we are not allowed to use here; in the textile industry, there are hardly any protective mechanisms; slave labor is allowed to be sold right next to us on the shelves*
(E10) Lack of clear signals from legislators	The state as a procurer of goods and services does not place enough importance on CE in public procurement; focus only on price is predominant; lack of a clear vision for sustainable change	*Politicians say the energy transition will take place by 2050, and three years later, they say that it will happen differently again, but we have to plan now; the tendering system does not consider ecological points; no framework in big institutions, so they could hide behind price and quality; submission procedure, the most inexpensive is considered*
(E11) Distorted societal values	Cheapness as the predominant paradigm acts as a barrier; throwaway mentality permeates society; short-lived cycles and fast-changing trends dominate and hinder CE implementation	*Affluent society used to having everything and is unable to live without it; cheapness as a new quality; price sensitivity; spoiled society with enormous desire to consume; optics of price, inertia, and*

		convenience; fast-moving characteristics
(E12) Lack of consumer awareness	Lack of customer awareness, preference, and initiative for change (e.g., taking reusable packaging) hinder CE; lack of willingness to pay for CE	*People say it must be cheaper and cheaper; packaging depends on the customer requirement; reducing packaging means customers must bring their own, and they do not; do you want to wear polyester—certainly not; awareness is not really there. What is behind a logistical delivery: it is ordered, prepared, provided, loaded*

3.4.2.1 Technology barriers

(E1) Immaturity of technological solutions: There are technical solutions to improve the CE that have not yet been implemented in a marketable form or, in some cases, are not yet technically possible or sufficiently tested for suitable use, such as certain energy sources in transportation. Although some authors identify the availability of technological solutions as an essential condition for CE and describe technical bottlenecks as the greatest challenge (Agyemang et al., 2019; de Jesus and Mendonça, 2018), others rate technological barriers as subordinate in importance (Kirchherr et al., 2018). Unsolvable technical problems are rare and rather subordinate in their intensity; they only occur partially in certain areas, such as packaging, but do not affect entire value chains. ***(E2) Limited circular potential***: A product is not detached from its context; it undergoes interactions at the chemical and physical levels that reduce its circular capability. Every process step and external influence on a

product leads to losses and devaluation of materials (Desing et al., 2020); for example, using car tires in logistics causes abrasion and produces rubber particles (Sieber et al., 2020). Though there are natural limits to CE, design and material decisions and the training and skills of product developers affect the intensity of this barrier (RSA Action and Research Center, 2013). ***(E3) Constraining product design choices***: Product design determines how much input goes into a product, how much output is generated after usage, and how much recovery is possible. Using mixed materials in products, known as mixed fibers in the textile industry, makes CE measures such as recycling challenging and expensive. This barrier also stems from upstream and downstream companies and consumers in the market via purchases, requirements, and preferences.

3.4.2.2. Market barriers

(E4) Lack of transparency: Lack of transparency in different forms in the market prevents CE implementation. Eco-labels reduce information asymmetries between buyers and sellers by communicating an understandable image of a product regarding its socio-environmental performance (Bratt et al., 2011). However, they are often expensive, labor-intensive, and time-consuming to acquire or assess. Eco-labeling as a decision-making tool (Thøgersen et al., 2010), induces certain challenges. Often, it is too burdensome and costly for SMEs to acquire eco-labels, and the ever-growing plethora of labels can cause confusion and generate a lack of transparency. Moreover, there are no specific and widely accepted labels for the CE. There is also a reported lack of CE role models to concretely show how to implement a CE successfully. It is known from other sustainability research that role models are important for sustainable change, and companies, individuals, and institutions imitate each other (Adger et al., 2005; Wamsler and Brink, 2015). ***(E5) Price premium:*** The prices of sustainable materials, products, and CE measures often differ from those created conventionally to the disadvantage of more sustainable ones. The prices of virgin raw materials and fossil fuels are

also commonly affordable than those of recycled materials or renewable energy. Various studies identify low virgin material prices as a barrier and relate it to distorting legislation actions, such as fossil fuel subsidies that make linear products like plastic-based products more lucrative (Kirchherr et al., 2018). The low prices of less ecological products and materials often lead to fewer ecological purchase decisions in SMEs. ***(E6) Unequal market power***: Usually, competition promotes innovation, as it drives companies to create new solutions (Dereli, 2015), such as cost reduction through material efficiency (Grafström and Aasma, 2021). However, it can be challenging for SMEs to compete with large market players. The literature clarifies the benefits of efficiency gains and cost-saving from CE measures (Charonis, 2012; van Keulen and Kirchherr, 2020); however, the barriers from asymmetric competition between large market players and SMEs have received less attention (Desarbo et al., 2006). This situation can inhibit innovation, as SMEs suffer from price pressure and, consequently, no resources are available to innovate CE measures. Moreover, the misleading use of environmental claims in marketing, also known as *greenwashing*, can be a barrier. Competitors marketing and selling *supposedly green* products dilute the aspirations of genuinely sustainable companies since consumers fundamentally lose trust and reduce consumption or prefer greenwashed products (Gephart et al., 2008). ***(E7) Lack of* collaboration**: Limited willingness to cooperate along the value chain can result in missing economies of scale and cross-company learning. Various authors acknowledge the lack of willingness to collaborate across companies in the value chain as a barrier (Kirchherr et al., 2018; Mont et al., 2017). Cross-sectoral collaboration is considered a success factor in CE implementation (Rizos et al., 2015). Large market players upstream and downstream exploit their size over SMEs and ignore sustainability efforts or impose stressful requirements that dampen these efforts.

3.4.2.3 Legislation barriers

(E8) Hindering legislation: SMEs are sometimes confronted with negative incentives regarding investment in a CE transition. A recurring theme is the existence of burdensome legal prescriptions, mainly in the domains of hygiene, health, and safety regulations (Paletta et al., 2019). It was mentioned particularly in interviews addressing substances in contact with products for human consumption. Without noting a precise regulatory barrier, the burden that comes with taking considering and adapting to the complexity and increasing regulations was mentioned as an important challenge for SMEs that impede innovation. It confirms previous findings that an increase in regulations could negatively affect the innovative spirit of SMEs (Ünal et al., 2018). ***(E9) Lack of institutionalized systems and standardization***: Reverse logistics and a well-functioning collection system are important for CE implementation because SMEs lack the size to internalize such activities (Brunner, 2020). SMEs from the textile and, to extent, food and beverage industries see the lack of established public or collective collection systems, such as those for aluminum or glass, as a barrier. As per SMEs from the logistics industry that consider options to reduce transport emissions, the network for alternative fuel varieties is insufficiently developed to allow for switching a fleet of vehicles. The lack of standardization was mentioned as a potential barrier to collaboration between entities and reuse, congruent with prior research findings (Anastasiades et al., 2021). However, too much international standardization, generally foreseen by legislation to facilitate global free trade (e.g., the Swiss Federal Law on Technical Barriers to Trade, RS 946.51), can also act as a barrier in more local or regional CEs, hindering the competitiveness of local production (Flynn and Hacking, 2019). ***(E10) Lack of clear signals from legislators:*** The legislator sends signals to the market via laws and the public procurement system. The clear direction and targets set by the authorities are key to streamlining investments and innovation toward a CE (Milios, 2018). The interviewees noted that the Swiss authorities have yet to provide a clear and ambitious vision. SMEs report that public procurement

tends to focus too much on price and neglect environmental factors. Including CE requirements in the procurement procedure could be vital by providing clear political signal and creating secured markets, thus incentivizing innovation. The *EU Action Plan for the Circular Economy* recognizes public procurement as a key driver of the transition toward the CE. This critique was addressed in Switzerland by a revision of the *Federal Act on Public Procurement* (PPA; RS 172.056.1), which entered into force at the beginning of 2021, abandoning competition based solely on the price criterion in favor of the quality of services. The contracting authority can now meet certain sustainability criteria, including a certain production method and life cycle costs.

3.4.2.4 Society and consumer barriers

(E11) Distorted societal values: Western society, the aggregation of all consumers, and their attitudes towards consumption are considered essential barriers. SMEs claim the prevalence of a cheapness paradigm, the decay of values, and a throwaway mentality, making implementing CE measures challenging. The term *consumer society* is used disparagingly, describing a society in which hedonism, instant gratification, convenience, and short-term fun maximization is paramount (O'Shaughnessy and O'Shaughnessy, 2002). The study reveals an overwhelming intensity of responses on this barrier, sometimes manifesting as frustration or anger. There is a feeling of powerlessness as SMEs cannot keep up with the social trends. ***(E12) Lack of consumer awareness:*** Consumers show different levels of awareness and interest in CE. The findings support prior findings, showing that a cumulative lack of awareness of sustainability is among the most influential barriers (IMSA, 2013; Kirchherr et al., 2018; Vasilenko and Arbačiauskas, 2012). Customers have preferences on products and their functions, appearance, and price, all of which influence companies' scope of action (Pollak and Wachter, 1975). Frequently, determinants such as novelty, identity, and price are more central to many customers than the question of the ecological implications of their consumption (Fisher, Cooper, Woodward, Hiller, Goworek, 2008).

3.4.3 Integration of the barriers in a holistic framework

Figure 5 shows the holistic framework, including the identified barriers based on the Stead and Stead (2008) framework. The identified barriers were allocated to different framework levels. The following section describes the findings on the interactions of the different barriers in detail.

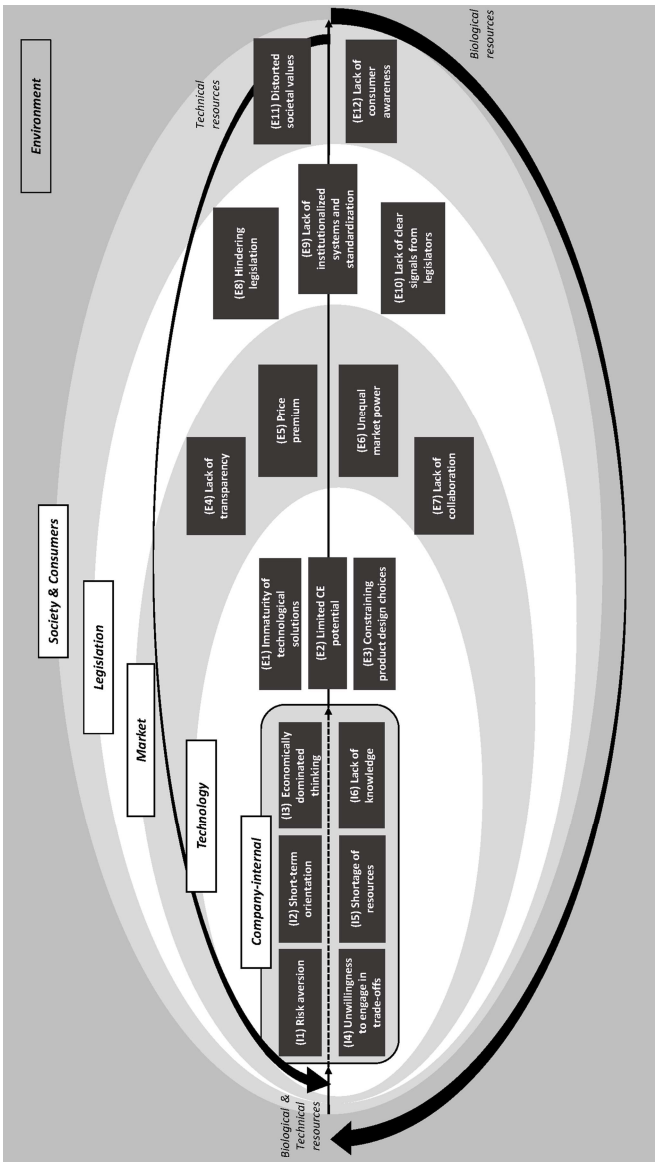

Figure 5 Multi-level framework. Adapted from Stead and Stead (2008)

3.4.3.1 Interaction of company-internal barriers

The three barriers—*risk aversion (I1), short-term orientation (I2)*, and *economically dominated thinking (I3)*—are considered the fundamental interwoven barriers that build the foundation of internal resistance to a CE, potentially conditioning the other three internal barriers: *unwillingness to engage in trade-offs (I4)*, *shortage of resources (I5)*, and *lack of knowledge (I6)*. The first three barriers form the basic assumption about coping with problems within and outside the company, impacting managerial attitudes toward change (Bleicher and Abegglen, 2017). The three barriers are closely related and interact. Their interactions can be powerful, may stop entire change processes, and can substantially impact a company's culture and leadership (Schein, 1986). Implementing CE measures is often associated with radical innovation and structural change in SMEs (Korhonen, 2004), increasing perceived uncertainty regarding economic outcomes. A certain willingness to take risks, tolerate failure, and unlearn what is known to learn something new are necessary for innovation (Sinkula, 2002). Organizational learning is closely related to deviating from the existing corporate culture (Simon, 1991). A lack of acceptance of failure can lead to an atmosphere of low risk-taking (Lawler and Galbraith, 1994). Critically questioning one's business model and breaking out familiar thinking patterns also represent risk-taking (Ritzén and Sandström, 2017). Risk-taking can impact *short-term orientation (I2)*, as it influences how intertemporal decisions are made, which can influence *trade-off (I4)* decisions. A company's approach to determining trade-offs ultimately distinguishes it from other companies (Kaptein and Wempe, 2001). Further, *short-term orientation (I2)* influences the organization's ability to learn from the past, connecting the past, present, and future (Ashkanasy et al., 2004). Organizations and individuals who can consider a long-term perspective and tolerate uncertainties can better innovate and invest sustainably in the context of their tradition and entrepreneurial continuity (Longoni and Cagliano, 2018).

The broader influence of *economically dominated thinking (I3)* is shown in its interaction with *risk aversion (I1)*, as risk aversion can be influenced by miscalculating the opportunity costs of not investing in the CE (e.g., losing the possibility of cooperating with stakeholders or developing new technologies); that is, postponing CE investments because opportunity costs are considered to low (Cassimon et al., 2016). *Economically dominated thinking (I3)* is the counterpart of valuing pluralism, influencing *trade-offs (I4)* by the fact that individuals ascribe only an economic value to objects of their consideration (Lo, 2014). Although SMEs often face a chronic *shortage of resources (I5)*, availability depends on corporate strategies and *trade-off (I4)* decisions. It influences capability and *knowledge (I6)* formation that considers issues beyond the core business, such as the CE (González-Benito and González-Benito, 2005). A *lack of resources (I5)* influences new process implementation, knowledge acquisition, and a successful partner search. A *lack of knowledge (I6)* can inhibit new partnerships and collaborations (Ritzén and Sandström, 2017) and hinder the gathering and adoption of technical skills outside the SME's bubble and the establishment of new technical solutions (Trianni and Cagno, 2012). Insufficient technical training of employees induces to insufficient knowledge of the technical CE possibilities (Shahbazi et al., 2016). A *lack of resources (I5)* leaves less space for strategic reflection on one's own activities in the context of environmental and social issues (Hoevenagel et al., 2007).

These barriers can become central, especially when they occur in the sphere of influence of decision-makers. Managers are often also owners of SMEs or related to them; much depends on their time, risk, and perspectives on their company's role toward society, as they are responsible for strategic initiatives and investments (Hoevenagel et al., 2007). This situation is particularly critical given that a personal risk assessment goes hand in hand with personal value judgments and individual and socialized perceptions of hazards (Lorenzoni et al., 2005). Thus, as per agency theory, managers or owners of family-run SMEs

emotionally attached to their company are less driven to diversify their risk (i.e., more risk-averse) (Hiebl, 2015). A strong risk aversion means possible disadvantages are perceived as more important than advantages of a CE (Rizos et al., 2016). Trivially, if managers are unaware of a CE, they may completely ignore it in corporate decision-making (Seidel et al., 2008).

3.4.3.2 Interaction of internal and external barriers

While understanding the interplay of different internal barriers is crucial for understanding the dynamics at stake in a transition process, it is also important to recognize that a company and, hence, its internal barriers are embedded in a larger picture. The internal barriers depend on—and, to some extent, are shaped by—external barriers that might indirectly influence them. The different external barriers we describe are interwoven and can impact one another. Some of the relationships seem evident, while others are latent but remain conceptually explorable.

The technological barriers, especially the barrier *constraining product design choices (E3)*, are characterized by customer requirements for which the company does not yet have a suitable answer, and the company may not have adapted product designs to a suitable business model (Lewandowski, 2016), which may also trace back to a *lack of knowledge (I6)*. A better interplay of products, system design, and revenue model can facilitate CE measures, such as longevity, disassembly, and recycling (Hart et al., 2019; Pajunen et al., 2013; Pheifer, 2017). *The immaturity of technological solutions (E1)* is a minor barrier. Many technical solutions exist but are not available where needed. Alternatively, there is a *lack of knowledge (I6)* of such solutions in SMEs or a *shortage of resources (I5)* to invest in them. Technological path dependencies can prevent the replacement of old, inefficient technologies with newer ones, which can be reflected in the company *trade-offs (I4)* (Korhonen et al., 2018a).

The level of market barriers is crucial and influences internal and various external barriers. This requires a detailed examination of the characteristics of modern market economies.

First, the *lack of transparency (E4)* reveals imperfect information as a market failure in the CE context, following the classical economic theory (Stiglitz, 2000). If the role models SMEs can adapt and copy are not visible to them, it can reinforce the barriers *risk aversion (I1)* and *lack of knowledge (I6)*. It also influences the barrier *immaturity of technological solutions (E1)*, as SMEs are strongly anchored in their bubble and have only a few opportunities to discover new technologies, business models, and processes given a lack of information (Hoevenagel et al., 2007). Eco-labels help overcome imperfect information; with labels, informed stakeholders can play out market forces (Sinclair-Desgagné and Gozlan, 2003). However, an increase in the importance of labels impacts SMEs, as they must free up extra resources for employees working in procurement and sales to acquire labels and classify them as buyers.

Second, firms must focus on the barrier *price premium (E5)*. The market economy is based on exchange and competition, making prices a central factor with a balancing function (Saari and Simon, 1978). The allocative function of prices should induce the efficient use of resources. Thus, the price of resources is central, steering business and consumer decisions (Thi et al., 2016). However, what if not all emerging costs (including environmental and social costs) are correctly reflected in the price? If the extraction of resources and manufacturing of products generates negative externalities (e.g., air pollution) that are not priced, the market price loses its efficient allocation function, inducing overproduction of the externalities (Stiglitz, 2000). The consequences are a decline in ecological welfare, resource overexploitation (Fischer-Kowalski and Swilling, 2011; Nelson et al., 2007), and failure of intergenerational resource allocation (Bithas, 2011). Market externalization prevention and market functioning are typically considered tasks of legislator regulatory power. If there is *hindering legislation (E14)*, counteracting or understimulating CE, such as enabling distorted prices of virgin resources or less environmentally friendly products, directly affects *trade-off (I4)* decisions in SMEs. Given frequent *shortages of resources (I5)*, SMEs are price-sensitive

and show an elastic demand that would react to rising prices and cause substitution and innovation boost toward ecological resources, products, and processes (González-Benito and González-Benito, 2005). For SMEs willing to push CE transformation, it means being aware and using the systemic link between companies and legislation to seek environmentally friendly price internalizations and gain a competitive advantage for the firm's circular solution.

Third, many SMEs operate in isolation with reduced market strength and face *unequal market power (E6)* and great pressure from large competitors that exploit their power, often accompanied by a lack of access to *knowledge (I6)*. Reduced market power can lead to less bargaining power regarding suppliers and buyers (Crook and Combs, 2007), leading to adopting preferences and the *lack of collaboration* (E7).

A strong barrier for SMEs lies in the prevailing societal values of cheapness and consumer behavior. Contemporary society is confronted with "a kind of fantastic conspicuousness of consumption and abundance, constituted by the multiplication of objects, services, and material goods" which initiated a "fundamental mutation in the ecology of the human species" (Baudrillard, 1998, p.25). The terms *materialism* (Belk, 1985) and *consumerism* (Trentmann, 2004) are emblematic of the present time, encompassing the phenomenon of modern humans and their relationship to objects, which is partially shown in the *distorted societal values (E11)* barrier. The consumption of products or services in a linear economy is always accompanied by increased in entropy in the system, breaking down materials into waste with low potential energy and (almost) no value (Csikszentmihalyi, 2000; Desing et al., 2020). Linear consumption occurred concurrently ecological depreciation. Behind fast-moving consumerism lies a reciprocal relationship between the levels of consumers and companies, driven by manufacturers—some of whom rely on low-cost, non-recyclable and fast-depleting materials, and extensively large marketing efforts— and consumers and their demand for recurring, low-priced

products and their inclination toward a hedonistic, fast-paced, and convenient lifestyle, shown by a *lack of consumer awareness (E12)*. This modern phenomenon is well known as *fast fashion* in the textile industry, where new collections are sometimes launched several times a year (Franco, 2017b). Moreover, a lack of awareness among consumers can induce a decline in the motivation of companies to address CE, as they expect little enthusiasm from consumers and unduly low sales (Kuo et al., 2010). The intertwining complexity is evident at the legislation level, as people in state institutions and political authorities are consumers affected by the prevailing social values and consumerism.

Finally, the legislation barriers levels interact with other external barriers and impacts company-internal barriers. Prior studies describe legislation as a *double-edged sword*, considered necessary for transition while being an obstacle (Backes, 2017; Bening et al., 2021; Milios, 2018). Legislation is closely linked with market barriers, as it influences price mechanisms through subsidies, green taxes, and importation regulation (Albrecht, 2006; Bithas, 2011). The market requires a framework to allocate resources and internalize externalities. Hence, the transition from a linear economy to a CE requires an adaptation of the framework conditions for the market to induce a less wasteful resources allocation. The price signal should internalize environmental externalities linked with the production of goods, which implies the relative prices of less sustainable resources and fossil energies are much more expensive (Ghisellini et al., 2016; Thi et al., 2016). Legislation to avoid cartels and other restraints to competition clearly influence market barriers. In certain contexts, information exchange and close cooperation among companies are prohibited by the state because it could undermine business competitiveness (IMSA, 2013). The potential lack of collaboration highlighted in the *lack of collaboration (E7)* barrier can be explained by the competitive instincts of companies (Hart et al., 2019) and legal uncertainties around new forms of close

cooperation between companies and their qualification regarding competition regulations (Claassen and Gerbrandy, 2018; Rizos et al., 2016).

Legislation also influences the technology level, for example, when setting new norms for efficiency standards, which tends to render older models obsolete. Regarding the reciprocal interaction between the regulatory external and company-internal barriers, a link can be drawn connecting *risk aversion (I1), short-term orientation (I2),* and *economically dominated thinking (I3)*. It is challenging to exit a short-term perspective, with accounting methods focused on annual statements and sales contract legislation designed for a linear economy (Nadeem et al., 2018). The Swiss *Code of Obligations* sets statutory warranties for only two years (cf. art. 197 ff. CO, in particular, art. 210 para. 1 CO). In the event of a defect, the code foresees replacement or price reduction, whereas repair is not compulsory for the producer. A short-term perspective, risk aversion, and economically dominated thinking, which can act as internal barriers, can also act as societal barriers via *distorted societal values (E11)*. While consumers with a *lack of awareness (E12)* are set in their habits and lack the time and knowledge to switch to more aware consumption patterns, politics are also embedded in a fast-paced logic, adapted to the rhythms of election cycles, as per a *lack of clear signals from legislators (E10)*. The fact that environmental legislation is a distinct field of law, with no integration into commercial law, shows that *economically dominated thinking (I3)*, which can act as an internal barrier, mirrors a larger phenomenon, where institutional and legal rules still reflect a reductionist and linear perspective on complex problems (Desing et al., 2020).

3.5 Discussion

This study began with the following three questions: (1) What company-internal barriers exist for SMEs seeking to implement a CE? (2) What company-external barriers exist for SMEs, and how can they be categorized? (3) How are company-internal and external barriers related, and how can they be integrated into a holistic, sustainable strategic management framework? The

inductive data analysis (Figure 4) reveals six main internal barriers: risk aversion (I1), short-term orientation (I2), economically dominated thinking (I3), unwillingness to engage in trade-offs (I4), shortage of resources (I5), and lack of knowledge (I6). They are embedded and interact with a broader spectrum of external barriers, categorized according to the levels of technology, market, legislation, and society and consumers. The next sections explain how the results relate to the literature and discuss the managerial implications. Further, we develop strategic recommendations for SMEs based on our findings.

3.5.1 Implications for research

This study has important implications for CE research and related fields.

Implications for the CE literature: First, the study builds on and extends the existing literature on barriers to CE implementation. Prior studies in this field largely focus on company-external barriers. We extend this research by adding a company-internal perspective. Specifically, we introduce six internal barriers and highlight their interrelationships. We find that *risk-taking*, *time orientation*, and *economically dominated thinking* are three highly relevant and interdependent barriers. For each, there exists a dichotomy (long-term vs. short-term, risk-averse vs. risk-taking, and monistic-economic vs. pluralistic-environmental). Prior studies on CE barriers have already noted topics such as risk aversion and short-term horizon (Hart et al., 2019; Ritzén and Sandström, 2017). However, studies thus far have not provided an overview of all company-internal barriers. This study, based on a large data set and thorough analysis, provides an overview of all internal barriers in CE implementation. Thus, by adding an internal barrier perspective to the discussion, we bridge an important theoretical void and offer a more nuanced understanding of why firms fail to implement a CE.

Second, this study provides a holistic framework that categorizes different barriers into different levels and puts them into relationships. Thus, we extend Kirchherr et al. (2018), who argued that research would benefit from an understanding of the embeddedness and interrelations of different CE barriers.

With the holistic framework, we show which barriers belong to which level. Such an overview is important to understand which stakeholders are responsible for addressing these barriers. Psychology research posits people create excuses if they are unwilling to take over responsibility. Furthermore, people tend to externalize their behavior when they either have no control over the situation or when their responsibilities are unclear (Sheldon and Schachtman, 2007). However, when a meaningful rationale is provided, and individuals have choices, people assume responsibility (Deci et al., 1994). By placing the barriers into an SSM framework, which shows clear areas of responsibility, we can help solve the problem of unclear responsibilities. For SMEs, the framework visualizes that certain barriers fall directly into their level of influence (company-internal barriers), while other barriers can only be addressed indirectly. We build on these findings and propose strategic recommendations for companies, thereby linking the CE and SSM literature.

Third, research thus far has focused on the size of companies. This study contributes to the existing CE barrier research by tailoring identified barriers to the SME context. SMEs drive many societies, making it even more important to understand the barriers to CE transition. De Massis et al. (2018) note that for SMEs endowed with relatively limited resources, a holistic understanding of their embeddedness is central to activating innovation. Following Schumpeter, SMEs show great potential to develop organizational innovation and innovative technological solutions for CE (Hashi and Krasniqi, 2011). Individual SMEs do not have high market shares, but the sum of SMEs is influential in market power and providing blueprints for other companies to replicate circular business models (Schaltegger et al., 2016).

Implications for circular business models and sustainable business model research: Research on sustainable and circular business models has skyrocketed over the last few years. While this study does not focus on circular business models directly, it directly and indirectly influences such research fields. Companies must adapt their business models to implement a CE. More

specifically, companies must transform from a linear to a circular business model at the operational level when they want to implement a CE in their organization (Brendzel-Skowera, 2021; Geissdoerfer et al., 2018). Thus, this study contributes insights into the antecedents of circular business models, an under-researched area in business model research (Foss and Saebi, 2017; Frankenberger and Sauer, 2019).

Implications to corporate responsibility research: although our paper is not positioned in the corporate responsibility research, which broadly deals with the topic that firms engage in social good activities beyond their interests and legal requirements (McWilliams et al., 2006; McWilliams and Siegel, 2001), connecting our study with this research stream shows a lot of potential. Future research could combine these two research streams of *barriers toward CE implementation* and *corporate social responsibility*, offering a CE-inspired conceptualization of corporate responsibility, thereby advancing both fields.

3.5.2 Implications for managers

The identified barriers and their embedding in a comprehensive framework are particularly relevant for practitioners.

First, this study shows which barriers exist when managers implement a CE in their organization. Thus, managers can address the barriers accordingly. Second, the study highlights the interactive nature of the barriers and the interrelationship between organizations, markets, society, and the environment (Stead and Stead, 2008). Given that CE implementation in an organization requires interaction with different organizations, the interrelated view allows for a correct CE implementation. Moreover, it highlights the importance of including environmental topics in organizational strategies, the implicit goal of SSM (Stead and Stead, 2013). Third, the analysis indicates that the business value chain is embedded in the processes of human capital, stakeholders, and social and environmental resources. The multi-level framework shows that SMEs are strongly nested in other levels, from which they receive decisive impulses (e.g., obstructive external barriers) on which they can have an impact

(e.g., overcoming barriers) (Kapp, 1976). Fourth, implementing a CE at the corporate level is about internalizing responsibilities at the management level and reducing negative externalities by enacting business model and process changes. Dividing clear levels of strategic responsibility can help company representatives see what is within their scope and help other stakeholders, such as politicians or consumers, see their responsibilities regarding the barriers.

3.5.3 Broader strategic recommendations

Corporate sustainability and CE are long-term projects requiring leadership and direct managerial attention and will fail without such involvement and commitment (Stead and Stead, 2008). Further, continuous stakeholder interactions strengthen entrepreneurial survivability and business resilience (Volberda and Lewin, 2003). Thus, an SME must see itself as an open system constantly in touch with its internal and external environments, incorporating feedback, and exploring and exploiting opportunities via strategic adaptation, innovation, and improvement (Madu and Kuei, 2012). Hence, we present six sustainable management strategies (Figure 6), building on the study framework.

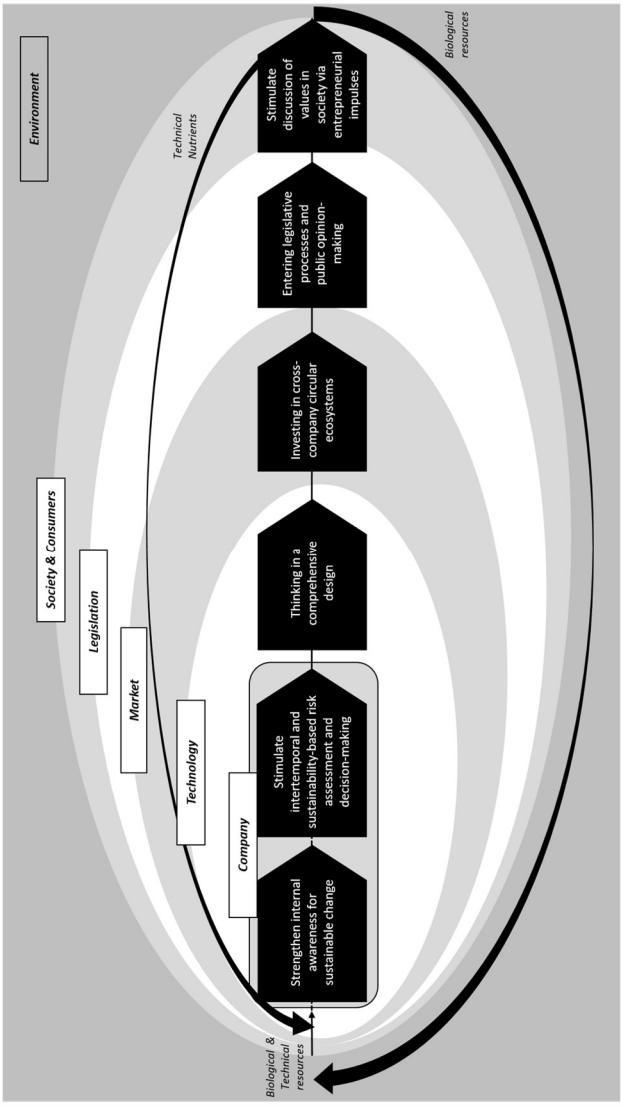

Figure 6 Six strategic management implications embedded in five levels

Strengthen internal awareness for sustainable change: Internalizing CE means aligning company values with the ecological environment. Given that the personal judgments and perceptions of managers and owners highly drive SMEs, awareness-raising from the top-down on the linear economy externalities, multiple consequences of resource waste, and links to climate change and biodiversity loss, to mention only the best-known consequences of resource overconsumption, is necessary. A shift in management perspective and mindset on CE helps to appreciate the boundary spanning and reciprocal interrelationships of the company and its business environment in its entirety over time. It includes stimulating sensing and seizing capabilities to identify opportunities for circular solutions. Management often connotes a denatured view of a company's environment, categorically excluding the environment level (Shrivastava, 1995a). It also connotes the rationale for doing business and its ethical foundations (Stead and Stead, 2008). It includes allowing for failures and a range of uncertainties that may appear during the CE implementation, which requires that all corporate functions internalize more sustainable behavior and implement it in their areas of responsibility, such as adjustments to the marketing strategy or accounting standards. This situation involves aligning all entrepreneurial functions with the shared CE vision, monistic-economical and pluralistic-environmental (Bleicher and Abegglen, 2017).

Stimulate intertemporal and sustainability-based risk assessment and decision-making: Managers and employees must constantly make business trade-off decisions, some of which are at odds with environmental and social issues. Clearly specified decision-making guidelines dedicated to an overarching sustainability goal and the CE implementation are required to reallocate entrepreneurial resources and introduce innovative (sometimes low) technologies and work processes (Madu and Kuei, 2012). Regarding risk, a more holistic integration of future aspects, focusing on short- and long-term economic risks associated with market, consumer, and environmental changes. Especially for family-owned SMEs with a long tradition spanning generations,

it fits well into the intertemporal perspective. It also regards accepting multiple conflicting rationalities on risk from a wide variety of stakeholders, and those who produce risks can also be affected by them (Shrivastava, 1995a). Risk must be understood more broadly as the basis for comprehensive stakeholder legitimacy (Driscoll and Starik, 2004) including a reciprocal relationship with legislative powers and society (Bansal and Clelland, 2004).

Thinking in a comprehensive design: It is necessary to take a holistic view of the company and its production to exploit the full CE potential. A product is more than a bundle of materials. Its handling and how it can be repaired, monitored, returned, and recycled relate strongly to its overall design. Therefore, it requires the integration of all relevant factors, such as the revenue model or consumer usage. Service should also be included to extend the value proposition, linking to an entrepreneurial vision of consumer purchases. It helps with undertakings initially considered challenging (e.g., product return), given targeted revenue models with appropriate intensification mechanisms for consumers, and regards aligning entrepreneurial value creation with customer requirements.

Investing in cross-company circular ecosystems*:* Technology, market, and internal barriers, such as resource shortages or lack of knowledge, can be addressed by forming business ecosystems. Stead and Stead (2013) consider ecosystems the perfect SSM structures to co-evolve and drive innovation across company boundaries and establish a shared vision for sustainable change. Developing sustainable business models is a challenging process supported by entrepreneurial ecosystems (Neumeyer et al., 2020; Neumeyer and Santos, 2018). It enables cross-company collaboration between SMEs and institutions and promotes cross-sectoral cooperation, leading to an increase in market and negotiating powers. Collaborations can compensate for knowledge deficits in SMEs and share risks. As product design is a key factor to successfully manage resource loops, a circular ecosystem can make an important contribution, as it can have a unifying and balancing effect for R&D

over several companies. Various mechanisms, such as standardization, nurturing, and negotiation, can facilitate the successful orchestration of such ecosystems (Parida et al., 2019). A circular ecosystem offers increased leverage in product design, procurement of resources, and sales, as it moves from a competitive to a collaborative paradigm and includes partners. By operating in networks, SMEs can make an essential contribution to solving systemic problems that underlie industrial ecology (Moore and Manring, 2009).

Entering legislative processes and public opinion-making: Various strategies allow SMEs to influence the legislation-making process and public opinion. SMEs can promote their CE through targeted lobbying and agenda-setting in industry associations. This influence can be direct or indirect and does not necessarily lead to changes exerted by the legislator but can induce rules and industry standards that anticipate regulations (Flynn and Hacking, 2019). CE measures can be anticipated through transparency initiatives, process adaptation, appropriate marketing strategies, or directly raising awareness among customers. Seeking and entering co-creation processes and partnerships with various stakeholders—public authorities, representatives of civil society or consumers, and academics (quadruple helix model)—can induce insight and an evolving interest among various stakeholders.

Stimulate discussion of values in society via entrepreneurial impulses: SMEs should see themselves as embedded in society. Through their activities, they can partially influence the values, attitudes, perceptions, decisions, and actions of people with whom they interact (Starik and Kanashiro, 2013). As people in society have difficulty classifying long-term, incremental, and silent environmental degradations, such as biodiversity loss (Driscoll and Starik, 2004), SMEs can contribute to framing the relevance of such problems and sharpen people's understanding to trigger actions. Adopting measures to raise awareness is considered an effective means of anchoring CE more strongly at the center of society (Geng and Doberstein, 2008). It includes management actively addressing social values, recognizing them, and perceiving itself as an

integral part of society (Rahardjo et al., 2013). New circular solutions can especially be beneficial if the company's strategic orientation is decoupled from common social values, such as throwaway mentality, and the company starts to evaluate solutions critically and reflexively, without bias on individual customers or partner groups.

3.6 Conclusion

This study analyzes the CE implementation barriers SMEs face. It identified six internal barriers: risk aversion, short-term orientation, economically dominated thinking, unwillingness to engage in trade-offs, shortage of resources, and lack of knowledge. Furthermore, it identified 12 external barriers in technology, market, legislation, and society and consumer areas. All identified barriers were integrated into a holistic framework, highlighting the interactions of different barriers.

This study makes the following important contributions to the literature on CE implementation barriers and the broader CE literature. First, it introduces six largely overlooked company-internal barriers. Second, it builds on and extends the existing research by highlighting and discussing the embeddedness and reciprocal interaction between barriers at different levels in the context of a holistic and integrative SSM framework. Third, it contributes to the existing barrier research by tailoring identified barriers to the SME context. Moreover, it offers strategic recommendations based on the findings.

Nonetheless, this study had several limitations. The major limitation stems from examining only three industries. Additional industries, such as the machinery or electronics industry, would have enriched the results. The study also focused only on SMEs. It would be interesting to learn whether internal and external barriers are present in shareholder-driven companies and which additional barriers arise. Another promising approach would be to examine companies in detail regarding their concrete implementation of CE measures (e.g., different recycling strategies) and place these measures in the context of

the barriers. Thus, further research should quantitatively explore how the identified barriers interact and how strongly they affect CE implementation. Building on such categorization and embedding it in a larger context, further research can show which drivers are most effective in circumventing the identified barriers.

CE implementation in SME practices is an ecological necessity. Even before conducting this study, it was clear that barriers existed. It is now evident what they are for SMEs and how they can be categorized. With this knowledge, it is now easier to work out solutions in the business and political contexts that concretely address existing barriers across multiple levels and enable a more resource-efficient and sustainable future with closed resource loops. In recent workshops with SMEs and institutions, many participants like to externalize their responsibility to actors external from their perspective. This study shows that while there are always barriers at the level of external actors, there are also barriers at one's level that can be overcome, possibly creating a positive effect on others, given reciprocal relationships.

Declaration of competing interest

The authors declare that there are no conflicts of interest.

Acknowledgments

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4. Paper B: Circular ecosystems: business model innovation for the circular economy

Status: Published on the research platform *Alexandria* (23.01.2020); Institute of Management & Strategy, University of St. Gallen

Abstract: A growing number of companies are focusing on sustainability. However, a closer look reveals a big disconnect (Dyllick and Muff, 2016a; Whiteman et al., 2013) between the actions propagated at the corporate level and the deterioration of the state of our planet and global society. By design, waste and other negative environmental externalities have become an integral part of our industrialized consumer society. The CE is a way to move away from the linearity of our current industrial and economic systems. The aim of a CE is to keep products, components and materials at their maximum utility and value at all times (Bocken et al., 2017). To overcome the big disconnect, the present article provides an actionable path for companies to design, validate, and implement a circular ecosystem with suitable BMs that enable sustainable solutions that are beyond the reach of single companies. Our easy-to-navigate framework consists of the following seven steps (see Figure 7):

- ***Impulse*:** Capture the need for change from a company perspective for reasons such as changing consumer behaviour and legislation, a possible reduction of resource dependencies and costs and increased motivation for current and future employees.
- ***Identify***: Assessing the environmental and social impact of the current company's BM and of the entire linear value chain. This is achieved by combining the three spheres of sustainability (planet, people, and profit) (Elkington, 1997) with the magic triangle concept of BMs (Gassmann et al., 2014).
- ***Ideate***: Creating ideas for circular ecosystems that go beyond existing solutions with 38 *Circular Ecosystem Patterns*—blueprints from other industries that support organizations in the design of their own

circular ecosystem. The blueprints are based on more than 200 mini case studies from different industries.

- ***Integrate***: Designing a circular ecosystem by consolidating the generated ideas into a circular logic. The *Circular Canvas* provides the structure and flexibility to design and—more importantly—work with the big picture needed to realize the CE.
- ***Imagine***: Expressing the vision and motivation for a circular transformation in one's company, as well as for partners in the circular ecosystem.
- ***Incorporate***: Approaching the ideal partners and incorporating them into the ecosystem. This aspect is of particular importance for the success of circular solutions because no company can deliver or create all the needed products, services, or guidelines alone.
- ***Implement***: For each company, implementing the ecosystem takes place at the individual BM level. Following the current best practices of de-risking and assumption-based testing for validating new BMs, as well as adapting these regarding the specific requirements of the CE, are the key elements to realizing the designed ecosystem and reaping the benefits of such a unique offering.

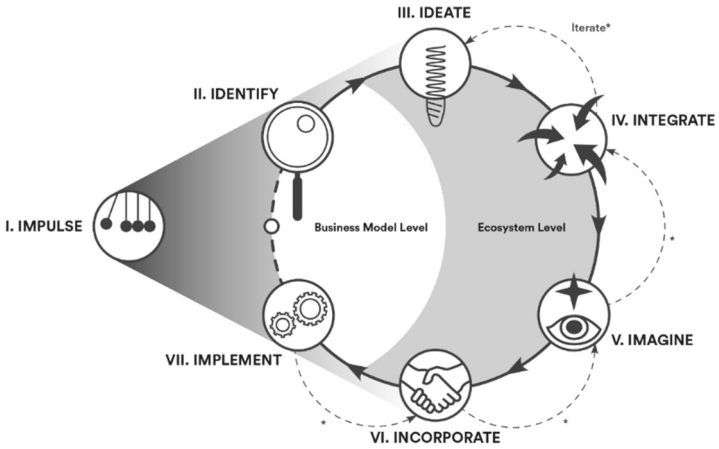

Figure 7 The seven steps of the Circular Navigator

The inherent logic and structure of the approach allows companies to create circular solutions without being overwhelmed by the complexity of the endeavor. This is critical because companies that want to stay ahead of the competition need to be able to create such solutions not only for their customers, but also for their employees, our planet, and our society.

When Schoeller Textil AG, a Swiss producer of textile fabrics, realized that the environmental problems in their industry could not be solved alone, they looked beyond their company's borders and began to build a circular ecosystem with customers, complementors and competitors. Coming from the innovation potential of its own BM, Schoeller formed this circular ecosystem in collaboration with seven companies, eventually naming their ecosystem wear2wear™. The aim was creating solutions to change the polluting, resource-consuming and waste-producing textile industry into a more sustainable one. Their approach was understanding and envisioning the product life cycle of the product and creating a shared value proposition for the whole ecosystem. wear2wear™ specifically designs their textiles in a way that

enables maintenance and recycling at the end of the product's life so that no material degenerates into waste (*design2recycle*). To do this, they decided to produce fully circular functional work wear using a synthetic polymer (100% polyester), thereby massively reducing the waste of resources. The remarkable aspects are how they dealt with design in a collaborative way (e.g., avoiding mixed materials and embracing modular tailoring) and how they built their ecosystem around it. They developed the product design through collaboration arrangements of individual offerings. The product design builds the anchoring point for the change—and analogous to the ecosystem concept—adds value for the customers (Jacobides et al., 2018; Kapoor, 2018).

The pioneering case of wear2wear™ shows us how companies can innovate their BMs to implement a CE in an ecosystem and how a common vision of how to solve a global problem can be realized. You can find more details about the wear2wear™ case in the Appendix. The present White Paper provides a condensed glimpse into the core elements of our forthcoming book, *The Circular Navigator***.** The Circular Navigator describes a systematic way to design, validate and implement BMs in a circular ecosystem.

About the research: The present paper is inspired and enriched by our work with the LACE project (Laboratory for Applied Circular Economy)—a large, interdisciplinary research project funded by the Swiss National Science Foundation. The project is a cooperation of the University of St. Gallen, the University of Lausanne, the ETH Zurich and the EMPA. Using an inter-disciplinary research approach allowed us to identify under which economic, legal, political, and technical conditions a sustainable CE can be ecologically beneficial and economically profitable for companies. The joint efforts of the partner universities have been enriched through cooperation with various companies and organizations, such as Losinger Marazzi, V-Zug AG, Entsorgung- & Recycling Stadt Zürich, Schoeller Textil AG, Sympatex, Carl Weiske and Rehau.

4.1 Methodology

Methodologically, this paper has three parts. First, we built a comprehensive set of patterns to build circular ecosystems, called *Circular Ecosystem Patterns.* This literature-based framework was developed with the help of a morphological analysis, analogous to Frow et al. (2015) and Lüdeke-Freund et al. (2018). A morphological analysis helps to structure and investigate "the total set of relationships contained in multidimensional, usually non-quantifiable, problem complexes" (Ritchey, 2006, p. 792). This method can be traced back to the Swiss physicist and astronomer Fritz Zwicky, who generalized it for the integrated processing and structuring of complex socio-technical problems (Zwicky, 1960). The structuring potential of this analysis technique has been used in different fields of research, such as engineering, innovation, and BM research (Álvarez and Ritchey, 2015; Frow et al., 2015; Remane et al., 2017). It envisages the creation of a parameter space that is based more on logic than on causal relationships or hierarchical structures. This involves identifying and defining the key dimensions of the complex problem and possible categories within them based on a comprehensive literature review. The formation of this parameter space for circular ecosystems creates a so-called morphological field (Frow et al., 2015; Ritchey, 2006). The key dimensions are the central pillars for the design of a circular ecosystem (here, *close the loop*, *improve the loop*, *monetize the loop*, and *excite the loop*); the categories they contain include the central characteristics of these pillars, that is, possible CE measures. Later, in the process, these categories are translated into patterns. In developing this framework, attention was paid to the distinctiveness criterion (Frow et al., 2015).

A research group of three people worked on the development of this parameter space. When structuring such a parameter space, group interaction is a central feature of the creation process. Critical in this "process of collective creativity" is group dialogue, and therefore, the number of participants should be less than six (Ritchey, 2006, p. 795). The dimensions were worked out iteratively, and

all redundancies and overlaps in the various categories were eliminated. The individual categories were converted into patterns, as in the work of Gassmann et al. (2014) and Lüdeke-Freund et al. (2018b).

The use of patterns as a systematic way of codifying knowledge (Leitner, 2015) and as a supporting tool in innovation processes has established itself in academia and practice in recent years. The specific processing and practical use of patterns refer back to the architect and design theorist Christopher Alexander (Alexander et al., 1977). Based on his considerations, patterns are helpful as specific solutions to repetitive problems and should have a certain degree of generalization, not overlapping with each other (Remane et al., 2017). Owing to its generalizability, the solution can be applied to all related problems (Alexander et al., 1977), and due to its fractional character, a pattern often represents only a part of the overall solution (Remane et al., 2017).

Therefore, a completely circular ecosystem is a combination of different patterns tied together. The pattern must be ordered and classified for theoretical understanding and practical applicability. This simplifies the applicability and reproducibility of the underlying knowledge, simplifies cognition, and facilitates effective communication (Lüdeke-Freund et al., 2018a). We were able to increase the practical relevance by searching for existing company cases that fit the patterns. In the end, we found more than 200 cases that underline the literature-driven background of the patterns with empirical relevance.

Second, a navigator process that was derived from various practice-oriented management tools was created, tested, and adapted in various workshop formats with practice partners. The core elements of the navigator are conceptually designed and bind the triple bottom line together with BM innovation among others, present a canvas for circular ecosystem creation, and form a process consisting of seven iterative steps. All steps include essential stages that are critical for the transformation toward circular ecosystems. Because this navigator process was created and used for purely practical purposes, it is not discussed further.

Third, a case was sought, observed, and recorded using interviews to illustrate the process of the navigator and the pattern logic. Then, the representatives of the companies involved in the case called wear2wear™ were interviewed using semi-structured interview guides, each 30–80 min in length. These interviews focused mainly on the BMs, the design of a circular ecosystem, their cross-company cooperation, and the potential of CE. From a research perspective, we were able to gain insight into an existing circular ecosystem and incorporate the most essential findings directly into the paper.

4.2 Why do we need a circular economy?

We have a problem: Companies are the engines of modern societies. They create value for society, bring prosperity and technical innovation and develop solutions for burning issues. They offer people purpose, jobs, and secure incomes. In addition, companies increasingly address their environmental and social responsibility, as seen in corporate social responsibility initiatives or sustainability reports; they invest in actions to increase eco-efficiency or commit themselves to more sustainable practices. Managers are increasingly emphasizing the advantage of being active in sustainability as a company. Cost savings, risk reduction or brand reputation are highlighted as important drivers for the commitment to more sustainability (Dyllick and Muff, 2016a; Kiron et al., 2013).

Unfortunately, a closer look reveals a striking discrepancy between the actions propagated at the corporate level and the deterioration of the planet and global society. This *big disconnect* (Dyllick and Muff, 2016a; Whiteman et al., 2013) is reflected by a lack of progress regarding environmental sustainability and achieving the sustainable development goals *(SDGs*) as set by the United Nations (Sachs et al., 2019). Six of the nine planetary boundaries[1] that define

[1] Planetary boundaries: biochemical flows, freshwater use, land-system change, biosphere integrity, climate change, novel entities, stratospheric ozone depletion, atmospheric aerosol loading, and ocean acidification

the safe operating space for humanity on Earth are already considered to be exceeded, thus endangering the resilience and stability of the Earth's system (Rockström et al., 2009a; Steffen et al., 2015). The concentration of CO_2 in the atmosphere is at a record high, which is being accompanied by a continuous increase of the annual temperature (NASA, 2019; Steffen et al., 2015). It is predicted that without changes, one million species will face extinction in the coming decades (Díaz et al., 2019). The amount of waste produced daily—a relevant part of it ending up as municipal waste in waters and oceans—is estimated to grow from 3.5 million tons per day today to 6.0 million tons per day in 2025 (Hoornweg and Bhada-Tata, 2012).

Overcoming the big disconnect: So why is this big disconnect happening? One credible explanation for this effect is that companies contribute to sustainability in varying extents and with different efforts. Reducing unsustainable practices delivers different environmental results than increasing sustainable practices (Dyllick and Muff, 2016a; Landrum, 2018). However, most firms choose only to reduce unsustainable practices to varying degrees (Malovics et al., 2008). By contrast, increasing sustainability would actively address the current problems relevant to society and the environment, and solve them. However, it is not only about the degree of sustainability, but also about the underlying economic logic: the way we create value in industrial systems, how the value chains are structured, and how the resources in these systems flow. How do we extract, process, consume and (not) return products after their end of life?

Since the beginning of industrialization, there has been a linear relationship between these steps of resource usage, also known as the take-make-use-dispose relationship (Bocken et al., 2016; Ellen MacArthur Foundation, 2013; Ghisellini et al., 2016). The causal consequence of this linearity is not only the production of unwanted material at the end of a product's lifetime, which is also known as waste, but also the acceptance of resource scarcity and further negative impacts along all steps (e.g., CO_2 emissions, micro plastics, or soil

poisoning) (Bell et al., 2013; Ellen MacArthur Foundation, 2017; Lieder and Rashid, 2016). This results in a situation where current and further economic growth depends on massive resource extraction (Ghisellini et al., 2016; Lieder and Rashid, 2016). By design, waste has become an integral part of our industrialized consumer society (Ellen MacArthur Foundation, 2013), so much so that incremental changes or efficiency measures do not offer acceptable solutions.

"If we want to do something to get this catastrophic pollution under control, then we have to tackle it fundamentally." (Thomas Weiske, Carl Weiske)

Fundamental BM innovation for a CE: To really tackle the big problems mentioned above, firms need to fundamentally change their BM—their underlying way of doing business. Instead of focusing on traditional linear-oriented BMs, companies need to develop BMs that allow for sustainable and closed resource loops in their industry (Ghisellini et al., 2016; Markard et al., 2012; Seiffert and Loch, 2005). If designed properly, this circular change leads to a regenerative industrial economy, (re-)capturing the enormous volume of finite and renewable resources to use them again and again (Ellen MacArthur Foundation, 2013). The goal of the CE is to keep products, components and materials at their maximum utility and value at all times (Bocken et al., 2017). Therefore, the product design is crucial for success (Ellen MacArthur Foundation, 2013). This, in turn, allows for the decoupling of economic growth and material extraction (Ghisellini et al., 2016; Lieder and Rashid, 2016). Although practitioners and academics speak of a CBM (Bakker et al., 2014a; Geissdoerfer et al., 2018; Lüdeke-Freund et al., 2018b; Pheifer, 2017; Planing, 2015; Urbinati et al., 2017), this is a rather illusory view considering the business activities that must be undertaken along all life cycle phases of a product. In our understanding, a BM itself can only lead to circularity as part of an ecosystem of BMs, thereby enabling a circular flow of resources along the ecosystem (Lüdeke-Freund et al., 2018b). A (business) ecosystem is an

organizational form with a modular architecture that is composed of independent complementors working towards a shared value proposition. This coordination allows an ecosystem to serve complex customer needs that one company could not fulfil alone (Jacobides et al., 2018; Müller-Stewens and Stonig, 2019). A circular ecosystem coordinates itself across the BMs of different complementors to create sustainable value propositions with closed resource loops that are based on an aligned product design. Based on this, the CE can be seen as the interplay of complementing BMs along a circular ecosystem. Therefore, companies need to design and create these ecosystems to make the CE work.

Schoeller alone would not have been able to design the circular ecosystem; it was a joint effort by all members. This included the innovation of material, product design and processes. This joint innovation was crucial to ensure the durability of the work wear and the safe recycling of the raw materials at the end of a product's life cycle.

Definition of a CE:

"A CE is a model adopting a resource-based and systemic view, which aims to take into account all the variables of the system earth, in order to maintain its viability for human beings. It helps society achieve well-being within the planetary boundaries. It achieves this through BM innovation and technology, providing the goods and services required by society and thus leading to long-term economic prosperity. These goods and services are powered by renewable energy and rely on materials that are either renewable through biological processes or that can be safely kept in the technosphere, requiring minimum raw material extraction, and ensuring the safe disposal of inevitable waste." (Desing et al., 2020)

However, shifting from a traditional BM to a circular ecosystem with suitable BMs for the involved complementors is not easy, and current strategy frameworks are of little help. It is important to change the perspective from a

micro view of supply chains to an integrated macro view that focuses on the value creation of different partners as part of an ecosystem (Kapoor, 2018). The big disconnect can only be solved if companies widen their perspective and accept that their products will create an impact throughout their whole life cycle. This necessitates moving away from an isolated view of buying and selling along the supply chain towards an integrated, systemic view where companies need to coordinate their actions and align their processes on a shared value proposition.

Based on our research, we developed a step-by-step navigator that allows companies to build and implement circular ecosystems. For this purpose, we initiate change from a systemic perspective, which enables the innovation of individual BMs and embeds them in an aligned ecosystem. Therefore, companies need to go through seven steps.

4.3 Impulse: why should we care?

Why should companies care at all? First, we give the simple answer: the basis of our existence as human beings is a functioning Earth system in a resilient and accommodating state (Steffen et al., 2015). Today, we are moving away from this state. We run the risk of producing irreversible changes, such as the destruction of natural ecosystems (e.g., coral reefs, mangrove forests and wetlands) and more extreme weather events (IPCC, 2018a, 2018b). People are becoming increasingly aware of these facts—also because of movements like Friday for Future, which increases pressure from different sides for firms to act. Beyond these macro needs, there are four concrete benefits for companies investing in CE.

"Sustainability is not a megatrend; it is an existential necessity." *(Rüdiger Fox, Sympatex)*

Changing consumer behaviour and regulation: Consumer preferences change over time. The demand for sustainable products is linked to personal norms and sustainability preferences (Biswas and Roy, 2015; Chen and Chai,

2010). Younger generations display an increasing awareness of climate change and sustainability. This could not only change consumption behaviour, but also create regulatory pressure (such as the EU ban on several single-use products made of plastic (European Commission, 2019b)). CE measures would allow companies to create competitive advantages as first movers while preventing issues with upcoming regulations. In addition, it has been repeatedly observed that companies that commit to sustainability display better financial performance and profitability (Evans et al., 2017; Haanaes et al., 2011; Kiron et al., 2013, 2012). A driving impact behind Schoeller creating the ecosystem *wear2wear™* together with its first partners DutchSpirit, Carl Weiske and Märkische Faser was the changing public tenders in the Netherlands, where because of growing awareness, the state suddenly demanded a renunciation of linearly processed garments in work wear.

Reduction of resource dependency: Resource availability is one of the most important factors for the long-term prosperity of businesses. The growing global demand for raw resources increases scarcity and drives up prices and volatility. The resulting pressure on corporate supply chains can become an existential threat to companies (Ellen MacArthur Foundation, 2013; European Commission, 2014a). CE measures could also massively reduce dependence on the fossil feedstock (Ellen MacArthur Foundation, 2015a; European Commission, 2014a, 2014b). We see this within the *wear2wear™* case, where all companies depend on synthetic polymers.

"The BMs we have right now will change within the next five to fifteen years because we will not be able to rely on the supply chains we have right now. We need crude oil […], and we throw materials away at the end. This BM will not work anymore." (Madeline Brey, Sympatex 2019)

Competitive advantage: Implementing innovative BMs in a circular ecosystem with complementor companies will create a competitive advantage for the companies who work together. For example, *wear2wear™* has developed a holistic solution in the field of polymer recycling, which pushes

all companies in the ecosystem further up the learning curve compared with unorganized competitors. Working with partners allows all firms within the CE to benefit from more customer insights, something that is not always possible when conducting linear supply chains. The textile industry has one of the worst ways of handling resources after usage, with less than 1% of materials being recycled(Ellen MacArthur Foundation, 2017). The cost-saving potential of material recycling combined with new forms of customer relationships in the CE is not being exploited, and huge benefits can be reaped for those willing to pursue this. Indeed, estimates predict that the European Union alone could achieve annual economic benefits of up to EUR 1.8 trillion and create 2 million additional jobs by 2030 (Ellen MacArthur Foundation, 2015a; European Commission, 2014b). CE measures such as waste prevention, the recovery of materials or new product designs could have annual net benefits for EU companies of up to EUR 600 billion (AMEC Environment & Infrastructure and Bio Intelligence Service, 2013).

Talent attraction and employee motivation: Challenging and solving environmental problems as a company creates intrinsic motivation for employees. Studies show that employees identify more strongly with their company when it acts responsibly (Glavas and Godwin, 2013). In this way, CSR, as well as a company's reputation in terms of environmental issues, increases the attractiveness of a company on the labour market (Aiman-Smith et al., 2001; Schmidt Albinger and Freeman, 2000; Turban and Greening, 1996).

4.4 Identify: Where do we stand today?

"We looked for the person behind. That's what I always wanted. When I do business, I want to do it fair and not while other people suffer to make me rich." (Erik Toenhake, DutchSpirit).

After the initial impulse, the CE transition starts at the BM level before moving to the ecosystem level with potential partners. Therefore, creating an

understanding of the environmental and social impact of all BMs involved in the liner value chain (take-make-use-dispose) is a crucial step. Only then can the firm decide which dimensions need to be adopted. Because the product design is a key aspect to enable circular solutions, an analysis of the current design and its consequences along the life cycle is central (Ellen MacArthur Foundation, 2015b). Finally, it is necessary to fully understand what happens to the products after the end of their lifetime and how the company is currently involved with that aspect (Ellen MacArthur Foundation, 2013; Strasser, 2000; Velis, 2015).

This identification can be done by taking a detailed look at one's own and all other relevant BMs along the value chain. To do this, companies need to link the BM concept with the *triple bottom line* (Elkington, 1997) concept and the three spheres of sustainability (planet, people, and profit). A BM consists of the following four dimensions (Gassmann et al., 2014):

Who are the BM's customers?

What is offered the customers, and what is the customer value proposition (Johnson et al., 2008)?

How can the value proposition be made available (value chain) – what processes, activities and resources are required, and what are their costs?

Why is the BM financially **valuable**, and how are revenues generated (revenue model)?

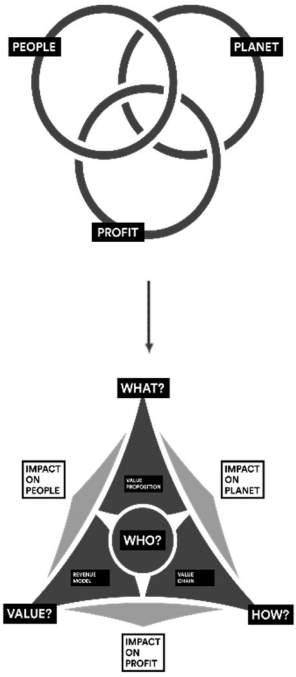

Figure 8 Merging sustainability and business model innovation

These dimensions are not only the key levers of BM innovation along the potential circular ecosystem, but also the cause for the impact on the three spheres of sustainability (both positive and negative):

Impact on the planet (results from the *what & how* dimension): What is the offer to our supply chain customers (e.g., material composition), and what does the design consist of (e.g., material choice)? *How* do we create our products (e.g., manufacturing methods), and how do we provide them (e.g., choice of logistics)?

Impact on people (results from the *what & value* dimension): *What* influence does the product have on people, and which (intended and unintended) side effects are a result (Shrivastava, 1995b)? Why is the BM financially *viable,* and how does the revenue model affect customers? Consequently, the design of the revenue model directly influences the people because it limits access and availability.

Impact on company's profit (results from the *how & value* dimension): The impact on a company's profit is described as the way a company converts the delivered value into profit (Teece, 2010). The revenue model and the design of the cost structure are of crucial importance (Johnson et al., 2008). Why is the revenue model *valuable* in the long term, and what influence does the structure of the value chain have? How do production processes generate costs?

This holistic integration of sustainability across all the BMs of a value chain reveals inherent trade-offs not only between the three spheres of sustainability, but also within each sphere. Any adjustment within one BM dimension has a direct impact on two spheres of sustainability (see Figure 8). For example, actions to reduce toxicity during the manufacturing process (*how* dimension) have an impact on profit (e.g., through the costs for the necessary new machinery) and an impact on the planet (e.g., through less toxic gas emissions). The change from fossil materials to biodegradable ones in the product design

(*what* dimension) has a direct effect on the planet (e.g., through reduction of CO_2 emissions) and on people (e.g., through new product handling).

It is important that companies not only do this for their own BM, but also for the BMs of the other companies involved in the entire development process of a product. In the *wear2wear*™ case, Schoellers, as the lead company, did this analysis for itself and all parties involved in the creation of its work wear, including everyone from yarn producers and garment sewers to the operators of collection logistics and recyclers. This assessment needs to be enriched with an analysis of future possible threats and benefits of industry-relevant megatrends. Considering the 'use' phase regarding the customers and their needs is also central when developing new solutions.

4.5 Ideate: Moving beyond existing solutions

Based on the identification of the shortcomings along the linear value chains with all the BMs involved, we now change perspectives to the ecosystem level. Here, the lead company needs to come up with fundamentally new value propositions and value creation mechanisms along a circular ecosystem. Ideally, the lead company does this exercise together with potential partner companies because this leads to a higher level of innovation. Often, companies have trouble thinking outside the box because they are caught in the dominant logic of their existing business. Statements such as "We have always done it this way" or "This is how the industry works" are clear evidence for a deeply rooted and dominant thinking pattern. However, to realize a CE, one has to break through these thinking patterns and redesign the value creation mechanisms of the entire industry, as we know from BM innovation research.

In our research, we identified 38 Circular Ecosystem Patterns, a blueprint of successful circular ecosystem elements that helps in designing a circular ecosystem for a company's industry. The patterns are based on a broad literature review and successful cases of companies that have created sustainable and circular solutions in their industries. This helps to break out of

dominant thinking patterns and come up with fundamentally new BMs for each involved company to create a circular ecosystem.

"This means we already identified three years ago that the design of a product, whether it's a shoe or a garment, is very important in terms of sustainability. You should better make it more simple and easier from the beginning to recycle in most efficient way." (Herve Clerbout, Sympatex)

38 Circular Ecosystem Patterns: Based on our research, we developed a classificatory framework that categorizes four types of patterns crucial to creating a circular ecosystem (see Figure 9). Together, these four pillars shape a financially valuable and attractive offering while simultaneously achieving sustainable resource loops. The first two pillars focus on the material aspects of the CE; they enable closing the material cycle with all the associated aspects of environmental sustainability (e.g., longevity or avoidance of toxic substances). The second two pillars are business driven and focus on the monetization of the circular solution, user excitement and possible incentives.

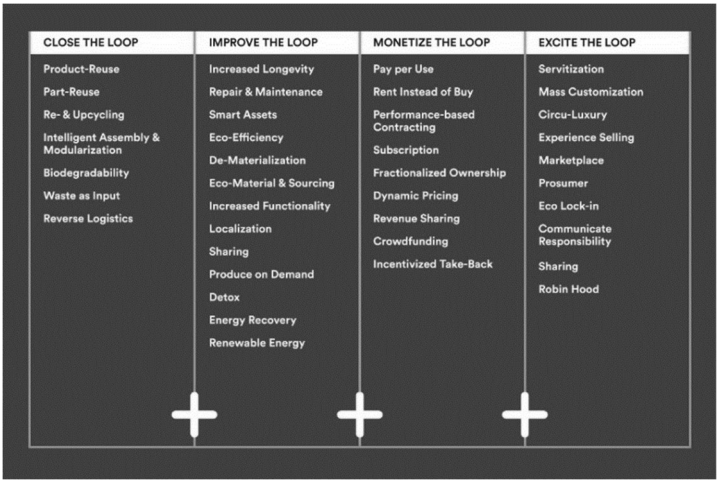

Figure 9 Circular Ecosystem Patterns

The ideas generated with the help of the patterns are then placed (see next step) along the phases of the CE. A detailed description of the pattern and case companies are shown in Appendix I.

Close the loop: This category includes all the patterns directly or indirectly crucial for the recovery of a product, the parts of a product or the material contained therein. Closing the resource loop is an important but not an exhaustive step towards achieving a sustainable circular solution (Desing et al., 2020; Korhonen et al., 2018b).

Improve the loop: This category is an essential cornerstone of a sustainable CE; it ensures that the new offering contributes to reducing or solving environmental problems, as well as avoiding any hidden, unwanted effects (e.g., rebound effects (Figge et al., 2014; Polimeni et al., 2008)) to stay within the planetary boundaries.

Monetize the loop: This category helps to identify innovative ways to capitalize and capture the value from circular solutions. These patterns help to break the link between sales and raw material extraction that predominates in the linear economy (Kalmykova et al., 2018; Korhonen et al., 2018a).

Excite the loop: These patterns are focused on inspired interaction with users, empowering and creating awareness for circular change, which should result in long-term relationships and improved customer loyalty. These patterns add value for users beyond the sustainability aspects, thereby further motivating them to adopt the offering.

4.6 Integrate: Designing consistent circular ecosystems

"Sustainability and recycling are all about cooperating together." (Hendrikus van Es, Schoeller)

Taking an ecosystem perspective is valuable because it allows a shift in focus not given in the classical firm–supplier relationship. Ecosystems—as a new structure of economic relationships (Jacobides et al., 2018)—shed light on the

interdependencies between activities and technologies of different companies, where innovation becomes the unit of interest (Kapoor, 2018).

The ***Circular Canvas*** (see Figure 10) serves to assign the ideas from the previous step to the relevant phases of the CE. The canvas helps to simplify the systemic complexity of the CE, highlighting the cross-company potentials by bringing the material science and business perspective together. The product—or in a broader sense, the shared value proposition—is at the core of the canvas, and the ecosystem is formed around it to reach that solution. To identify the potential of value creation mechanisms, the ideas can be clustered into modules on the canvas (e.g., logistics provider). As known from ecosystem research, these modules are separable and allow for inter-connectivity (Jacobides et al., 2018), and they represent opportunities for innovative BMs that together form the circular ecosystem. The canvas identifies future partner companies and their complementarity through the newly created BMs (Müller-Stewens and Stonig, 2019). The canvas contains the following phases and factors:

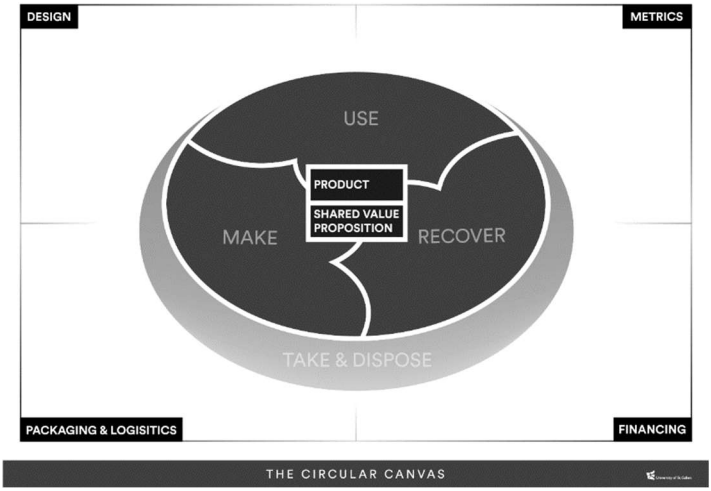

Figure 10 The Circular Canvas

Core phases: The *Make* phase covers the activities of manufacturing, sales, qqwand distribution. This is followed by the *Use* phase, where the user takes advantage of the circular solution. In the *Recover* phase, the products are collected or returned and triaged, and the recovery of the materials takes place (Bocken et al., 2016; Kalmykova et al., 2018). The product's material, in varying states of order (e.g., parts of the product or recycled components), is then used again in a new *Make* phase, effectively closing the loop.

Surrounding phases: The *Take* and *Dispose* phases enclose the three core phases. The material cycles often cannot be completely closed because production, usage and reprocessing deteriorate materials, for example, through degradation, dilution, or contamination (Desing et al., 2020; Verhoef et al., 2004). This necessitates some form of *Take,* which should consequently be minimized. In accordance with Desing et al. (2020), it is crucial that the highest possible state of order of materials is preserved in the circular flow (and with that, the 'stored' work energy) (Desing et al., 2020). In short, product reuse is preferred over part reuse, which is preferred over recycling but still better than incineration. These aspects are in accordance with the EU waste hierarchy logic (reduce, reuse, recycle, recover and dispose).

Integral and strategic factors: There are additional factors that need to be considered when creating a circular ecosystem: these are either integral (*Design* and *Packaging & Logistics*) in how they affect the phases, or they are of strategic importance (*Metrics* and *Finance*). The latter need to be covered to measure the outcome, as well as navigate and fund the implementation. Here, the ideas that do not belong to any concrete phase of the CE become relevant.

4.7 Imagine: Expressing your vision

A key element of circular transformation is the formulation of a common vision that addresses the purpose of change for the whole ecosystem. Why do we need to change? The vision must fulfil three functions: identification (personal meaning), legitimation (relevance) and focusing (value promise) (Bleicher and

Abegglen, 2017). This vision can also serve to communicate the project within the own company. Therefore, the vision raises the topic of CE and sustainability to a normative level of argumentation. Without a convincing vision *why* the company should change, it will not be successful. The most common obstacles in the CE transformation process are the lack of awareness regarding the need for sustainable innovation (de Jesus and Mendonça, 2018; Vasilenko and Arbačiauskas, 2012) and a hesitant company culture (Kirchherr et al., 2018). It is critical to support the understanding of environmental problems and show how these issues can be tackled at the company level. Linking this understanding with the development potential of the company in an ecosystem is key. Circular transformation of the BM and the creation of an appropriate ecosystem can lead to competitive advantage, and this is an important message that needs to be given to employees. Having a vision is important to engage partners, motivate and onboard employees and excite customers. A purpose-driven narrative allows the ecosystem to better communicate the vision and offer while ensuring that it sticks. Within the process, it also allows the ecosystem to create a common understanding and helps to align all partners on further steps. A circular ecosystem, especially as a freshly designed concept, is a complex interplay of imagination, processes, assumptions, and facts, resulting in varying perspectives and interpretations. The clear structure of a story helps to navigate this complexity.

A well-known example from the textile industry shows that the vision of a single person can be enough for a major change. Ray Anderson, founder and former CEO of Interface, a manufacturer of modular carpet tiles (one billion in sales annually), proves this with his *Mission Zero®*. They launched it in 1994 and continuously reduced their negative environmental impact with innovations and new products on the market. After successfully liberating the company from linearity, eliminating waste, and reducing all negative externalities to the environment, Interface went even further: they developed a carpet with a negative CO_2 balance that contributes to decarbonisation.

Through their holistic focus on sustainable CE combined with a corporate vision, they have achieved what many did not achieve until now: actively closing the big disconnect.

4.8 Incorporate: Identifying suitable partners

Overall, partnerships are of great importance because of the long-lasting nature of CE solutions. Interestingly, the impact created by the CE is partly time-lagged. Although the marketing and sales results will come in quickly, the material loop is typically closed after years of product use, because the products are preferably used as long as environmentally reasonable. This highlights the importance of a lead company as an orchestrator for the long-term nature of circular ecosystems.

In the case of *wear2wear™*, having an orchestrator role was one of their key success factors. Developed from a business friendship, two key figures from Schoellers and Dutch Spirit were personally inspired to form the ecosystem. They saw themselves as "the catalyzer" (Toenhake, Dutch Spirit, 2019) and evaluated the opportunities, invited potential partner companies, supported cross-company design development, excluded partners when necessary and actively acquired customers. By taking responsibility for the activities, they eased the complexity for their partners and allowed the ecosystem to grow. In market segments where they may have previously competed, they now act in a partnership and break down barriers to create a circular solution together.

"So, we are a partner of Sympatex but we are also their customer because we buy the membrane from them." (Hendrikus van Es, Schoeller).

This necessitates the long-term involvement of all partners, which requires trusting relationships and the possible creation of incentives that stimulate this long-term cooperation. This also addresses and lowers market-relevant barriers (Boons and Lüdeke-Freund, 2013; Mont et al., 2017) towards CE, such as dependencies on larger market players and destructive competition. Companies

should ask themselves the following: What do our potential partners offer? What benefits does the ecosystem offer to them? Do they share the same vision?

4.9 Implement: Realizing a circular solution

Although the previous steps took place at the ecosystem level, we are now back at the level of the individual company BM. Thus, it is essential that companies be able to adjust their BMs in practice and create shared value propositions with a measurable impact. To do so, the involved companies have to align their BM dimensions (*who, what, how, value*) to form the designed circular ecosystem. Implementing circular solutions is done in the same way as the usual testing and implementation of innovation projects: falsifying and validating the hypotheses of a circular solution. This process is always iterative because the company must gradually test the involved BMs and user needs, moving closer to the launch step by step. The underlying hypotheses need to be falsified by choosing and conducting adequate tests. These tests serve as the basis to adapt and iterate the offering and to update BMs along the circular value chain. It is important to test the phases in parallel to ensure they work as intended. Here, minimum viable products and prototyping are often a necessity. Overall, this is the longest and hardest step, where motivation, communication and coordination are key for success. In practice, these implementations often need to be accompanied (or in some cases lead to) a cultural change for the involved companies. In addition, new and suitable KPIs need to be defined to allow measuring the success of the new BM. Flagship projects are a great way to show that it is possible to create circular solutions that really pay off. Continuously measuring the success of the project, sharing what has been learned and ideally further improving the company's offerings, the company itself and the new circular ecosystem.

That is what Schoeller did. At first, they looked for an exchange with key companies from a technical perspective (yarn, membrane, and clothing manufacturers), which inspired them to become partners in the *wear2wear™* ecosystem. Then, even before the circular ecosystem was complete, they started

with the first prototypes of recyclable yarns and fabrics. After successful testing, they were able to gain CWS, an established German manufacturer of work wear, as a partner for the ecosystem and thus scale their solution. Now, the entire ecosystem benefits from the extensive customer contact of CWS and its already existing (reverse) logistics infrastructure, as well as its knowledge about monetization strategies. To close the cycle, they acquired Decontex, a cleaning company that uses liquid CO_2, as well as a dismantling and recycling company. This will help them remove potential toxicity and enable the recycling of garments.

"I strongly believe in the cooperation of companies. I call it the integrated textile line." (Tommy Verminck, Decontex)

It is time to act: Incremental changes in our business operations and marginal efficiency gains are no longer sufficient for companies willing to address the world's problems. If we intend to take seriously the alarming reports of climate change, the crossing of planetary boundaries and the increasing deterioration of resource valuations, we need to stop doing business as usual. Different paths lead to the design of a circular ecosystem. The benefits for society, the environment, and the companies themselves would be immense. Be inspired to initiate a circular innovation process. All interviews and discussions we held with company representatives revealed that technical barriers towards CE are relatively small or non-existent. Much more critical obstacles are corporate culture or attitudes towards change—we take this as a highly inspiring sign. Cultural obstacles should be taken seriously, but they can be overcome. Taking this into account, there is no need to wait for new technical innovations; we can begin today. The planet does not care about intentions. A simple question can be the starting point for your company: *What would you do differently today if you were responsible for taking back all the products you sold?* Internalizing responsibility means standing up for one's own activities. This will build the path to comprehensive sustainability. CE, as a fundamental change in the way we deal with resources, offers the needed tools.

4.10 Appendix I: Circular ecosystem patterns

4.10.1 Close the Loop (C)

Table 4 Overview of the Close the Loop patterns

No	Pattern Name	Case Companies	Pattern Description	Literature
C1	Product-Reuse	Bee's Wrap; ReCup; Dopper	The product-reuse pattern describes the reuse of products for the purpose for which they were designed. Reuse is one of the most environmentally friendly options for closing the cycle. Product reuse effectively preserves the manpower, materials, capital, and energy used to produce the product while preventing further negative externalities (e.g., emissions of CO_2 or toxic substances).	(Ranta et al., 2017) (Ellen MacArthur Foundation, 2013) (Geyer and Jackson, 2004) (King et al., 2006)
C2	Part-Reuse	Apple Certified Refurbished; Bosch eXchange	The part-reuse pattern represents a process by which used products are collected and disassembled. These parts are then either repaired or directly used to create the same or a different product. The result can be a refurbished or remanufactured product that is sold cheaper, an upgraded product with a higher quality (technologically or aesthetically) or a completely different and *new* product. This saves a proportion of the original energy and labour that went into the production of the part.	(Wells and Seitz, 2005) (Korhonen et al., 2018c) (Reichel et al., 2016) (Ellen MacArthur Foundation, 2013) (Moreno et al., 2016) (Potting et al., 2017) (Bakker et al., 2014b)
C3	Re-& Up-cycling	Bionic Yarn; FREITAG; I:CO	Recycling and upcycling are about maintaining or improving the material value by mechanically or chemically converting *waste* products or materials into new materials or products. This enables a cyclical flow of resources,	(Bocken et al., 2016) (Braungart et al., 2007) (Geyer and Jackson, 2004) (Planing,

			preserves the value of the material, and even supports the production of products with higher value.	2015) (Kalmykova et al., 2018)
C4	Intelligent Assembly & Modularization	Fairphone; Shift GmbH; ClickBrick	Intelligent Assembly and modularization describe a design pattern that is a prerequisite for further steps towards a CE. Because design influences and significantly shapes all phases of the CE, an intelligent design can use modularity, and reversible connection techniques while avoiding mixed materials to simplify assembly, improve the repair during the use phase and facilitate the disassembly of the product at the end of its life cycle.	(Vanner et al., 2014) (Bogue, 2007) (Moreno et al., 2016) (Crowther, 1999) (Zussman et al., 1994) (Desai and Mital, 2005)
C5	Biodegradability	Plantastic; Compostella; Dell	Biodegradability describes the effort to shift the resource composition of products towards degradation or, even better, composting in nature. On the one hand, this requires a product design that focuses on biodegradable, safe and healthy materials; on the other hand, it must be ensured that these biological resources can safely return to the biosphere and thus become valuable biochemical starting nutrients for a new cycle (e.g., via composting).	(Braungart et al., 2007) (Moreno et al., 2016) (Hopewell et al., 2009) (Ellen MacArthur Foundation, 2013) (Lüdeke-Freund et al., 2018b) (Bocken et al., 2016)
C6	Waste as Input	Full Cycle Bioplastic; Marmite; Pentatonic	Waste as an input aims to search for and develop new, ecologically, and socially reasonable sources for used resources, by-products, and postconsumer waste. The goal is to stop using classic virgin resources. Material that seems worthless at first can thus be given new value.	(Chertow, 2000) (Lombardi and Laybourn, 2012) (Bisgaard et al., 2012) (Clinton and Whisnant, 2014)

C7	Reverse Logistics	Cycleon; Wastebox; Resourcify	Reverse logistics includes all the logistical processes necessary for closing a loop by returning the products or materials after the use phase. This involves a comprehensive perspective on the processes relating to collection, transport, storage, handling, and selection, as well as the sorting out of products or product components. In addition, environmental externalities should be minimized by optimizing factors such as the vehicles used, the choice of fuel or route planning.	(Kumar and Putnam, 2008) (Govindan et al., 2015) (Woodburn and Whiteing, 2010) (Vermeulen and Ras, 2006) (Linton et al., 2007) (Velis, 2015) (Govindan and Soleimani, 2017)

4.10.2 Improve the loop (I)

Table 5 Overview of the Improve the Loop patterns

No	Pattern Name	Case Companies	Pattern Description	Literature
I1	Increased Longevity	Cutco; Davek; Feetures	This pattern aims to prevent planned obsolescence and extend the product lifetime. This can be achieved with product-related changes (e.g., surface hardening, reduction of wear parts) design changes (e.g., modular product structure, timeless look) or changes to the positioning and marketing (e.g., branding, quality, creation of customer awareness).	(Allwood et al., 2011) (Andrews, 2015) (Packard, 1960) (Bakker et al., 2014b) (Bocken et al., 2016)
I2	Repair & Maintenance	Nudie Jeans, V-Zug; Agito Medical	This pattern describes the maintenance, early recognition of defects and repair of products during the use phase to enable the longest possible product life cycle. This is generally regarded as one of the most environmentally friendly and efficient measures in the	(Allwood et al., 2011) (Bocken et al., 2017) (Iung and Levrat, 2014) (Ajukumar and Gandhi, 2013) (King

			CE to reduce overall resource consumption; it often influences the handling of warranties, changes to the product quality and construction and the involvement of customers in the process.	et al., 2006) (Bakker et al., 2014b)
I3	Smart Assets	Arup; Angaza	A problem for the CE is the lack of producer knowledge about the condition and location of their sold products. The increasing, area-wide interconnection of intelligent assets and Internet of Things devices with sensor technologies creates transparency, simplifies the traceability of products or resource units, and enables data-driven decision making. This simplifies patterns such as maintenance and repair and enables take-back systems.	(Ellen MacArthur Foundation, 2016) (Bradley et al., 2013) (Bughin et al., 2010) (Gholami et al., 2016)
I4	Eco-Efficiency	Interface; 3M	This pattern is about minimizing the resource inputs needed for the manufacturing of products and the providing of services, thereby improving eco-efficiency. The fewer resources required, the less waste, emissions and pollution are generated during the production of the product. The resulting cost savings through reduced resource use, waste reduction and increased environmental sustainability can lead to increased revenues and competitive advantages.	(Allione et al., 2012) (Evans and Bocken, 2014) (Kalmykova et al., 2018) (Ayres et al., 1997)
I5	De-Materialization	Blueland; Skipping Rocks Lab; Evoware	De-materialization aims to create products that require less or no material. This can be achieved by intelligent product design that allows to remove certain materials or parts from a product while maintaining the functionality. Alternatively, technological progress enables	(Evans and Bocken, 2014) (Kuta et al., 1995) (WRAP, 2019) (Lewandowski, 2016) (van Renswoude et

			the creation of a digital variant of a physical product or service that allows for the reduction of even more resource use and environmental externalities.	al., 2015) (Ellen MacArthur Foundation, 2015b)
I6	Eco-Materials & Sourcing	Adnams; Allbirds;Veja	This pattern describes the reduction of environmental impact through the use of environmentally friendly eco-materials (e.g., fiber-based materials or eco-cement). These materials reduce the environmental load along the whole life cycle while maintaining a comparable performance. These materials often already exist but are not affordable or procurable in desired quantities. Attention must also be paid to the way in which raw materials or product components are sourced.	(Kalmykova et al., 2018) (Vanner et al., 2014) (Lüdeke-Freund et al., 2018a) (Lacy et al., 2014) (Ghisellini et al., 2016) (Seuring and Müller, 2008)
I7	Increased Function-ality	Hinter-her.com; Dr.Bonner; Apple Watch	By adjusting and integrating additional product functionalities into one product, the manufacturing of new products can be minimized. The efficient combination of functions can save resources in production because less products need to be produced.	(Lewis et al., 2010) (Bocken et al., 2014) (Bisgaard et al., 2012)
I8	Local-ization	Infarm; Rotterzwam; Wasser für Wasser	This pattern describes a holistic view of how a company—or a circular ecosystem—is embedded in a geographical context. The use of local resources in a geographically close environment reduces the negative environmental impacts and energy consumption (through e.g., reduced logistical effort). The company can also increase control over its resource procurement.	(Despeisse et al., 2012) (Despeisse et al., 2017) (Lüdeke-Freund et al., 2018a) (Bocken et al., 2014) (Korhonen, 2004) (Gibbs and Deutz, 2007)

I9	Produce on Demand	Tesla; Books-on-demand	Produce on demand looks for solutions so that products are only manufactured when consumer demand has been quantified and confirmed. This can reduce overproduction, unsaleable stocks, and the inefficient use of resources. By using Internet platforms, customer preferences can be clarified in advance. This also makes it possible to include customers in the development phase.	(van Renswoude et al., 2015) (Datta and Roy, 2011) (Clinton and Whisnant, 2014) (Bocken et al., 2014) (Lüdeke-Freund et al., 2018a)
I10	Detox	S.C. Johnson; MUD Jeans; Better Life	This pattern describes the elimination of toxic substances from products and services that harm natural ecosystems. This not only involves the product itself, but all the processes and activities associated with the creation and use of it. Detoxification also includes focusing on the supply chains of the suppliers and their production methods.	(Rockström et al., 2009a) (Starik and Kanashiro, 2013) (Djuric Ilic et al., 2018) (Bocken et al., 2014) (Ellen MacArthur Foundation, 2015a)
I11	Energy Recovery	HomeBiogas; Fiberight; Plastic2Oil	Energy recovery describes the conversion processes and the steps required to convert waste materials into usable heat, electricity, or fuel. This can be done by incineration, anaerobic digestion, or biomass gasification. It is important to note that the mere reuse of the energy content stored in the material through so-called *thermal recycling* cannot be regarded as circular. Energy Recovery opens new sources of income for companies and reduces waste costs.	(Kalmykova et al., 2018) (Bocken et al., 2016) (Hopewell et al., 2009) (Haupt et al., 2017) (Reh, 2013)
I12	Renewable Energy	LEGO Group; Bio familia; Biobean	This pattern covers all the solutions for the production, purchase and use of energy from renewable sources (solar, hydro, geothermal, wind and	(Ghisellini et al., 2016) (Ellen MacArthur Foundation,

		biomass-energy). This also includes the sustainable use of energy as a resource in the manufacturing of products or services (e.g., energy efficiency).	2013) (Preston, 2012) (Geng et al., 2014) (Lüdeke-Freund, 2009)

4.10.3 Monetize the loop (M)

Table 6 Overview of the Monetize the Loop patterns

No	Pattern Name	Case Companies	Pattern Description	Literature
M1	Pay per Use	Zipcar; Share Now	Pay per use describes a revenue model in which customers no longer buy products in the traditional way but agree on a usage fee with the providers on a contractual basis. The product or service use by the consumer is measured based on a specified metric such as time or unit count. This metric serves as the basis for the payment, increasing the consumer's incentive for more efficient and economical use.	(Lüdeke-Freund et al., 2018b) (Kley et al., 2011) (Bocken et al., 2014) (Tukker, 2015) (Gassmann et al., 2014) (Frishammar and Parida, 2019) (van Eijk, 2015)
M2	Rent instead of Buy	Leihbar; Rent the Runway; Islabikes	The customer does not buy a product but instead rents it. This lowers the capital typically needed to gain access to the product. The company itself benefits from higher profits on each product because the company is paid for the duration of the rental period. Both parties benefit from higher efficiency in product utilization as time of non-usage, which unnecessarily binds capital and resources, is reduced for each product. In addition, keeping ownership allows companies to retain access of them, simplifying their reuse, or recycling.	(Tukker, 2015) (Cohen and Kietzmann, 2014) (Teece, 2010) (Knox and Eliashberg, 2009) (Agrawal et al., 2012)

M3	Performance-based Contracting	Signify; Rolls Royce; Xerox	Performance-based contracting enables companies to deliver a comprehensive service promise to their customers, considering the necessary contractual and revenue-relevant factors. The offer is aimed at providing a desired outcome or performance instead of purchasing of a product. Thus, the transfer of ownership from producers to users is avoided; producers retrain the value of the product and material.	(Gordon et al., 2019) (Tukker, 2004) (Tukker, 2015) (Chesbrough and Rosenbloom, 2002) (Hypko et al., 2010) (Datta and Roy, 2011) (Besch, 2005)
M4	Subscription	Bio Bouquet; Vigga; Swapfiets	This pattern allows customers to purchase products or services by regularly paying a predefined fee. The advantage for customers is that they do not have to worry about buying products or services (time saving). It can also increase the motivation to purchase sustainable products by critical customers, thus lowering entry barriers. A regular subscription fee can be cheaper than buying the product at once or several times (money saving). For companies, on the other hand, it enables regular and predictable revenues and the development of a long-term customer relationship.	(Pauwels and Weiss, 2008) (Linder and Williander, 2017a) (Danaher, 2002) (Lüdeke-Freund et al., 2018a)
M5	Fractionalized Ownership	The Hideaways Club; Absolute Fractionals; Mobility	Fractionalized ownership is suitable for products or services that are cost-intensive and hence deter customers from purchasing them. Fractionalized ownership allows the customer to purchase only a portion of the entire product and share it with others. Usually, this happens in a kind of association, where each customer receives predefined access. In this way, access to sustainable products	(Gassmann et al., 2014) (Haws and Bearden, 2006)

			and services for customers can be simplified and possible prejudices reduced because different customers *acquire* or *use* the products together.	
M6	Dynamic Pricing	Octupus Energy; Wasteless	Dynamic pricing describes a type of price management that flexibly structures the pricing of products or services. This allows for quickly reacting to demand or competition and reducing stocks or preventing waste. This pattern requires a high degree of knowledge about its own products and good data processing. It also allows for optimizing capacity utilization and preventing inefficiencies.	(Gallego and Ryzin, 1994) (Elmaghraby and Keskinocak, 2003) (Kannan and Kopalle, 2001) (Faruqui and George, 2005) (Haws and Bearden, 2006)
M7	Revenue Sharing	klickrent; Fairmondo	Revenue sharing refers to a firm's practice of sharing revenues with their stake-holders, such as complementors or even rivals. Because the CE can only be achieved in a circular ecosystem, this pattern allows the sharing of the additionally generated profits among the partners. This helps to create commitment in long-term circular partnership.	(Gassmann et al., 2014) (Cachon and Lariviere, 2005) (Yao et al., 2008) (Wang et al., 2004)
M8	Crowd-funding	Bettervest; Pilzkiste	A crowd of investors who wish to support an underlying idea, typically via the Internet, finances a product, a project or entire start-up. Because of the strong intrinsic motivation to realize CE solutions, crowdfunding is a suitable approach to finance the development of new, sustainable products or services, especially because of the growing public awareness.	(Vanner et al., 2014) (Fischer and Achterberg, 2016) (Achterberg and van Tilburg, 2016) (Rizos et al., 2016)
M9	Take-Back	Eileen Fisher; Lush; Apple	Crucial to the success of the CE is how products find their way from the hands of the users into	(Quariguasi Frota Neto and van

		the *Recover* phase. Without contractual agreements in place, an incentivized take-back should be in place. Two incentive systems are common: the producer charges a deposit that is paid back when the product is returned, or the producer buys back the product once the customer no longer wants to own it.	Wassenhove, 2013) (Klausner and Hendrickson, 2000) (Heese et al., 2005) (Lüdeke-Freund et al., 2018a) (Lewandowski , 2016) (Spicer and Johnson, 2004)

4.10.4 Excite the loop (E)

Table 7 Overview of the Excite the Loop patterns

No	Pattern Name	Case Companies	Pattern Description	Literature
E1	Servitisation	Burba; Michelin	Servitisation describes the combination of an intangible service and a tangible product with the aim of comprehensively satisfying the final user's needs and intensifying the relationship with the end user. Currently, this is often achieved by modern technologies such as Big Data and the Internet of Things, which enable more efficient and satisfying offerings via data collection and analysis. Product ownership remains with the producers and increases their incentive for long-lasting products, which serves as a strong selling point for customers because since costs and effort can be reduced over the entire life cycle.	(Nobre and Tavares, 2017) (Ellen MacArthur Foundation, 2016) (Jabbour et al., 2019) (Spring and Araujo, 2017) (Chen et al., 2008)
E2	Mass Customisation	Paris Miki; MyMuesli; My Esel	The approach of modular products and production systems has enabled the efficient and price-competitive individualization of products. Meeting individual customer	(Choi, 2013) (Hora et al., 2016) (Boër et al., 2013) (Hankammer

			needs can support to stimulate the demand for circular products. The goal is to fulfil engineering and customer requirements, as well as circular and economic constraints.	and Steiner, 2015)
E3	Circu-Luxury	Stella McCartney; Charlotte Bialas; Elvis & Kresse	This pattern describes the strategy with which companies can offer their customers high-end sustainable and circular solutions and, in contrast, demand a maximum price. This is about stimulating the customer's need to own an exquisite circular product. The typical target is the growing market of young, urban, and sustainable consumers who want to put quality before quantity and make a statement against the disposable and consumer society with their exclusive consumption.	(Bocken et al., 2016) (Gassmann et al., 2014) (Frishammar and Parida, 2019) (Franco, 2017a)
E4	Experience Selling	Patagonia; Vermont Teddy Bear; Polar Bottle	The value of a product or service is increased with the customer experience offered with it. Sustainable and circular products can especially benefit from an improved experience because this can increase the demand for the product and further differentiate the offering from the competition. This means that the customer experience must be adapted in accordance with the proposed value proposition (e.g., by attuning promotion, shop).	(Tynan and McKechnie, 2009) (Helkkula et al., 2012) (Pine and Gilmore, 1998) (Poulsson and Kale, 2004)
E5	Marketplace	TUTAKA; Clothing Exchange; Home Exchange	A marketplace facilitates interactions between multiple interdependent groups of customers. The value of the platform increases as more groups or individual members use it. The two sides usually come from distinguished	(Clinton and Whisnant, 2014) (Lüdeke-Freund et al., 2018a)

			groups (e.g., businesses and private interest groups).	
E6	Prosumer	PlasticBank; Screenmend; iFixit;	Users have a powerful potential to (co)create innovative products, especially for products with a sustainable character. The prosumer pattern describes opportunities that motivate and empower consumers to become producers and to integrate themselves into value creation and preservation. This can also be done by enabling them to repair, maintain or execute reverse logistics themselves. This is particularly suitable for environmentally aware consumers who wish to conserve resources through their commitment. As a result, companies have lower investment costs for production and less overhead. This also increases the perceived benefit for consumers.	(Lüdeke-Freund et al., 2018b) (Zhong and Pearce, 2018) (Prendeville et al., 2016) (Jacobs, 2016)
E7	Eco Lock-in	Epson; TIO Care	Customers are locked into a vendor's world of products and services, which allows to establish a sustainable and circular solution. Using another vendor is not desired because this would reduce the sustainability advantages. This lock-in can be strengthened by technological mechanisms or the substantial interdependencies of products or services.	(Planing, 2015) (Lüdeke-Freund et al., 2018a) (Bakker et al., 2014a) (Bakker et al., 2014b) (Lewandowski, 2016)
E8	Communicate Responsibility	Pad & Quill; Flint and Tinder; Global Sustainable Enterprise System (GSES)	A producer taking responsibility for the full life cycle of their products is the basis for the CE. To facilitate achieving this in a profitable way, the sustainable approach can be signaled to the market. Typically, this includes certificating the products,	(Wijethilake, 2017) (Spicer and Johnson, 2004) (Armstrong et al., 2015) (Joyce and Paquin, 2016)

			giving long guarantees or committing to taking the product back via predefined channels. Through education, producers can increase the sustainable action taken by partners, employees, and consumers.	
E9	Sharing	TrendSales; Dropbox; Sharely	Sharing helps where products are either used too little and thus inefficiently or where consumers even refrain from purchasing them. The aim is to be able to share products between different users and ensure that they no longer have to spend money on purchasing them, only on using them. Companies that offer sharing solutions can thus increase utilization rates and the sustainability of the products, while users have to pay less for the same benefit.	(Cohen and Kietzmann, 2014) (Heinrichs, 2013) (Botsman and Rogers, 2010) (Firnkorn and Müller, 2011) (Dreyer et al., 2017) (Lüdeke-Freund et al., 2018a)
E10	Robin Hood	Toms; NIKIN, Robin Hood Energy	The same product or service is provided to *the rich* at a much higher price than to *the poor*. Thus, the main bulk of profits are generated from the rich customer base. Serving 'the poor' is not profitable per se but creates economies of scale that other providers cannot achieve. In addition, for the CE, this could be achieved by giving *the poor* access to refurbished or reused products while extending the life cycle.	(Gassmann et al., 2014) (Hiteva and Sovacool, 2017)

4.11 Appendix II: Journey through the wear2wear ecosystem

Observing this first-in-class approach allows us to gain insights into a concrete CE realization, illustrating the interplay of companies and their BMs along a circular ecosystem and showcasing the application of the patterns (Figure 11).

The journey starts with the yarn producers. In the beginning, there is no input from the *Recover* phase because the cycle has not started yet. *wear2wear™* opted for the usage of recycled polyester from used PET bottles to start the resource flow *(C6: Waste as Input)*. They guarantee clean PET that would not be contaminated with toxic substances and purchased only from safe, local bottle suppliers *(I10: Detox, I8: Localisation)*. They produce the yarn under high qualitative polyester manufacturing procedures with reduced antimony use *(I4: Eco-Efficiency, I10: Detox)*. Not yet realized, but an option for the future is the insertion of markers via additives into the polymer to increase the traceability of the material for quality control at recovery *(I3: Smart Assets)*.

Using these yarns, the fabric producer manufactures a functional fabric, coated FC-free, and brings it together with water-repellent membranes *(I10: Detox)*. They do not use mixed materials – no cotton/ polyester blend that would be difficult to recycle – thus enabling a straightforward recycling process in which the garments can be melted down into one piece thanks to a uniform melting point of all the membranes and fabrics *(C4: Intelligent Assembly & Modularization)*. The final fabrics are of high quality and designed for long and durable use *(I1: Increased Longevity)*. Here, efficient production facilities and internal factory cycles, such as for the reprocessing of dyestuffs, increase the sustainability of the whole process *(I4: Eco-Efficiency)*. The revenue between these steps is generated by product selling.

In the next step, the manufacturer of the garments design and tailors the work wear on a recycling-based concept and avoids unnecessary buttons, zippers, or trimmings *(I5: De-Materialization)*; they rely on solvable sewing threads,

which facilitate the removal of zippers and hook-and-loop fasteners during recovery and thus allow for an easier disassembly in the *Recover* phase *(C4: Intelligent Assembly & Modularization)*. This additionally simplifies repairs during the *Use* phase *(I2: Repair & Maintenance)*. If desired by the user, they can also work in radio frequency identification (RFID) codes for traceability, which helps to monitor the garments during the *Use* phase and to take back the right garments with ensured material quality *(I3: Smart Assets, E1: Servitisation).*

The garment manufacturer acts as the interface with the customer, focusing on the design of the revenue model in combination with contractually fixed take-back (M9: *Take-Back*). Therefore, they keep ownership and hand over the garments in a rental relationship to the customers (M2: *Rent instead of Buy*). This simplifies the correct washing, maintenance, and repair of the garments *(I2: Repair & Maintenance).* When they collect the garments for regular washing, they immediately check for faults and repair them. During or after the *Use* phase, *wear2wear™* can offer a specialized cleaning process that allows for the cleaning contaminated garments with liquid CO_2, which is more energy-efficient and uses less water *(I10: Detox, I4: Eco-Efficiency)*. After using the work wear, the institutions collect the garments from their workforce, and the producer retrieves them in *boxes (C7: Reverse Logistics)*, evaluates them and sends them to the disassembly. The recycler then removes everything that is unusable for the polymer recycling process (e.g., metals, zippers, etc.) and melts the garments for further processing into granules and filaments *(C3: Re- & Upcycling)*. The recovered material now flows into a new cycle and thus reduces the inflow of used PET bottles.

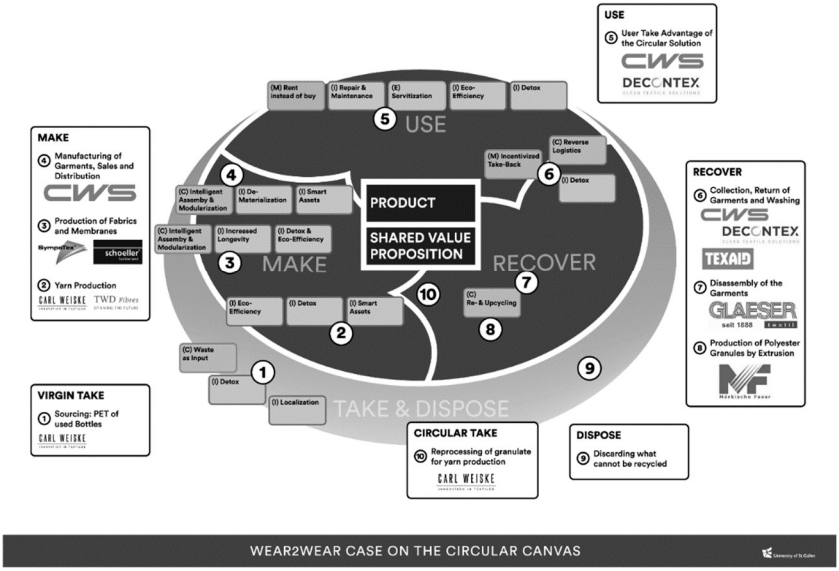

Figure 11 wear2wear™ case on the Circular Canvas

5. Paper C: Managerial and organizational antecedents of business model innovation for a circular economy

Status: Published on the research platform *Alexandria* (21.12.2021); Institute of Management & Strategy, University of St. Gallen

Abstract: Today's economic system and the companies operating within it are strongly oriented toward a linear pattern of value creation in which raw materials are extracted from the earth, products are manufactured, sold to customers, and end up as waste. This economic linearity causes material waste, global warming, and other environmental degradation. There is increasing pressure being put on companies to implement sustainable, material-conserving BMs. An economical alternative is a CE in which companies focus on closed material loops implemented with so-called CBMs. Although some research has been done in this field, there is still a significant research gap regarding the company-internal driving factors that facilitate the implementation of CBMs. This current study involved conducting interviews with 59 Swiss managers of SMEs from three industries: food and beverage, textile, and logistics. Helped by an inductive grounded theory approach, five managerial and five organizational drivers were identified and analyzed first. In the second step, the concept of DCs was used to explain the possible influence of drivers on the creation of CBMs conceptually and with reference to data. This study shows which company-internal drivers can act as antecedents of CBM innovation in the entrepreneurial context and how they can affect the higher-order DCs of sensing, seizing, and transforming, according to Teece (2007). This current study contributes to the analysis of factors that stimulate economic transformation toward a CE from a company perspective.

Keywords: Circular economy, Drivers, Dynamic capabilities, SMEs, Entrepreneurship

5.1 Introduction

The business environment is changing rapidly due to increasing environmental problems. Societal, regulatory, technological, and market realities are becoming increasingly dynamic. The start of the 21st century heralded a change in the environmental-organizational relationship and pushed the issue of sustainability regarding materials use, pollution, and climate change onto the agenda of companies' strategic management (Dyllick and Hockerts, 2002; Stead and Stead, 2008). A frightening picture of the state of our planet has emerged; six of the nine planetary boundaries defining the safe operating space for humanity have already been exceeded (Rockström et al., 2009a; Steffen et al., 2015). Massive volumes of solid waste end up in nature (Kaza et al., 2018), extremely high amounts of greenhouse gas emissions are emitted (NASA, 2019), and virgin materials are overexploited (Ashby, 2013). Consequently, companies face an increasingly pressurized stakeholder environment and feel the need to react as society demands solutions, and consumers are progressively asking for more sustainable products (Jakhar, 2017; Sarkis et al., 2010). Governments are increasingly pressuring companies (Sachs et al., 2019), such as with recycling quotas or the EU ban on some single-use plastic products (European Commission, 2019b).

One of the most promising solutions to tackle environmental degradation is transforming today's linear economic system into a CE. CE focuses on a sustainable transformation regarding materials usage in manufacturing, consumption, and waste production—reducing and avoiding the negative effects of economic activities (Henry et al., 2020). CE covers all measures to close materials loops while increasing sustainability (Bocken et al., 2016; Ghisellini et al., 2016) and incorporating the limitation of the planetary system (Desing et al., 2020) . CE aims to keep products, components, and materials at the highest utility and value at all times, reduce waste, and increase the utilization of materials (Bocken et al., 2017).

These aspirations can be implemented at different levels, such as the business, legal, institutional, or consumer level (Kirchherr et al., 2017b). At the business level, CE is implemented via the transformation of companies' BMs toward CBMs (Frishammar and Parida, 2019), describing the rationales of how an organization creates, delivers, and captures value within closed material loops (Bakker et al., 2014a; Ghisellini et al., 2016). The interplay of different CBMs leads to a regenerative industrial economy, (re-)capturing the substantial volume of renewable and finite resources to use repeatedly (Ellen MacArthur Foundation, 2013). The innovation of CBMs affects product designs (Andrews, 2015; Kalmykova et al., 2018), value-creation and value-capture mechanisms (Takacs et al., 2020), and the activities and interactions of different actors along circular supply chains (Lüdeke-Freund et al., 2018b). Done effectively, this positively impacts the environment and leads to superior company performance. Prior research has shown that companies committing to sustainability and CE display better financial performance and long-term value creation for all stakeholders (Cantele and Zardini, 2018; Funk, 2003; Kiron et al., 2013, 2012).

While BM innovation has received much attention in management research (Chesbrough, 2010; Johnson et al., 2008; Wirtz et al., 2016), CBM innovation has received less attention. The former looks at how an organization can positively influence its own economic value; in contrast, CBM research takes a holistic view and includes environmental concerns (Antikainen and Valkokari, 2016). With a few exceptions (Bocken and Geradts, 2020; Frishammar and Parida, 2019; Tse et al., 2016), the management perspective on sustainability-driven BM innovation—such as that of CBMs—has rarely been taken. Foss and Saebi (2017) highlighted the need to clarify how managers can innovate their BMs for increased sustainability, and they systematically pointed out the importance of using the BM construct.

Even less attention has been paid to the managerial prerequisites of CBM innovation, and it is not fully understood what the antecedents are—especially

the company-internal drivers. In the management literature, there is a strong focus on external drivers, such as new technologies (Chesbrough and Rosenbloom, 2002; Zott et al., 2011), regulations (Saebi et al., 2017), and changes in a competitive or stakeholder environment (Amit and Zott, 2015; Wirtz et al., 2016). The company-internal antecedents of BM innovation in general and CE contexts have yet to be explored (Foss and Saebi, 2017). This current study aims to close this research gap by exploring the internal antecedents of CBM innovation; more specifically, the focus is on the role of (top) management in pursuing CBM innovation. Therefore, this paper uses the CE, DCs, and strategic entrepreneurship literature.

Foss and Saebi (2017) distinguished between the internal drivers of BM innovation and those related to the DC concept and open innovation. Here, the focus lies on DCs, a concept for analyzing the origins of value creation and value capture in organizations (Teece et al., 1997). It investigates how organizations can achieve different competitive advantages and performances despite similar environmental conditions, all following a resource-based view of a firm. The three higher-order DCs are at the heart of this, encompassing *sensing*, *seizing*, and *transforming* capabilities (Teece, 2007). These three DCs are particularly central for managers, as they are essential for discovering, innovating, selecting, and implementing BMs (Teece, 2018).

The concept of DC is also related to entrepreneurship and leadership, as entrepreneurial leaders influence the architecture of an organizations' capabilities (Schoemaker et al., 2018). Entrepreneurs play a central role in transforming and (re-)configuring organizational resources and routines (Zahra et al., 2006). Cullen and de Angelis (2021) highlighted the importance of combining entrepreneurship with the BM perspective in a targeted manner when implementing business solutions for closed material loops. Following Wang and Ahmed's (2007) research model, which focuses on the antecedents of DCs, and following the research of Bocken and Geradts (2020), which focuses on higher-order DCs in large incumbents in the context of sustainable

transformation, the focus here lies on the exploration of the antecedents of DCs in the context of CBMs. Therefore, this current study looks at company leaders and presents a *multilevel framework* that illustrates how the identified drivers affect three higher-order DCs and how they support the implementation of CBMs in practice.

Two research questions were derived from this:

(1) What company-internal drivers exist regarding implementing CBMs, and how can they be classified?

(2) How do identified drivers, as antecedents, affect the formation of higher-order DCs and, consequently, the creation of CBMs?

A qualitative empirical design was chosen (Flick, 2009), giving meaning to the abstract higher-order DCs of sensing, seizing, and transforming. A broad database consisting of semi-structured interviews with (top-level) managers helps identify company-internal drivers for implementing CBMs and supports the explanation of possible relationships between these drivers and higher-order DCs. The data were examined using an inductive grounded theory approach (Corbin and Strauss, 1990; Glaser and Strauss, 1967). The research team interviewed 59 company managers of Swiss SMEs in three industries: food and beverage, textile, and logistics. SMEs are central to the far-reaching transformation toward a CE, as they account for 99.8% of all companies in the EU-28 non-financial business sector and employ 93 million people (Muller et al., 2017).

This study contributes to the literature and to practice. First, it enriches the research on CBM innovation because it addresses the intersection of BMs and management. Second, it specifies the role of company-internal antecedents in CBM innovation by exploring the roles of strategic leaders and organizational factors. Third, it contributes to the entrepreneurship literature by specifying the roles of strategic leaders in BM transformations and by bringing together the driving factors for sustainable change with the concept of DC. This study also

elaborates on conceptual relationship between drivers and DCs important for CBM innovation as propositions—supported by the literature and the data, which are ready to be tested in further quantitative investigations.

Research in this field has yet to fully discover the role of strategic leaders in sustainable transformations, focusing on economic benefits and environmental outputs, which adds exciting insights to strategic entrepreneurship research. Our research follows the call of the literature to explore, in general and across sectors, how CE solutions can be enabled (Kirchherr et al., 2018; Ormazabal et al., 2017) and to identify suitable drivers that enable DCs to create sustainable entrepreneurial solutions in the form of CBMs (Amui et al., 2017; Bocken and Geradts, 2020).

5.2 Concept and theory

5.2.1 Business models for a circular economy

CE as a comprehensive model for (re)designing the economic system has become widely appreciated and recognized in practice and politics (European Commission, 2018; Ghisellini et al., 2016; Kirchherr et al., 2017b). Implementing a CE should lead to a regenerative industrial economy, (re)capturing the enormous volume of finite and renewable materials to use them again and again, thereby internalizing the negative externalities of economic actions (Desing et al., 2021; Ellen MacArthur Foundation, 2013). The generic goal is to keep products, components, and materials at their maximum utilities and values (Bocken et al., 2017). A CE can be implemented at different levels in the socioeconomic system, such as via changes in consumer's behaviors, via legislative reforms (Desing et al., 2020), or at the entrepreneurial level via BMs (Geissdoerfer et al., 2018; Lüdeke-Freund et al., 2018b). Necessary adjustments at the entrepreneurial level often require comprehensive strategic renewal and reallocation of resources in terms of technologies, collaborations, processes, or human capital (Braungart et al., 2007; Korhonen et al., 2018a; Lieder et al., 2017).

The BM concept, in its classic view, provides a heuristic logic that links technical potential to realizing economic value intended to survive in a market (Chesbrough and Rosenbloom, 2002). BMs can emerge implicitly from operational activities and explicitly from entrepreneurial intentions (Teece, 2010), which helps explain different performances and innovations (Lambert and Davidson, 2013). It is an architectural illustration of various factors relevant to a business, such as a product, information flow, or revenue source (Timmers, 1998).

Closely related to strategic management is the renewal of BMs, as they often run in parallel with established and already operating BMs (Markides and Charitou, 2004). This current study builds on Gassmann et al.'s (2014) classical perspective on BMs. They defined BMs along the dimensions of value proposition, value creation, customers, and revenue model. This is enriched with the conceptual considerations of a CE, which state that CBMs serve the implementation of closed and sustainable material loops (Ghisellini et al., 2016). Although the design and conceptualization of a CE in general and CBMs in particular are described differently by authors (Kirchherr et al., 2017b), they all build on a convergence of natural-scientific and business-organizational perspectives. The material-science understanding of economic activities and value-creation processes has been inspired by the work of environmental economists Pearce and Turner (1989), industrial ecologists (Erkman, 1997), the industrial cradle-to-cradle standard (Braungart et al., 2007), and the publications of the Ellen MacArthur Foundation (2013).

There are different ways to classify the business-operational implementation of CE: along with BM dimensions of value proposition, delivery, creation, and capture (Lüdeke-Freund et al., 2018b; Whalen, 2019), along with the ReSOLVE model of regeneration, sharing, optimization, loop, virtualization, and exchange (Ellen MacArthur Foundation, 2015a; Jabbour et al., 2019), or along with re-strategies based on CE measures such as reuse, recycling, or refurbishment (Linder and Williander, 2017b; Sihvonen and Ritola, 2015). BM

innovation for a CE can cause design reconfiguration in the production, distribution, use, and recovery processes to keep materials in a loop and minimize energy use (Bocken et al., 2014; Wells and Seitz, 2005; Winkler, 2011).

To reduce complexity in data collection, a general definition of CE is used:

"A CE describes an economic system that is based on BMs which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations." (Kirchherr et al., 2017, p.224)

Derived from that, this current study implicitly assumes that CBMs can be composed of different patterns (Frankenberger et al., 2021; Takacs et al., 2020). These patterns comprise different measures tailored to a CE along the dimensions of closing a loop (e.g., recycling, circular design), improving a loop (e.g., increased longevity, renewable energies), monetizing a loop (e.g., performance-based contracting, incentivized take-back), and exciting a loop (e.g., sharing, mass customization).

5.2.2 Entrepreneurship in SMEs for a circular economy

This paper builds on over two decades of entrepreneurship research and brings it together with CE and the concept of DCs. Entrepreneurship research addresses how (business) actors seek opportunities, create something new, and exploit opportunities (Venkataraman, 1997). Entrepreneurs intentionally deviate from existing ideas, frameworks, and rules to create new products, methods, and social norms (Webb et al., 2014). Teece (2016) described an entrepreneur's role as one that can best internalize higher-order DCs, take responsibility for sensing and seizing opportunities, and realize competitive

advantage by orchestrating resources. This understanding of entrepreneurship fits into the context of implementing a CBM in which a break with existing logics (linear versus circular) in production, consumption, and recovery processes is emerging, and a circular value proposition, created in cooperation with other companies, is being enforced (Desing et al., 2020; Frankenberger et al., 2021). The business implementation of a CE requires an entrepreneurial, innovative spirit (Zucchella and Urban, 2019).

This current study focuses on sustainable entrepreneurship with an environmental focus (Patzelt and Shepherd, 2011), aiming to implement a CBM, excluding research on social entrepreneurship (Zahra et al., 2008). Sustainability-driven entrepreneurism, such as circular entrepreneurs (Zucchella and Urban, 2019), describes individuals capable of identifying opportunities and successfully implementing their visions despite resource constraints, thus achieving sustainable improvements via their entrepreneurial activities (Keogh and Polonsky, 1998).

While environmental market failures are opportunities that sustainable entrepreneurs seek to generate economic and environmental benefits via their solutions (Dean and McMullen, 2007), they also trigger entrepreneurs to seek institutional solutions that facilitate the allocation of natural resources (Hall et al., 2010). Often, there is a focus on start-ups in entrepreneurial CE implementation (Bauwens et al., 2020). However, it is crucial to consider circular entrepreneurship detached from company form and size, which is much more characterized by entrepreneurial attitudes and capabilities, including incumbents (Henry et al., 2020; Teece, 2016).

In this current study, the focus is on already established SMEs. SMEs make an essential contribution to an economic transition to a CE due to their high occurrence—99.8% of all companies in the EU's non-financial sector (Muller et al., 2017)—and local integration, with a high degree of interaction with other actors (Rizos et al., 2015; Zamfir et al., 2017). SMEs often show high flexibility and adapt quickly to markets, making them extremely interesting

objects of study in the context of a CE (Koirala, 2018). In the Schumpeterian sense, managers of SMEs have great potential as entrepreneurs to develop technological and organizational innovation toward a CE (Hashi and Krasniqi, 2011). While SMEs need not have large market shares, they can indirectly contribute to the transformation of an economy via mechanisms such as providing a blueprint for other companies to replicate BMs (Schaltegger et al., 2016). Cullen and de Angelis (2021) described a circular entrepreneur as someone who explores and exploits the opportunities of a CE by innovating and implementing a CBM.

5.2.3 Dynamic capabilities in the context of a circular economy

The concept of DCs is a powerful approach for explaining and relating the source of value creation, competitiveness, and adaptability of companies in changing environments (Teece et al., 1997). While *dynamic* refers to the capacity to continuously align with a business environment, *capabilities* refer to the role of strategic management in adapting, integrating, and reconfiguring internal and external organizational skills, resources, and competencies (Teece et al., 1997). Theoretically grounded in the resource-based view of the firm, it seeks ways to explain how firms integrate, build, and reconfigure internal and external resources for entrepreneurial purposes (Eisenhardt and Martin, 2000). This includes a behavioral orientation involving integration, reconfiguration, recreation, and the improvement of resources and capacities to achieve a competitive advantage in a changing environment (Wang and Ahmed, 2007). Although DCs are often idiosyncratic and path dependent (Katkalo et al., 2010), commonalities and patterns can be noted across organizations (Eisenhardt and Martin, 2000). DCs also evolve from the routines that are learned. They become ingrained via repetitive use and tacit knowledge (Winter, 2003), from the analysis of decisions made, and from creative entrepreneurial activities (Katkalo et al., 2010).

DCs are the antecedent of organizational and strategic routines to change entrepreneurial resources and BMs. They help companies create, exploit, and

protect their market positions and assets and support long-term performance. The three capabilities of *sensing*, *seizing*, and *transforming* are highly relevant in the business context and are called higher-order DCs (Teece, 2007). *Sensing* describes the capability to evaluate opportunities, threats, and changes. It involves monitoring and exploring the environment. *Seizing* means exploiting identified opportunities, committing, investing resources, and refining and designing (circular) BMs. *Transforming* refers to reconfiguring entrepreneurial and external assets toward change, which allows for overcoming organizational path dependencies. Organizational processes help anchor these capabilities and discard them via recurring renewal processes and replace them with new ones (Teece, 2007; Teece et al., 1997; Zahra et al., 2006). These higher-order DCs include various entrepreneurial activities that affect product development, BM innovation, or the formation of partnerships (Schoemaker et al., 2018).

This current study builds on the ideas of Bocken and Geradts (2020), who analyzed the impact of strategic, institutional, and operational drivers as influencing factors on the three higher-order DCs in the context of managers in large incumbents dealing with sustainable BMs. Here, the focus is on drivers as antecedents of the three higher-order DCs (i.e., sensing, seizing, and transforming) in an entrepreneurial setting in which companies are implementing patterns of CBM. Being successful means managing the right capabilities to identify opportunities and allocate the proper resources to generate value (Kor et al., 2007), which can also be used as a research perspective in the context of a CE and DCs (Khan et al., 2020).

Figure 12 shows the conceptual relationship between the drivers to be explored, the higher-order DCs, and the implementation of CBMs.

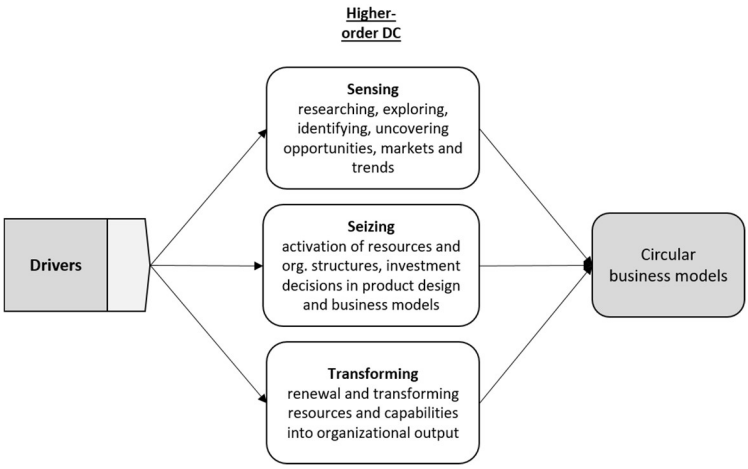

Figure 12 The relationship between drivers, higher-order DC, and CBM

5.3 Methodology and approach

This study builds on a qualitative research design with exploratory characteristics (Maxwell, 2009). The methodological goal was to develop a theory from the data material; therefore, an inductive grounded theory approach was used (Gioia et al., 2012; Strauss and Corbin, 1994). This was based on the assumption that the corporate world is socially constructed and that the individuals acting in this reality can consciously describe and reflect on it (Gioia et al., 2012).

5.3.1 Sampling and data collection

This paper covers two types of data: the literature and 59 semi-structured interviews. The literature research included comprehensive literature on academic, policy, and gray literature using different criteria to identify relevant research content in the field of CE (Saidani et al., 2019), as well as in the field of DCs, entrepreneurship, and SMEs on platforms such as JSTOR, Science Direct, SAGE Journals, Wiley Online Library, Emerald, and Google Scholar. The literature research allowed us to design an interview guide for the semi-structured interviews to get a sense of the subject matter.

All interviews were conducted with management representatives—CEOs, business owners, and founders—from Swiss SMEs between September 2018 and January 2019. The SME representatives represent three industries (i.e., food and beverage, textile, and logistics), which enables a broad picture of companies with exciting CE characteristics. In the food and beverage industry, packaging (Foschi and Bonoli, 2019; Geueke et al., 2018) and natural resources (Maxime et al., 2006) play central roles. The textile industry is more concerned with insufficiently developed material recycling and appropriate product designs (Ellen MacArthur Foundation, 2017). The logistics industry has an integral function in transporting materials and products in a CE, both upstream and downstream (Nadeem et al., 2017; Seroka-Stolka and Ociepa-Kubicka, 2019). Aligned with the European Union's definition of SME (10–250 employees), this research considered companies as SMEs with 8–250 employees (European Commission, 2003). Representative cases are found in companies with eight and nine employees, so this study included them because they are sufficiently large to represent a company with different activities, DCs, and resources. To ensure the homogeneity of each SME examined, only the Swiss part of companies with non-Swiss subsidiaries was considered.

This current work methodologically follows the work of Takacs et al. (2021), which relied on a purposeful sample (judgment sample) with a non-randomized sample of respondents (Marshall, 1996). This study drew on various lists in the data generation process, including those from official Swiss authorities; using snowball sampling for enrichment helped to include additional interviewees in the sample (Handcock and Gile, 2011). In the end, the study team approached 341 companies, of which 59 were interviewed (response rate: 17.3%) with a length between 30–60 minutes. Following Bowen (2008), the goal was to have the most comprehensive sample possible to obtain theoretical saturation during the data analysis. An overview of all interviewed representatives and information about their companies can be found in Table 1.

Based on the literature review, the research team developed an interview guide to gather as much consistent and comparable information from the interviews as possible (Meuser and Nagel, 2009). In the first step, the interviewee was asked to explain the essential aspects of the current BM along with the definition presented (Gassmann et al., 2014). Second, the definition of a CE (Kirchherr et al., 2017b) was presented and checked to determine whether the interviewees understood it. Based on this, the interviewed company representatives were asked about all the activities undertaken in the direction of a CBM and to indicate which factors and solutions helped introduce them and overcome barriers. Based on this, all the drivers that enable and facilitate the implementation of a CE in the entrepreneurial context were identified. Finally, critical data about the company were collected, which was done by telephone, recorded, and manually transcribed (verbatim).

5.3.2 Data analysis

The data were analyzed to identify the plethora of possible company-internal drivers of CBMs in the entrepreneurial context, in line with the research questions. This involved evaluating the statements made by the company representatives and the connections between the drivers, the higher-order DCs, and the implementation of CBMs.

The procedure consisted of two steps.

First, following the grounded theory approach inductively, a conceptual level was aimed at using the data (Corbin and Strauss, 1990; Gioia et al., 2012) to identify categories and concepts around drivers based on the data (Bogner et al., 2014). Data coding helps to transform raw data into theoretical constructions of social processes (Kendall, 1999). We coded analogously to the procedure in a partner study by Takacs et al. (2021) in which the focus was on barriers, specifically company-internal barriers. In contrast, all those dealing with government or legislation drivers, for example, were not considered here.

In a first-order analysis, codes describing drivers were formed close to the text using an open-coding approach, not aggregating categories but generating a wide range of descriptive codes (Hernandez, 2009). The result was a high number of first-order concepts (Gioia et al., 2012). This procedure involves ongoing, recurrent comparison at the data level, identifying, and conceptualizing similarities and differences between codes (Kendall, 1999), referred to as axial coding, which reduces the number of codes and sharpens the conceptualization (Corbin and Strauss, 1990). Based on this, theoretical codes were formed in second-order coding, called second-order themes, described as accurately as possible with the phrasal description, and, if necessary, reordered, and reclassified (Gioia et al., 2012). The number of codes diminished after this step revealed 10 drivers in the entrepreneurial context. To reach the aggregated level, these themes were assembled into core categories via selective coding—also called focused coding (Thornberg and Charmaz, 2014)—which ultimately resulted in two aggregated-level categories of drivers: managerial and organizational drivers. Before reaching the fifty-ninth interview, no new categories and themes emerged from the data; therefore, theoretical saturation could be considered a given (Bowen, 2008). Gioia et al. (2012) and Tracy (2010) highlighted the importance of creating a visual data structure to trace the data processing steps performed from raw data to aggregate levels, as shown in Figure 13.

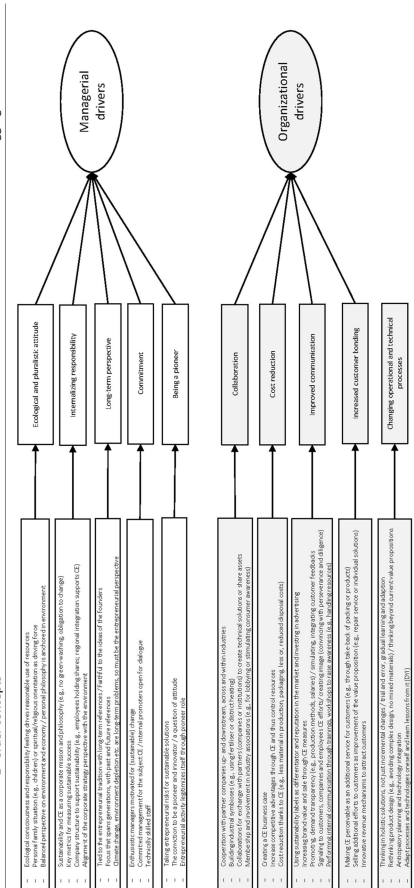

Figure 13 Visualization of the data structure. Adapted from Gioia et al. (2012)

Second, starting from the identified drivers, the relationships to the higher-order DCs of sensing, seizing, and transforming were elaborated upon conceptually. To do this, the author returned to the data by systematically examining the data fragments underlying the first-order concepts for connections to the DC literature. Due to the methodologically rigorous approach in the first step, all relevant data fragments were analytically separated (Saldana, 2009) and openly accessible for reexamination in the context of the DC concept. The data fragments underlying the first-order concepts were compared with the conceptual considerations underlying the higher-order DCs using qualitative content analysis to ensure the transferability of the findings (Elo et al., 2014). To illustrate the links between the drivers and the respective DCs of sensing, seizing, and transforming, representative quotes from the data are presented in the Discussion section.

5.4 Findings

This section presents the findings in line with the first research question. The identified managerial drivers are presented first, followed by the organizational drivers.

5.4.1 Managerial drivers

Table 8 lists representative quotes from the interviews for the identified managerial drivers, as well as a brief description.

Table 8 Managerial drivers

Driver Theme	Description of the Driver	Representative Quotes
(M1) Ecological and pluralistic attitude	This driver supports the transformation toward a CE, as personal values aligned with environmental principles can foster an integral understanding of the environment and economy and allow for	*mindset for the preservation of natural creation, as a corporate mission (02, 15); human sanity guides to the reasonable use of resources (04, 29); my ecological conscience: not only thinking economically (06, 21); my personal attitude: I also live this way in my private life, and I want to do the same in the company (14,*

	entrepreneurial impulses; family and spiritual-religious beliefs can support a positive attitude toward the environment; the need for coherence between personal attitude and entrepreneurial action and philosophy can also be a driving force.	*19); it unites us in the team, this philosophy that we are aware that our consumption has a powerful ecological impact (16, 25); I am the father of two children, by trying to preserve the earth that continues to be worth living for our successors (18, 52)*
(M2) Internalizing responsibility	Taking on entrepreneurial responsibility for sustainable transformation can have a driving effect on the implementation of a CE; the integration of sustainability can lead to a reformulation of a corporate mission, philosophy, or also to new organizational structures, processes, and key performance indicators that support the measurement of endeavors; it is also about understanding that corporate responsibility is more than green marketing.	*we do not pursue any kind of shareholder maximization (04, 29); this is important for us as an SME, we do not work with the cheaper ones, but we look for the best partners (08, 21); we measure the success of these measures with various key figures (09, 11); that is simply our basic idea, that is how we tick or have always ticked (15, 47); we do what we are convinced makes sense and is also verifiable, and we do not do things that are simply done for marketing purposes (19, 25); so we do not just have economic goals (21, 39); it is already a philosophy of our company over 15 years (29, 15)*
(M3) Long-term perspective	Climate change and environmental degradation are long-term problems whose mitigation is supported by a long-term entrepreneurial time perspective; it links past and future activities and enables an intergenerational understanding of	*we are a family business that is over 190 years old, the next generation is just around the corner, and the whole business cycle is set up for the very, very long term (01, 13); longstanding friendly relationships, this is also resource-saving (04, 29); produce over generations in such a way that the environment does not suffer damage (13, 17); we were always like that: we use as few resources as*

	solutions and problems; CE implementation can also be lengthy, fostered by persistence and longevity.	*possible [..] that is our basic idea (15, 47)*
(M4) Commitment	It has a driving effect when managers are involved who are enthusiastically committed to a change, have willpower and perseverance, and are backing it personally; this also includes properly trained (technical) staff.	*enthusiastic people who deal with this issue, push it through, all the way up to the top management, you need someone with the passion for doing this (02, 15); it always needs suggestions, questioning, and looking at how we can do it better (15, 51); in our management, we have committed ourselves to have environmental standards that we follow consistently in every possible way (19, 49); because we all feel that this topic moves us, that calls for innovative, new ideas and the corresponding resources (23, 13)*
(M5) Being a pioneer	The desire to be a pioneer has a driving effect; it also means the confidence to bear an entrepreneurial risk and to rate the benefits higher than the costs; it is also a question of risk aversion and entrepreneurial attitude, which legitimize actions.	*that is the brand's legitimacy, that is the philosophy of our founder, we were a pioneering company already in the 50s (21, 39); but if I do not do it, who will? A long journey begins with the first step, and if I think I can do something good, then the economic component is a natural result of that (23, 27); we are a bit of freak, maybe we have a particular pioneering role, and if not us, then who should do it? Someone must do it, and we have very few fears about doing specific things with partners (29, 26)*

Ecological and pluralistic attitude (M1): As the concept of a CE is demanding and difficult to implement, a supportive, ecological attitude is favorable for understanding the business advantages of a CBM, such as reduced price volatility and resource dependency. Ecological awareness and a sense of

responsibility among managers can support the reasonable use of resources in the entrepreneurial context. This relates to a balanced perception of the triple bottom line (Elkington, 1997) in which personal views toward the environment, economy, and social aspects appear to be aligned. Personal attachment to family, spirituality, or religion can also serve as a driving motivator. Organizational willingness to change and innovate can be explained and predicted by an individual's attitude toward innovation (Bhupendra and Sangle, 2015). A pluralistic entrepreneurial orientation defines the relationship between economic, ecological, and social responsibility more broadly and sees the starting and endpoints of economic activities embedded in multiple social and environmental concerns. This differs from a purely monistic economic orientation, which understands the economy as an end in itself (Bleicher and Abegglen, 2017). This is supported by the need to bring personal values into coherence with entrepreneurial activities.

Internalizing responsibility (M2): This is about the managerial obligation to address environmental problems corporately and develop solutions. This can be reflected in a managers' philosophy, corporate culture, or vision and mission. Taking responsibility drives a strategic management direction, provides alternative perspectives on environmental issues, and integrates sustainability as a fundamental principle in the corporate foundations. The internalization of responsibility can cause changes at various levels, such as adapting key metrics or a corporate mission. Responsibility is used more broadly, as we know it from corporate social responsibility initiatives, including philanthropic and environmental aspects (Egri and Ralston, 2008). Here, responsibility is understood as an integral duty inherent in entrepreneurial activities that cross a wide range of corporate areas (Waddock, 2008). It may also involve implementing changes in processes or corporate culture that assist in trade-off decisions (Hahn et al., 2010) and activate openness to the subject of sustainability. It also includes a business's willingness to engage in

stakeholder dialogues and respond to stakeholders' demands, including non-organized demands, such as those of the environment (Zappi, 2007).

Long-term perspective (M3): There are many concepts of time and how individuals or organizations perceive time and make temporal decisions (Huy, 2001; Mosakowski and Earley, 2000). Taking a long-term perspective on management has an important effect on the implementation of a CE. This can be triggered, for example, by a reference to a longstanding company tradition or the founder's ideas to which one feels connected. A long-term perspective creates a temporal link between past and future activities. Environmental problems, in particular, often go hand in hand with long-term problem causation and a time-consuming search for solutions. A temporal perspective geared to the short term runs counter to the objective of a CE seeking the long-term use of materials (Bocken et al., 2016). Time and how management views it in planning periods and investment decisions is central to how companies respond to environmental issues, such as climate change or natural resource scarcity (Hahn et al., 2015; Slawinski and Bansal, 2012).

Commitment (M4): Successful corporate change takes time and is facilitated by enthusiastic and motivated managers who join forces and commit themselves to a change. It is about bringing together entrepreneurial vision with actual activities. Having social capital to overcome entrepreneurial boundaries supports managers in integrating and recombining resources, and helps achieve change (Blyler and Coff, 2003). Committed managers with social capital and many social ties can provide access to resources, finances, and skilled people, facilitating opportunities needed for transition to CMBs (Helfat and Martin, 2015).

Being a pioneer (M5): Implementing a CBM is often a long and complicated project due to the involvement of different partners and stakeholders in a network or business ecosystem (Takacs et al., 2020). Being a role model also means taking risks, standing up for change, and thus legitimizing oneself. CE solutions can be risky for various reasons. As their profitability is further away

in time, more innovative partners need to be involved, and the market demand is often not yet clear. Practical examples of pioneer projects, such as the city of *Kalundborg* in Denmark, with the first large-scale industrial symbiosis and innovative CBMs developed in the 1970s, have been characterized by the indispensable desire to change and be a pioneer (Vanner et al., 2014). This goes hand in hand with patience and perseverance. The desire to be a pioneer also depends on a willingness to take risks. This may lead to higher profits due to first-mover advantages, with a higher risk due to more uncertainty and copycat effects (Min et al., 2006).

5.4.2 Organizational drivers

Table 9 shows the identified organizational drivers, including a brief description and representative quotes.

Table 9 Organizational drivers

Driver Theme	Description of the Driver	Representative Quotes
(O1) Collaboration	The formation of collaborations and strengthening of cooperation with partner companies and institutions allows access to knowledge, technologies, inspiration, and innovation; solutions can thus be found together, which is in line with the characteristics of CE; participation in higher-level bodies, such as industry alliances, also drive change thanks to influence and agenda-setting.	*we are represented in all trade associations, directly or in part via the industry (09, 11); sustainability in the energy sector happens when larger companies get together (11, 45); we put this out to tender at universities, and then we held an innovation competition (19, 51); we have informal innovation meetings with the bag supplier from time to time, where ideas are exchanged (20, 67); we are members of the industry association and make proposals there; we hope to gain attention through lobbying (27, 53); we could enter into a partnership with a waste incineration plant, where our waste is used, and with this heat, we can heat our whole building (35, 25)*

(O2) Cost reduction	Cost control and improvement in cost reduction through a CBM allow to build a business case for a CE and to gain legitimacy for further change, which translates into a competitive advantage in the market.	*reusable: for economic reasons alone, we have a great interest in this (05, 11); there is also an economic interest in being able to process this valuable raw material (06, 21); CE is part of this, as we are able to save even more costs in the future if we use our resources efficiently (09, 29); reduction always means lower costs, and in the highly competitive market we are in (19, 21); an empty run is neither ecologically nor financially sensible (38, 45)*
(O3) Improved communication	Suitable and targeted internal and external communication drives a transformation toward a CE; external communication contains the steady and persistent sending of signals by using labels, creating transparency, stimulating consumer purchasing decisions, advertising, or raising visibility; internal communication contains various channels, such as workshops and training for employees and communication platforms to raise awareness.	*it takes a lot of convincing and explaining so that customers can understand this sustainability strategy with a long life cycle (01, 15); to exploit this in terms of advertising can be interesting, it can give us an advantage on the market (02, 15); we invite customers to visit us and take a tour of the plant and talk about our calculation, there are no secrets (04, 37); we are also raising awareness among our employees about how to handle materials (09, 11); we point this out to our customers in our advertising brochures, as the sustainability issue appears to be more and more important (17, 13); internal training courses for our employees are helpful, where they learn about how to drive a car ecologically, how many revs to drive with the lowest possible consumption (25, 19)*
(O4) Increased customer bonding	A circular product and solution add multiple dimensions to a traditional, linear value proposition, which can positively influence and shape the customer-	*take-back programs of products and packaging for recycling is our service to the customer (06, 21); our pricing model is adjusted to the extent that we make attractive prices (25, 45); another added value that we create for the customers, that we provide the*

	business relationship; in this way, CBMs can be perceived as additional customer benefits (e.g., repair services or revenue models) that can bind and retain customers long-term.	*packaging material free of charge and take it back (41, 25); customer loyalty: jeans repaired here for free, it leaves an impression (42, 17)*
(O5) Changing operational and technical processes	Changing processes and techniques in day-to-day business activities allows for continuous learning, improvement, and reflection, supporting CE implementation.	*so if I make pure fabric knits, I can initiate a recycling process more effectively (23, 21); we have projects underway with Tencel, a viscous fiber that is environmentally friendly, to mix it in to see what kind of product that gives, so we already have initiatives and projects like that (26, 25); doing it here with a commercial machine, and we found: longer shelf life (40, 51); we started to test our processes, develop our machines, I welded, worked with the local people until we got something that we could make slippers with (53, 21)*

Collaboration (O1)*:* Collaboration and exchanges with other companies, institutions, and partners drive the implementation of CBMs. This can occur upstream and downstream in already established supply chains via the formation of industrial symbioses, ecosystems, or participation and engagement in industry associations. This exchange provides access to knowledge, insights, and technical skills that can be implemented in the entrepreneurial context. Collaborations serve as information-gathering networks for companies that are sufficiently alert and responsive to processing the received information accordingly (Zaheer and Zaheer, 1997). SMEs are relatively limited in their access to new knowledge and innovations due to their sizes and resources. Therefore, partnerships in networks can help sharpen the understanding of a CE jointly and drive change (Rizos et al., 2015).

Cost reduction (O2): Changing and controlling costs via a CBM provides a strong argument for CE transformation at the operational–economic baseline. Thus, a competitive advantage can be enhanced via cost reduction. Implementing patterns of a CBM, such as dematerialization in production or reuse, can positively affect the cost structures of companies (Mont et al., 2017; Pavel, 2018), creating a business case for a CE that serves as an argument for further investment and the use of resources. Reusing packaging or vehicles, for example, or making more efficient use of materials in products or fuels in logistics, leads to cost reductions. The design of costs is linked to the success of a BM and affects the alignment of entrepreneurial resources. With a suitable BM and revenue, even higher manufacturing costs for a (circular) product can be accepted (Teece, 2018).

***Improved communication (O3*)**: Basically, two directions of entrepreneurial communication can be identified, which signal different target groups: internal and external. Internal communication supports CE transformation and works through various channels, such as workshops, employee training, or internal communication platforms. In this way, strategic goals can be communicated at a higher level via a mission and vision statement, and on a practical level via training to strengthen employees' awareness and skills in participatory processes, such as the sustainable use of resources or incremental efficiency improvements. Management's active communication and appreciation of sustainability can strengthen the internalization of sustainable behaviors by employees supporting sustainable changes (Pellegrini et al., 2018). External communication establishes a company's position in a market regarding CE. Different CBM patterns, such as the detoxification of products or repair options, support corporate differentiation in a market and thus enable competitive advantages. This can be stimulated by transparency initiatives and the integration of consumer feedback. Perseverance and diligence are required here, as external perceptions are settled over time. The inclusion of labels as a signal toward the markets can help to inform stakeholders (Sinclair-Desgagné

and Gozlan, 2003) and provide them with decision-making tools (Thøgersen et al., 2010). Labels can thus reduce information asymmetries and position value propositions.

Increased customer bonding (O4)*:* Various patterns of CBM can intensify a company–customer relationship, supporting the extension of a value proposition and, therefore, customer benefits. Additional services necessary for a CE are not just additional effort for a company but can be actively integrated into the value proposition, such as repair services or return of packaging. Thus, a unique customer relationship can be designed and cultivated. Well-developed customer relationship management is an essential factor in the successful implementation of CBMs. A CE aims to focus on the maximum utilization of a product and its life-cycle extension. Longer product life cycles also lead to longer customer relationships and a greater potential to shape them positively and (re)create value (Pavel, 2018). This can be supported by adapting a CBM and its revenue models, which not simply focus on ownership change through sales but can better retain customers over time via new contract models and pricing mechanisms. Customer relationships in a CE go beyond the mere desire to sell products and more toward long-term, accompanying, and supporting functions. Intensified customer relationships can sharpen customers' value proposition via user reviews and expressions of loyalty (Stein et al., 2020).

Changing operational and technical processes (O5): Operational and technical process changes in day-to-day business and rethinking product design can have a driving effect. Successful implementation of process and product solutions can legitimize a change to a CE in an entrepreneurial setting. It can qualify efforts made as feasible, prove critics wrong, and stimulate internal and external demand for similar solutions. It appears that the trial-and-error approach enables a step-by-step implementation of different patterns of CBM without necessarily putting everything under a CE paradigm or simply implementing individual measures for sustainable improvement. For example,

adapting product designs by avoiding complex product designs or mixed materials can set new standards and trigger thinking processes within a company. Adaptive approaches and direct learning from changes made in processes and products can thus drive transformation. An operational adjustment also allows new data to be generated, which can legitimize other ventures (Ilić and Nikolić, 2016) and create demonstrative projects (Vasilenko and Arbačiauskas, 2012).

5.5 Discussion and integration of the dynamic capability concept

This section reveals how the identified drivers influence the formation of higher-order DCs of sensing, seizing, and transforming, and thus the creation of a CBM, as antecedents. The relationships and interdependencies among drivers and between drivers and the DCs are conceptually elaborated on and enriched by underlying data fragments. The results are supported by representative quotes from the data. It also explains how this can affect the implementation of CBMs. The elaboration of the relationships between drivers and a DC thus emerges inductively and conceptually from the literature and data. This serves as a proposition for further quantitative empirical investigations. A multilevel framework that relates the different elements is presented for clarity and to promote an understanding of the relationships. The discussion shows the relevance of different managerial and organizational drivers for circular entrepreneurs to identify opportunities, break with existing logistics, and implement sustainable entrepreneurial solutions.

5.5.1 The Sensing Capability: How Are Circular Opportunities Uncovered?

Figure 14 shows the managerial and organizational drivers that impact the DC of *sensing*.

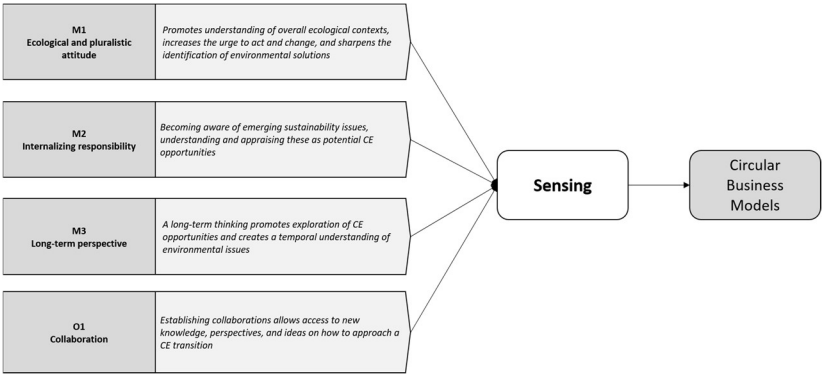

Figure 14 The relationship between drivers and the higher-order DC of sensing

The driver ***ecological and pluralistic attitude (M1)*** enables leaders' sensing capabilities because it broadens the horizon and enlarges the perspective, thus facilitating the perception and recognition of ecological issues and supporting the finding of a suitable CBM. A supportive personal attitude also assists in identifying threats and assessing market trends that could lead to economic losses or market exit if adjustments are not made. This driver acts as a radar for screening company-external factors. "It is the entrepreneurial mandate: we must address this, whether we like it or not. Those who do nothing in this area will lose out. These companies will not survive for long" (02, 15). Because managers define which signals from a business environment are seen and heard within a company, a vigilant attitude is highly relevant for a company to explore and anticipate (Schoemaker et al., 2018). Being aware of environmental issues promotes motivation to uncover market opportunities related to a CE. Changes in consumer behavior and perceptions of possible trends toward sustainable products can be sensed thanks to a mindful and pluralistic view. "We see the demand for such systems in the market, and therefore, we see it as an absolute necessity to be involved in such projects or experiments" (56, 23). This also means uncovering solutions that are not

obvious and facing the question of usefulness and, thanks to a distinct ecological attitude, making trade-offs accordingly, taking all factors into account holistically. Managers who understand a social environment and ecological problems can recognize that it takes innovation and involvement to generate ideas on becoming more circular and resource efficient. Without sensing capability, it seems rather challenging to unlock the full potential to allocate resources later in a CE transition process. “We are all responsible for doing as much as possible for the environment, and where there are opportunities to reuse or recycle, we should do so. [...] I think you always have to clarify or look at where it makes sense and where it does not make sense to recycle” (32, 25).

Internalizing responsibility (M2) supports the activation of sensing capability because it puts management in relation to an entrepreneurial environment and all stakeholders, internally and externally. This sharpens the ability to discover opportunities and threats (Maak, 2008). It is about finding ways to anchor ecological awareness in management orientation and make it an integral part of strategic decisions. Internalized responsibility as a key characteristic of entrepreneurial decision-makers allows uncovering CBM solutions and addressing them with an entrepreneurial spirit initially and recurrently. “We have had a mission statement for some time now that we want to protect the environment or contribute something to the environment, and that is why one question comes up in every process: What can we contribute?” (39, 43). Actively integrated and practically applied responsibility serves in early detection and uncovering of opportunities resulting from ecological changes and the perception of problems that might be associated with ecological conditions, where the own business can provide a solution. O’Reilly and Tushman (2008) noted that sensing capability requires space for encouraging debate, the establishment of an open culture, and the ability to gain leader commitment. “It is about persistence, discussions, and about the willingness to examine two or three sub-variants to get all the people on board and get them

enthusiastic about this topic. You must convince people; you cannot just push something through or give orders. You must allow for a certain learning curve, but you have to remain persistent and not lose sight of the goal, especially in sustainability" (09, 25). Actively integrating stakeholder objectives and interests via institutionalized exchanges and dialogues with an entrepreneurial environment helps identify social and environmental concerns, search for new technologies, and early detection of regulatory changes (Inigo et al., 2017). For example, internal workshops or exchange sessions with external partners are suitable measures that help generate ideas for new BMs, revenue mechanisms, and products (Mezger, 2014). "We advertised this at universities, and then we held an innovation competition [...] so concretely discovered many small things, which we do in the sense of reduction and optimization" (19, 51).

The inclusion of external opinions and views enhances sensing capability, which is also promoted by the driver, **collaboration (O1)**. Social network research has found that close and loose relationships enable a foundation for sensing capability (Granovetter, 1973; Krackhardt, 1992). Establishing collaboration means relying on the ability to experience different exchange levels in new partnerships and help uncover sustainable solutions that allow entrepreneurial opportunities to emerge. Such solutions can be triggered in a continuing process of idea generation, or they can emerge as a non-planned product of exchanges. "When there is a desire, you create possibilities. You are looking for whatever you can do to make things change […]. I met someone who works in this company; he showed me the material; I thought it was great, and in the discussion, he said it would become their waste, and that's how the business started. I saw the opportunity" (54, 18). Inigo et al. (2017) emphasized the importance of being part of an ecosystem (i.e., types of industry, or sustainability-driven associations), which help develop a CBM, acquire technological capabilities and knowledge, and complementary assets, which are not possible with a mere focus on one's strengths. "We are members of the industry association, and we make proposals; we hope that lobbying will draw

attention […] In this way, we could work out a few solutions. I am aware that it takes a long time and much educational work to break down barriers a bit" (27, 53). The screening and identification of possible suitable collaboration partners stimulates the sensing of opportunities and helps generate awareness (Petricevic and Verbeke, 2019). Coming together, generating ideas beyond corporate boundaries, and observing what others are doing can have a stimulating effect. "In logistics, everything is at the beginning, and there are various projects where you have to get involved and think along. However, sustainable things happen when larger companies join forces in terms of energy" (11, 45).

The managerial driver, ***long-term perspective (M3)***, can support sensing capability because it establishes a connection between the entrepreneurial past and the future and extends the range of temporal perception. Environmental changes are often characterized by slow, steady, and sometimes not easily visible shifts in conditions. The expanded time perspective helps to identify such changes over time and classify them accordingly. Research suggests that the long-term thinking of leaders with corresponding mindsets promotes the exploration of opportunities (O'Reilly and Tushman, 2008). For example, understanding the historical roots of a business (i.e., how the company was founded, managed, and has existed over generations) can provide a lasting arc between the past, present, and future. "This is the legitimization of our brand. It is the philosophy of our founder […] we have always taken it for granted from the 1950s that we try to avoid waste, use resources optimally, and try to make the best product every day" (21,39).

5.5.2 The Seizing Capability: How to Activate Resources for Sustainable Change?

Figure 15 shows which managerial and organizational drivers influence the higher-order DC of seizing.

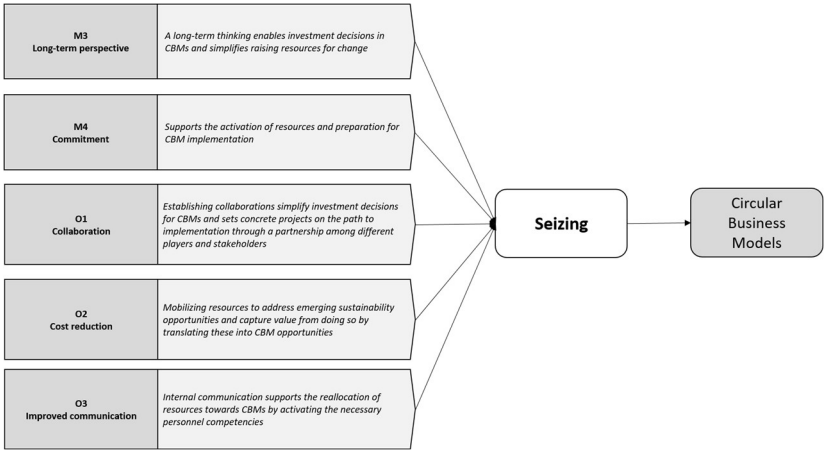

Figure 15 The relationship between drivers and the higher-order DC of seizing

The driver, ***long-term perspective (M3)***, is essential for activating the seizing capability because it facilitates investment decisions in favor of a CBM. An extended sense of temporality and long-term planning periods can lead to a higher degree of sustainable innovation potential (Longoni and Cagliano, 2018) or incremental, sustainable actions (Haugh et al., 2019). Thus, the time perspective can be considered central to entrepreneurial investments because it impacts business cycles and the allocation of resources. This is closely related to questions regarding the periods in which return on investment is due, assets are depreciated, and how capital is accumulated over time. “Global climate: there we have to think in the long term and invest long term and depreciate long term. Otherwise, every bill will be in red. That is the first thing: longer depreciation” (02, 23). Leveraging resources and investing in the transformation to a CBM thus requires a long-term perspective and an understanding of the long-term effects of environmental challenges. The entrepreneurial cycles in which planning, innovation, and implementation take place are decisive and impact the ability to identify opportunities and activate

resources. “We are an entrepreneur-led company. This sustainability cycle is the top priority for our strategy so that we use resources and materials as carefully as possible and in a targeted manner” (01, 13).

Commitment (M4) enables the purposeful seizing and activation of resources, making good decisions and appropriate investments. The technologies required for CE transformation must first be discovered and then adapted and developed in the business context (Inigo et al., 2017). Here, supportive managers and well-trained technicians play decisive roles. “These technicians are practical people looking for solutions and implement them […] we simply need internal promoters who uncomfortably keep holding up these mirrors and keep spreading these visions that we could do more” (02, 23). If this commitment is reflected in a manager’s involvement, for example, in committees and industry associations, it helps develop social capital and enables resources to be gathered across companies and adapted in their own context. Understanding commitment as effective support in the transformation process from its beginning to its end also means internalizing the will to change entrepreneurial management. “I took part in the Swiss Green Economy Forum and joined discussions because we all feel that this topic moves us, and customers must also move with us. And that requires innovative, new ideas, and related resources, i.e., funds, to drive this topic forward” (23, 13).

Along with this goes the targeted use of **communication (O3)**. Improved intra-organizational communication stimulates the reallocation of resources and prepares employees to transition to a CBM by activating the necessary competencies. Internal communication means sending signals to the company to activate the implementation of a CBM and gear toward strategic renewal. Active and open communication with employees and their involvement in strategic activities increases commitment and fosters the transformation toward new solutions (Achtenhagen et al., 2013). “The most important thing is to sharpen the employees’ understanding so that they know that certain things, which may still have a negative impact on our environment, can be

compensated by other activities, such as the reduction of waste, water, or electricity consumption" (21, 53). Standardized communication with common codes enables learning in the organization during transformation, as it establishes new routines and patterns of interaction relevant for change processes (Teece et al., 1997). Thus, different communication channels can bring together and activate different resources for the transformation toward a CBM. "Every week, different things are posted on a notice board for the employees. We show how we saved materials, where we increased production or processed more. The employees must feel that we have achieved something, but they also must notice when a problem occurs […]. If an employee has a positive impact, he becomes an employee of the month" (29, 25).

Collaboration (O1) also serves to acquire resources and make investments in CBM. Strategic partnerships help build new assets and restructure resources when building circular products (Ettlie and Pavlou, 2006). External social ties help acquire (financial) resources (Blyler and Coff, 2003), which could be essential for a costly and time-consuming CBM innovating journey. "The […] Association is working on the relevance of the local beer industry. The idea was to bring producers, distributors, and consumers together. We had developed a 90% Vaud beer as an example to motivate consumers to take an interest in the origin of the products" (49, 23). This shows that, especially for smaller companies (cross-sectoral), collaborating with partners brings scalable advantages in allocating resources. Collaborating helps to develop a shared understanding of the problem and a possible solution in networks and ecosystems (Rizos et al., 2015). Collaborative partnerships enable bonding between organizations, helping to create value for all companies involved (Leder et al., 2020). "As a small company, we have too little influence, so we try to group with others, with partners. If you are alone, you have little weight and room for maneuvering for advertising, communication, etc. When you are small, you must do everything by yourself, you have little time and resources" (55, 28).

As the transition to a CBM requires free resources in the form of time and finances, driver ***cost reduction (O2)*** could be helpful. Reducing costs frees up resources that can be targeted for further CE projects. Mobilizing resources by changing the cost structure and thus improving competitive positions allows for capturing value and legitimizing the transformation. It improves the balance between a company's costs and its benefits, enabling new investments (Winter, 2003). Reducing costs creates legitimacy for further innovation and adjustments in products and a CBM. "I can do the same transport with a second-hand truck that has a third of its service life behind it as with a new one, it is cheaper, even though the repair costs are higher. So, we reduce the financial risk and need the same resources at the same prices as others" (36, 34). Changing cost trajectories can influence investment decisions regarding new products or adapted BMs; leaving learned routines is costly, so changing the cost structure can be helpful (Teece, 2007). Since cost reduction is quickly reflected in the company's balance sheet, it is a proven and effective means of creating added value and pursuing new development paths. "Reduction always means lower costs, and in the extremely competitive market we are in, that means reducing all the resources we use, whether that is, say, packaging materials [...]. We reduce everywhere we can, simply to be fitter" (19, 21).

5.5.3 The Transforming Capability: How is Entrepreneurial Output Achieved?

Figure 16 shows which managerial and organizational drivers influence the higher-order DC of transforming.

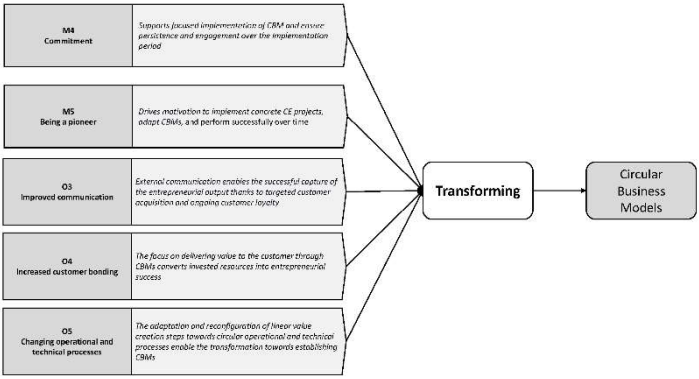

Figure 16 The relationship between drivers and the higher-order DC of transforming

Commitment (M4) in management is essential since the transformation to CBM can be time-consuming and lengthy (Halme et al., 2007) and requires mature implementation skills. It can trigger transforming capability and create consistency over time, legitimization, and entrepreneurial perseverance to implement the innovations envisaged (van Gelderen, 2012). Broad commitment, which translates into organizational support, releases the necessary drive to access and deploy limited resources (Simon et al., 2002). Especially when commitment is shown in financial investments, it supports the implementation process toward a sustainable and circular company over time. "Resource conservation is a huge issue. We have invested a lot in technology in the last two or three years and are continuing to invest in technology to reduce electricity and energy consumption, waste, or water" (21, 23).

This is also accompanied by the desire to be ***a pioneer (M4)***. The pioneering role allows for extending and capitalizing seized advantages to be expanded if learning and transformation are fast enough (Teece, 2018). The pioneering function includes a certain willingness to take risks, foresight, and the will to change, which promotes perseverance in change processes. Inventing new

products and bringing them to the market are associated with high uncertainty and possibly longer unprofitable periods (Kerin et al., 1992). The interplay between the desire to be a pioneer and a long-term perspective (M3) can help. "Maybe we have a certain pioneering role, and if not us, then who should do it? Someone must do it, and we have little fear of doing certain things with appropriate partners […] life is a cycle. What I pass on to my grandchildren; they may want to pass on to their children and grandchildren" (29, 26). Although being a pioneer is no guarantee of success, established solutions from first movers can massively increase switching costs for those coming after (Schoemaker et al., 2018). For SMEs, introducing new products into the market as pioneers is an important entrepreneurial activity for survival and gaining market share. The pioneering role goes hand in hand with strong commitment (M4) over time and adaptive decision-making in a dynamic environment (Simon et al., 2002). "I also know that customers are not always enthusiastic from the start, certainly not willing to pay to support such ideas. But if I do not do it, who will? A long road begins with the first step, and if I get a good feeling about it, and in my opinion, I can do something good" (23, 27). Transforming capability is also characterized by the pioneer's ability to repeatedly renew and adapt resources to project progress to generate entrepreneurial output over time. Transforming capability involves balancing potential risks and trade-offs between the economic and environmental aspects of a CE. "We purchased a new rolling machine […]. This means that I took the risk that we would not be able to roll a good two tones an hour, but perhaps only 100 or 500 kilos. So, there would have been a much cheaper machine that could have produced the husk in a fast cycle, but then it would not have been possible to reuse it" (33, 15).

Three organizational drivers are strongly related to transforming capability. First, ***improved communication (O3)*** beyond company borders is central to strengthening the transforming capability, as it helps capture entrepreneurial output thanks to target customer acquisition. Marketing and communication

capabilities influence the innovation intensity and competitive advantage of organizations; successful communication with customers plays a fundamental role in launching and establishing circular products and solutions in the market and generating revenue from the resources invested (Weerawardena, 2003). Communicating CE endeavors work as a differentiator capability in the markets, as it helps companies attract new customers and retain old ones. "Exploiting this in terms of advertising can be interesting, it can give us an advantage on the market. If we produce in Switzerland with our organic label, then this one market advantage is one of the reasons why it is interesting for the company" (02, 15). The marketing of sustainability efforts, or so-called green marketing, can positively affect customers' purchasing behavior (Boztepe, 2012). External communication carries and transforms efforts made within the company to the outside world and sharpens the overall picture and value proposition perceived by customers. "So how can we improve this so that people from outside perceive what we do? We have to put it in the right light, we have to make it accessible, so that it becomes noticeable, but in such a way that we can also pay for it" (04, 41). External communication strategies are crucial to show those involved that the material loop can be closed only under certain conditions. Therefore, the commitment of all is needed, such as the return of products for appropriate recycling (Leder et al., 2020). Targeted CE communication enables leveraging customer attitudes toward the company (Stein et al., 2020). "It takes a lot of convincing; it takes much explaining to be able to show customers this sustainability strategy, this long-life cycle" (01, 15).

Second, **customer bonding (O4)** helps to build and cultivate unique customer relationships through CBMs. This affects transforming capability because it converts invested resources into entrepreneurial output. Over time, customers who are successfully satisfied support the ongoing renewal of corporate value creation by maintaining relationships. A successful BM delivers the value customers demand and satisfies their needs (Teece, 2010) by transforming

entrepreneurial resources into valuable output (Wang and Ahmed, 2007). Bonding activities between companies and customers characterize a CE's success beyond the point of sale (Leder et al., 2020). "Customer loyalty: when our customers can have their jeans repaired here for free, it leaves an impression on the customer. They like to come back here and repurchase something because they see that we are serious and do not just want to tempt them to spend much money and keep buying new things" (42, 17). Therefore, CBMs with repair or maintenance services can also be perceived as an additional benefit for customers. Various CBMs containing patterns, such as recycling or reuse, directly benefit the customer through cost and space savings or a feel-good character. "In the case of the boxes, it is also the customer benefit, as it is usable several times. Of course, we create another added value for the customers, providing the packaging material for free" (41, 25). The service concept can intensify customer loyalty by extending the value proposition and providing additional benefits to customers.

Third, the relationship between **changing operational and technical processes (O5)** and transforming capability shows how essential everyday stimuli can be for sustainable change. Thus, reconfiguring resources through new processes is central because it can free up time and new ideas and actively help to leave familiar routines and path dependencies. Especially because CBM planning and implementation can be demanding and lengthy (Halme et al., 2007; Lambert and Boons, 2002), it is necessary to consider factors that stimulate the capability to transform, support, and accompany innovation processes. Nevertheless, changing daily routines is costly and can create anxiety and uncertainty (Teece, 2007). Solutions can occur in day-to-day business through incremental adjustments, whereby success depends on acceptability in the market.

The capability to transform comes to the fore when the learning can be directly implemented and thus leads to new solutions. "Where possible, we try to test it ourselves, so that we can perhaps get a sample of textiles, that we wear

ourselves for half a year and see how it behaves? So, we have things in the store that we can present and sell with conviction" (42, 29). A trial-and-error approach makes it possible to test market demands in real time and see whether there is a market for the solutions developed. "We have projects underway with Tencel, which works with viscous fiber that is environmentally friendly, to mix it in to see what kind of product that gives. […] It is often the case that if the market does not take it up, it remains with one attempt" (26, 25). Changing everyday processes and techniques allows for the periodic, routinized, repetitive nature of transformation. The strength of a company lies in translating the opportunities envisioned, sensed, and seized into organizational transformation (Teece, 2018). It can also happen that the way a sustainability issue is handled becomes a corporate philosophy and a driver for change.

5.6 Implication and conclusions

Implementing a CE in the business context using CBMs is central to solving different environmental problems (Desing et al., 2020; Geissdoerfer et al., 2018). Understanding driving factors is beneficial, especially regarding the different barriers that hinders the implementation of a CE (de Jesus and Mendonça, 2018; Kirchherr et al., 2018).

The following two research questions guide this study: (1) What company-internal drivers exist regarding implementing CBMs, and how can they be classified? (2) How do identified drivers, as antecedents, affect the formation of higher-order DCs and, consequently, the creation of CBMs?

Helped by an inductive research approach, this study identified the managerial and organizational drivers of CBM implementation. Five managerial drivers were elicited: *ecological and pluralistic attitude (M1), internalizing responsibility (M2), long-term perspective (M3)*, *commitment (M4),* and *being a pioneer (M5).* Alongside this, five organizational drivers were identified: *collaboration (O1), cost reduction (O2), improved communication (O3),*

increased customer bonding (O4), and *changing operational and technical processes (O5)*.

There is already a basic understanding of the need for a certain entrepreneurial spirit in management and companies to create CE solutions (Zucchella and Urban, 2019), and that the perspective on BMs embedded in a larger context of society and the environment can drive circular entrepreneurs (Cullen and de Angelis, 2021). This study builds on these insights and takes further step in analyzing the underlying mechanisms of driving factors and the capabilities that managers should have to transform their businesses toward a CE. It provides an understanding of what possibilities exist at the management level to identify CE opportunities and what skills might be needed to implement them.

The following section explains how these results relate to the literature and their implications for further research.

5.6.1 Implication for research

This study revealed the importance of looking at the management and organizational factors driving a transformation toward sustainable and CE business solutions. The 10 identified drivers show how business conditions can be created to facilitate the implementation of CBMs and what roles management and managers' preferences, values, attitudes, and perspectives can have. This research refers to the literature on implementing a CE, the concept of DCs, and sustainably driven entrepreneurship. In the sustainable entrepreneurship literature, it is evident that sustainable market solutions do not emerge randomly but are a product of entrepreneurial activities and arise when they become a relevant aspect of BMs (Schaltegger et al., 2016). This highlights the importance of analyzing facilitating factors promoting the exploration and exploitation of CE opportunities (Zucchella and Urban, 2019). This is where the research comes in and provides essential insights into the possible drivers of CE transformation in SMEs and delivers conceptual links

to the DC approach. In doing so, this study contributes to the limited understanding of the underlying entrepreneurial mechanisms that enable a business to transition to more sustainable solutions, such as a CE (Hall et al., 2010).

The following two implications can be identified for future research: First, identifying the five managerial drivers fits well with the existing entrepreneurship literature regarding the use of BMs in sustainable transformation. Cullen and de Angelis (2021) addressed the importance of considering the value generation of CBMs as embedded in different spheres of environment, society, and economy that enclose a company and understanding the trade-offs and tensions derived from these to unlock CE potential. The identified drivers concretize this embeddedness and narrow it down to clear factors: on the one hand, it is a question of management's perspective on the relationship between a company and its environment, and how management perceives time as a temporal variable. Both perspectives influence how a company sees itself in the complexity of environmental factors and how it can sense and seize possible opportunities, threats, and changes. On the other hand, it is a question of management's internalized sense of responsibility toward sustainability, level of commitment, and role as a pioneer. Thus, it turns out that the transformation toward a CE depends on the characteristics and behaviors of a company's management staff.

Second, the sustainable orientation of companies varies greatly. Some companies are founded and managed for the purpose of sustainability, also called "born sustainable" (Villa Todeschini et al., 2017, p.759); others change in this direction during their existence. Of particular interest is the sustainable change potential of SMEs, which is the object of this study. From a systemic viewpoint, SMEs offer great leverage for change toward a CE, as their sustainable solutions can serve as role models for large companies suffering from inertia and provide them with opportunities (Veleva and Bodkin, 2018). This study analyzed from a sustainable entrepreneurial perspective the organizational factors that can be relevant for SMEs and their management to

implement a CE and shows how these can be beneficial through DCs to transition toward a CE to unleash the "*entrepreneurial spirit*" of an organization (Zucchella and Urban, 2019, p.146). The drivers that stimulate communication, both internally and externally, play a decisive role here.

Collaboration with partners and the strengthening of internal company dialogues and the intensification of customer relationships are of central importance for research on entrepreneurship and sustainability at the SME level. Identifying organizational drivers and their interaction between organizational-internal and external reality supports the view of companies as embedded in an open system with different exchange flows within its environment (Zucchella and Urban, 2019). Thanks to this research, there is a more robust understanding of the mechanisms supporting these communicative measures and instruments.

5.6.2 Limitations and further research

The following two limitations can be characterized. First, this study is based on SMEs from three industries. While the broad scope and the many interviews conducted allow relatively generalizable conclusions to be drawn, further research must show whether the findings can be applied to other industries, such as the machinery industry, which is structurally and product-specifically different. Generalizability is essential because the findings suggest profound changes in the entrepreneurial context. Second, while the relationships between the drivers and the higher-order DCs have been created conceptually and on extracts from the data, the quantitative validity is limited. Thus, it would be central for future research to quantify the relationships between individual drivers and an individual DC and analyze which drivers impact a DC and how strongly, and what implications this could have for management. This would require cross-industry data collection from companies with varying degrees of CBM implementation and access to management activities.

6. Conclusion and further research

This dissertation examines the business implementation of a CE. Therefore, it relies on a literature-driven, conceptual, and theoretical approach on the one hand and the generation and analysis of data on the other. In addition to the three papers, this dissertation presents a thematic analysis in the introduction, thus setting appropriate priorities for problem identification and problem solving. It achieves insightful breadth and engaging depth, both methodologically and in terms of content. The findings can help practice to concretely implement a CE and support research in finding innovative research questions. In the following section, theoretical and practical contributions are presented, and an outlook is provided.

6.1 Theoretical contributions

The five theoretical contributions of this dissertation are presented below, which are of interest to the scientific community.

(1) Structuring and framing the business implementation of a CE: One of the novel elements of academic discourse is the interconnectedness of BMs and ecosystems regarding CE implementation. Understanding circular ecosystems as the coming together of different CBMs opens new possibilities, both conceptually and theoretically, and allows product design, which is central to a CE, to be a key factor. The role of the orchestrators in circular ecosystems, bringing together different BMs, design aspirations, and the shared value proposition, experiences an exciting realignment. Investigating this role, the interaction in an ecosystem and the interplay of different BMs are promising. Barrier research has confirmed the importance of addressing these findings. The relevance of network effects, diffusion of knowledge in ecosystems, and the consideration of competencies required for this purpose gain further momentum through this research.

(2) *Creation of patterns for circular ecosystems:* Identifying patterns for the formation of circular ecosystems changes the theoretical perspective on CE. The four categories of patterns (*close the loop, improve the loop, monetize the loop, excite the loop*) are novel and innovative. With its typology, the framework uniquely presents how solutions in this field can be developed systemically and conceptually. The theoretical use of patterns is thus strengthened and made remarkable because it makes an essential contribution to structuring complex problems. It also facilitates an interdisciplinary understanding of the subject.

(3) *Relevance of trade-off decisions in management:* This dissertation demonstrates how trade-off decisions between different factors, such as planning time, investment cycles, or material selection, to name a few, can hinder the successful implementation of a CE. It highlights several trade-offs and invites further studies to analyze them in a differentiated way. For example, it would be helpful to ensure economic and environmental measurability for common trade-offs in CE implementation. This study shows how important it is for companies to have access to tools to help them decide on trade-offs when economic factors outweigh environmental factors.

(4) *Relevance of analyzing different theoretical and conceptual intersections:* This dissertation reveals the relevance of different management research intersections concerning CE implementation. Disciplines such as leadership, entrepreneurship, and change, are pivotal. For instance, the analysis has shown that internal issues such as managers' preferences and perspectives can slow down the implementation of a CE. Therefore, there is often a need for adjustments in the perspectives of thinking, attitude, and leadership.

The linking of the DC concept with the entrepreneurship literature in the context of CE has provided opportunities for various management concepts to find and provide solutions to environmental problems.

(5) *Embedding an organization in an overall systemic environment:* A system-wide perspective on problems and possible solutions is central. The three papers included in this dissertation illustrate how essential it is to look at situations from micro, meso, and macro perspectives and to perform analyses based on this. In this way, it was also possible to find various points of connection to different management-theoretical research areas, such as SSM or DC, and thus to embed cross-disciplinary research on CE in the business context.

6.2 Managerial implications

(1) *Overview, understanding, and strategic alignment:* Papers A and B are characterized by a systemic perspective on the underlying phenomena and problems of a CE. Identifying and presenting barriers promotes an understanding of the interconnectedness, embeddedness, and challenges in implementing a CE. The ability to identify barriers in advance and thus avoid them before they occur can also provide a company with competitive advantages and cost savings. An understanding of management can facilitate strategic decisions and changes in sense potential. This systemic view provides clear possibilities for top-down strategy development and partner acquisition. Likewise, as in Paper B, the conceptual elaboration of the BMs in ecosystems and applying the pattern framework enables systemic, networked thinking, and ensures successful implementation.

(2) *Patterns and cases as transformation triggers:* The patterns and presented cases show ways to operate successfully in the market with circular measures. Thus, the big picture (no business on a ruined

planet) is skillfully connected with the small picture (business opportunities and competitive advantages), and a direction for implementation is presented. In this way, changes in consumer behavior or adjustments in regulations can be anticipated and adapted by innovating BMs and ecosystems. These patterns serve as a source of inspiration for companies and serve as a practical framework to generate ideas. They are designed to be applied from the top management side and, at the same time, help generate ideas in bottom-up innovation projects, product development, or process optimizations. The application of these patterns is based on already known approaches in innovation management, and thus enables embedding along with familiar logic. It can provide companies with the confidence that a CE is implementable, knowing that it has already been successfully implemented several times by other companies.

(3) *Radical rethinking of economic logic, however, within the current system:* From a sustainable perspective, more radical approaches than CE exist. Sustainably closing resource loops with innovative BMs enables addressing environmental problems without changing the fundamental assumptions of today's market economic system. The frameworks presented in this dissertation help systematically reduce the risks and uncertainties for businesses associated with sustainable changes and develop innovative BMs. This dissertation examines the sustainable change of companies from an internal perspective and targets the core actors of economic systems, namely, companies. Knowing the interdependencies within and between companies, sustainable impacts can be generated beyond company borders.

(4) *Focus on management capabilities:* The selection and hiring of suitable managers is a crucial issue in implementing sustainability efforts and therefore requires close attention. A company's

management takes an active and essential position in sustainable change. It has been shown that there are drivers and DCs in management that can promote CE. This knowledge can support and guide companies in selecting employees and leaders, and it provides guidelines for the training of managers and the design of organizational structures.

(5) *Overview and evaluation of Swiss SMEs*: While there have been quantitative studies on the barriers and drivers of CE in Switzerland, this dissertation provides qualitative insight. It allows for the identification of factors and relationships that are often forgotten in quantitative studies. Thus, this dissertation discovered 18 barriers and 10 drivers and attempted to establish the quality of the relationships between them. These insights are crucial for policymakers and institutions that can bring about sustainable transformation using regulations and incentives. The broad base of the data on various industries and SMEs enabled targeted statements to be made on this critical segment of companies in Switzerland.

6.3 Outlook

Several new questions arose from the analyses of this dissertation, which future research should answer.

First, although the implementation of CBMs has already begun in practice, many companies are confronted with the problem of a lack of measurability and guidance. How can the measurability of environmental and economic progress in a CE be designed? What decision-support tools would assist companies in selecting appropriate CBMs? Although methods exist to calculate CO_2 emissions at the product level or possible toxic impacts, to date, little CBM design guidance exists in relation to their impacts. This would allow a comparison of different successfully operating CBMs with each other. Further research can investigate the impact of different combinations of CBMs

and ecosystems on the profit and sustainability dimensions. This would require a deep understanding of successful and failed companies over time and a way to frame, assess, and compare their CE engagements. From this, the creation of possible roadmaps for implementing promising CBMs can be derived.

Second, future research could build on the findings of Paper C by further investigating the intensity with which drivers affect DCs, and thus the successful implementation of CBMs. Furthermore, an analysis of the interaction between management and employees will be worthwhile. The questions to be addressed are regarding the influence of attitude, time perspective, and ecological awareness in management and their impact on employees and company development. Insight into how such drivers change over time and how organizational and managerial drivers interact would also be relevant to practice.

Third, there is a need to quantify the overall economic effects of CE activities and legitimize policy changes toward sustainability. In this context, future research should also shed light on the interactions between policy measures and entrepreneurial anticipation and reactions. Papers A and B show the potential for companies to achieve cross-company solutions in cooperation with other actors. How does the impulse for change come about, and what influence do external shocks and internal company triggers have? The perspective on external shocks has only been mentioned in passing in this dissertation, but it is crucial for forecasting future change. The question is how, for example, price shocks on commodity exchanges or regulation changes affect the behavior of economic actors and, therefore, consumers. Understanding the causalities in this respect would provide solid arguments for a transition toward CE.

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Work Experience

University of St. Gallen, Institute of Management & Strategy — since 07/2018
Research assistant at the chair of Prof. Dr. Karolin Frankenberger — St. Gallen

- Primary research interest focuses on how companies transform toward circular economy business models in a circular economy

University of Lucerne, Institute of Management — 01/2017 – 06/2018
Research assistant at the chair of Prof. Dr. Karolin Frankenberger — Lucerne

- Organization and implementation of lectures, seminars, and workshops

Hirslanden Klinik St. Anna Luzern, Head Office — 02/2015 – 03/2017
Member of staff; project management and project coordination — Lucerne

- Development and implementation of a sustainable mobility management system
- Designing of CRM databases and implementing process optimization
- Supporting clinic management in communication

Caritas Zürich, Communication and Marketing — 10/2014 – 01/2015
Internship — Zurich

- Campaign planning, coordination, and preparation of the annual report

Schindler Aufzüge AG, Modernization & Design Centre — 06/2012 – 08/2012
Internship — Ebikon

- Creating budget calculation tool, processing, and data analysis

Genossenschaft Migros Luzern, Cash desks — 07/2010 – 09/2014
Cashiers; cash flow processing — Kriens

Education

Ph.D. in Business Administration, University of St. Gallen — 07/2018-01/2022
St. Gallen

- Dissertation title: "Circular Transformation: Creating Business Models and Ecosystems for a Circular Economy"
- Supervisor: Prof. Dr. Karolin Frankenberger; supported by the Swiss National Science Foundation (SNSF)

Ph.D. in Business Administration, University of Lucerne — 01/2017 – 06/2018
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- Dissertation topic: Circular economy and business model Innovation in ecosystems
- Supervisor: Prof. Dr. Karolin Frankenberger

Master of Arts (MA) in Political Economics, University of Lucerne 09/2013 – 01/2017
- Master thesis: "Auswirkung der Frühpensionierung auf die Gesundheit – eine statistische Analyse" Lucerne

Bachelor of Arts (BA) in Business and Economics, University of Zurich 09/2010 – 06/2013
- Bachelor thesis: "The influence of professional development programs on employee fluctuation" Zurich

Gymnasium, Matura at Kantonsschule Alpenquai, Luzern 08/2004 – 06/2010
- Focus: Mathematics and physics Lucerne

Teaching

- Lecturer at the Schweizerische Textilfachschule (CAS Sustainability Management in Textiles)
- Lecturer at the University of St. Gallen, Managementausbildung für die Kreislaufwirtschaft (Zertifikatskurs CAS-HSG, Kompetenzzentrum Energy Management, ior/cf-HSG)
- Lecturer at the Universität of St. Gallen, Executive MBA HSG, Sustainability – Pflichtkurs (EMBA 56)
- Co-organizer and lecturer of seminars and courses at the University of Lucerne, Social Networks, Strategic Management (Bachelor seminars and courses)

Awards & Academic Engagement

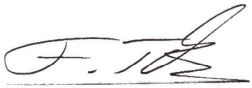
- University of St. Gallen Impact Award 2020 06/2020
  Subject: *Business Model Innovation for the Circular Economy*
- Supervision of ten master and bachelor theses 01/2018-12/2021
- Top grade for the Bachelor thesis at the University of Zurich 07/2013
  Title: "The influence of professional development programs on employee fluctuation"
- Award from the Department of Political Science at the University of Lucerne for outstanding gymnasium thesis 12/2010
  Title: "Integration comparison between the Hungarians and the Kosovo-Albanians in Switzerland"

Languages

- German (mother tongue), English (business fluent), and French (basic)

Personal

- Long-distance hiking, electronic music, basketball, contemporary philosophy



Luzern, 02/2022