

**The Circular Economy transition: Barriers faced and enablers
used by managers of Dutch manufacturing SMEs**

Radboud University



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Preface

Hereby I present to you my Master Thesis 'The Circular Economy transition: Barriers faced and enablers used by managers of Dutch manufacturing SMEs'. With this master thesis, I finalise my master's degree in Business Administration, within the specialism of Innovation and Entrepreneurship at the Radboud University in Nijmegen.

First of all, I would like to thank my supervisor Dr. Alexandra Holz for giving me the chance to investigate a subject that really triggered me. Her infinite support guided me through this sometimes rather difficult process, as she always had time for me when I needed help.

Furthermore, I would like to thank my internship company Volantis, who supported me throughout the process where possible. Also, I would like to thank all the informants that were prepared to share their time and interesting experiences with me. Finally, I would also like to thank my family and friends who have supported me throughout this exciting period of writing this Master Thesis.

I wish you a delightful read!

Jelle Kerstjens

Nijmegen, August 2021

Abstract

The circular economy concept is a much discussed concept and is often presented as a more sustainable alternative to a 'linear' economic system. Manufacturing SMEs play a crucial role in realizing economic and environmental gains by a transition to a circular economy, however the extent of implementation of circular economy principles in manufacturing SMEs across the globe is below expectations. Most researchers blame various barriers that pose challenges to SMEs in their transition to a circular economy. Yet, there is a lack of in-depth understanding into which barriers and enablers apply to manufacturing SMEs and especially how these different barriers and enablers behave and interact with each other. The aim of this paper is to increase knowledge and understanding about the barriers and enablers and their interaction experienced by managers in manufacturing SMEs. This study adopts an explorative approach to understand the barriers, enablers and their interaction at the micro-level of circular economy implementation in Dutch manufacturing SMEs. This explorative research is conducted through 5 case studies. The findings indicate that cultural/organizational barriers, particularly '*lack of consumer interest and awareness*' and '*limited willingness to collaborate in the value network*', are considered the main circular economy barriers by manufacturing SMEs. These barriers are partly driven by market and regulatory barriers like '*lacking standards*', as interaction effects among these barriers result in chain reactions towards circular economy failure. According to our research no technological barrier is among the most pressing circular economy barriers for manufacturing SMEs.

Besides barriers, several enabling factors that help SMEs adopt circular practices were identified, particularly enablers with regard to the '*culture*', '*management*' and '*organizational structure*' and '*support from the demand network*' are considered important driving factors for manufacturing SMEs. The analysis shows that the barriers and enablers identified do not act in isolation, but rather form a complex web of interconnecting barriers and enablers. Further research is recommended to explore this complex web of relations that manufacturing SMEs experience, to prevent barrier chain reactions which lead towards CE failure. Furthermore, this paper illustrates how certain barriers are context specific and thus influence particular stages throughout the process of circular economy implementation.

Keywords: Circular Economy, Barriers, Enablers, Stages, Manufacturing SMEs

Table of content

Preface	2
Abstract	3
1. Introduction	5
2. Literature review	7
2.1 The Circular Economy concept and the relevance of manufacturing SMEs	7
2.2 The concept of CE barriers and enablers	11
2.2.1 Categorization of barriers and enablers in the literature	11
2.2.2 Adapted categorization of barriers and enablers	13
2.2.3 Barriers	14
2.2.4 Enablers	18
2.3 Stages CE transition	19
2.4 Relations and interactions of CE barriers, enablers and stages	20
2.4.1 Nesting of CE sub-barriers	20
2.4.2 Interaction of barriers and enablers	21
3. Methods	23
3.1 Research design	23
3.2 Operationalization	24
3.3 Case selection	24
3.4 Data collection	25
3.5 Data analysis	26
3.6 Research ethics	26
4. Results	27
6. Conclusion	41
5. Discussion	42
5.1 Theoretical implications	47
5.2 Managerial implications	48
5.3 Limitations and Directions for future research	49
6. Literature	51
Appendix A	60
Appendix B: Operationalization	Fout! Bladwijzer niet gedefinieerd.
Appendix C: Informant overview	Fout! Bladwijzer niet gedefinieerd.

1. Introduction

Society is making increasing demands on the industry and the trend towards sustainability is unmistakable. International manifestations of this are the Paris climate agreement, the OECD guidelines for multinational companies and the European Green Deal. To implement the much-discussed concept of sustainable development, both practitioners and researchers refer to the Circular Economy (CE) concept, since CE is viewed as an operationalization for businesses to implement sustainability (Ghisellini, Cialani & Ulgiati, 2016). CE comes with the promise that circular relationships among markets, customers and natural resources (Lacy & Rutqvist, 2015) have a unique capacity to combine economic growth with sustainability (Ghisellini et al., 2016). The CE looks beyond the current take-make-waste extractive industrial model, by gradually decoupling economic activity from the consumption of finite resources and designing out waste from the system (Ellen MacArthur Foundation, 2020). For achieving a CE on a national or European level, small and medium-sized enterprises (SMEs) are particularly important. Since, SMEs are the backbone of the economy and are therefore of great importance in the transition from a linear to circular economy (Rizos, Behrens, Kafyeke, Hirschnitz-Garbers & Ioannou, 2015). Particularly, SMEs from the manufacturing sector play a crucial role in realizing economic and environmental gains by a transition to a CE. SMEs are increasingly aware of the benefits of closing loops and improving resource efficiency (Rizos et al., 2015). However, the manufacturing industry is bound by tradition where change is slow and costly (Herman, 2016; Lieder & Rashid, 2016). Additionally, the CE is more complex than the linear model, resulting in barriers to move towards CE (Hopkinson, Zils, Hawkins & Roper, 2018).

In recognition of this, a growing body of literature has emerged to understand the diverse barriers and enablers faced by organizations, that ultimately influence the transition to a CE (e.g., Kirchherr, Piscicelli, Bour, Kostense-Smit, Muller, Huibrechtse-Truijens, & Hekkert, 2018; De Jesus & Mendonça, 2018; Rizos, Behrens, Van der Gaast, Hofman, Ioannou, Kafyeke, & Topi, 2016). In fact, several scholars investigated critical factors towards CE specifically for SMEs (Ormazabal, Prieto-Sandoval, Jaca & Santos, 2016; Ormazabal, Prieto-Sandoval, Puga-Leal & Jaca, 2018; Rizos et al., 2015; 2016; Garcés-Ayerbe, Rivera-Torres, Suárez-Perales & Leyva-De La Hiz, 2019; Ghenta & Matei, 2018; Zamfir, Mocanu & Grigorescu, 2017; Mura, Longo & Zanni, 2020; Dey, Malesios, Budhwar, Chowdhury & Cheffi, 2020). So far, however, there has been little discussion about how barriers and enablers interact and behave, in the specific context of (manufacturing) SMEs. As Kirchherr et al. (2018) and De Jesus and Mendonça (2018) argue that there are interaction effects among barriers and enablers. Kirchherr et al. (2018) indicated that interacting barriers can lead to a negative chain reaction of barriers, which may

ultimately hamper the transition to a CE. Additionally, Kirchherr et al. (2018) argue that there is a lack of synthesis of key findings, which is further elaborated in section 2.3. Therefore, Kirchherr et al. (2018) suggest that careful analysis and critical discussion of CE barriers and enablers and their interaction is required to ensure that the CE concept will ultimately turn out to be a mainstream success.

At the micro level, many manufacturing SMEs are faced with barriers when implementing CE principles, and although CE gained momentum in recent years, the extent of implementation of CE principles in manufacturing SMEs across the globe is below expectations (Masi, Kumar, Garza-Reyes & Godsell, 2018; Ormazabal et al., 2018). It is therefore crucial to understand what barriers they face to take appropriate action (Jaeger & Upadhyay, 2020). A large number of studies have recognized the need for micro-level research into CE implementation in order to provide managers with insights into addressing barriers that challenge implementation and enablers in the transition of enterprises to CE (Govindan & Hasanagic, 2018; Luthra and Mangla, 2018; Mangla, Luthra, Mishra, Singh, Rana, Dora & Dwivedi, 2018; Agyemang, Kusi-Sarpong, Khan, Mani & Rehman, 2019).

However, in their critical review of CE literature Kirchherr and van Santen (2019) state that empirical studies are notably understudied in contemporary CE literature. Against this background, this research evaluates barriers and enablers regarding CE implementation at the micro-level (i.e., single firms), excluding analyses at the meso (i.e., eco-industrial parks) and macro (i.e., city, province, region, nation) levels (Ghisellini et al., 2016; Murray et al., 2017). This research aims to increase the practical understanding of barriers and enablers faced by managers in manufacturing SMEs, that can facilitate a successful transition to a CE. This leads to the following research question:

“Which barriers do managers of Dutch manufacturing SMEs face while implementing circular practices and how do enablers help to overcome them?”

This paper contributes to the CE literature on micro-level by conducting empirical research, in order to gain more understanding of the driving and constraining factors and their interaction influencing CE transition, as conceived by managers in manufacturing SMEs. Besides, there is little research on the interaction effects regarding CE barriers and enablers (Kirchherr, et al., 2018), let alone in the field of SMEs literature. This research provides new insights into the barriers and enablers and their interaction effects experienced by manufacturing SMEs and therefore differentiates from the existing SMEs research.

By employing a multi-case study approach, a comprehensive understanding of the complex challenges faced by manufacturing SMEs can be reached. Manufacturing SMEs are key actors in the

transition from a linear economy to a circular one, so it is important to gain more insight in the barriers and enablers experienced by managers in these manufacturing SMEs. Therefore, this research will focus on manufacturing SMEs in The Netherlands.

The findings of this paper do not intend to provide statistically significant conclusions, it rather aims for broad exploration, identification and analysis of barriers and enablers influencing CE initiatives of manufacturing SMEs.

The remainder of this paper is organized as follows: In chapter two the theoretical framing of this paper will be explained. Thereafter, chapter three outlines the methodology of this paper, by explaining topics such as the design of the research, the data collection, operationalization, the data analysis and research ethics. In chapter four the main results will be presented. Finally, chapter 5 includes the conclusion, followed by the discussion of the results, the limitations of the research, as well as practical implications and suggestions for future research.

2. Literature review

In this chapter the theoretical background of the CE concept and the relevance of manufacturing SMEs will be discussed. After that, the concept of CE barriers and enablers will be discussed, whereafter the conceptual framework of this research is proposed

2.1 The Circular Economy concept and the relevance of manufacturing SMEs

The CE debate has flourished in recent years and attracted the interest of a growing number of researchers and practitioners (Centobelli, Cerchione, Chiaroni, Del Vecchio & Urbinati, 2020). Both researchers and practitioners are interested in the CE concept because it is viewed as an operationalization for businesses to implement the much-discussed concept of sustainable development (Ghisellini et al., 2016; Murray, Skene & Haynes, 2017). Among researchers the CE concept receives major consideration because it fosters both environmental protection and social well-being (Govindan & Hasanagic, 2018). CE comes with the promise that circular relationships among markets, customers and natural resources (Lacy & Rutqvist, 2015) have a unique capacity to combine economic growth with sustainability (Ghisellini et al., 2016). This promise has attracted the open support from a wide range of economic and political actors: inter-governmental bodies (OECD), influential forums (World Economic Forum), advocacy associations (World Business Council for Sustainable Development – WBCSD, the Ellen MacArthur Foundation, Circle Economy), leading corporations and consulting firms (e.g., Accenture, Cisco, Dell, H&M, Hewlett Packard, Intel, IKEA, McKinsey, Renault, and Levi Strauss), cities (Amsterdam, Glasgow) and regions (Region Skane in Southern Sweden) (Corvellec, Böhm, Stowell & Valenzuela,

2020).

It is possible to bring together a whole series of interpretations and approaches under the term "circular economy" (Corvellec et al., 2020). CE is informed by different schools of thought which have evolved over time (Borrello, Pascucci & Cembalo, 2020). Such as, 'cradle-to-cradle' which is based on the methodology of "waste equals food" or regenerative design where, like 'cradle-to-cradle' (C2C), the emphasis is on the planning of restorative systems and circular products at their design stage (Braungart & McDonough, 2009; Lyle, 1996). Other approaches related to the circular economy include the performance economy (Stahel, 2010), urban metabolism (Newman, 1999), Blue Economy (Pauli, 2010), the sharing economy (Allen, 2015), biomimicry (Benyus, 2002), Industrial ecology (Sharfman, 1995). This mixed theoretical background of the CE concept has moved some authors to revise CE literature to achieve a common understanding of the discipline or to question its usefulness (Borrello et al., 2020). This includes authors who describe disagreement on the basic concepts (e.g., Sandoval, Jaca & Ormazabal, 2018; Reike, Vermeulen & Witjes, 2018), definitions (e.g., Kirchherr, Reike, & Hekkert, 2017) and similarities with the sustainable concept (e.g., Geissdoerfer, Savaget, Bocken & Hultink, 2017). You can state that academics and practitioners do not necessarily agree precisely on what the CE entails and how it should be implemented (Corvellec et al., 2020). Hence, the CE concept can possess distinct applicability over a vast range of contexts (Russell et al., 2020). The CE concept has been defined in various ways (Govindan & Hasanagic, 2018). According to Geissdoerfer et al. (2017) and Schut, Crielaard and Mesman (2015) one of the most prominent definitions of CE is provided by Ellen MacArthur Foundation (2012, p. 7): *"[CE] is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."* However, a more comprehensive definition is formulated by Kirchherr et al. (2017). Kirchherr et al. (2017) acknowledge the prominent character of the Ellen MacArthur Foundation (2012) definition. However, based on an analysis of 114 definitions, Kirchherr et al. (2017, p. 1) *"formulate the first comprehensive and systematic analysis of CE definitions in the current scholarly and practitioner discourse"*. The often-cited definition reads as follows:

"A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and

beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations” (Kirchherr et al., 2017, p. 224-225).

The definition of Kirchherr et al. (2017) partly incorporated the definition of EMF (2012), but the definition of Kirchherr et al. (2017) is in its entirety more extensive. Also, in contrast to EMF (2012), Kirchherr et al. (2017) includes the different levels of analyses: microlevel (e.g., products or company), mesolevel (industrial parks) and macrolevel (e.g., region or nation). This distinction is desirable since this paper investigates manufacturing SMEs from a micro perspective. Based on the above and with the controversial character and mixed theoretical background of the CE concept in mind, the definition of Kirchherr et al. (2017) serves best as conceptual foundation for this paper.

To come from concept to operationalization, this paper follows the ReSOLVE framework which is based on the three core principles of circularity (see Appendix A, figure A1), as formulated by the Ellen MacArthur Foundation (2015). The first principle refers to the preserves and enhancement of natural capital and will be achieved by controlling finite stocks and balancing renewable resource flows. The second principle, optimize resource yields, focusses on circulating products, components and materials at the highest utility rate in both technical and biological cycles. The third principle, foster system effectiveness, focuses on designing and revealing out negative externalities (Ellen MacArthur Foundation, 2015).

To make the overwhelming potential of CE more understandable, the Ellen MacArthur Foundation (2015) transformed these core principles of circularity into six implementation areas: Regenerate, Share, Optimize, Loop, Virtualize, and Exchange. This framework has been constructed as a tool to accelerate transition towards CE for both business and governments alike (Russell et al., 2020). The comprehensive nature of the ReSOLVE framework makes it an effective tool to help firms identify implementation activities within the growing circular economy (Pitkänen, Antikainen, Droste, Loiseau, Saikku, Aissani & Thomsen, 2016). Therefore, the ReSOLVE framework (see Appendix A, table A1), will be used to analyze the CE initiatives studied within this paper.

The implementation of CE activities is essential for maintaining and increasing the competitiveness of the European Union (European Commission, 2015a). Applying circular economy principles across the EU economy has the potential to reduce CO₂ emissions by 48%, create a net economic benefit of EUR 1.8 trillion, and two million additional jobs until 2030 (Ellen MacArthur Foundation, 2015; European Commission, 2014a). In the process of achieving a European CE, SMEs have been acknowledged as particularly important, in terms of their contribution to activities such as

recycling, repair and innovation (European Commission, 2014a, 2015a). SMEs are increasingly aware of the benefits of closing loops and improving resource efficiency: saving material costs, creating competitive advantages and new markets are among the main reasons for European SMEs to take action (Rizos et al., 2015). SMEs have a high environmental footprint since SMEs contribute 60-70% of industrial pollution in Europe (Miller, Neubauer, Varma & Willians, 2011; OECD, 2018). Particularly, SMEs in the manufacturing sector account for a large share of the global resource consumption, pollution, and waste generation (OECD, 2013). Thus, given the economic and environmental significance of SMEs, they are important drivers of the CE transition. SMEs represent around 99% of all businesses in the EU and 90% of all businesses worldwide, through which they employ 60-70% of the world population and account 55% of GDP in developed economies (World Trade Report, 2016).

However, when defining an SME there is the lack of a universal definition of what constitutes an SME (Ardic, Mylenko & Saltane, 2011). SMEs represent a broad and heterogeneous class of enterprises, and their legal and technical definitions may vary by country and even among OECD member states (Koirala, 2019). SMEs even exhibit firm-level, sector level, and national-level heterogeneity (OECD, 2017). For example, the United States government defines SMEs as having fewer than 500 employees, but the criteria vary by type of enterprise and the defining governmental body (United States International Trade Commission, 2010). Whereas the EU defines SMEs as: *“The category of micro, small and medium-sized enterprises (SMEs) includes enterprises employing fewer than 250 people and whose annual turnover does not exceed EUR 50 million and / or the annual balance sheet total does not exceed EUR 43 million. The company must be independent, i.e. 25% of the capital or of the voting rights must not be held by one company or several companies jointly that do not meet the definition of SMEs”* (European Commission, 2016, p. 3). According to Koirala (2019), varying definitions of SMEs represent different policy and structural context in which they operate as well as their vast heterogeneity. The EU definition can be used beyond the geographical scope that falls under the jurisdiction of the EU (Berisha & Pula, 2015). This paper investigates Dutch manufacturing SMEs which operate mainly in the same policy and structural context at national level but also on the European level. For instance, the definition for an SME in the EU is important for access to finance and EU support programs. This paper uses the above EU definition of an SME as it best fits the policy and structural contexts in which the Dutch manufacturing companies operate.

The manufacturing industry is a diverse sector which processes raw materials and materials into semi-finished goods and products. In addition to the manufacturing sector being the cornerstone of the economy and crucial to sustainable economic growth, it is also one of the most resource greedy and

polluting sectors (Halstenberg, Lindow & Stark, 2017). Therefore, becoming circular through closing raw material cycles is particularly important for the manufacturing industry, since many companies in this sector are dependent on certain critical raw materials (European Commission, 2018). If the manufacturing sector is organized according to circular principles this would reduce raw material procurement costs by 19-23%, which on an annual basis equates to savings of 460 to €550 billion (Ellen MacArthur Foundation, 2014). Securing a sustainable supply of raw materials by means of circular initiatives is therefore a key priority for the EU (European Commission, 2018). Besides economic gains, the manufacturing industry has a huge impact on ecology (Franco, 2017). For instance, the largest emitters of the Dutch economy are the process industry and energy sector, with 35 and 47 billion kg of CO₂ respectively. The manufacturing industry appropriates a large part of their materials and energy, so making those production processes circular will yield significant environmental gains (Het Groene Brein, n.d.)

For these economic and environmental reasons, adoption of CE principles is especially promising for manufacturers (Acerbi & Taisch, 2020). However, the manufacturing industry is bound by tradition where change is slow and costly (Herman, 2016; Lieder & Rashid, 2016). Additionally, the CE is more complex than the linear model, resulting in barriers to move towards CE (Hopkinson, Zils, Hawkins & Roper, 2018). Manufacturing companies are faced with barriers when implementing CE principles, and although CE gained momentum in recent years, the extent of implementation of CE principles in manufacturing firms across the globe is below expectations (Masi et al., 2018; Ormazabal et al., 2018). It is therefore crucial to understand what barriers they face to take appropriate action (Jaeger & Upadhyay, 2020). Especially, as this question is not comprehensively discussed in current literature.

2.2 The concept of CE barriers and enablers

This section describes the theoretical background of CE barriers and enablers. First, literature regarding CE barriers and enablers will be elaborated on, by proposing different categorizations and perspectives about barriers and enablers. After that, it is explained which categorization of barriers and enablers this research adopts. Finally, the different barriers and enablers are described.

2.2.1 Categorization of barriers and enablers in the literature

In line with the rise of the CE concept at large, an emerging body of academic literature has sought to examine the associated barriers, challenges, enablers and drivers in the transition towards CE (Russell et al., 2020). There are many ways to think about barriers and enablers to a CE (Hart, Adams, Giesekam, Tingley & Pomponi, 2019) and examples can be found in the literature.

The sector specific research of Van Buren, Demmers, van der Heijden and Witlox (2016)

highlight significant institutional, social, economic and professional barriers in the Dutch logistic industry. Similarly, Hart et al. (2019) categorizes cultural, regulatory, financial and sectoral barriers and enablers specific to the build environment. Perhaps a more recent contribution to this literature is De Jesus and Mendonça (2018), who's extensive literature review distinguishes four groups of barriers and drivers: Technical, institutional/regulatory, economic/financial/market and social/cultural. Additionally, De Jesus and Mendonça (2018) divide barriers and enablers in soft (institutional and social) and hard (technical and economic) categories. They conclude that technical barriers stand out as the most mentioned problem of implementing CE and that social/cultural barriers are least mentioned. Departed from the paper of De Jesus and Mendonça (2018), Kirchherr et al. (2018) presented the first large-N-Study on CE barriers in the EU.

In contrast to the findings of De Jesus and Mendonça (2018), Kirchherr et al. (2018) formulates cultural barriers as most pressing for implementing CE. With three of the five most pressing barriers being cultural ones, namely 'lacking consumer interest and awareness', 'hesitant company culture' and 'operating in a linear system' (Kirchherr et al., 2018). These holistic findings over the EU support the findings from sector-specific research (van Buren et al., 2016). According to Kirchherr et al. (2018), their results reveal a difference between the key CE barriers indicated in academic literature and those experienced by business and policy practitioner's.

Barriers and enablers of CE implementation are extremely heterogeneous across both different sectors and spatial dimensions (van Buren et al., 2016). Similarly, in their review of case study literature on CE in manufacturing organizations, Bjørnset, Skaar, Fet and Schulte (2021) argue that the barriers documented in literature appear to be many and seem moreover to be context specific. Both De Jesus and Mendonça (2018) and Kirchherr et al. (2018) acknowledge this heterogeneous character by noting that their CE barrier and enabler frameworks require more empirical content by expanding the sample size and/or explore CE barriers in specific sectors or business models. This paper will partly fulfill these requirements by exploring CE barriers and enablers within the specific context of manufacturing SMEs.

Furthermore, several scholars investigated the barriers and enablers towards CE in the SME context (e.g., Ormazabal, Prieto-Sandoval, Jaca & Santos, 2016; Ormazabal et al., 2018; Rizos et al., 2015; 2016; Garcés-Ayerbe, Rivera-Torres, Suárez-Perales & Leyva-De La Hiz, 2019; Ghenta & Matei, 2018; Zamfir, Mocanu & Grigorescu, 2017; Mura, Longo & Zanni, 2020; Dey, Malesios, Budhwar, Chowdhury & Cheffi, 2020). For example, Rizos et al. (2016) take a less exclusive and sectoral approach to the critical factors towards CE, as they formulate barriers and enablers specific for SMEs in the EU that adapt circular business models. Explicitly, Rizos et al. (2016) distinguishes seven barrier and enabler

categories, including barriers like 'lack of capital', 'lack of government support', 'relatively low knowledge of CE' and enablers like 'company environmental culture', 'networking' and 'support from the demand network'. Rizos et al. (2016, p. 14) argues that *"the insights gained are particularly relevant for policy-makers at the EU and national level when devising policy frameworks for SMEs"*. These results are intended to help policy-makers and not necessarily help the managers in the SMEs to recognize and overcome certain barriers.

Like, with the example of Rizos et al. (2016), these SMEs specific studies view the critical factors like barriers and enablers from a relatively high level perspective. These papers often formulate broad and different categories of barriers and enablers, wherein the in-depth understanding of how barriers and enablers interact and behave is lacking. At the same time, the papers of Kirchherr et al. (2018) and De Jesus and Mendonça (2018) argue that this understanding is required to ensure that the CE concepts will ultimately succeed and of course this also applies in the field of SMEs. Therefore, it can be stated that these SMEs specific papers are limited regarding their outcomes and are not answering the questions of this research.

2.2.2 Adapted categorization of barriers and enablers

As described above, there are several ways and perspectives to categorize barriers and enablers regarding CE. In this paper we build on the categorizations of De Jesus and Mendonça (2018) and Kirchherr et al. (2018), by applying the CE barrier framework of Luttikhuis (2020) (depicted in Appendix A, table A1). Since, Kirchherr et al. (2018) and De Jesus and Mendonça (2018) are one of the few who indicate interaction effects among barriers and enablers. Luttikhuis (2020) departed from both de Jesus and Mendonça (2018) and Kirchherr et al. (2018) and integrated the categorization of both papers into a comprehensive but clear framework of CE barriers. Because of the practical usefulness and the comprehensiveness of this framework, this paper will depart from the categories of CE barriers formulated by Luttikhuis (2020). Therefore, this paper adopts the categorization as formulated by Luttikhuis (2020) as we identify the following categories: Cultural/organizational, regulatory, market and technological (as shown in Appendix A, table A1).

The sub-categories of barriers are mainly adopted from Cantú, Aguiñaga and Scheel, (2021). Their systematic literature review regarding barriers and enablers, from a firm level perspective, is considered most comprehensive and useful for this research. Furthermore, much of the above formulated papers, regarding CE implementation of SMEs, are part of the Cantú et al. (2021) framework (e.g., Ormazabal et al., 2016; 2018, Rizos et al., 2016, Garcés-Ayerbe et al., 2019, Mura et al., 2020). Sub-categories of barriers are further elaborated in section 2.2.3. Categorization of barriers and enablers as

supposed is helpful in identifying the four fronts on which progress must be made in order to progress towards CE. However, allocation of specific barriers and enablers is not always clear cut (Hart et al., 2019).

To bypass and dismantle the barriers to a more CE, certain enabling actions (enablers) must be implemented. These enablers promote better conditions for CE and can help solve individual challenges regarding CE implementation (Hart et al., 2019). However, like barriers, enablers face the question of how to categorize them. In contrast to barriers, enablers tend to be less clearly defined in literature. According to Hart et al. (2019, p. 621) "*authors can frequently see and evidence a barrier, but be unable to articulate what is needed to address it and unable to provide evidence that such action will promote circularity*". Rizos et al. (2016) acknowledges this by stating that research into barriers is evolving rapidly but investigation of SME specific enablers is lacking. Therefore this paper does not categorize the enablers like the barriers in four main fronts but builds on the more general enabler categories as formulated by Rizos et al. (2016) and Cantú et al. (2021). Firstly, Rizos et al. (2016) is one of the few who identified clear enablers that specifically help SMEs adopt CE practices. Since this paper specifically relates to (manufacturing) SMEs, Rizos et al. (2016) enabler focus on SMEs is a good fit. Also, Rizos et al. (2016) indicate that to resolve the research gap, regarding SME specific enablers, additional research and testing is required to validate and confirm their formulated enablers. Furthermore, the organizational enabler categories formulated by Cantú et al. (2021) will be incorporated with those of Rizos et al. (2016). Just as the organizational barrier categories, the organizational enabler categories as formulated by Cantú et al. (2021) are very specific and clearly defined which makes deeper understanding of the organizational/cultural barriers and enablers possible.

2.2.3 Barriers

Cultural and organizational barriers relate to aspects of the social, behavioural and managerial contexts in which the CE must develop (Hart et al., 2019). According to Kirchherr et al. (2018), cultural barriers refer to a lack of awareness, or willingness to engage with CE within and beyond organizational boundaries. The cultural/organizational category in this paper presents a total of eight subcategories. The first subcategory **corporate governance** refers to the structure and hierarchical systems of an organization (Cantú et al., 2021). The structure of an organization can influence its behavior in developing CE (Liu & Bai, 2014). Rigid organizational structures by means of hierarchical systems can hamper innovation and inhibit flexibility which is needed for CE. For example, a strong hierarchy system can prevent awareness and recognition of CE opportunities, because the ideas coming from lower levels cannot get to the top of the organization easily (Pheifer, 2017). Also resistance or conflict among

powerful stakeholders can negatively influence a company's behavior towards CE (Pheifer, 2017). The subcategory **culture** refers to the shared values, goals, and predominant attitudes of managers and employees within a company (Cantú et al., 2021). A hesitant company culture is closely connected to a rigid organizational structure, since silo mentality and resistance to change of certain departments can discourage information sharing across the company. These organizational silos hamper smooth development and implementation of circular business models (Pheifer, 2017). Perceiving sustainability as a cost and overemphasizing recycling were also identified as barriers in this subcategory. Some barriers are associated with the **management** of the organization. For example, managers can have limited knowledge of the CE concept or they are characterized by a linear mindset, which both can hamper the implementation of CE initiatives (Cantú et al., 2021). In the case of SMEs, the highest manager is usually the owner of the company and therefore has a lot of power in terms of strategic decision making. This makes the attitude of SME managers towards CE, a key factor in the CE transition of SMEs (Rizos et al., 2015). Additionally, extreme risk aversion of managers can hinder disruptive transition to CE (Ritzén & Sandström, 2017). Some barriers are associated with the **capabilities** of an **organization** to manage its resources. The clear knowledge and understanding of what CE entails is not common sense (Rizos et al., 2015; Pheifer, 2017; Ritzén & Sandström, 2017). Therefore, organizations still struggle with the lack of expertise and skills or the lack of organizational capabilities necessary for implementing circular business across the organization (Cantú et al., 2021). **Organizational resources**, which are closely connected to the organization capabilities, can also act as a barrier. This is the case when there is lack of organizational resources (e.g., in time and human) or when employees have no support and guidance (Cantú et al., 2021). **Operating in a linear system** is problematic for many organizations because this can lead to the fact that the strategy of the organization does not align with CE goals. When CE practices are not integrated in the strategy, mission, vision, goals or key performance indicators (KPI) of a company, then these practices are not perceived as key activities. This hampers the implementation of CE practices (Cantú et al., 2021; Pheifer, 2017; Ritzén & Sandström, 2017). Also, a firm's lack of adaptation to the local context, customers' needs or regional conditions can hinder CE implementation. Another barrier is **limited willingness to collaborate in the value network**. Within supply chain's partners can be very conservative (Kirchherr et al., 2018) and initializing a "green supply chain" is troublesome because of the potential cost's suppliers must deal with (Rizos et al., 2015). A barrier associated with the value network is the lack of supply chain integration and collaboration between partners. The international character of managing supply chains makes it more difficult to collaborate on CE initiatives (Preston, 2012; Rizos et al., 2015). Other found barriers are related to the

lack of transparency and information sharing, lack of trust and resistance to change within the supply chain (Cantú et al., 2021). Additionally, SMEs have problems related to the power balance in buyer-supplier relationships and supply chain positions (Cantú et al., 2021). SMEs often have little influence on their suppliers' attitude towards green activities because of their small size and bargaining power (Luttikhuis, 2020). Lastly, a **lack of consumer awareness and interest** in the CE concept is identified as barrier. Kirchherr et al. (2018, p. 268) states that "*consumers change their mind too quickly*" which could hamper the production of durable products, because these products last longer than the fashion trend. On the other hand, De Jesus and Mendonça (2018) argue that the slow change of consumer habits, because of inadequate information spreading regarding CE and the possible consumer choices available, leads to a lacking consumer awareness and interest. In addition to that, there are still many misunderstandings about refurbishment, reuse and the product-as-a-service business model (Mont, Plepys, Whalen & Nußholz, 2017). For example, most customers still prefer new products over refurbished ones, because they still believe that new products are superior to refurbished ones (Mont et al., 2017; Ranta, Aarikka-Stenroos, Ritala & Mäkinen, 2017).

Regulatory barriers refer to lacking policies that support CE or existing policies that hinder a CE transition (Kirchherr et al., 2018). The first type of barrier is **lacking standards**. Standards could provide guidelines to define sustainability in SMEs and could address CE processes, activities and materials (Bressanelli, Perona & Saccani, 2019; Mura et al., 2020). Furthermore, standards can help to diminish the '*lacking consumer awareness and interest*' barrier by providing product certifications and labelling standards (Preston, 2012; Cantú, Aguiñaga & Scheel, 2021). In this way, consumers can better understand the value of the CE concept and therefore greater awareness of the concept will be created (Preston, 2012). Currently, there are **not enough (financial) incentives for circularity, while there is for linearity**. The literature shows that limited funding and an unaligned taxation system can hinder CE (Cantú et al., 2021). The current regulatory system has many subsidies in place, but these mostly apply to linear practices, instead of circular ones (Pheifer, 2017). For example, there is inexistence of incentives toward using secondary material over virgin material, as large oil companies have access to tax reduction and subsidies, whereas governmental incentives for circular business models are nil (Pheifer, 2017). In addition to that, current regulations merely focus on recycling in term of certifications and awards, but do not focus on institutional support for reuse (Ranta et al., 2018). Lastly, many businesses **face obstructing laws and regulations** instead of getting incentives for CE (Ranta et al., 2018). For example, De Jesus and Mendonça (2018) argue that how policies define what is waste, and what is not waste, highly influences the development of CE practices. Furthermore, Pheifer

(2017) indicates that current (waste) legislation and regulations are designed for linearity and that resources are too easily defined and allocated as waste. This in turn makes labelling resources for reuse difficult and creates an administrative burden, which in the end discourages businesses to rethink their waste management policies (Pheifer, 2017).

According to Kirchherr et al. (2018), market barriers refer to a lacking economic viability of circular business models, that originate from high incurred costs and limited funding possibilities. Firstly, **low virgin material prices** make circular products much more expensive compared to fossil-fuel based plastics (Mont et al., 2017; Kirchherr et al., 2017). Low virgin material prices have a large impact on the sales of circular products, since price is still the most important motive for customers when it comes to buying decisions. Therefore, higher virgin material prices would lead to more affordable circular products (Kirchherr et al., 2018). The complexity associated with a CE transition requires a **high upfront investment**, with a high market uncertainty, whereas most organizations **still focus on short term results** (Ritzén & Sandström, 2017; De Jesus & Mendonça, 2018; Hart et al., 2019; Kirchherr et al., 2017). By providing funding and a clear and strong policy framework, that encourage investment and experimentation, governments can play a very important role to diminish this barrier (Preston, 2012; Kirchherr et al., 2017). Closely linked to this is that **limited funding for circular business models** is also a pressing barrier. Finding appropriate funding (apart from governmental subsidies) for the innovations needed for a CE transition is perceived very difficult, especially for SMEs (Geng, Xinbei, Qinghua & Hengxin, 2010; Rizos et al., 2015; De Jesus & Mendonça, 2018). In fact, CE innovations and initiatives have such high costs that financial injections are essential to make CE initiatives economically viable, which means that financial support is key for a CE transition (Ranta et al., 2017; Rizos et al., 2015). For example, circular business models, such as product-as-a-service, need huge funding because costs need to be financed upfront and revenue will be delayed for months (Bresanelli et al., 2019). Investing in these types of business models requires a strong financial position or the right external investors (Pheifer, 2017). When using a circular business model, like product-as-a-service, or when manufacturing circular products, **a reverse logistics system and supply chain** needs to be in place. Many organisations which operate in the current linear system lack networks and/or supply-chains that take care of disassembled products, components and materials (Mont et al., 2017). Organizing these reverse supply-chains is not easy due to geographical dispersion and therefore CE business models would drastically increase transportation activities, since all the products must go back to the producer or refurbishment organization (Bresannelli et al., 2019).

Technological barriers refer to the lacking presence of proven technologies that enhance the

implementation of CE (Kirchherr et al., 2018). According to De Jesus and Mendonça (2018), this barrier does not only include the existence of technology, but also technology gaps and the lack of well qualified staff to design and use these technologies are important. The challenge to deliver **high-quality circular products** is the main barrier identified. Most of the time, current technologies and products are not designed for CE, hence they cannot be easily disassembled, repaired, refurbished and remanufactured (Pheifer, 2017). Most organizations lack highly qualified staff that can identify, adapt, assess and implement advanced circular technologies (Rizos et al., 2015). Furthermore, current infrastructure of organizations does not always support circular services (Mont et al., 2017) and is often highly dependent on fossil fuels and "*once-through manufacturing models*" (Preston, 2012 p. 14).

2.2.4 Enablers

An important enabler identified by Rizos et al. (2016) is **networking** in the broad sense.

For example, by working together with like-minded SMEs striving for sustainability or joining a membership of a supply chain partnership. Also, **support from the demand network** enables SMEs to adopt CE principles. When consumers prefer "green" products or services, this motivates SMEs to adopt circular business models (Rizos et al., 2016). According to De Jesus & Mendonça (2018), such demand-side factors are decisive towards greener practices and more sustainable choices. Drivers from the marketplace can motivate manufacturers to initiate their sustainable purchasing efforts (De Jesus & Mendonça, 2018). **Financial attractiveness** by means of special funds like specific start-up financing or local grants can enable organizations to implement circular solutions (Rizos et al., 2016). Similarly, Cantú et al. (2021) argue that greater access to financial tools, such as private investors or international or national prize challenges, are necessary to overcome funding barriers. Furthermore, external **recognition** of circular principles can enable SMEs to become more circular. For example, when organizations use a circular business model, they are treated more favorably in government project tender procedures (when sustainability is a criterion for tendering) (Rizos et al., 2016). One of the last enablers mentioned by Rizos et al. (2016) is (non-financial) **support** by the (local) **government**.

According to De Jesus and Mendonça (2018, p. 82) the government plays a leading role in promoting institutional frameworks necessary to facilitate a CE, "*by reforming existing laws, enacting new regulations, promoting the application of new environmental technologies, and organizing public education*". The right **corporate governance** can enhance the implementation of CE activities (Cantú et al., 2021). For example, the creation of a new and independent business unit for sustainable principles changes the structure of an organization and can therefore influence its behavior in developing CE (Liu & Bai, 2014). Another enabler associated with this category is support from the parent company (Cantú et

al., 2021).

Rizos et al. (2016), identified company environment culture as one of the most important enablers. The mindset and commitment of both staff and management is an important factor when adopting CE principles. In fact, company leadership, that goes beyond pure everyday management and considers circular business models, tends to be more effective and efficient in the long run. Therefore, strengthening and improving SME management and leadership can be an important enabler (Rizos et al., 2016). Cantú et al. (2021) acknowledges this enabler but divides it in two categories namely ***culture*** and ***management***. This paper follows Cantú et al. (2021) categorization as it makes sense to make a distinction between company ***culture*** and ***management***, since the culture of the management may not be the same as the companies and the other way around. Cantú et al. (2021) formulates internal collaboration and company culture as the two dimensions of the ***culture*** enabler. Whereas, the enablers support and commitment from top managers and strategic leadership for CE refer to ***management***. Another enabler mentioned by Rizos et al. (2016) is the personal knowledge of individuals within an organization. As with the previous enabler Cantú et al. (2021) acknowledges this enabler but divides it in two categories namely ***organizational capabilities*** and ***organizational resources***. ***Organizational capabilities*** refer to the companies' ability to manage organizational resources. The right skills and expertise and the right technological capacities are necessary for implementing CE across different organizational functions. The CE capabilities and skills of the employees can be increased through training and education programs. (Cantú et al., 2021). More ***organizational resources*** e.g., human and time can support and accelerate CE initiatives (Cantú et al., 2021). Furthermore, Cantú et al. (2021) argues that some ***strategies*** can diminish the effects of operating in a linear system. Some identified enablers involve integrating CE within the firm's strategy, mission, vision, goals and KPIs or outsourcing of technical activities (Pheifer, 2017). Also, lobbying practices are mentioned as these can promote legislation to be more aligned towards CE (Cantú et al., 2021).

2.3 Stages CE transition

In order to provide context, different stages of circular implementation will be considered while researching the described barriers and enablers. According to Löwik (2020), there are five stages which organizations face, while transitioning to more circular practices: unformed, basic, improving, engaged and advanced.

In the unformed stage the organization has not or minimally developed circular innovation capabilities and is just slightly aware of circular economy developments. In the unformed stage, CE principles are not integrated into the organization's mission or strategy (Löwik, 2019). The basic stage

does involve some conscious and intentional development of basic circular innovation capabilities. In this stage the impact on society and environment is known, but actions comply with minimal regulatory requirements (Löwik, 2019). In the third stage organizations recognize the potential of the circular economy, by starting to develop innovation capabilities with commitment from management (Löwik, 2019). In the engaged stage the organization has embraced and established circular innovation principles. The organization is also aware of its societal and environmental impact and proactively takes action to minimize its effect. Lastly, in the advanced stage there is continuous improvement of circular innovation capabilities, which were established in the engaged stage (Löwik, 2019).

Organizations may encounter other barriers and enablers in the basic stage than in the advanced stage. Russell et al. (2020) acknowledges this by arguing that certain barriers and enablers influence particular stages of circular implementation. In fact, certain barriers can become enablers in later stages of implementation, or vice versa (Russell et al., 2020). Therefore, to overcome the barriers that constrain the circular transition of organizations, it's necessary to identify at which implementation stage these occur.

2.4 Relations and interactions of CE barriers, enablers and stages

This section describes the theoretical background of the different relations and interactions between barriers, enablers and stages. Firstly, the theoretical background of the interaction effects and the chain reactions among barriers is described. After that, different interactions between barriers and enablers are discussed. Thereafter, the relations between barriers, enablers and stages is described and the conceptual framework of this research is proposed.

2.4.1 Nesting of CE sub-barriers

Both De Jesus and Mendonça (2018) and Kirchherr et al. (2018) indicate that there are possible interaction effects between the different categories of CE barriers. De Jesus and Mendonça (2018, p. 77) argue that there is not just one barrier or enabler, *"but rather a mixture of facilitating and constraining factors, deriving from particular local conditions"*. Kirchherr et al. (2018) note that a 'lacking consumer interest and awareness' may result in a 'hesitant company culture'. Furthermore, 'high upfront investment costs' can be a symptom of the barrier 'hesitant company culture'. Also, Kirchherr et al. (2018) identify 'low virgin material prices' as a root cause of the cultural barriers. Higher virgin material prices create more affordable circular products, which could increase 'consumer interest and awareness', since consumers are very cost-conscious. A spur in 'consumer interest and awareness' will then lead to company interest in circular products, which then may diminish the barrier 'operating in a

linear system' (Kirchherr et al., 2018).

As depicted in Appendix A, figure A3, the interaction effects among the four interrelated categories of CE barriers can result in a chain reaction towards CE failure (Kirchherr et al., 2018). Therefore, more research into the four main categories and their different sub-categories is required to provide insight into the main causes of an unsuccessful transition to a CE (Kirchherr et al., 2018). However, much of the SMEs barrier and enabler literature up to now has not taken these interactions and chain reactions into account.

2.4.2 Interaction of barriers and enablers

In addition to the interaction between the different barrier categories themselves, interaction between barriers and enablers might be suggested in several forms. Some barriers and enablers can be mirror images, because the barrier is created by the absence of the enabler (Hart et al., 2019). Like the barrier 'no support and commitment of top management' and the enabler 'support and commitment of top management'. If there is support and commitment of the top management the barrier 'no support and commitment of top management' may be automatically diminished. Furthermore, some enablers might target specific barriers (Hart et al., 2019), such as the enabler 'training and education' target the specific barrier 'lack of expertise or skills'. As specific training, to develop new CE capabilities and skills, might diminish the lack of expertise or skills of employees. Other enablers improve conditions for CE in general and therefore target multiple barriers (Hart et al., 2019). An example of such an enabler might be 'strong and strategic leadership for CE'. If the top management or owner of the organization has strong and strategic leadership qualities focused on CE, then this may diminish different organizational barriers associated with 'corporate governance', 'culture' and 'management'. However, a point to note is that enablers are of generic nature, which may be linked to certain observed barriers. Like described above some enablers may influence a few of them, or just one, as it is a fluent and dynamic situation. An enabler therefore does not have to have a one to one relationship with a barrier and should therefore be seen as antecedents.

Although a lot was said regarding the different barriers, this paper investigates barriers and enablers regarding CE initiatives from a micro level perspective and thus focuses on how managers in SMEs can deal with the barriers they face while implementing CE practices. However, with regard to all four described fronts in literature (cultural/organizational, technological, market and regulatory), barriers, but mainly enablers, are often stated vaguely, and focus more on what must happen in general (e.g., organizational structure, strategy and culture have to change to support CE (Tura et al., 2019)) rather than the actions that managers can take to get that result (Hart et al., 2019). Additionally, Hart et

al. (2019) states that connections regarding cultural barriers and enablers are not suggested in their research as they are numerous and diffuse. However, both Kirchherr et al. (2018) and Rizos et al. (2016) indicate that cultural/organizational barriers are the most pressing ones and should be further investigated, as their research only provides a helicopter kind of view. This research mainly focuses on organizational/cultural barriers and enablers, because this category is seen as most important on the one hand and seen as more relevant from a manager's perspective on the other. However, the technological, market and regulatory barriers will definitely not be neglected, as this research aims to contribute to the bigger picture on all four fronts.

Furthermore, Luttikhuis (2020) states that during different stages of the CE transition, different barriers were perceived. Also, Russel et al. (2020) acknowledges this by arguing that certain barriers and enablers influence particular stages of circular implementation. Therefore, organizations may encounter other specific barriers and enablers or their interactions, in the basic stage than in the advanced stage.

Until now current literature has not investigated the interaction between barriers, enablers and stages from a micro level perspective especially regarding CE implementation of SMEs in the manufacturing industry. Managers of SMEs in the manufacturing industry need to understand the interplay between barriers and enablers to successfully and efficiently implement CE. This qualitative research is intended to uncover the different relations between barriers, enablers and stages experienced by SMEs in the manufacturing industry in order to see whether a pattern regarding the relations is existing, or if the relation is different in each of the examined companies. Therefore, the conceptual model shown in figure 4 was created for this research.

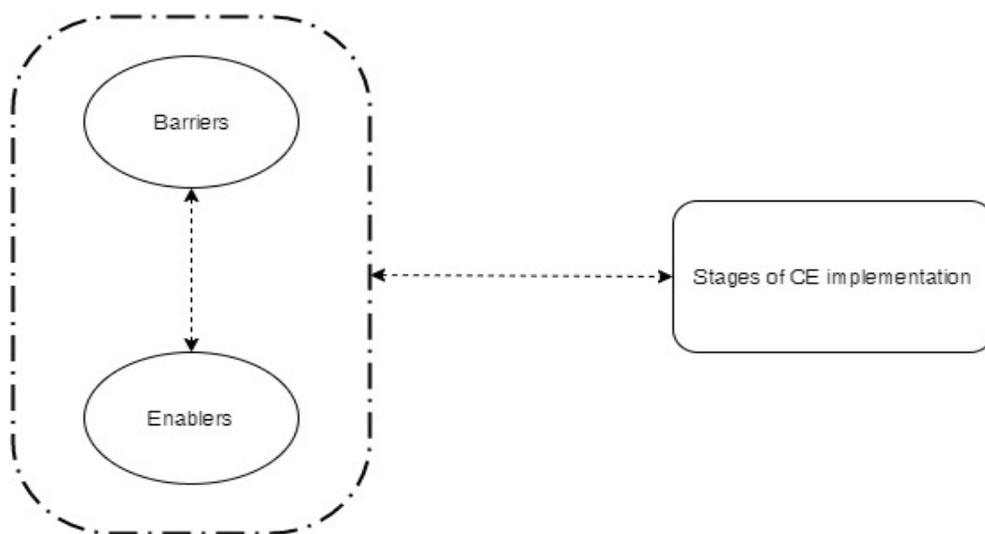


Figure 4: Conceptual Model

3. Methods

This chapter will outline the methodology of this research. First, the research design will be described. After that, the operationalization, case selection, data collection, data analysis and research ethics will be described.

3.1 Research design

A qualitative multiple-case study approach is used to explore the barriers and enablers experienced by managers in manufacturing SMEs. According to Symon and Cassell (2012), qualitative research is suitable for investigating multiple causalities and how different relationships of phenomena are linked (Symon & Cassell, 2012), such as the many barriers, enablers and stages of CE implementation in this research. As mentioned in the literature review, existing research in the field already approached the barrier and enabler topic, regarding CE implementation of SMEs, with qualitative research. However, the underlying aim of this study is to clarify and explore interaction effects among barriers, enablers and stages, which previous research is lacking. Therefore, the complexity of this research, due to the different and often vague relationships between barriers, enablers and stages, asks for qualitative rather than quantitative research. Hence, a qualitative research approach is best suitable when the research phenomenon takes place within complex and uncontrolled natures (Yin, 2012). Qualitative research allows for the exploration of detail and in-depth research (Curtis, Gesler, Smith & Washburn, 2000), which is necessary to obtain more empirical information about the barriers, enablers and implementation stages and their underlying issues and relations.

Also, the qualitative approach is used over a quantitative approach, because this study is very much explorative. According to Creswell (2003) and Yin (2012), qualitative precedes quantitative in exploratory research. This study does not intend to offer final and conclusive solutions to the existing problems, it rather aims to gain more insight into how barriers and enablers influence manufacturing SMEs in their circular transition. Therefore, an exploratory research design is chosen, because it is not intended to provide conclusive answers, it just helps us to have a better understanding of the problem (Saunders, Lewis & Thornhill, 2009). Furthermore, there is hardly any literature about the interaction between barriers, enablers and stages of CE implementation experienced by SMEs in the manufacturing industry. According to Brown (2006) exploratory research is preferred, when the research tackles problems on which little or no previous research has been done.

A case study approach is chosen because it allows a practical type of research in which a social phenomenon can be studied in its natural context (Bleijenbergh, 2015; Cresswell, 2013). According to Starman (2013), case studies emphasize subjective experiences and the meanings they have for an

individual, which is essential as this study investigates individual managers within organizations. Furthermore, a case study attempts to explain causal links that can be investigated in real-life and these are too complex for a survey or experiment (Yin, 2014). The barrier and enablers investigated are often stated vaguely, very heterogeneously and context specific, consequently this makes the starting point, the endpoint and the roles of the multiple actors within this process not clear and therefore a case study research design fits. Both Yin (2014) and Symon and Cassell (2012) suggest that to increase the transferability of the results, a multiple case study is more suitable than a single case study approach. Additionally, a multiple case study approach enables the exploration of differences within and between cases (Baxter & Jack, 2008). This research will explore how barriers and enablers are perceived and managed by individual employees within different organizations. Therefore, a multiple case study approach is used.

3.2 Operationalization

As this study deals with subjective meanings and therefore the main concepts are operationalized. This study deals with three main constructs: barriers, enablers and stages of CE implementation. Additionally, some control variables were taken into account. All concepts have extensively been discussed in chapter 2 and because of the space limitations the overview of the relevant constructs and their operationalization are presented in Appendix B, table B1, B2 and B3.

3.3 Case selection

The qualitative data will be collected through in-depth semi-structured interviews, with managers from manufacturing SMEs. These managers are part of the management team or important information carriers regarding the circularity concept within their organization. To ensure credibility two key stakeholders per case have been interviewed. However, at Fastfiles two informants were supposed to be interviewed, but unfortunately, one informant cancelled several times at the last minute due to the fact that he was too busy. We tried to reschedule the interview several times, however it turned out that the informant simply did not have the time for an interview. Furthermore, the CEO of Fastfiles indicated that there were no further information carriers regarding the research topic, so it was decided to cancel the second interview at Fastfiles. The number of cases is five, as between 4 and 10 is the ideal number of cases chosen (Eisenhardt, 1989). Furthermore, an exploratory expert interview was conducted, with an expert informant of TNO which had a coordinating role regarding the circular transition of the Dutch manufacturing sector. This exploratory expert interview served as an external source of knowledge by providing contextual knowledge about the target group, in this case the Dutch manufacturing sector (Bogner & Menz, 2009).

The cases are selected in a way that variance was both minimized and maximized. Since, the researched barriers and enablers are context specific and heterogeneous across different sectors. To minimize the variation a relatively homogenous group of cases is used. The cases are similar in the way that they are all SMEs, which operate in the manufacturing industry. Furthermore, they are all located in the same geographical region of the Limburg province. Variance is sought in some aspects as almost all cases operate in different parts of the manufacturing industry. The expert is selected for his specific background and knowledge, as he is specialized in the circular transition of the Dutch manufacturing industry. Table 4 shows the selected cases and their selection criteria.

Table 4: Selected cases and selection criteria

Organization	Greensharp	Woodbox	Steelwind	Greenway	Fastfiles
Industry	Mechanical and industrial engineering	Packaging and containers	Machines	Civil engineering	Office supplies and equipment
Description	Provide wide range of engineering services and high-quality tools	Produce industrial corrugated board packaging	Designer and manufacturer of custom fans (for wide range of industrial sectors)	Road sign manufacturer and produces signage, supporting structures, signage, electrical and tunnel safety products for the national and international market	manufacturing, services, filing solutions and office supplies
Employees	130	65	50	45	50

3.4 Data collection

The data for this explorative research is gathered through semi-structured interviews. By Conducting interviews primary data is generated which adds more reliability and richness for the specific purpose of a research (Myers, 2019). The interviews are semi-structured, meaning that a question list with open-ended questions is created, leaving enough room for new input. Semi-structured interviews are chosen as it obtains real-world descriptions of a described phenomenon (Brinkman & Kvale, 2015) while leaving enough room for additional questions to gain new and valuable information (Symon & Cassell, 2012).

Therefore, the researcher has the opportunity to deviate from the interview guidelines and gather more relevant information and clarification of given answers (Bleijenbergh, 2015). This might lead to new and valuable perspectives of the constructs with sufficient theoretical relevance (Symon & Cassell, 2012).

The interview questions were derived from the constructs of the conceptual model and are based on the operationalization of the theory. After the first two interviews it became clear that it was difficult to determine the stage of CE transition, based on the questions asked. A number of interview questions, focused on the phase of CE transition have therefore been added. These are the questions about insights of energy use and CO₂ emissions. The semi-structured interview guide can be found in appendix B. Each interview follows the structure of the interview guideline, but there is enough space for discussion and different levels of analysis. The expert interview departs from a more helicopter view level of analysis, but still follows the general structure of the interview guideline. To ensure credibility, triangulation of data was used (Symon & Casell, 2012), as additional data from sources such as websites or obtained documents were analyzed as well.

3.5 Data analysis

The interview will be recorded and transcribed verbatim. After transcription, the interview transcripts will be sent to the informants to check if the interviews were perceived and interpreted in the correct way. This peer debriefing is used to ensure credibility (Symon & Cassell, 2012). As suggested by Miles and Huberman (1994), the interviews are analyzed one by one and then compared to identify common patterns (Yin, 2017).

A template analysis is used to analyze the data and compare patterns. The template analysis is suitable for this research as it balances both flexibility and structure while analyzing data. Template analysis combines both inductive (i.e., bottom-up approach) as deductive (i.e., top-down approach) way of coding, which suits the explorative nature of this research (Symon & Cassell, 2012). As suggested by King and Brooks (2017) a priori themes will be defined based on the literature, after which codes are clustered into high order concepts and finally the templates are produced.

3.6 Research ethics

It is important to handle data sensitively when doing qualitative research (Symon and Cassell, 2012). This research acted according to the ethical guidelines as described within the Master Thesis handbook of Business Administration of Nijmegen School of Management. This means there is no place for plagiarism, manipulation of data, fabrication of data, misrepresentation of data or mismanagement of data in this research.

4. Results

In the following the results from the different cases are presented. Given the space limitations I decided to focus on the barriers and enablers that are considered most important and interesting in the context of the underlying research question. The cases are presented according to their level (stage) of CE implementation. An overview of all the barriers, enablers and stages can be found in Appendix A (Table A4, A5 and A6).

Case Steelwind

Steelwind is a designer and manufacturer of custom-made industrial fans for specific applications, in a wide spectrum of industrial sectors. Furthermore, Steelwind is a classic manufacturing company, which tries to produce everything in-house as they process, cut, weld and assemble the plate themselves. Steelwind produces custom-made fans as their (infra) structure is not suitable for large series.

Stage

Steelwind is currently in the first – unformed – stage of the CE transition. Steelwind complies to minimal legal requirements and CE principles are not part of the organization's mission or strategy. Also, Steelwind is organized to serve linear economic principles and they are slightly aware of the developments towards a circular economy.

Barriers and enablers

Steelwind focusses purely on efficiency and performance and not on circular initiatives because there is no circularity demand from their customers or the market. Steelwind produces mainly for OEMs and their end customers do not care about circularity or sustainability when it comes to the industrial ventilators, so you can state that there is *'lack of consumer awareness and interest'*. The CEO and Owner of Steelwind (I:1) argues: *"if we say to a customer, that motor is a bit more expensive, but it does save energy for you, then that customer says because that is not the end consumer, that is the machine builder, then that customer says: my end user is not going to pay for that, so I don't need a more durable motor"*. Also, the *'position'* of Steelwind in the *'supply chain'* is not helping, as they have no power to influence the end user in any way. The CEO and Owner of Steelwind (I:1) argues that only the government through new legislation can push the OEMs and the end users to buy more energy efficient fans: *"if you are talking about the engines now that is a big issue, but it is purely and solely controlled by the government [...] 10 years ago we had to move from IE4 motors to IE3 motors in a more energy efficient class, and now we have to move from IE3 to IE2. And those IE2 motors have been around for a*

few years [...] So only when the government says, we have to go to IE2 motors, then the chain will go to IE2 motors". So, 'government support' in the form of stricter legislation is the most pressing factor to implement sustainable initiatives. This has an influence on the value chain as a whole, but does not have any impact whatsoever on Steelwind, as they do not produce the motors themselves: "Look, if that new engine is 100 euros more expensive, then that goes into the price with me too, I don't make anything from it and I don't lose anything from it I have no interest in it" (CEO and Owner of Steelwind, I:1).

Furthermore, *'geographical dispersion'* and the lack of a *'reverse supply chain'* hamper business models like refurbishing or remanufacturing, because Steelwind's products are spread all over the world: *"Yes, look at most of that stuff that ends up far away from here and it doesn't pay for us to get it back"* (CEO and Owner of Steelwind, I:1).

Also, Steelwind is *'operating in a linear system'* in which they focus on commercialism and where CE is not integrated into the strategy of the organization: *"We are mainly commercially oriented, so what is economical to make. If you look at sustainability, that is not something we currently include in our purchasing process"* (Manager Improvement Projects, I:2). The Manager Improvement Projects (I:2) argues that there is also no sign of environmental awareness in the company *'culture'*: *"No, that's not really part of the corporate culture yet"*. This may not immediately be a direct problem for the organization, however it can cause difficulties in the future regarding their CE transition. However, some customers, who are working on circular or sustainable initiatives, inspire Steelwind to be more aware than it now is: *"But one of our largest customers is very busy with it. And I think that to a certain extent also inspires us to do more with it. It just so happens that my boss just came to my desk and he said you should visit a certain company, they are also very concerned with sustainability, and that I had to go and have a look at that. And I think that other company certainly has an influence on that"* (Manager Improvements Projects, I:2). The image of these customers inspires and thus enables in this sense Steelwind to become more environment and circular aware. One can indicate this as a form of *'support from the demand network'*.

All in all, the product Steelwind makes is reasonably circular, as it is recycled very well despite being shipped all over the world. This is because the technology is easy, and the virgin material price of the various components is very high. Thus the *'underlying nature of the product itself'* and the *'high virgin material price'* can be seen as unintentional enablers, as the CEO and Owner (I:1) argues: *"it's in the product itself, the technology is simple, virgin material price is quite high so people are aware that they have to recycle because it makes them money so nobody throws it away"*. Because of the easy technology there is no need for refurbishment or remanufacturing services from Steelwinds side: *"Well*

no actually it is very circular isn't it, but the technology is so simple that the circularity takes care of itself from the outside, by a mechanic who goes to the places himself, or sometimes they need a spare part, well then that is ordered" (CEO and Owner of Steelwind, I:1). Furthermore, the CEO and Owner of Steelwind (I:1) argues, that different materials and components like, RVS, aluminum and steel are used in the product in such a way that it is easy to recycle: *"it is rarely, if ever, that two different kinds of materials are joined together [...] And when it is finally at the end of the cycle, nothing is thrown away, the steel, the copper, the aluminum all go into the scrap bin and that goes back to smelters. Because it is too valuable to throw away so almost nothing is thrown away"*. Steelwind has it in its DNA to focus on efficiency and performance and in that way they are unconsciously fairly circular, because the nature of the whole value chain is already focused on a high degree of recycling.

Case Fastfiles

Fastfiles is a former family company founded in 1949. Traditionally, Fastfiles serves two market segments, the archiving market and the office supplies market. However, these markets are declining, so Fastfiles is looking for new product-market combinations, and they want to position themselves more as a producer of products made of cardboard and plastic, instead of an office and archive product producer.

Stage

Fastfiles is currently in the second – basic – stage of the CE transition. There are some intentional developments of basic circular innovation capabilities, as they try to experiment with new sustainable products and materials. Fastfiles main circular principles are currently aimed at recycling, so there is attention to material use and re-use. Also, the impact on society and environment is known, but circularity is not really incorporated in the organization's strategy and processes. Furthermore, there is not much insight into CO2 emissions and effects of raw materials.

Barriers and enablers

Firstly, circularity is not really part of Fastfiles culture: *"Well no, I don't think it stands out very clearly. It's not that people don't care, but more as a consumer than that it's really striking behavior"* (CEO of Fastfiles, (I:3). The CEO of Fastfiles (I:3) argues that *'the lack of awareness'* and *'culture'* may be the biggest bottlenecks when it comes to the circular transition of Fastfiles, as these are hard to change: *"yes I think ultimately consciousness, culture. To change that isn't something that happens in a week and I think that's what it takes to finally get it right"*. The CEO of Fastfiles states that the company itself must

also take steps to work more circularly and sustainably. The CEO of Fastfiles (I:3) claims that the organization needs to think much more creatively and innovatively to implement circular initiatives: *“yes, initiative and innovation and trying things out and daring to do things. And don't be afraid to try something new”*. The CEO of Fastfiles (I:3) argues that a flat ‘*organizational structure*’, with as less hierarchy as possible, may help to overcome the above barriers: *“It is fairly flat and I also try to run it as non-hierarchical as possible [...] because I believe that the collective ideas, creativity and knowledge of people is worth much more than all individual knowledge and I try to use that knowledge as well. So, you have to make much more use of bottom-up initiatives”*. This flat ‘*organizational structure*’ influences the ‘*culture*’ in the organization, in the sense that much more ‘*internal collaboration*’ is possible and this is the case with Fastfiles: *“Well, we invite everyone to think along about new products or improvements that you can implement. And people have to get used to that, because in the past people listened to or asked less about it. And when it was asked, little was done about it. So what we're trying to do now is to collect those ideas from people, and if we don't execute an idea, feed it back anyway. That people at least have the feeling that they have at least thought about it and at least listened. And that works”* (CEO of Fastfiles, I:3). In this newly created culture there is more room for knowledge sharing within Fastfiles, which can support and thus enable circular initiatives in the future. As quoted above the CEO of Fastfiles observed some good results however, it's too early to say what the precise influence is on circular initiatives.

The ‘*management*’ can also be seen as an enabler in the case of Fastfiles. There is a real internal driver for Fastfiles to be more sustainable and circular in the future. The CEO of Fastfiles (I:3) argues that this intrinsic motivation comes from management and that as CEO he also plays a really driving role in this: *“Yes, intrinsically mainly from the management team in the first instance and I think I also play a bit of a role in that myself because I can really boost it. There is enthusiasm about it in the organization, but then you must activate that too. You can also just say we don't react to it, or we hear the signals, but we don't do anything. So actually, doing it, that's what it's all about. And that is something that really must come from within”*. You can conclude from this that ‘*support and commitment for the top management*’ may be very important. Also ‘*strategic leadership for CE*’ is recognized as an enabler, as the CEO of Fastfiles (I:3) indicates that without a circular or sustainable turnaround, the organization will no longer be able to participate in the game in 10 years: *“It all seems to be accelerating now, I have the idea and I think that in 10 years, if you don't master that game, you just can't play along. So, what we are going to do is really build up knowledge about circularity, sustainability, etc., so that we can really help our customers in this”*. To move to a further stage of the CE transition, the CEO of Fastfiles (I:3) argues that

there is some *'lack of knowledge'* and that more specific knowledge is needed: *"yes, you will also need knowledge, but what I foresee is that we will do that in the beginning with external agencies that just know about it"*. To overcome the *'lack of knowledge'* Fastfiles will outsource expertise and technical capabilities from external bureaus. Thus, this outsource *'strategy'* can be seen as an enabler to overcome the *'lack of knowledge'* barrier.

In addition to this Fastfiles plans to train and educate their employees, so that these employees can develop themselves: *"Yes, we also want to pay more attention to educating and training people [...] We want to ensure that people are trained and we also want to ensure that people are more open to it, for example through such an online training tool. We also want to see if we can move people to develop a little more"* (CEO of Fastfiles, I:3). The CEO of Fastfiles (I:3), indicates that this will especially be the case in the area of circularity and sustainability. Thus, *'training and educating'* of employees may also diminish the barrier *'lack of knowledge'*. Furthermore, to create more insights of all the processes going within the organization, Fastfiles has attracted new human resources in the form of a value stream manager: *"But we are now going to start with a value stream manager, and that is someone who will be responsible for the entire process from order to cash, so there will already be more insights into what is happening throughout the organization"* (CEO of Fastfiles, I:3). In this case accumulating *'organizational resources'* can also be seen as an enabler that can moderate the barrier *'lack of knowledge'*.

Lastly, the CEO of Fastfiles (I:3) indicates that *'social media'* influences the *'consumer awareness and interest'*: *"I also think that social media plays a role in that. As a company, you can no longer get away with shouting something, you also have to show that you are working on it"*.

In conclusion you can say that Fastfiles is in a transition phase in which they do a lot of different things, to change things around. Fastfiles focuses on changing the company culture which is more suitable for circular and sustainable business operations. However, this takes time and time will tell if the above enablers have been successful to diminish and moderate the described barriers.

Case Woodbox

Woodbox is a producer of corrugated cardboard packaging in the broad sense. They produce for various market parties from corrugated cardboard packaging for the food industry or the medical industry to the packaging of photocopiers or make-up. Woodwork focuses mainly on corrugated cardboard packaging for niche products, so the more difficult the product the better.

Stage of transition

Woodbox is currently in the third - improving - stage of the CE transition. However, you can state that Woodbox is progressing towards the fourth stage, as the management actively integrates circular principles in its strategy, systems and culture. Woodbox is also aware of its environmental impact and proactively takes action to minimize its effects. However, Woodbox has mainly insights into the effects of raw materials and CO2 emissions from owned and controlled sources, which belongs more to stage three. The fourth stage requires insights in the emissions of their used resources and the emissions of their value network and this is not yet the case.

Barrier and enablers

Woodbox experiences a number of barriers when it comes to their circular transition, but the biggest barrier is the *'limited willingness to collaborate in the value network'*. Woodbox depends on their suppliers to take the next steps in their circular transition, because Woodbox itself does not produce corrugated cardboard. However, as already quoted above by the CEO of Woodbox (I:4) the vast majority of its suppliers are *'very conservative and resist change'*. Because of the pioneering role that Woodbox takes around CE, they often run into a wall of unwillingness when it comes to their suppliers as stated by the CEO of Woodbox (I:4): *"The moment you choose to take on a pioneering role, you know that you have to pull the rest after you. So yes, you regularly run into a wall of unwillingness or people who do not yet see the benefits or realizing the necessity [...] we had to wait 5 years before we could make a choice from sufficient suppliers with FSC certification"*.

In addition to the conservatism among the suppliers, the current raw material shortages cause that they are forced to purchase from non-certified suppliers: *"With that raw material shortage, we are forced to open our vision further, which means that we still require all suppliers to be FSC certified, but no longer require ISO140001 [...] So you see necessity knows no law and right now the need is quite high when you look at resource availability. And if you want to prevent that factory from standing still, you will have to be more flexible"* (CEO of Woodbox, I:4). The Head Business Office of Woodbox (I:5) also acknowledges that there are currently too few certified suppliers that they can turn to as the *"choice is not large, for cardboard suppliers"*. As a result, Woodbox cannot always guarantee the minimum requirement of a ISO140001 certificate from its suppliers, which in turn has the consequence that they have less or no insight into the CO2 emissions of their suppliers, because suppliers without certification often lack transparency and information sharing abilities as mentioned by the CEO of Woodbox (I:4): *"but that's a very traditional market that is very, very careful about releasing any kind of data. It's very*

hard to find that out”.

Lastly, as an SME Woodbox has little influence on their suppliers attitude because of their small size and bargaining power: *“we are also too small for that to propose requirements to large parties and you have to imagine there are 300 corrugated cardboard factories in Europe and each factory does about 150 million square meters per year we do 10, so in that entire part we have no influence whatsoever”* (CEO of Woodbox, I:4).

Furthermore, the barrier ‘*low virgin material price*’ emerged since the nature of corrugated cardboard and its low virgin material price make it is almost impossible to create high end business models based on refurbishment, remanufacture, reuse etc.: *“practically absolutely impossible because the value of the product is too little to guarantee a return [...] No no, we can never reuse the materials without fully recycling them first”* (CEO of Woodbox, I:4). However, on the other hand, the CEO of Woodbox (I:4) argues ‘*the nature of the product*’ is also an enabler as it lends itself extremely well to recycling and with the fact that the reversed supply chains regarding cardboard recycling are already in place in the Netherlands and Europe: *“Corrugated cardboard has been 100 percent recyclable for 30 years if you use the right ink and there are no metals in it for the boxes to adhere, but otherwise it is 100 percent recyclable all year round [...] the recycling process is so well organized that there is already 100 percent or at least 95 percent recovery of old paper in the Netherlands. Therefore, there is no need for another model for that”*. Also, the Head Business Office (I:5) argues that the product itself, the branch and the technology needed for the production process facilitate high a degree of CE within their company: *“that actually happened naturally because the industry we are in, so the product we make lends itself very well to do that, I must say. So the raw material is of course already yes, in advance very good for that and the production process is not really shocking”*.

Another enabler is ‘*culture*’ as circularity and sustainability are in the DNA and culture of the company: *“I think circularity is just part of an organization, just as a high-quality product is part of it [...] We actually have that in our DNA so much that we sweat it out [...] We were the first sheet plant in the Netherlands to be FSC certified, we were the first sheet plant in the Netherlands to be ISO 140001 certified, we are now the first sheet plant to be 260001 certified. Yes, we think it's important to be progressive in that regard”* (CEO of Woodbox, I:4).

In addition, the CEO (I:4) indicates that employees also play an important role here: *“We also had the advantage that the employees here were always enthusiastic about taking steps in this direction. So, when I, or a colleague suggested an idea for that, there was rarely or never a negative response like ‘oh no we have to do it again’”*. Furthermore, the CEO (I:4) also indicates that the ‘*structure of the*

organization plays an enabling role, with regard to circular initiatives: *“that we can indeed respond a little faster to developments with a somewhat smaller company, as a very large company with all kinds of legislation and regulations and internally with its own politics, then you see that those kinds of strategies take much longer before they are converted to the practice. And we can hit that pretty quickly”*.

Also, *‘management’* plays an enabling role in creating a circular culture, as the Head Business Office (I:5) argues: *“It’s a top down thing. So, if the CEO says we’re going to sail that course and he himself leads the way and he also stimulates that and things are regularly on the agenda, then the rest will follow naturally”*. Thus, the intrinsic motivation of the CEO of Woodbox plays an important role in the circular culture of the company.

Also, *‘support from demand network’* is mentioned as an enabler because a number of large customers partially pushed Woodbox to get certain certificates according to Head Business Office (I:5) of Woodbox: *“Indeed, at a certain point, attention was paid to this, also from customers, so we have taken up the certifications for that, such as ISO 14001 [...] And so there are more customers who, without an ISO 9001 certificate or 14001 certificate, we don’t have to knock on”*. The CEO of woodbox (I:4) emphasized that this is usually the other way around and that the certificates and circular mindset of Woodbox brought in large customers: *“For example, Apple came to us because we had it, we didn’t do it because Apple wanted it, it went the other way around. So yes, the reason for wanting to do this, this has nothing to do with the customer’s requirements, we are actually, in that respect, always ahead of the customers’ requirements”*. Thus, large customers come to Woodbox as they prefer *“green products”*, which can push Woodbox to keep its eyes open for certain certificates. Finally, *‘product standards and certifications’* enable Woodbox to attract these major customers who prefer green products, because, as quoted above, without the right certificates they don’t want to do business.

Case Greenway

Greenway is a road sign manufacturer and produces signage, supporting structures, signage, electrical and tunnel safety products for the national and international market in a sustainable way. Greenway produces sustainable products with proven technologies in which C2C and circularity are of paramount importance. Greenway’s market consists of government and semi-government consumers like civil servants, the municipalities, the provinces and Rijkswaterstaat.

Stage

Greenway is currently in the fourth – engaged – stage of the CE transition. Greenway actively integrates circular principles in its strategy, systems and culture. Greenway is also aware of its environmental impact and proactively takes action to minimize its effects. Furthermore, they have insights in the emissions of their used resources and the emissions of their value network. Greenway also has a new circular business model, whereby they "re-sign" old traffic signs, so a buyback system.

Barriers and enablers

In the case of Greenway the most important barrier is *'lack of consumer awareness and interest'*. As a road sign manufacturer Greenway only delivers to governments and semi-government organizations, however these government organizations *'lack the willingness to pay'* for sustainable products: *"Were we also have a lot of problems with is simply price, in our industry we only buy on price. So, it doesn't really matter how sustainable your product is. Look, the government is doing pilots with new products, but a tender is only based on price"* (Managing Director of Greenway, I:6). A barrier that may strengthen the barrier *'lack the willingness to pay'* is the *'employment term limit imposed on the managers'* of the government organizations as argued by the Quality Manager of Greenway (I:7): *"so actually, that is the bureaucracy there, there is someone who is responsible for the policy these four years and within four years this will be the cheapest investment, but what will happen in eight years after that, yes the next two board members will have to look at that again"*. This hampers *'long-term CE strategies'* as there is no long term horizon for these officials and no long term budgets: *"they don't see that because budgets change every year and job changes happen a lot, and yes, responsibility often shifts"* (Managing director Greenway, I:6). The Managing Director (I:6) of Greenway even mentioned that they went back to producing, less sustainable, steel road signs: *"The signage service simply says the sign must be made of steel [...] I started my steel production again three years ago, I'm just making steel plates again. Hot-dip galvanized steel yes, well I think they would rather not have hot-dip galvanizing in the Netherlands, but otherwise they get them from China so"*. The *'lack of consumer awareness and interest'* to buy a more expensive but sustainable board, leads to a more *'hesitant company culture'*, since further investments and innovation in Greenway "re-sign" concept have been stopped: *"at a certain point we see we don't sell as much as wanted, so the shareholders literally say we have to freeze the budget temporarily. Because as long as there are no more sales, we will no longer invest in it."* (Quality Manager of Greenway, I:7). The Managing Director of Greenway (I:6) even mentioned that they went back to producing, less sustainable, steel road signs, because there is a wrong perception towards reused road

sign in the market: *“There is so much ignorance in the market about reuse of materials but also for a second life, and also very wrong interpretations of LCAs, that you just can't beat that, because it's just what people believe [...] The signage service simply says the sign must be made of steel [...] I started my steel production again three years ago, I'm just making steel plates again. Hot-dip galvanized steel yes, well I think they would rather not have hot-dip galvanizing in the Netherlands, but otherwise they get them from China”*.

Another barrier which both the Quality Manager and the Managing director mentioned is *‘lack of standards’*: *“a civil servant who is forced to do so, and who also understands that it must be sustainable. But then he can't make the link between different traffic signs and their sustainability”* (Quality Manager of Greenway, I:7). There is no central labeling or certification that distinguishes different road signs according to the degree of sustainability: *“That's what I'm saying, now we're all doing it ourselves and then it's just which story do you think is plausible. So that leaves free interpretation [...] It is of course important that measurements are taken in a uniform manner”* (Managing Director of Greenway, I:6). In fact, the different municipalities and regions in the Netherlands have different methodologies and tools with which they look at the sustainability and circularity of traffic signs, as the Quality Manager of Greenway (I:7) argues: *“Then the Municipality of Wageningen comes again and has come up with another tool, which all has to be filled in manually. Three weeks later, the municipality of Rotterdam again came up with this idea where you have to enter everything manually, then the municipality of Groningen came again, who came up with this which you have to enter manually and from all of them comes a different result. And also at every municipality they ask for something completely different, and why”*. The Managing Director of Greenway (I:6) indicates that the barrier *‘lack of standards’* is caused by the government's subsidy policy and thus by *‘obstructing laws and regulation’*: *“look yes they also have far too many agencies for that, and they subsidize far too much, so that there is no unity”*. In turn, the barrier *‘lack of standards’* creates a situation in which the barriers *‘lack of trust’*, *‘lack of information sharing or data transparency’* and *‘lack of supply chain collaboration’* arise in the market and supply chain. Because without the right product certifications and labelling standards there are no guidelines to define sustainability, which leads, as already quoted, to own interpretations and own truths about products and materials: *“And that's really the bias, not being open to, and also the wrong information and yes it is what someone wants to believe but it is also possible because there is just a lot of noise”* (Managing director of Greenway, I:6). Also, the Quality Manager of Greenway (I:7) acknowledges this: *“Yes, actually, save your own ass a bit. The trust is too low for sharing your business plan [...] In fact, if you are the only one transparent, I think we will be*

bankrupt within the next 3 years". In order to overcome the barrier of *'lack of standards'* and create more *'awareness and interest among consumers'*, Greenway, together with all organizations affiliated to the road sign trade association, commissioned independent research into the various road signs of the industry organizations in order to create a central labeling and hierarchy that indicates how sustainable each road sign is compared to one another. However, it did not work because the government did not recognize it: *"at the VMVF we compared all those plates, everyone can hand in their plate, but the government says: that is the butcher who inspects his own meat that is not correct. But the VNVF is a trade association and we simply say we deliver, and all signs are done with the same methodology at the same agency"* (Managing Director of Greenway, I:6). According to the Managing Director of Greenway (I:6) *'Government support'*, in terms of new regulations and the creation of clear standards, could create clarity and unambiguity in the market. According to the Quality Manager of Greenway (I:7): *"it really should start with civil servants, the municipalities, the provinces, Rijkswaterstaat who have the will to buy this"*. *'Government support'* can thus be a crucial enabler in the case of Greenway as it might break down the whole chain reaction of barriers.

Another mentioned enabler is *'networking'* by *'developing a business case that is acceptable for all actors'*: *"a very big step will soon be made, because what will happen, there is a party, coincidentally a competitor of ours, but from the same trade association, so that will be something that we will share transparently with each other, that colleague has developed a system that all signs are named in that system by means of QR codes, so that you actually get a national database containing all signs"* (Quality Manager of Greenway, I:7). The Quality Managers (I:7) argues that this networking and *'supply chain collaboration'* could create more circular products and initiatives: *"I think if you have that then you have a base to start with [...] For me personally, that is a vision with which you could create a solution that can create a more circular product"*.

Lastly, *'culture'* and *'management'* also play an enabling role in the case of Greenway. Firstly, you can state that the company and its shareholders are oriented towards environmental awareness and that they are intrinsically motivated to be sustainable and circular, according to the Managing Director of Greenway (I:6): *"distinctive capacity, but we also really think it is intrinsically important for the future, for our children, grandchildren and their descendants [...] But also yes the management and the shareholders who think it is really important that we also look at our posterity"*. Furthermore, the Managing Director has some strategic leadership qualities as she initiated the *"re-sign"* and reuse business model: *"in this case this was also the initiative of Franka, with the re-sign boards, what will franka do then, he will write an investment plan for our shareholders"* (Quality Manager of Greenway,

I:7). The Managing Director (I:6) has also a strong long term vision which can be an enabler on the long run: *“look it doesn’t stop us from innovating, it’s really just the long haul”*.

Case Greensharp BV

Greensharp BV is legally a Dutch entity (SME) but it is wholly owned by Techhub, which is a Swedish OEM. Greensharp BV has 130 employees and produces specific round cutting tools for the parent company Techhub. Techhub produces high-quality carbide cutting tools for various high-tech industries.

Stage

Greensharp is currently in the fourth – engaged – stage of the CE transition. Greenway is aware of its environmental impact and proactively takes action to minimize its effect. Furthermore, Greensharp actively integrates circular principles in its strategy, systems and culture. Greensharp has also very high insights in energy usage and in the emissions of their used resources and their value network. Lastly, Greensharp has integrated a circular business model, whereby means of reconditioning used cutting tools are recut.

Barriers and enablers

Firstly, the barrier *‘corporate governance’* can be recognized. Since Greensharp has a large parent company, it has to deal with a very large and hierarchical organizational structure: *“especially the sluggishness of the organization and the size to anticipate it yourself, so to speak, that’s just difficult. You are always dependent on your mother company and your sister company”* (Manager Building & Infrastructure, I:8). The Manager Building & Structure (I:8) argues that this can slow down circular initiatives because they often require permission from above: *“So, in other words, everything we develop ourselves about circularity is making proposals. But we are not in the lead so to speak, we cannot decide ourselves we are going to buy back our products”*. Thus, the *‘hierarchical system inhibits flexibility and innovation’* in the case of Greensharp. In addition, there is a lack of communication between Greensharp and her sister companies, as communication lines are too centralistic: *“Yes no they just don’t hear how we do it, they just don’t get to hear from anyone how we do it and in fact I don’t even know the people who should hear it from those other sites. [...] Yes, too central, and not enough informing about the success stories, so to speak”* (Manager Building & structure, I:8). This can hamper the implementation of circular and sustainable innovations, as there is no knowledge sharing between Greensharp and the different sister companies.

However, being part of a parent company and having sister companies also has advantages:

“And what you indeed expect and see there is that you have the resources and no longer just in Lottum but really worldwide [...] For example, you can return recycled product collected in bulk in a normal and responsible manner to Wolfram in Austria” (Global Head Reconditioning, 1:9). Because of their sister company Wolfram, which is the biggest hard metal producer in Europe, Greensharp can recycle their hard metal to the grain. And from that same grain Greensharp produces its products as it buys its hard metal from Wolfram, which makes it 100 percent circular in that way. Thus, besides that having a parent company creates barriers, it also creates opportunities and enablers. One of them is *‘organizational resources’* in the form of financial strength: *“Yes, that all comes from the parent company, in that respect we have a luxurious position because the moment we make a business case that is interesting enough, there is in fact enough money to invest in it”* (Manager Building & structure, 1:8).

Another barrier mentioned by the Head Global reconditioning of Greensharp is the *‘geographical dispersion’* of its consumers and the accompanying problems of a *‘reverse supply chain’*. Greensharp has a circular business model in which they re-sharpen customers’ tools. However, as mentioned by the Manager Building & structure (1:8) this reconditioning model is very difficult because of the *‘geographical dispersion’* of Greensharps customers: *“that is the difficulty of our product, because we make the product on those four sites if we only talk about those round tools. We make a product and it is distributed all over the world and if you want to get it all back in that one place, yes that costs a lot of energy”*. Also, the Head Global Reconditioning (1:9) sees the *‘reverse supply chain’* and *‘geographical dispersion’* as main barrier to their reconditioning project: *“That will probably be the logistical handling, with respect for the customer's wish with regard to door-to-door time, i.e. how quickly they have their tools back, that's the biggest barrier”*. Furthermore, the Head Global Recondition argues that working with local certified satellites is not really an option, because there is strong competition in the market and the possibility exists that products are copied: *“But yes, of course you also have to deal with very eager and aggressive competition there, and certainly now, in our industry it is not that we are in a crisis, or at least not a crisis like in 2008, but that is a surplus of machines right now and in the world, and in a nutshell, that means everyone likes to have more work. Then you just see an increase in it. Then you hear left and right again that our product is being copied and yes, that is, that goes quite quickly and we are just very careful with that”* (Global Head Reconditioning, 1:9). So you can state that there is a *‘lack of trust and information sharing’* in the value network.

However, Greensharp can overcome the *‘geographical dispersion’* and the *‘lack of a reverse supply chain’*, as Techhub has enough resources to buy local sharpening hubs: *“So the investments, which can also take place, for example, in the form of a collaboration with a local regrinding unit, which*

are then certified [...] And that's exactly where we are now that we want to ease that and that's because of that increased focus" (Global Head Reconditioning, I:9). Thus, the 'support of the parent company' is in this case an enabler to really unroll the reconditioning concept for Greensharp.

Another enabler is 'support from the demand network': "I dare to say that our customers support us in this, yes of course SECO is also very consciously involved in yes, circular manufacturing and recycling, etc., but if our customers also continuously get more demand for this, then we will switch" (Global Head Reconditioning, I:9). As big clients of Greensharp ask for reconditioning services, more focus is also being placed on it from the parent company: "also because customers are going to demand more, we are increasing the focus on this, so you get very large accounts, for example: a Bosch, Siemens, Stryker Medical, who are already claiming that we investigate every offer of a new tender or in a new application, that we also include reconditioning" (Global Head Reconditioning, I:9). So, more 'support from the demand network' activates more 'support from the parent company'. Furthermore, in the last two years 'CE and sustainability are integrated into the strategy, mission, vision, goals and KPI' of the whole Techhub group. This may be an enabling factor as there is more and more focus on circularity from the parent company: "Yes, the first presentation was in 2019, and it was not so professional yet, but this is becoming more and more professional. And more and more attention is being paid to it, more and more people are being deployed to steer this in the right direction, so to speak" (Manager Building & structure, I:8). The Manager Building & structure (I:8) even indicated that the "the global vision presented" was the most important enabler. In line with this, the Global Head Reconditioning (I:9) argues that 'social media' plays a role in increasing the awareness around CE and that this is also the case for Greensharp and its industry:

"This is of course now due to the awareness and I also think that the media shapes us a bit [...] But if you also see the initiatives and yes the awareness process of humanity in a general sense developing there. Yes, then I can only conclude that it is something that, in a general sense, is causing a wave in the industry at the moment".

6. Conclusion

The main objective of this research is to increase the practical understanding of how barriers, enablers and their interaction influence the CE transition, as conceived by managers in manufacturing SMEs. The research question of this study was therefore: *“Which barriers do managers of Dutch manufacturing SMEs face while implementing circular practices and how do enablers help to overcome them?”*

First of all, the results of the five case studies indicate that managers of manufacturing SMEs experience a broad range of barriers across the four categories: (i) organizational/cultural; (ii) market; (iii) regulatory (iv) technological. Predominantly, SMEs in the case studies mention organizational/cultural barriers; *‘lack of consumer awareness and interest’* and *‘limited willingness to collaborate in the value network’* as barriers to implement CE practices. The first barrier illustrates that there is *‘low willingness to pay’* from the demand site for sustainable or circular products. The second barrier *‘limited willingness to collaborate in the value network’* highlights the fact that SMEs often have little influence on their suppliers’ attitude towards circular or “green” activities. This applies specifically to SMEs due to their *‘small bargaining power and place in the supply chain’*. Other more specific barriers underlying *‘the limited willingness to collaborate in the value network’* are *‘lack of trust’*, *‘lack of information sharing or data transparency’*, *‘lack of supply chain collaboration’*. Similarly, *‘lacking standards’* is observed as an underlying barrier to the *‘lack of consumer awareness and interest’*.

Therefore, this paper observed new possible interactions between barriers and chain reaction mechanisms that can lead to CE failure. Importantly, it must be recognized that barriers identified do not act in isolation, as barriers can arise from regulatory problems but manifest themselves as organizational or cultural barriers that may even dominate the supply chains.

This paper also indicates several enabling factors that could help managers in SMEs in their transition to a more CE. The results of this research demonstrate that success of SMEs in transitioning to a CE depends on how well this process is supported by enablers such as: a circular *‘culture’* through the circular mindset of *‘management’*; or the right *‘organizational structure’* to enhance flexibility and innovation; or the *‘support from the demand network’* to enhance awareness and information sharing. Furthermore, just like with the barriers, the findings of this study suggest that enabling factors like *‘culture’*, *‘management’* and *‘organizational structure’* exist in a web of interrelations and thus influence each other. When managers understand these interplays better conditions for circular initiatives can be created.

Also, this paper suggests that the different stages of CE transition have to be taken into account, as some specific barriers are more common in earlier stages and others in further stages of the CE

transition. Barriers are context specific and therefore SMEs need to understand that different stages of CE transition bring different contexts and thus different barriers.

It can be concluded that the barriers and enablers identified do not act in isolation, and form a complex web of interconnecting barriers and enablers. Furthermore certain barriers are of significant influence at particular stages throughout the process of CE implementation. The results in this regard are promising and shed a new light on the complex web of interconnecting barriers and enablers, however it is an exploratory step in the long road to a CE.

5. Discussion

This paper contributed to CE literature regarding barriers and enablers perceived by SMEs, by gaining better understanding of barriers, enablers, as well as their interplay and the influence of the stages in the CE implementation process by analyzing cases in the Dutch manufacturing industry. As this study was set up as exploratory research, it was not intended to measure relevance by counting the frequency of barriers and enablers. Therefore, we cannot claim that one barrier or enabler has been more significant and thus more important than others. It is merely an indication of how often SMEs feel themselves confronted by a barrier or enabler, the frequency of these barriers and enablers could only be considered a token of significance for SMEs in this sample.

As mentioned in the literature review, barriers can be categorized in four main barrier categories: (i) cultural/organizational, (ii) market, (iii) regulatory and (iv) technological (Kirchher et al., 2018; De Jesus and Mendonça, 2018). In general, the findings of this study are consistent with the categories formulated by Kirchher et al., (2018) and De Jesus and Mendonça, (2018), because different barriers and enablers regarding SMEs emerged for all four categories. Furthermore, it seems that cultural/organizational barriers were perceived as more pressing for SMEs when implementing CE, because the barriers *'lack of consumer awareness and interest'*, *'limited willingness to collaborate in a value network'*, *'lack of culture and awareness'*, and *'rigid organizational structure'* emerged most strongly from the different cases. These results reflect those of Kirchherr et al., (2018), but contradict those of De Jesus and Mendonça (2018) as they argue that technological and regulatory barriers are most pressing when implementing CE.

The barrier *'Lack of consumer awareness and interest'* came forward as case studies mention that there is a *'low willingness to pay'* for circular or sustainable products (Pheifer, 2017). Surprisingly, in one case the finding in this regard is that the *'low willingness to pay'*, is strengthened or influenced by an *'employment term limit imposed on the managers'*, which hampers long-term CE strategies. This

result may be explained by the fact that government officials in municipalities, provinces and the like often have a four-year term of office with strict budgets.

Furthermore, this study confirms that the barrier '*limited willingness to collaborate in the value network*' is associated with the fact that SMEs have little influence on their suppliers' attitude towards green activities, as several cases acknowledge their small size and bargaining power as cause (Cantú et al., 2021; Luttikhuis, 2020). For instance, one case had to wait several years to only produce FSC certified corrugated cardboards, as their big suppliers had no willingness or interest to produce FSC certified corrugated cardboard. Eventually time made the supplier certify themselves and FSC is now very common. Surprisingly, because of the current '*raw material shortages*', it was found that the problem came back as the SMEs had to switch to more suppliers as their regular suppliers (which were ISO140001 certified) could not deliver enough materials. As a result, they ended up with suppliers who were not ISO140001 certified and again it hampered their CE transition. The barrier '*raw material shortages*', does not explicitly appear as a barrier in the literature review, but it played a major role in this case. Also, other cases noticed '*raw material shortages*', but they indicated that this did not really affect them yet, but that it should not last too long. The results show that larger SMEs, especially with a parent company, seem to suffer less from '*raw material shortages*', as in one case the parent company of the SME also owned the raw material supplier of this SME. This can reduce the problems surrounding '*raw material shortages*' as the barrier like small size and bargaining power may be diminished, because of the parent and daughter situation. However, the effect of '*raw material shortages*' may therefore be stronger on SMEs as they generally have less power with regard to their suppliers (Cantú et al., 2021; Luttikhuis, 2021). Nevertheless, you can indicate that raw material shortages will always have an impact, but in the situation outlined with regard to the bigger SMEs, the consequences will be smaller. Furthermore, '*the place in the supply chain*' matters, as one case mentioned the fact that they deliver to OEMs and not directly to the end consumer, which makes it difficult to have any influence on the end product.

The '*corporate governance*' of a SME itself can also hamper CE initiatives (Liu & Bai, 2014; Pheifer, 2017; Cantú et al., 2021). Firstly, the findings of two cases indicate that hierarchical organizational structures inhibit flexibility and innovation, which hampers CE initiatives. This finding is consistent with that of Pheifer (2017) who indicates that a strong hierarchy system can prevent awareness and recognition of CE opportunities, because the ideas coming from lower levels cannot get to the top of the organization easily. This is contradicting with the research of Luttikhuis (2020) where no barriers regarding organizational structure and hesitant company culture were perceived. A note of

caution is due here, since one of the two cases is an SME from a legal point of view, but is owned by a multinational parent company. Therefore, the parent company can cause these hierarchical problems regarding the organizational structure and not the SME itself.

Furthermore, in line with Cantú et al. (2021) *'culture'* and *'management'* can play a constraining role for SMEs to implement CE initiatives. Interestingly, *'culture'* and *'management'* problems mainly occurred in the two cases that were in stage one and two of the circular transition. A plausible explanation for this observation could be that the other SMEs of the sample, which are in further stages of the CE transition, already adopted circular-economy types of businesses and therefore it is more likely that their company culture is more respective to CE (Rizos et al., 2016). It can thus be suggested that SMEs that are in the early stages of the circular transition experience relatively more problems with *'culture'* and *'management'* than SMEs that are in further stages.

Also, market barriers, like *'low virgin material prices'* and *'lack of reverse logistics and supply chain'* were mentioned. For Instance, in one case the *'low virgin material prices'* to produce their product, made it almost impossible to create high end business models based on refurbishment, remanufacture, reuse etc. Since the value of the product is too little to guarantee a return and therefore there is *'no consumer interest and awareness'* in such business models (Kirchherr et al., 2018). This in turn may strengthen the *'lack of reverse logistics and supply chain'* as there is almost no incentive to create reverse logistics and supply chains based on remanufacturing and refurbishment models, especially when there is *'geographical dispersion'* of the products.

However, despite the fact that cultural/organizational and market barriers are most frequently mentioned in this research, SMEs in this sample also suffer from regulatory barriers that mainly manifest themselves in the form of *'lacking standards'* (Preston, 2012; Bressanelli et al., 2019).

In addition, this paper contributes literature regarding the nesting of CE barriers and sub-barriers (Kirchherr et al., 2018; De Jesus & Mendonça, 2018). For example, according to one case, the *'lacking standards'* strengthens the *'lack of consumer awareness and interest'* and *'limited willingness to collaborate in the value network'*, considering that not having product certifications and labelling standards, leads to own interpretations and truths about products and materials. This in turn creates the situation that the barriers *'lack of trust'*, *'lack of information sharing or data transparency'* and *'lack of supply chain collaboration'* arise in the market and supply chain. In this case *'Lacking standards'* creates a chain reaction of barriers, which eventually strengthens the organizational/cultural barriers like *'lack of consumer awareness and interest'* and *'limited willingness to collaborate in a value network'*. These results indicate a chain reaction of CE barriers, in which a regulatory barrier namely *'lacking standards'*,

influences cultural/organizational barriers like *'lack of trust'*, *'lack of information sharing'* and *'transparency and lack of supply chain'*. However, in this case, the *'lack of standards'* was created by *'obstructing laws and regulation'*, as the government subsidized too many different certification and labeling organizations, which resulted in no central labelling and certifications in this market. These findings corroborate the ideas of Kirchherr et al. (2018) and De Jesus and Mendonça (2018) who suggested that there are possible interaction effects between different categories of CE barriers and enablers. However, the chain reaction of barriers in this research seems to be more complicated and different than depicted by Kirchherr et al. (2018) and De Jesus ad Mendonça (2018). A possible explanation for the complex chain reaction, observed in this one case, might be that their only customer is the government. So, the customer who is unwilling to buy the product, is the only one who can change the *'lack of standards'* and thus ease the described chain reaction. In this case SMEs have little power to overcome this policy problem, as these external regulatory factors are beyond their influence. Although, less complicated interactions have also been observed. For example, in one case the management and shareholders were hesitant and eventually stopped financing one particular circular innovation regarding refurbishment, as there was *'lack of consumer interest and awareness'* to buy this refurbished product. This result confirms the interaction between *'lack of consumer interest and awareness'* and a *'hesitant company culture'* as described by Kirchherr et al. (2018).

Alongside barriers, this paper contributes to the literature regarding different enablers to overcome and diminish the above described barriers. In general, it could be concluded that the enablers mentioned in the literature (Cantú et al., 2021; Rizos et al., 2016) also apply to a number of SMEs in the sample. The results further support the idea that company *'culture'* and *'support from the demand network'* are among the most enabling factors to overcome barriers (Rizos et al., 2016). Several cases indicated that interest or preference, from big customers, in "green" products motivated manufacturers to initiate their sustainable efforts. In one case certain customers only bought products which were certified, which indicates that certification and labeling do enable awareness and interest of certain customers. This in turn indicates that the enabler *'government support'* regarding the creation of sufficient standards may strengthen the *'support from the demand network'*. These results are in accord with recent studies indicating that demand-side factors are decisive towards more circular practices (De Jesus & Mendonça, 2018; Rizos et al., 2016). This again is something that managers of SMEs can do little about as this is a regulation problem, which calls for better policy frameworks. These results further support the idea of Mura et al. (2020) that regulatory fragmentation, in this case with regard to standards and labeling, is perceived as a barrier by SMEs and therefore is a challenge to the spread of

CE. The chain reaction indicated between *'government support'*, *'creation of standards'* and *'support from the demand network'* was not observed in the literature review, however to overcome these different barriers, such chain reactions have to be understood by both policymakers and managers in SMEs. Regarding organizational culture, an interesting finding is that the organizational *'culture'* is influenced by both the *'management'* of the organization and the *'organizational structure'*. One case indicated that making the organizational structure less hierarchical, while promoting bottom-up ideas, resulted in more internal collaboration and communication between employees.

Interestingly, the concept of *'issue selling'* emerged in a number of situations, as *"issue selling is the process by which individuals affect others' attention to and understanding of the events, developments, and trends that have implications for organizational performance"* (Dutton, Ashford, O'Neill & Lawrence, 2001, p. 1). For example in the case of Fastfiles, where the top management tried to influence the company culture and structure in order to make circularity and sustainability an intrinsic part of the organization. By often putting circularity on the agenda and also making the structure in the organization less hierarchical, innovative ideas in these areas get off the ground more easily. It is possible, therefore, that *'issue selling'*, from top management to employees takes place to make circularity and sustainability an intrinsic part of the organization. Therefore, you may argue that *'issue selling'* is important in this regard, as the top management in this case tries to create their employees' attention and understanding of CE in order to guarantee the future performance of the organization (Dutton et al., 2001). In addition to *'issue selling'* within the organization, it can also play a role for the organization with regard to the external environment as *"selling the idea of circularity helps SMEs that adopt circular practices achieve better economic performance"* (Blasi, Crisafulli & Rita Sedita, 2021, p. 6). This has also been noted to some extent in several case studies. For example, in the case of Greensharp who's reconditioning concepts gained a lot of traction, by *"signaling"* the advantages of this circular business model to its SME clients. However, in the case of Greenway, *"signaling"* the advantages of their re-sign concept has not led to the traction that was expected. A possible explanation for this might be that, in the case of Greenway, the *'lack of trust'* and *'lack of information sharing and transparency'* in the market may hamper the *'issue selling'* of their circular concept. In general, therefore, it seems that *'issue selling'* might play an enabling role in promoting CE practices for the internal and external environment of SMEs. Furthermore, several cases, in line with Kirchherr et al. (2018) mentioned that the enabler *'high virgin material prices'* created more awareness and interest of consumers and thus erodes the barrier *'lack of consumer awareness and interest'*. Surprisingly, two cases mentioned that *'social media'* influences the development of humanity's and organizations awareness process in general and

that this also exerts its influence regarding CE and a sustainable world. In line with this Ormazabal et al. (2018) argues that practices and techniques focused on increasing awareness and importance of CE are vital to long term sustainability and should therefore be identified. *'Social media'* may be such a new technique or practice in order to implement the CE in (other) SMEs. This finding was unexpected and suggests that *'social media'* can be seen as an enabling factor to create more awareness regarding CE and thus may diminish the barrier *'lack of consumer awareness and interest'*. Ormazabal et al. (2018), argues that actions which increase the awareness and importance of the CE are vital for the long term and that one should identify these practices and techniques, which in this case may be *'social media'*.

Lastly, the results also indicate that the different stages of circular transition have to be taken into account when assessing barriers and enablers regarding the implementation of CE. The more internal barriers like *'culture'* and *'management'* were mainly mentioned by the cases in the early stages (1 & 2). The more external barriers such as *'supply chain collaboration'* or *'lacking standards'* mainly occurred in the cases that were in the later stages (3 & 4) of the CE transition. A possible explanation for this is that, in the further stages (3, 4 & 5) more external collaboration is needed to close resource loops for example to diminish indirect CO2 emissions, which are not directly under control of the organization.

5.1 Theoretical implications

The insights derived from this study contribute to the CE literature on micro-level by gaining more understanding of the barriers and enablers and their interaction influencing CE transition, as conceived by managers in manufacturing SMEs. Besides, more careful analysis and critical discussion of CE barriers and enablers in specific sectors is required to ensure that the CE concept will ultimately turn out to be a mainstream success (Kirchherr et al., 2018). This paper fulfils these requirements by exploring CE barriers and enablers in the specific context of manufacturing SMEs on a micro-level. This study shows that manufacturing SMEs experience barriers with regard to all four pathways (cultural/organizational, market, regulatory, technological) as described in literature when implementing CE initiatives (De Jesus & Mendonça, 2018; Kirchherr et al. 2018; Luttikhuis, 2020).

This paper first contributes to the CE barrier literature by suggesting that the cultural/organizational barriers and their interactions are the most pressing for manufacturing SMEs, which is in line with Kirchherr et al. (2018). The barrier frameworks of Luttikhuis (2020) and Cantú et al. (2020) were combined and used in this study. The majority of the barriers correspond with both frameworks, however in contrast to Luttikhuis (2020) *'organizational structure'* was perceived as an barrier by the two bigger SMEs in the sample. Both SMEs are self-contained entities of a larger parent company. An implication of this is the possibility that *'organizational structure'* in these kinds of SMEs

can cause problems with regard to implementing CE.

Furthermore, this research suggests that barrier chain reactions hamper SMEs to implement CE initiatives. Like the described chain reaction from *'lacking standards'* to *'lacking consumer awareness and interest'*. However, these results have not previously been described by SMEs specific literature, as only Kirchherr et al. (2018) and De Jesus and Mendonça (2018) suggest these kinds of barrier interactions.

In addition, this paper contributes to the literature regarding different enablers to overcome and diminish the described barriers. The majority of the enablers found correspond with the combined frameworks of Cantú et al. (2021) and Rizos et al. (2016). However, this research shows that the concept of *'issue selling'* can play an enabling role for manufacturing SMEs. Since, in some cases managers used *'issue selling'* to influence the *'culture'* of the organization or to influence certain clients. These communication techniques in the form of *'issue selling'* may play a vital role in overcoming certain barriers. Furthermore the enabling factor *'social media'* is suggested in this research as this can create more awareness regarding CE and may therefore diminish the barrier *'lack of consumer awareness and interest'*. This extends the existing literature on enabling factors.

Furthermore, this paper showed that more internal barriers like *'culture'* and *'management'* were perceived in the earlier stages of the CE transition and that more external barriers such as *'supply chain collaboration'* or *'lacking standards'* occurred in later stages of the CE transition. These implications contribute to the literature in the sense that the stage of transition, a SMEs is currently in, matters to understand the context of the barriers and enablers. There is abundant room for further progress in determining how barriers, enablers and stages interact and how concepts like issue selling play a role in this complex web of interrelations.

5.2 Managerial implications

All in all, these findings have important implications for developing a better understanding in how managers of manufacturing SMEs can overcome different constraining factors regarding their transition to CE. From the results, it is clear that managers in manufacturing SMEs experience many barriers which constrain the transition to a CE. Additionally, in several cases interactions among the four interrelated categories of CE barriers, cause a chain reaction towards CE failure. It is therefore important that managers of manufacturing SMEs better understand and recognize these barriers and their interaction so that they can respond better to the problems that arise during their transition to a more CE. For example in the Fastfiles case, in which the understanding of the CEO, regarding the interplay between barriers such as *'culture'*, *'management'* and *'organizational structure'*, led to several business changes,

which have already led to certain positive effects. Therefore, when the barriers and their interactions are more clear, managers of manufacturing SMEs can more effectively use possible enabling actions to diminish these barriers. Since, if the underlying causes of barriers are not clear, then an enabling action can serve as a symptom treatment as there are other barriers that have an underlying influence.

Furthermore, the enabling factors mentioned in this research can contribute to a wider understanding and arsenal of options for managers in manufacturing SMEs to diminish and overcome certain barriers and barrier chain reactions.

Finally, managers of manufacturing SME should be aware of the CE transition stage they are in. The results of the research indicate that the barriers regarding '*culture*' and '*management*' arise in the beginning stages (1 & 2) and other specific barriers like '*collaboration in the value network*' and '*regulatory*' related barriers, like '*lacking standards*', arise in later stages of the CE transition (3 & 4). Barriers are context specific, therefore managers of manufacturing SMEs should keep this context in mind (by means of different stages of CE implementation), this can enable them to respond better to the barriers.

5.3 Limitations and Directions for future research

Firstly, whereas the research aimed to better understand the barriers and enablers that managers of manufacturing SME experience regarding their transition to a CE, only 5 organizations have been researched. Of these five firms, two firms turned out to be part of a larger group of firms. From a legal point of view, they are both self-contained entities and meet the requirements of an SME. However, it should be taken into account as this may have influenced certain outcomes.

Another limitation is the sampling from the case studies, as the data has been obtained from 10 respondents, all living in the Netherlands. This has possibly affected the generalizability of the results because a case from a different country would have led to more diversity regarding potential results.

In addition, regarding sampling, the cases are all sampled in the region (Limburg) of my internship company as these cases are more interesting to them. Because of this, other more interesting companies may not have passed by, since those cases were not located in the region of Limburg.

It can be noticed that the in depth semi-structured interviews were needed to gather data about the underlying barriers and enablers and their interaction effects, as described in this study. These underlying interactions would have been difficult to identify with any kind of survey. As indicated before, qualitative research often precedes quantitative research, in explorative research. Now that several underlying interactions are made visible, quantitative research makes sense to learn more about the proposed barriers, enablers and their underlying interactions. The results of quantitative research

can help to conclude whether the indicated barriers, enablers and their interactions can be confirmed.

At last, this research impedes the generalizability of the results because it includes only 5 case studies. Therefore, the results cannot be generalized to all other manufacturing SMEs. In future investigations, it might be possible to use a mixed-method approach in which both large-scale quantitative research and in depth qualitative research is necessary. Hereby, the results could be analyzed by statistics to result in more accurate results, which paves the way for more specific and critical qualitative studies. This is needed as barriers, enablers, stages and their interaction are very context specific and not much research has been done regarding it. Furthermore, this study did not take firm size into account properly. By definition, SMEs can be very different from each other as an organization with three people and an organization with 250 people is still seen as SME (depending on definition). This could lead to a variety of situations especially for CE implementation, therefore analyzing more diverse cases of SMEs in terms of firm size is suggested.

6. Literature

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Appendix A

Interview protocol

Introduction:

Currently I am doing my master thesis of the master Innovation & Entrepreneurship at the Radboud University. This research focuses on the circular transition of manufacturing SMEs and how managers within these organizations perceive different barriers and enablers that play a role in this transition. I also try to find out in which phase of circular transition the company is currently in.

Is it okay if I record this interview, so that I can encode and analyze it later?

Warmup-context background

1. Can you give a short description about the organization?
2. How many employees does your firm have?
3. In which industry does your firm operate?
4. What is your role in the organization?
5. For how long do you work here?
6. What is your professional experience?
7. Can you describe the business model of the organization? (*How does the organization create, deliver and capture value*).
8. What do you understand by circular economy?

Circular economy definition (as additional information and memory aid for interview)

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

Circular practices (as additional information and memory aid for interview)

General introduction to circularity at the company

7. To what extent is your organization engaged in circularity? (refer to some circular practice examples from the ReSOLVE framework).

8. How did the transition to more circular operation work? (when it is indicated that a lot is already being done with circularity)

- How did this come about?

- Which problems did you face regarding this transition?

9. How would you like to be more circular in the future?

10. Why haven't you managed to be circular so far? What did you run into?

11. What kind of circular business models could you use or insert?

12. To what extent are you aware of your energy consumption?

13. To what extent are you aware of your material use?

14. To what extent are you aware of the CO2 emissions of your products and processes?

15. To what extent do you understand the emissions of your value chain and to what extent do you try to minimize these emissions in this value and supply chain?

Organizational/cultural

12. To what extent is CE integrated and embraced within the organization?

- (Is it part of the strategy, mission, vision, goals, KPI or accounting rules?)

- (If not does this effect the CE transition?)

13. Can you describe the company culture? And how CE might be part of this culture?

- (Does this effect the CE transition?)

14. Can you describe the structure of the organization? Is it decentralized or hierarchical?

- (Is there room for flexibility and innovation?)

- (Does this effect the CE transition?)

15. How is the knowledge of circularity throughout the company?

- (Is there enough knowledge and skill to implement circular business practices?)

16. Do you provide any training or education to your employees to develop themselves?

- (If yes, how does this effect the knowledge, skills and capabilities of the organization? And are circular principles part of this training or education?)

18. Does a circular transition affect your supply or value chain? (e.g. partners, distributors, logistics)

- (If yes ask how and if cooperation within this network is necessary and possible? E.g. resistance from partners)

19. Are your (potential) customers interested in circular products?

- (how is the market)

20. To what extent do customers influence your choice in working (more) circular?

Regulatory

21. To what extent does government policy in terms of law and regulation influence both the choice to work circularly and the transition to working circularly?

Market

22. To what extent is funding needed for the circular transition?

- (If yes, how do you feel about finding investors for circular business initiatives?)

23. Did you experience problems regarding large pre-investment, but the lack of short-term results?

24. Would circular business affect your logistical process? (e.g. reverse logistics for future business model)

- (if yes, how?)

Technological

25. Which circular products could you have?

- (In what ways could these products be circular?)

- (Leasing business model?)

- (products disassembled, repaired, refurbished and remanufactured?)

- (Current technology available?)

Wrap up

26. What are or will be the main barriers to making circular products or to a CE transition?

(Which have the most influence on the transition to circular working?)

27. What are or will be the main enablers that contribute to making circular products or to a CE transition?

28. As we talked different things through now, what would be the main motivation to implement (more) CE practices and initiatives?