Enabling the Circular Economy:

Management Innovation as a driver for Circular Economy Strategies.

- A Quantitative Research -

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Preface

"If you want something new, you have to stop doing something old." –Peter F. Drucker

Not only in business, but also in our private lives we find ourselves in a remarkable period in time. Our drive to learn and develop over time brought us the industrial revolution. A development with effects to nature that increasingly drive us to change our current ways. Like many others starting their career, I saw an organizations goal being translated to the growth of its financial position. Eat or be eaten has fitted the definition of competition within industries for many years and to a large degree still does. But this one-way road of gaining comes with its cost and sometimes seems blind for an organizations true goal: adding value to its environment. This contrast fascinates me and propelled me searching for a more sustainable path. The circular economy as a concept fits this path, as its highest goal is to eliminate the use of raw material and reduce emissions. By performing this research, I gained a lot of new insights. It not only changed my approach towards the production process, but towards all business processes using physical resources. The quote by Peter Drucker therefore not only fits this study in which new measures were used, but I think it also fits the attitude needed towards the way we do business and add value.

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Abstract

Our current economy dominated by a take – make - disposal model, depletes our natural resources and causes emissions leading to global warming. As means to an end, the circular economy provides organizational strategies that aim for a closed-loop product cycle in which product use, use of raw materials and production resources are being reduced as far as possible. But the transition towards these strategies and their acceptance and application move slow, while governmental objectives aim high. The circular economy is in need of novel innovations to accelerate the transition. The key challenge is to change people's perceptions and behavior in order for acceptance of new technological solutions. As an attempt to contribute to this challenge, this study explored to what extend non-technological Innovation can drive circular strategies.

Findings of this study indicate that Management Innovation applied in a radical form, holds great potential to help propel organizations towards high circular strategies. A survey was sent to Circular Economy practitioners and provided data (n=57) indicating which circular economy strategy (CES) the company pursued, and to what extent radical management innovation (RMI) and incremental management innovation (IMI) was executed. Analysis was first performed using linear regression. Extensive validity testing was performed, as all three variables were newly designed and applied for the first time in this study. Influence of both RMI and IMI on CES was studied using a four-step linear regression analysis. Normality for the dependent variable, linearity for IMI as an independent variable and discriminant validity between both independent variables could not be ensured. As a result, the linear regression was validated using an ordinal regression. Non-discriminant independent variables negatively impact the confirmation of RMI to positively influence CES, but still provides an indication to what extent it can contribute for the transition to a circular economy. Although the outcome requires nuance and needs further research, this study gives cause to add Management Innovation to the pallet of possibilities for accelerating the developing of Circular Economy within organizations.

Keywords:

Circular Economy, Circular Economy Strategies, Management Innovation.

1. Introduction

1.1. Background

Protecting our planet

As the effects of climate change become clearer every day, the call for action can no longer be denied. We emit greenhouse gas emissions into the air that we breathe and pollute the land with waste. The result can be seen in the worlds rising temperature, extreme weather and the amount of plastic in the sea. A new business model is needed to reduce our footprint on this planet. A Circular Economy business model can be the solution in reducing this issue. This fairly new concept aims at slowing and closing resource cycles towards sustainable development (Bocken et al. 2017) in order to reduce the use of natural resources and emissions emitted into the atmosphere. And the need for such a development is high. The threat of climate change is no longer theoretical and can be noticed in the speed governments, industries and organizations develop new practices and provide new CE objectives.

The transition towards a circular economy (CE)

In the challenge to eliminate barriers towards adopting CE practices, solutions need to be sought. With the ambitions governments and organizations globally have, the focus is aimed to rapidly develop innovations that lead to slowing product use, closing product loops and implementation of the CE in all industries. And this transition has already been set in action as 99% of large company CEO's agree that *"Sustainability issues are important to the future success of their businesses."* (Winston 2019). In 2015 the European Commission adopted an ambitious CE Action Plan. This plan includes measures and objectives that will help stimulate Europe's transition towards a CE and by doing so, boost global competitiveness, foster sustainable economic growth and generate new jobs (EU 2019). To take this a step further, in 2016 the Dutch government launched a highly ambitious plan towards a full CE in 2050. In 2010 the Ellen McArthur foundation was founded to speed up the implementation of a CE (Ellen MacArthur Foundation 2012) supported by large companies such as consulting firm McKinsey which, on their own part, help their clients towards a CE (McKinsey 2020), not left behind by other large firms such as the Bain & Company and the Boston Consultancy Group (Bain 2018; BCG 2018). The OECD is a partnership of 36 countries to discuss, study and

coordinate social and economic policies. To boost the CE concept, OECD started the RE-CIRCLE project to provide policy guidance on resource efficiency and the transition to a CE (OECD 2019). With all this in mind it might be stated that the CE concept is gaining traction and is rapidly evolving (Kirchherr, Reike, & Hekkert, 2017), also in research as the number of growing publications indicate (Lieder and Rashid, 2016). As the interests underpinning the need for such a concept seem clear and is supported by the European Union, the process for organizations to adopt this concept seems to move rather slow (Bocken et al. 2017), even when adoption has been proven to boost the firms market equity (Aboulamer 2018). Reason for this has been explained by Ranta et al. (2018) who showed that China, Europe and the US only focused on a small definition of CE, but that regulations in China boosted the adoption, being a possible solution to eliminate barriers. Several studies show that there are issues with the adoption of the concept (Linder and Williander 2017; Planing 2014; Santibanez et al. 2019). This research aims to gain insight on how to speed up the transition. Little is known about the motives that encourage organizations to apply various circular strategies.

Promoting CE Strategies (CES)

A well-known concept in the CE literature is the 9R model framework (Potting et al. 2016) that conceptualizes strategies which are also referred to as 'circular business models' (CBM's), in the pursuit for closed loops. The framework developed a way of 'how' to measure transitions without addressing the 'what' to be measured, but also provides a clear typology for circular strategies. The framework consists out of ten ordered strategies starting with R0, being the highest circular strategy, and ends at R9 having the lowest contribution to a CE. The study describes that the application of (radical) technological innovation has little to no influence on the transition towards a CE, and is particularly applicable to the less ambitious strategies. Still, innovations targeted at the development of technology and products, hold a strong relation to the CE as closing material loops directly involves the production and use of products. As a result, a great deal has been said about the relationship between the CE and product innovation, in order to make products or supply chains more sustainable and close product loops (Buijs, 2003; Potting et al. 2016; Verstraeten-Jochemsen et al. 2018). This technological view on the CE is limited, as the dynamics of the whole system also include other types of capital such as human, social, political, cultural and digital (Nogueira et al.

2019) which are often ignored. Along with the technological innovations the main focus seems to be addressed to production organizations, as natural resources and waste are consumed and generated by these types of organizations (Blomsma et al. 2019). According to Potting et al. (2016) and van Buren et al. (2016) the more ambitious strategies specifically need socio-institutional change and innovations that enable new technology, revenue models, and product design. This societal form of change is argued to be the biggest obstacle for the transition to a CE as it concerns change not directed at technology, but at human behavior as it needs to accept new technology. According to Quinn et al. (1987), social responsibility is an important corporate duty and has an impact on social change (Stephan et al. 2016). As a big part of social influence originates from organizations and their business leaders, the question arises what forms of innovation can drive this change that is not directed at developing technology?

Management Innovation as a driver

Management Innovation (MI) is a form of organizational change which has been conceptualized in a framework developed by (Birkinshaw et al. 2008). As the execution of related processes create organizational renewal and opens the door for new business models and concepts (Birkinshaw and Mol 2006; Birkinshaw et al. 2008), the question arises what the potential of MI could provide for the expansion of CES? The influence of MI has not been researched before within the context of the CE, although the concept offers a lot of potential as many other innovations result from this concept (Khosravi et al. 2019). It can be said that MI in itself is an instigator towards several corporate outcomes. Is this the most potential non-technological innovation form to be utilized by organizations driving the more ambitious strategies? What effect will it have? This could not be answered by studying the literature, but seems highly relevant according to Potting et al. (2016) and van Buren et al. (2016) might address the need for action which governments call upon organizations.

Previous research

To promote the CE and its strategies BCG (2018) mentions process and product innovation as forms needed for reaching a CE. Although scientific literature could not support this claim, process engineering is closely linked to product innovation as both seem to be targeted on

making the production chain more efficient (Reh 2013; Avraamidou et al. 2020; Buijs 2003; Xie et al. 2019).

Within the spectrum of non-technological innovation, literature surrounding CE seems mainly dominated by business model innovation as the vehicle for reaching circularity (Antikainen and Valkokari 2016; Guldmann and Huulgaard 2020; Heyes et al. 2018; Mentink 2014; Pieroni et al. 2019; Planing 2014). Hall and Wagner (2012) claim that, to gain the benefits from environmental product innovation, business model innovation is needed. Although Linder and Williander (2017) warn that business model innovation brings inherent uncertainties for entrepreneurs, it seems to be the most dominant form of innovation regarding the CE, especially on the non-technological domain. But as this form of innovation is aimed at generating new revenue models revolving around a product, it seems less sensitive for change aimed at human capital. Business model innovation helps organizations to tailor their business model to a specific strategy, and research within this domain seems to focus on barriers that are encountered when implementing specific business models (Guldmann and Huulgaard 2020; Linder and Williander 2017; Planing 2014).

But beside this structural form of innovation, little is known on the interface between MI and CES. With the strong focus on business model innovation, there seems to be a gap for unexamined forms of non-technological innovation, and to what extent MI positions as a candidate to boost the transition to a CE. Hence, the question remains open as to what form of non-technological innovation can contribute best to specifically the higher CES such as R0, R1 and R2, and how MI can fulfill this role. This leads to the main research question for this study.

<u>Main research question:</u>

"To what extend can non-technological innovation drive the Circular Economy Strategies?

<u>Sub questions:</u>

What are CES and their promoting factors?

What are relevant forms of non-technological innovation?

What is MI and its potential for CES?

How can MI drive CES?

1.2. Relevance and research contribution

The relevance is partly dictated by the contribution a CE makes to nature and society. As previously mentioned, the signs our climate provides us with, can no longer be ignored and have been translated to concrete objectives that are in great need of new effective innovations and methods. Studies that facilitate an acceleration for a transition towards sustainable development, in the end contribute to a better living environment for every living organism.

From a theoretical point of view, this study attempts to chart new outcomes for CE literature. Although the development of the concept of a CE finds itself in an early phase, research on this theme is on the rise. Yet, little has been written about the various strategies and characteristics of businesses executing them. This study attempts to gain new insights, particularly for the high circular strategies, on what drives are. Insights gained can help narrow the gap from a linear towards a CE. With this, an attempt has been made to enrich and utilize the existing knowledge about CES.

1.3. Structure of the thesis

The first chapter provides the background and the context towards the main research question and its sub questions. Chapter two display's the outcomes of a literature study, in which relevant studies provide the foundation for the hypotheses and a conceptual model. Chapter three explains the methodological approach in which clarity is given on how the conceptual model will be executed answering the hypotheses, while leading to validated and reliable results. These results are recorded in chapter four in a factual manner. The fifth and last chapter first discusses the results in order to define a clear context, and address possible limitations and nuances. These outcomes form the basis for reflection and drawing conclusions that addressing the main research question and its implications within a broader context.

2. Literature review

This chapter holds an overview of the relevant scientific literature answering the sub questions and forming the foundation for this study. This review explores CE as a concept, its strategies and driving factors. Secondly, typologies of innovation are explored to define the forms within the definition of non-technology. These forms will be reflected upon CES, and the specifically the position and potential of MI will be discussed. Based upon this literature research relations are drawn between MI and how this could influence CES, resulting in hypotheses and a conceptual model.

2.1. What are CES and their promoting factors?

"[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." Geissdoerfer et al. (2019, p.759) and Schut et al. (2015, p.15) argued that this definition, provided by Ellen MacArthur Foundation (2012, p.7), is the most prominent definition of CE, but limits the concept to an industrial system. According to Blomsma et al. (2019) CE is an umbrella concept which groups a range of underlying concepts. No single definition of a CE has been found, but the underlying principles of the concept seem unambiguous. The CE is diametrically opposed to the Linear Economy that encompasses a "take, make, disposal" model. The discussion about CE has recently moved beyond the product and material itself. According to Bocken et al. (2017) it is now time for discussions about circularity to develop business models and institutional change. "The ultimate goal of promoting Circular Economy is the decoupling of environmental pressure from economic growth" (Ghisellini, Cialani, & Ulgiati, 2016).

The CE has two types of core principles: Those relating the "R frameworks" and the "systems" perspective (Kirchherr et al. 2017). The Systems perspective is divided in discussions aimed at a micro, meso and macro level. As this study focusses on the micro level, the systems perspective provides no solid basis to gain insights for organizational circular strategies. The "R" framework, which is based upon the "Ladder van Lansink", has been developed into the 9R strategy (Potting et al. 2016) and stems from the work of other studies (Buren van et al.

2016; Silva et al. 2013; Sinha et al. 2016). This framework holds a central position in this study and in CE literature (figure 1). According to Kirchherr et al. (2017) there is no consensual definition on strategies promoting the CE and some strategies can be ambiguous, although more recent studies provide more clarity on definitions and their characteristics (Blomsma et al. 2019; Moraga et al. 2019; Morseletto 2020).

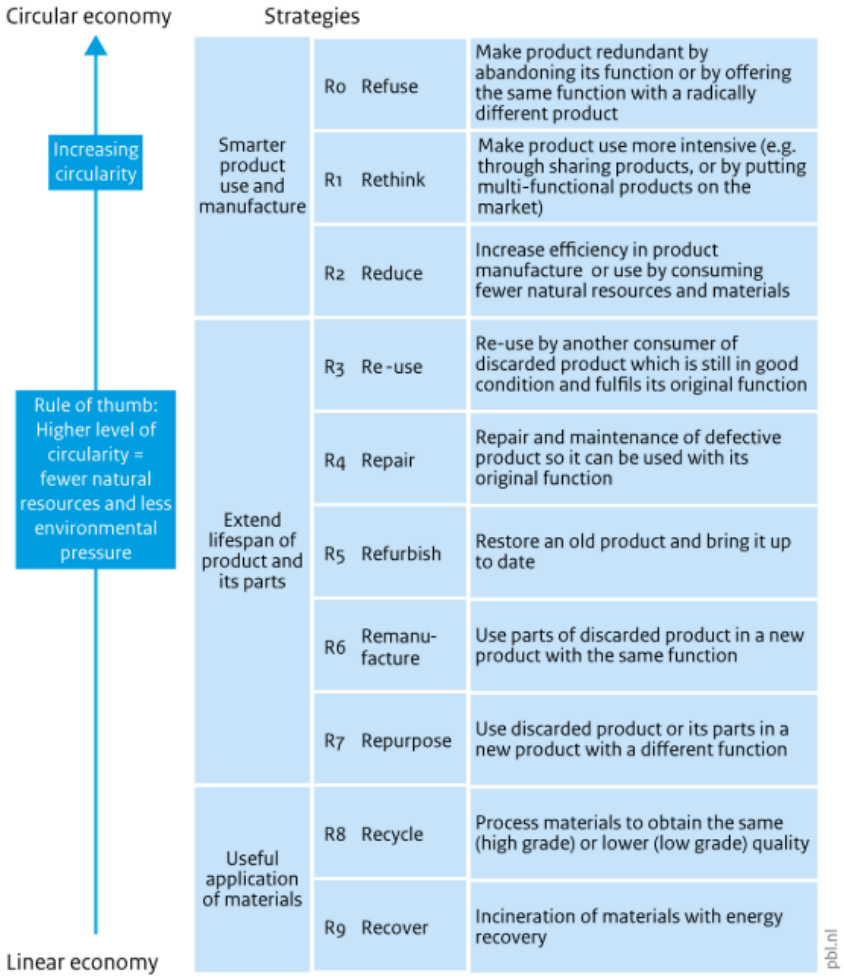

Figure 1. *Source:* Kirchherr, Reike and Hekkert (2017)

The strategies are presented in a hierarchy of circularity and their need for innovation. From strategy R9 towards R0 circularity increases, and vice-versa decreases when moving towards R9. Need for technological innovation increases towards the R9 strategy. In a contrary, the need for non-technological innovations increases towards the R0 strategy (Potting et al. 2016). To illustrating the characteristics and promoting factors of strategies, the grouping used in their framework and combines the strategies by their characteristics is used in the following paragraphs. Strategies R0–R2 are assigned to "Smarter product use and manufacture" (group one) and form the main objective for this study as circularity is at its peak. "Extend lifespan of products and its parts" (Group 2) consist of strategies R3–R7 and has a medium contribution towards a CE. "Useful application of materials" (group three) holds strategies R8–R9 and provide the lowest contribution to circularity as products reached the end of their life-cycle.

2.1.1. Group 1: Smarter product use and manufacture

The category “Smarter product use and manufacture” yields the highest circularity and holds strategies for redundancy, multifunctionality and use intensification, which lead to more innovative business models (Moraga et al. 2019). This group and its strategies are precursory as they occur before other CES, enabling as they favor all other strategies and transformative as they can make the economic system a truly circular one if applied extensively (Morseletto 2020). Accordingly, R0–R2 can lead the transition to a CE. Instruments are concepts such as sharing, renting and pooling via Product Service Systems (PSS) which focusses on the product, the use and the result (Kjaer et al. 2019; Tukker 2015). To add measures to this group, Moraga et al. (2019) discusses the 'Function' of products as being the main subject. In order for an organization to result in smarter use of products or its production, it needs innovations that enable technology instead of innovations in core technology (Potting et al. 2016). Morseletto (2020) stated that strategies in group one act as an enabler for strategies in group two, and directly reduce products and materials in group three. This makes group 1 not only the highest in its contribution to circularity, but also add a less visible contribution by influencing the other two groups. The strategies in this group are the only ones that enable the possibility to dematerialize and replace the product for a non-material alternative. Strategies R0 and R2 are closely linked to ‘design’, which also encompasses the design of production processes, logistics systems, consumption patterns and lifestyles (Despeisse et al. 2017; Jayaraman 2006). Where the other lower strategies in group two and three can be applied without having a circular goal or conviction and even without realizing to be circular, by definition, strategies R0 refuse, R1 rethink and R2 reduce, require an effort to rethink the function of a product. Although not supported by literature, it is likely that organizations engaged in this group of strategies, are more receptive for acceptance of new products and organizational changes, as these changes can form means towards an organizations mission reaching circularity. Organizations executing strategies within this group are scarce, young in age and small in size. Based upon firm age and the environmental dynamism, it can be expected that innovation and change will take place more radically than incrementally (Koberg et al. 2003).

2.1.2. Group 2: Expand lifespan of product and its parts

Strategies within this group share the same goal to maintain or improve value of products or their parts keeping them longer in the economy. Reusing products or their parts can be profitable (Guide 2000). Hence, it is not said that an organization executing one of the related strategies strives for circularity, but instead seeks profitability. A bicycle repairer belongs to strategy R4 Repair, but many of them are unaware of fulfilling a circular strategy. As this group of strategies tries to extend the lifespan of products, it can actually cause a delay for innovations and prevent the development of new or evolved products that are more environmentally friendly (Bressanelli et al. 2019). Opposite to this, Morseletto (2020) argues the positive effect of this group as they postpone products being subjected to group 3 where they reach their end of life. The same study showed that strategies from group 1 promote the development of strategies in group 2. At heart most strategies within this group can be related to replacement costs being the main driver for development (Okada 2001; Scott and Weaver 2014). Other external factors promoting group 2 can be linked to the development of circularity itself, leading to new concepts and ideas propelled by governments and local initiatives. As related organizations vary greatly as to why and how they execute a strategy, little could be found what combined factors promote development driven by the organization.

2.1.3. Group 3: Useful application of materials

Recovery and Recycle refer to waste that is otherwise destined for landfills or incinerated without heat recovery. Strategy R8 Recycle generates new materials out of waste. The yield of processing waste can vary greatly per type of material. R9 Recovery, obtains energy out of burning waste. Both strategies yields are often extremely low, treatments are expensive, and the original product is destroyed. Waste management relates to discarded products and the R9 - R8 strategies have relatively little impact on the system of production and consumption (Potting et al. 2016). Nevertheless, most circular policies and objectives are currently concentrated in organizations implementing these strategies (Ghisellini et al. 2016). The underlying principles have been integrated into society for a long time and organizations that implement them, are often recycling and waste management organizations who work under government regulations. This could explain the density of circular policies and objectives. Related organizations are united in a branch and mainly

consist of small organizations. (Ministerie SZW 2015). From a circular standpoint, promoting these strategies can be avoided by the application of strategies in group 1 and 2 as they prevent the use, or end of life of a product. With national and local governments influencing and regulating these well rooted organizations, it is expected that they provide the main promoting factors for development and innovation. Given these characteristics, innovation within these organizations is expected to be low and happen incrementally.

2.2. What are relevant forms of non-technological innovation?

In his early work, Schumpeter (1939) divided innovation into new modes of production, new products, new markets, new sources of production and new ways of organizing the business. According to Damanpour and Aravind (2011), technological and non-technological are the two types of innovations scholars have generally agreed upon. The differences between both is that they produce different outcomes. Yet, there is no exclusive view for typologies on innovation, and some forms seem to have an ambiguous definition or overlap other typologies (Doran 2012).

The OECD Oslo Manual Typology is a much-used methodology in literature and defines innovation as: *"An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)"* (OECD 2018). In the several editions of the Oslo manual, changes in definitions can also be detected, but a much-used typology of their third edition consist out of Product, Process, Marketing and Organizational innovation. Product Innovation and Process Innovation are both pointed towards a product or service and its production process, and therefore can be classified as non-technological innovation forms, as they are aimed at the production of technology (Schmidt and Rammer 2007; Pino et al. 2016). Yam et al. (2011) argued that process innovation should also be grouped under Product Innovation, as it contains process or product development which can be codified. With this, product and process innovation are assigned outside the definition of non-technological innovation forms. As a result, Marketing Innovation and Organizational Innovation remain.

According to the Oslo Manual the definition for Marketing Innovation reads: "*A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.*" (OECD 2018).

Improving the presentation and promotion of products are the common elements between product design and marketing activities. This led to the definition of marketing innovation which is based on the 4P model for marketing strategies (Perreault and McCarthy 2005) consisting out of product, price, placement and promotion. As the definition shows, the domain of marketing innovation is mainly defined by elements that determine in what way a product is put on the market. As this study tries to trace which forms of innovation can contribute to strategies that focus on avoiding product use, marketing innovation tends to be lack potential in reaching this goal. Gunday et al. (2011) have studied the four innovation forms in regard to firm performance, and showed that there is a hierarchy between the four, positioning organizational innovation at the top, positively influencing marketing and process innovation which both are positioned as mediators for innovative performance.

2.2.1. Organizational Innovation and its manifestations

The OECD (2018) divides organizational innovation into new organizational methods for business practices, workplace organization or external relations. It consists of changing the structure or processes of an organization, by implementing new management, or working methods (Damanpour and Evan 1984; OECD 2005). Yet, other studies use other intersections such as procedural and structural (Armbruster et al. 2008), or structural and managerial (Wengel et al. 2000). Where the other innovation forms seem to illustrate clear boundaries, organizational innovation can be seen as an ambiguous concept as it overlaps with other typologies such as administrative and management innovation (Birkinshaw et al. 2008; Damanpour and Aravind 2011; Lam 2004). With the single construct of organizational innovation remaining as a potential solution, these other forms that fit under the umbrella of organizational innovation will be studied in order to gain richer insights.

Wengel et al. (2000) stated that organizational innovation is important for two reasons. Firstly, because new improved organizational forms or management methods can be implemented, leading to better results than previous forms or methods. Secondly, because there is complementarity between organizational and technological innovations. With this it becomes clear that managerial innovation, as part of the cross-section used by Wengel et al. (2000), fit the definition as given by Birkinshaw et al. (2008). A counterpart for the structural view could not be found, although Business Model Innovation (BMI) seems closely related as it alters organizational structures.

2.2.2. Business model innovation versus Management Innovation

"The essence of a business model is in defining the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit" (Teece 2010). A business model consists of the logic how a company creates value for customers. One of the most used representations might be the Business Model Canvas designed by Osterwalder et al. (2010) which encompasses the dimensions: Customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships and the cost structure. *"In essence, a business model (is) a conceptual, rather than financial, model of a business."* As argued by Teece (2010) who also claims that *"A good business model yields value propositions that are compelling to customers, achieves advantageous cost and risk structures, and enables significant value capture by the business that generates and delivers products and services"* addressing the outcome of what a good business model should deliver. Although BMI is an extension of the business model, it contains a number of important research questions that cross the boundaries of traditional business model literature (Foss and Saebi 2016). In contrast to Management Innovation (MI) which aims at managerial innovation, BMI aims at creating new organizational structures to meet goals. The link between product life-cycle management and BMI was established early on (Grosse-Dunker and Hansen 2012). New business models are often required for the implementation of a CE as closing loops of material can be aimed at any aspect of the organization and its direct environment (Mentink 2014; Planing 2014). The presence of BMI within the CE literature is evident as various articles can be found that are linked to BMI (Antikainen and Valkokari 2016; Fernandes et al. 2020; Guldmann and Huulgaard 2020; Mentink 2014). Potting et al. (2016) state that specifically socio-change and innovations are needed to adapt strategies that have a higher contribution to circularity. But although this has been said, little has been researched on the relation between managerial innovations that does not seek for new ways of earning, but look for new ways of working. New ways that positively influence an organizations learning dynamic capability (Nieves 2016) perhaps making an organization more receptance for the adoption of higher circular strategies. Whereas BMI focusses on altering the business model, MI focusses on managerial innovations that might lead to smarter product use. It has also been a subject for many other studies that examined the influence of BMI on a CE. This study

therefore researches MI further, which could rank higher in hierarchy and even lead to innovations such as on the business model.

2.3. What is MI and its potential for CES?

MI is *"Usually a highly complex social system with many different actors and relationships"* (Birkinshaw and Mol 2006). A more precise and much used definition reads: *"The invention and implementation of a management practice, process, structure, or technique that is new to the state of the art and is intended to further organizational goals."* (Birkinshaw et al. 2019, p.825). Another definition from a much-cited article is by Gary Hamel (2006): *"A management innovation can be defined as a marked departure from traditional management principles, processes, and practices or a departure from customary organizational forms that significantly alters the way the work of management is performed."* MI can come in a variety of forms proven by Birkinshaw et al. (2008) who identified 175 significant MIs from 1900 to 2000 in their study. Although no exhaustive list of MIs is available, Birkinshaw et al. (2008) provide examples in their article and define the concept by using a list with specific criteria to validate innovations fitting the profile of a MI. Concrete examples include methods such as Total Quality Management (TQM), Lean Manufacturing, Agile Scrum or Six Sigma. Besides enabling technological innovation, it is argued by Mol and Birkinshaw (2009) that MI is the most important source of competitive advantage as they state that: *"Management innovation may represent one of the most important and sustainable sources of competitive advantage for firms because of its context specific nature among others"*. Lean Manufacturing is one of the most known forms of MI, but just the presence of a specific way of working, such as Lean or TQM within an organization, does not prove the presence and ability of MI. Many studies have argued that MI leads to a variety of corporate outcomes. At the end of the outcomes are the performance measures such as financial performance (Camisón and López 2010; Evangelista and Vezzani 2010; Mol and Birkinshaw 2009; Montes et al. 2005; Nieves 2016), operative/service performance (Damanpour et al. 2009; Montes et al. 2005; Naranjo-Gil 2009), overall performance (Camisón and Villar-López 2014; Gunday et al. 2011; Hansen 2010; Kraus et al. 2012), management performance (Walker, Damanpour, & Devece, 2011) and innovation performance (Gunday et al. 2011; Pino et al. 2016). These studies show that MI leads to better performance, but as MI in itself comes in many forms, it is interesting to know which general elements of MI can be held responsible for this boost in performance.

Outcomes of MI in literature that can act as a source for new activities, are divided in capabilities and innovation outcomes. Capabilities consist of a company's dynamic and learning capability (Gebauer 2011; Nieves 2016) whereas innovation outcomes consist of technological innovation (Khanagha et al. 2013; Santos-Vijande and Álvarez-González 2007), product innovation (Kraus et al. 2012; Nieves 2016), process innovation (Camisón and Villar-López 2014; Gunday et al. 2011), marketing innovation (Pino et al. 2016) and innovation projects (Cobo-Benita et al. 2016). With the dynamic and learning capability at the heart of MI, the link to the higher circular strategies seems evident as Potting et al. (2016) claim that in order for organizations to implement these high circular strategies, socio-institutional change is needed, consisting out of peoples beliefs, convictions, behaving's and acceptance for new innovations contributing to a CE. To conclude this all, MI does not only boost other innovation forms, and several performance outcomes, it also provides the social elements needed in order for people to accept new concepts.

2.4. How can MI drive CES?

Before connecting the effects of MI and the promoting factors of the strategy groups, the basis for MIs potential might lie in an organization's learning capability. According to Nieves (2016) MIs favor the development of an organizations learning capability and product innovation and considers the learning capability as a company's ability to renew the existing operating capacities with new knowledge. In this capability's extension is an organizations dynamic capability which, according to Gebauer (2011), is driven by MI and consists of sensing, seizing, and reconfiguring capabilities needed to gain competitive advantage. Both the learning and dynamic capabilities provide the elements needed for the type of change Potting et al. (2016) identified, consisting of changing believes and behaviors in order for new technology to be accepted.

When relating MI to the factors promoting the development of strategies within group one, several connections can be drawn. Firstly, Gunday et al. 2011; Pino et al. (2016) showed that MI leads to a boost in several forms of performance amongst innovative performance. This corresponds with type of innovation Potting et al. (2016) described as needed for further development of core technology. Secondly, both Morseletto (2020) and Potting et al. (2016) emphasize the products function as subject for continuous validation and improvement for reaching high circular strategies. In order to do so, the afore mentioned learning capability

provides the requirements that are beneficial for this process, but MI also boosts technological innovation (Damanpour and Aravind 2011; Kraus et al. 2012; Nieves 2016) and product innovation (Khanagha et al. 2013; Santos-Vijande and Álvarez-González 2007) both having design as an activity at their core. Third link can be drawn between the organizations environment as being dynamic (Koberg et al. 2003). Naranjo-Gil (2009) showed that the environments uncertainty positively influences administrative innovations. According to them, organizations in a dynamic environment are high adopters of this type of innovation. Radical innovation is defined as to result in a new market infrastructure (O'Connor 1998). Specifically, strategies R0 and R1 lean on the theme of design and changing the use of a product and therefore generating a new market infrastructure. This leads to the proposition that MI strongly influences the higher circular strategies.

For group two and three, the relational specifics towards MI are less visible. Both groups can benefit from the learning and dynamic capabilities and performance outcomes MI can offer, for accelerating the introduction and acceptance of new products and concepts. Unlike group two, group 3 provides a more demarcated view of organizational characteristics. As Potting et al. (2016) indicated, innovation for these strategies will be less driven by social change and positively influenced by innovations in core-technology. Their submission to governmental influence might mute the level of innovations these organizations produce. To summarize the above, two linear directional elements can be proposed. First, MIs potential is expected to have a high influence on the higher circular strategies and decreases when moving towards R9. Second, this innovation is likely to happen radical for the higher strategies and also decreases towards lower circular economy strategies.

H1: *Radical Management Innovation positively influences Circular Economy Strategies.*

H2: *Incremental Management Innovation negatively influences Circular Economy Strategies.*

2.5. Conceptual model

In order to confirm the proposed hypotheses, constructs for measurement and determination of interrelationships need to be established. The hypotheses both imply a linear relationship between independent and dependent variables.

The dependent variable as the predictor is aimed at measuring an organizations circular strategy. A conceptualization study of CE definitions by Kirchherr et al. (2017) concluded that no single study has comprehensively and systematically investigated CE definitions. According to the same study the 9R framework holds the most nuanced definitions for CES. Linearity of circularity is assumed as a derivative on a scale from zero (R9) to ten (R0).

For the independent variables a distinction between radical an incremental MI has to be established. Gary Hamel (2006) mentions MI as being best suited for tackling a big problem and changing it radically. The MI context given by Birkinshaw et al. (2008) offer no specifics on the intersection of radical or incremental implementation. Therefore, two new and unique latent variables have to be defined in order to measure the proposed hypotheses. These are Radical Management Innovation (RMI) and Incremental Management Innovation (IMI).

Both variables influence will be measured in relation to CES as conceptualized in figure 2.

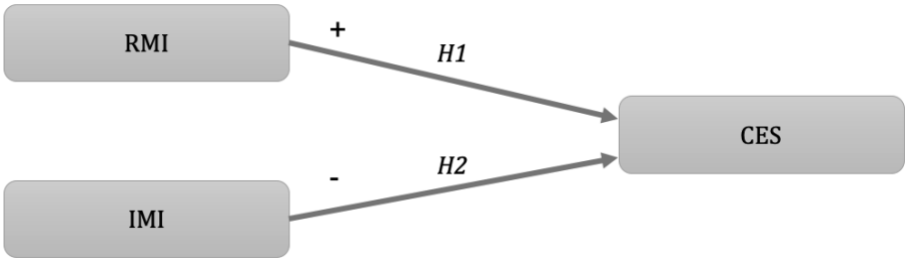

Figure 2. *Conceptual model*

3. Methodology

This section presents and explains how research is conducted to generate reliable and validated outcomes confirming or rejecting the proposed hypotheses. The research context provides the approach and an overview of this study, followed by detailed insights on the research population, definitions of measuring constructs and the methods used for data collection and analysis ensuring validity and reliability.

3.1. Research context

This descriptive study used a quantitative method to examine the influence of radical and incremental MI as drivers for CES. This was executed on an organizational (micro) level, targeted at circular organizations within the Netherlands, and took place in the second quarter of 2020. Data collection was done using a survey method as an efficient solution to gather and validate data, and perform statistical analysis. The questionnaire consisted of items belonging to new created constructs for radical and incremental MI as independent variables, and CES as the dependent variable. All three constructs were new and were extensively validated. To test the relationship between the variables, a linear regression analysis was performed to discover statistical relationships and significance between study variables. For this, a four-step model was built enabling analysis to detect influence of independent and control variables. An ordinal regression was performed to validate the outcomes of the linear regression. Significance of hypotheses was set at a probability threshold of 95% *(p*=<0.05*)*. The correlations as an outcome and rejection or acceptance of the hypotheses formed the basis for the discussion, limitations and conclusions.

3.2. Research population and data sample

This research was aimed at organizations that are actively enrolled in the use of CE activities as not all organizations classified within a specific CE strategy are aware of executing such a strategy (PBL 2019). Therefore, industry and network organizations were approached giving access to organizations such as Het Groene Brein, MVO Nederland and Socialenterprise.nl.

Although there were no limitations to the organizational size, organizations with more than five employees were selected to boost validity. CE research is mainly restricted to manufacturing firms. But this limitation was not used as the service industry holds potential

for CES (Heyes et al. 2018), and MI has been proven to be higher in this industry (Nieves 2016). Geographically the research was limited to the Netherlands due to a combination of factors. The Netherlands are at the forefront of the CE in Europe with a multitude of initiatives (Ecopreneur 2019) and therefor meet the required variation on execution of circular strategies. Secondly, as this research was initiated from the Netherlands, it is to be believed that the response rate could be improved by utilizing the personal network. Thirdly, using networking organizations and CE platforms to gather data make it more practical to select a single country. To reach significance the study's objective was to gather a minimum of 50 respondents (n=50) and ultimately reached n=57. With an expected response rate of 33% the aim was to address at least 300 organizations, but as new channels had to be sought, some LinkedIn posts on circular economy groups even reached over a million people, blurring the actual response rate.

3.3. Construct measurements

Circular Economy strategies. The output of the dependent variable, records the circular strategy and is limited to one answer. The variable consists of the ten strategies as defined in the 9R framework (Potting et al. 2016) and provides nominal data. However, the ten strategies also represent a hierarchical level of circularity increasing towards strategy R0, and decreasing towards R9. Therefore, recording the CES also measures the level of circularity on a scale from zero to ten, providing ratio data. For this, the original numbering of the strategies (R0 – R9) are translated into a scale, where R0 represents the highest rating, and R9 the lowest value being zero. After regression testing the data type was set to ordinal as the strategies are categorical and led to a non-normal distribution.

Radical and Incremental Management Innovation. Vaccaro et al. (2012) developed a construct for MI which is based upon relevant literature, resulting in a six-item construct for MI (a= 0.76) with a 7-point Likert scale. The items reflect the manifestation of MI in new practices, processes, and structures. The construct and items from Vaccaro et al. (2012) translated to the Dutch language formed the basis for, two new derived constructs 'Radical MI' and 'Incremental MI'. The items of Vaccaro et al. (2012) were duplicated for both a radical and incremental construct based upon the definition of (Garcia and Calantone 2002). This definition defines incremental innovations as major advances to an established technology

or knowledge, and radical innovation as major changes in technology or knowledge that originate from the discovery of something new. The items for radical MI have been changed to MIs that are entirely new to the organization, using the 7-point Likert scale. For incremental MI the items have been modified to MI's that are not entirely new, but a change on an existing subject. On the definition of radical and incremental innovation, these new constructs deviate from traditional literature which define both restricted to product innovation and include impact on market structures and discontinuation (Garcia and Calantone 2002). Although both independent variables contain unique definitions, they do share the same foundation originating from the MI construct as developed by Vaccaro et al. (2012). These similarities between constructs can lead to the risk of multicollinearity and needs extensive validation.

The items for the dependent variable and both independent variables are included in Appendix 1.

Control variables. The control variables organizational age, number of employees, sex and age were taken into account during the data analysis. Findings of the literature study indicated organizations executing high circular strategies to be young in age and small in size. Therefore, control variables measuring the organization's age and number of employees have been added, enriched with the respondent's gender and age as possible determinants enriching the analysis.

3.4. Data collection

Online research and contacting network organizations was planned to provide a list of organizations involved in the CE. The latter did not provide contact information as of privacy reasons. For each gathered contact, a LinkedIn profile scan has been performed to ensure the respondent has a position overseeing the company's interests. A personal message including the survey was used in an attempt to engage the manager to participate in this research. As these planned actions did not lead to sufficient results, an invitation for participation, was placed on several circular economy LinkedIn groups. This led to a number of new respondents.

The survey using the prescribed items was build using Google Forms, as it contains all needed functionality updating data in real-time. Using the questionnaire's belonging to the

constructs provided with an explanation of each construct. Four missing's were detected as some of the fields were not configured as required, bringing the response down from *n*=61 to *n*=57.

3.5. Reliability

Reliability is consistency across time, across items, and across researchers. Reliability was tested on internal consistency using Cronbach's alpha. A general rule of thumb is using an alpha level higher than 0.7 as a threshold. Independent variables were tested as both constructs used a seven-point Likert scale. Radical MI scored *a*=0.908 and Incremental MI scored *a*=0.911. No tests were performed to ensure reliability across time and researchers.

3.6. Validity

Validity is the extent to which the scores actually represent the variable they are intended to. Validations were performed. As all three constructs were designed or altered for this study, extensive testing was done to validate outcomes, and included validations on both structure model and measure models. Test results can be reviewed in appendix II.

Construct validity was confirmed for convergent, and rejected for discriminant validity. Convergent validity is defined as the extent to which a set of indicator variables actually represents the theoretical latent construct those variables are designed to measure. Discriminant validity refers to the extent to which a construct is truly distinct from other constructs (Campbell and Fiske 1959). Convergent validity was tested for both independent variables by using a factor analyses, rotated with Varimax to provide the factor loadings which than were calculated to the average variance extracted (AVE). Appendix II shows the calculations an outcome for both constructs. Both constructs exceeded the greater than 0.5 rule of thumb for AVE (Radical MI 0,690 and Incremental MI 0.693) confirming convergent validity.

Discriminant validity could not be corroborated. Wilk's lambda tests how well each level of independent variable contributes to the model, and hypothesizes variables to be discriminant. With a scale ranging from 0 to 1, where 0 means total discrimination, and 1 means no discrimination. Results in appendix 'Discriminant validity' shows high, non-

significant canonical correlations Wilks' Lambda 0,754 (p=0.115) for Radical MI and 0.827 (p=0.384) for Incremental MI for equality in group means. This indicates non discriminant variables as confirmed by the null hypothesis of equal population covariance (p=0,799).

To rely on multiple regression analysis, four assumptions require validation in order to reduce the risk for a Type I or Type II error and unreliable estimations (Osborne and Waters 2003) The first assumption is a normality of a distribution for study variables. The Shapiro-Wilk test was used for study variables and tests the null hypothesis that a sample came from a normally distributed population (p=<0.05). A 2011 study concludes that Shapiro–Wilk has the best power for a given significance (Mohd Razali and Bee Wah 2011). As appendix II shows, normality could only be confirmed for independent variables Radical MI (p=0.066) and Incremental MI (p=0.752). The dependent variable CE Strategy failed normality and did not reject the null hypothesis (p=0.000). Also, distributions were analyzed by using distribution plots and by interpreting the descriptive statistics on their mean, standard deviation, skewness and Kurtosis.

Linearity between dependent and independent variables is the second assumption. Therefore, significance (p=<0.05) of linearity was tested for both relations. Using curve estimation, both relations between dependent and independent variables were tested as results show in appendix II. Linearity for Radical MI was confirmed (r^2= .113, p= 0.011) and rejected for Incremental MI (r2=.014, p= 0.385).

The last assumption requires homoscedasticity for study variables. Heteroscedasticity as the opposite is the circumstance in which the variability of a variable is unequal across the range of values of a second variable that predicts it. Prescence of heteroscedasticity was confirmed through subjective graphical analysis using a scatterplot.

The last assumption referred to by Osborne and Waters (2003), refers to internal reliability and requires variables without error, as was already tested and confirmed using Cronbach's alpha.

3.7. Data analysis

A four-step linear regression analysis was built to generate the study results in table II. The construct 'CE strategy' was used as the dependent variable. The method used concerns a regression procedure that includes single additional independent variables in a stepwise

manner. The base model (model 0) was built using only the dependent variable with the controlling variables (gender, age, organizational age, number of employees). The next two models, independent variables Incremental MI (model 1a) and Radical MI (model 1b) were individually added to model 2. By doing so, their individual influence on the outcome variable can be analyzed. Model combines all variables and present the results for the proposed hypotheses. After validation and regression testing an ordinal logistic regression test was added to validate the linear regression outcomes.

4. Results

As an outcome of the execution of the described methodology, the empirical results are shown and explained in this chapter. In the first paragraph, all variables will be analyzed and validated, before being admitted for regression analyses. After this, the results of the linear regression analyses provide the study outcomes.

4.1. Descriptive statistics

Table I shows the descriptive statistics and correlations for study variables. A total of N=57 respondents participated in this study.

Table I.

	Mean	SD	Skewness	Kurtosis	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
(1) CE Strategy	6.5	2.7	-0.82	-0.81						
(2) Radical MI	3.6	1.5	0.11	-0.93	.34*	(.91)				
(3) Incremental MI	4.0	1.3	-0.15	-0.37	.12	.56**	(.91)			
(4) Gender	1.3	0.5	0.81	-1.39	.05	.02	-.21			
(5) Age class	3.2	1.1	0.65	-0.05	-.28*	-.02	-.01	.12		
(6) Org. age class	5.5	3.2	-0.16	-1.61	.07	-.19	-.07	-.23	-.07	
(7) # Employees	3.8	2.2	0.30	-1.39	.16	-.01	.14	-.18	-.17	.87**

Notes:
N = 57. Numbers in parentheses on the diagonal are Cronbach's Alphas of the composite scale.
* $p< 0.05$, ** $p<0.01$

A total of 57 respondents participated in this study. The descriptive statistics in table 1 show that Radical MI is moderately positive correlated to the dependent variable (r=.336, p=0.011) indicating the proposed outcome for the first hypothesis. Conversely, Incremental MI indicates a negative outcome for the second hypothesis as the correlation is positive and not significant (r=.117, p=0.385). Internal reliability was confirmed for both independent variables (Radical MI: a=0.908, Incremental MI: a=0.911). Yet, both independent variables Radical MI and incremental MI are positively correlated (r = .563, p =0.000). This correlation indicates the presence of multicollinearity. A discriminant validity analysis confirmed the null hypothesis of equal group variance (p=0.799). Subsequently, linearity was tested and confirmed for Radical MI (p=0.011) and rejected for incremental MI (p=0.385). Furthermore, independent variables were normally distributed (Radical MI p=0.066, Incremental MI

p=0.752) but normality failed for the dependent variable (CE strategy *p*=0.000). Heteroscedasticity was visually detected as residuals not showed a pattern of equal variance. Age class had a negligible, but significant negative correlation (*r*=-.278, *p* =0.036). The number of employees positively and highly correlated with the organizational age class (*r*=-.867, *p* =0.000) seems a tautological relation.

Other descriptive statistics on distributions are the distribution of gender: 68.42% (n=39) of the participants were male, and 31.58% were female (n=18). Distribution of age class (21-30 =22.8%, 31-40 =40.4%, 41-50 =22.8%, 51- 60 =10.5%, 61-70 =3.5%). Distribution of organizational age class (Yrs.) is: 0-4 =17.5%, 5-9 =7%, 10-14 =10.5%, 15-19 =8.8%, 20-24 =5.3%, 25-29 =3.5%, 30-34 =10.5%, 35-40 36.8%. Distribution of number of employees is: 0-5 =17.5%, 6-49 =19.3%, 50-99 =15,8%, 100-499 =10.5%, 500-999 =8.8%, 1000-5000 =3.5%, >5000 =24.6%.

4.2. Linear Regression analysis

Table II presents the linear regression results for CES.

Model 2 in table II shows that the proposed positive effect of radical MI on CES (hypothesis 1) was supported (*r*=.711, *p*=0.015). The proposed negative effect of incremental MI on CES (hypothesis 2) was not supported (*r*= -.236, *p*=0.497). Yet, the reliability and validity test outcomes have to be taken into account when interpreting the regression results. Since the second hypothesis has been rejected, the emphasis lays on the first hypothesis. Firstly, Radical MI as an explanatory variable was not tested to be discriminant from Incremental MI, making its theoretical latent definition to be ambiguous. Secondly, the normality test for the predictor variable failed, causing the predicted outcomes to be unreliable. This is also confirmed as heteroscedasticity illustrated unequal distances for residuals.

Basemodel 0 shows no significant correlations for the predictor variable. Yet, age class probability value shows strong indications for a moderate negative correlation (*r*= -.642, *p*=0.070). Koberg, Detienne, & Heppard, (2003) showed that circular organizations are young in age and small in size. Although a causal relation cannot be drawn, it is a plausible explanation along with the prematurity of the concept fitting younger generations. The total proportion of the variance for the dependent variable is R^2.04.

Model 1a adds Incremental MI to the regression and shows a negative correlation to the dependent variable, lowering R_2 to -.01. None of the correlations were tested significant.

Model 1b removed Incremental MI and added Radical MI to the regression, showing a significant moderate positive correlation (r= -711, p=0.015) adding .10 to the determination coefficient.

Table II.
Effects of incremental and radical MI on circular strategies

	CES			
	Model 0	Model 1a	Model 1b	Model 2
Main effects				
Radical MI			.61	.71
			(01)*	(.01)*
Incremental MI		-21		-.24
		(.51)		(.50)
Control variables				
Gender	.52	.68	.60	.44
	(.50)	(.41)	(.41)	(.58)
Age class	-.64	-.67	.-67	-.64
	(.07)	(.06)	(.05)*	(.06)
Organizational age class	-.17	-.10	.04	-.01
	(.45)	(.70)	(.86)	(.96)
# Employees	.38	.28	.12	.20
	(.25)	(.46)	(.71)	(.56)
Adjusted R^2	.04	.03	.13	.13
Δ Adjusted R^2		-0,01	,10	-.01

Notes:
n = 57
* p< 0.05, **p<0.01

4.3. Ordinal Logistic Regression analysis

To remove the requirement of normality, an ordinal regression was performed to validate the results of the linear regression. The dependent indicator variables are nominal as they represent the circular strategies. Yet, they indirectly represent a ratio scale based upon their hierarchy in circularity, causing a non-normal distribution. This non-normal distribution made predictions of linear modeling potentially unreliable leading to the risk of a Type I or Type II error. By means of ordinal regression this violation could be bypassed.

Table III.
Ordinal Logistic Regression

		Log odds			
		Model 0	Model 1a	Model 1b	Model 2
Threshold	[CEStrategy = 1]	-4,48*	-2,86	-1,63	-1,45
	[CEStrategy = 2]	-1,26	0,40	1,87	2,05
	[CEStrategy = 3]	-0,93	0,74	2,24	2,42
	[CEStrategy = 4]	-0,78	0,90	2,40	2,58
	[CEStrategy = 5]	-0,50	1,20	2,70	2,89
	[CEStrategy = 6]	0,01	1,75	3,26	3,45
	[CEStrategy = 7]	0,45	2,23	3,75	3,95
	[CEStrategy = 8]	2,84*	4,64	6,31*	6,50**
	[CEStrategy = 9]	5,03*	6,81**	8,62**	8,81**
Location	RMI			0,65**	0,08*
	IMI		0,36		0,62
	[Gender=1]	-1,57	-1,86*	-1,21	-1,30
	[Gender=2]	0a	0a	0a	0a
	[AgeClass=2]	3,29	3,75*	3,99*	4,07*
	[AgeClass=3]	3,07	3,42*	3,69*	3,73*
	[AgeClass=4]	3,18	3,28	3,57	3,58
	[AgeClass=5]	2,70	3,16	3,86	3,90
	[AgeClass=6]	0a	0a	0a	0a
	[OrgAgeClass=1]	0,13	-0,24	-0,32	-0,38
	[OrgAgeClass=2]	-3,00	-2,88	-2,40	-2,42
	[OrgAgeClass=3]	0,88	1,40	1,99	2,05
	[OrgAgeClass=4]	-2,64	-2,28	-1,06	-1,08
	[OrgAgeClass=5]	-2,55	-1,99	-0,04	-0,06
	[OrgAgeClass=6]	-1,11	-0,34	0,51	0,58
	[OrgAgeClass=7]	-1,24	-0,87	-0,85	-0,80
	[OrgAgeClass=9]	0a	0a	0a	0a
	[#ofEmployees=1]	-1,73	-1,48	-1,77	-1,72
	[#ofEmployees=2]	1,60	1,68	0,67	0,74
	[#ofEmployees=3]	-1,78	-2,13	-2,73	-2,75
	[#ofEmployees=4]	-1,01	-0,34	-0,16	-0,06
	[#ofEmployees=5]	-1,01	-1,49	-2,24	-2,28
	[#ofEmployees=6]	0,66	1,11	1,54	1,58
	[#ofEmployees=7]	0a	0a	0a	0a
Pseudo R^2 (Nagelkerke)		0,48	0,50	0,54	0,54
Δ Pseudo R^2			0,02	0,04	0,00

* p< 0.05, **p<0.01

Note: a This parameter is set to zero because it is redundant.

Table III shows the ordinal regression results of all models and provides the log odds ratio (estimates) which is associated with a one-unit change of the predictor. The full test results for each model are included in appendix III. Logic regression used the log-link function to transform variables in such a way that it simulates a linear regression. Therefore, the outcomes are estimates and are less accurate using a Gaussian distribution for the predictor variable in a linear regression. Model 1b failed the Pearson test (p=0.028) indicating that the observed difference between the ordinal sets could arise. All other tests passed as the model fit, goodness of fit and the test for parallel lines were not violated. When comparing the R-squared of the linear regression with the Nagelkerke pseudo R^2 of the ordinal regression, the changes between each model are less.

Although the violation of discriminant validity still remains, the outcome for hypothesis one is still confirmed (p=0.023) and hypothesis two rejected (p=0.796)

5. Discussion and conclusions

This chapter discusses the results and its limitations. The results are then positioned in the context of the research question leading and a broader context of CE studies to conclude the outcomes of this research and provide direction for future research.

5.1. Discussion

Potential of MI for CE and CES. The literature study has linked MI to CES as a potential instrument to accelerate the acceptance and process for the transition towards a circular economy. But how does this relate to what we already know? From the MI perspective the positive influence on several performance, innovation and capability was already confirmed. But the context of the CE for MI was found to be unexplored, and seems to offer a lot of potential to accelerate implementation and acceptance of CE strategies and the propositions they produce. Not only can this form of innovation act as a driver for various other forms of innovation that create new CE solutions, it can also increase the learning and dynamic capacity of the organization which can enable the environment to embrace and accelerate the process of change and acceptance for new CE business models and products. By increasing the focus and investing in the learning capacity of an organization, the amount of MIs will also increase (Gebauer 2011; Nieves 2016).

RMI positively influences CES. The first hypothesis proposed Radical MI to positively influence CES. This is also the most important finding, as it is the only one of two hypotheses that that holds the potential to remove implementation barriers towards the more favorable high circular strategies. The outcome was statistically confirmed, but discriminant validity was violated and therefore needs to be interpreted with caution. Also, the ordinal regression used a logit function and provides estimates. Still, the study outcomes provide clear indications that the occurrence of MIs, being it in a radical form, increase linear with CES from strategies R9 towards R0. Although definitions of both 'MI' and 'Radical' possibly lack a distinctive character and can be argued, indications for new insights for circular economy literature can be derived. Innovation within CE research predominantly focused on an organizations structural elements and product development, but as mentioned before, Potting et al. (2016) showed that "*Achieving socio-institutional change is a bigger challenge than spurring*

technological innovation." when it comes to reaching the high CES. Without this socio-institutional change, acceptance for new product forms and technologies is low and slow as a process. The quantitative study confirmed the extent to which MIs are driving the high circular strategies and partially the radical form in which it unfolds. Although this does not demonstrate a causal link for a development towards circularity, the quantitative approach of this research has led to the inverse finding that the more circular an organization is, the more radical MIs can be detected. This implicates that in order to reach a higher circular strategy, more MIs are needed in a more radical form, indicating the requirements needed in order to boost the transition towards a higher circular strategy. Previous CE research focused on new CE business models and CE product concepts as they contribute directly to CEs portfolio, but this study's finding indicates that radical MI might be the fertilizer for the ground these new business models and product concepts are launched upon.

Reduce and Recyle. Within the CE literature little research has been done at micro level. At this level, Barreiro-Gen and Lozano (2020) have shown that companies mainly focus on reducing and recycling. This study confirms these results, since 'Reduce' (n=21) and 'Recycle' (n=10) are the two highest responses and together make up 54% of the total response. It can be argued to what extent respondents recognize the strategies as indicator variables of the latent variable CES. Almost every commercial company will strive for efficiency and could therefore find itself in the term "Reduce", and therefore could propose a possible limitation.

IMI negatively influences CES. The second hypothesis proposed IMI to negatively influence CES could not be confirmed. It showed no clear correlation and no significance and therefore holds no implications. The root cause of this outcome cannot be addressed as the latent variable was not discriminant to RMI. Either it is a flaw in the contrast between the definitions of incremental and radical, or its proposed influence is not correct.

The transition to a circular organization is not only reflected in the objectives of many organizations, but also in the ambition and objectives governments proclaim. These are a direct indication for the relevance and scale in which new solutions have to be developed in order to speed up the transition. The contribution of this research provides a foundation for

a shift in how innovation must take place to achieve a higher degree of circularity. With this, the focus shifts by stimulating and allowing (radical) MIs within organizations, in addition to innovations on new business models, products and technologies.

5.2. Limitations

The key limitation of this study is that independent variables partially overlap in their theoretical latent variable's definition. Both variables were not discriminant indicating multicollinearity, making them ambiguous and hard to distinct from one and other. Yet both variables share the same foundation which causes the problem, but also resolves a part of the ambiguity, as the only thing that sets them apart is the radical and incremental definitions. Resolving this issue could be done by using MI as the explanatory variable and Radical and Incremental definitions as a moderator. With this, the concepts can be measured separately.

Another limitation is the measure model for the dependent variable. Although it provides a simple and efficient way to gather data, the ordinal scale limits the use of linear regression and can only deliver estimates as a result of ordinal logistic regression. As a result, the outcomes are produced using a logit function simulating a linear regression. The log-odds are estimates and provide less reliability compared to a linear regression based upon a Gaussian distribution.

5.3. Conclusions

"To what extent can non-technological innovation drive CES?" was the central question to be answered in this study. To answer this question the promoting factors of CES and the organizations that execute them were first studied. Organizations in higher strategies tend to constantly focus on reshaping a products function, and are willing to change their whole way of working in a radical way, while organizations in the lower strategies seem more settled, implementing change more incremental, focus on innovations in core technology and being les autonomous. As previous research indicated, socio-institutional change and innovations are needed in order to adapt high circular strategies. To stimulate this from an organizational standpoint, the search in literature for a non-technological innovation form

led to MI. MI was linked to the promoting factors of CES and illustrated great potential, as it not only boosts other innovation forms that can accelerate CE development, but as it also stimulates the learning and dynamic capabilities which are needed in acceptance of new concepts such as the high circular strategies and the concepts they produce. It also links to the high circular strategies as is provides the requirements needed when constantly challenging a products function. Two hypotheses were developed. First hypothesis proposed Radical MI to positively influence CES. The second hypothesis proposed Incremental MI to negatively influence CES. This was conceptualized using the ten circular strategies from the 9R framework (Potting et al. 2016) as a predictor variable, and separating the construct of MI (Vaccaro et al. 2012) into a radical and incremental construct as explanatory variables. As a linear relation was assumed, both hypotheses were tested using linear regression modeling. An ordinal regression was added, as normality of the predictor variable could not be confirmed. Reason for this was that the indicator variables were nominal, but indirectly represented a ratio scale of circularity. Linearity could only be confirmed for the relation between Radical MI and CES. Furthermore, both regression tests confirmed hypothesis one and rejected the second. Using a shared foundation for explanatory variables led to non-discriminant variables and negatively impacted the confirmation of Radical MI to positively influence CES. Albeit, clear indications are given that MI, being it in a radical form, is present within organizations executing the higher circular strategies.

This study has attempted to deviate from innovations aimed at product reduction, new production methods and new business models to facilitate them, but to search for other and new forms of innovation that can accelerate the transition towards circularity. The extent to which MI can drive circular strategies could not precisely be determined, but the outcome provides new leads for researchers and introduced MI as a potential mean for accelerating circularity.

5.4. Future research

To strengthen the study outcomes, the suggested moderating model could be used for future research preventing violation of discriminant validity. Reconfirmation of hypotheses and new insights on how MI can drive CES could provide several new directions for future research.

More important, qualitative research could give deeper insights on how MI contributes to the high circular strategies. This study tried to confirm the presence of MI within circular organizations, but did not research the opposite direction confirming if this presence is by choice or as a result of the organizational dynamics and uncertainty. This could be derived by using qualitative and more abductive methods.

Also, this study suggests further investigation to what the effects are when using MI as a mean for implementing CES. Central for this approach is to investigate whether MI can speed up the process and acceptation for CE and the products and concepts its produces. This might need a longitudinal approach following organizations divided by their (non) use of MI while seeking circularity.

Furthermore, the constructs of measurement used in this thesis could be further developed to provide less ambiguous definitions, and make quantitative research more accessible. Especially the construct for CES could be a valuable mean to gather new data and insights for future research. But the limitations indicated that a scale would be preferred for more detailed results. For this the level of circularity and the strategy could be uncoupled and measured separately. Still, methods for measuring circularity were found to be complex and time-consuming (Moraga et al. 2019; Parchomenko et al. 2019). Therefore, developing an easier way to measure circularity for quantitative methods would greatly benefit other researchers.

CE Practitioners could use the outcomes to explore and broaden their focus towards enabling MIs in their daily operation. They can become a conscious management innovator to see which benefits this can bring. As Birkinshaw and Mol (2006) suggest, a questioning and problem-solving culture can be created to enable MIs to happen. Also, analogies and exemplars from other and different environments can be sought as well as using external change agents to explore new ideas. Examples of change agents are academics, consultants and management gurus.

Acknowledgements

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Bless you all!

Appendix I: Survey

Circular Economy Strategies

(Single selection)

- Wij zijn actief in het overbodig maken van de functie van een product, of bieden een radicaal ander product van een gelijke functie aan.
- Wij zijn actief in het intensiveren van het gebruik van producten (bijvoorbeeld door producten te laten delen of producten multifunctioneel in de markt te zetten.)
- Wij zijn actief in het verhogen van de efficiency in de productie van producten of in het gebruik van natuurlijke grondstoffen en materialen.
- Wij zijn actief in het hergebruiken een afgedankt product die nog in goede conditie is en zijn originele functie vervult voor een nieuwe gebruiker.
- Wij zijn actief in het herstellen of onderhouden van een defect product zodat het opnieuw gebruikt kan worden in zijn originele functie.
- Wij zijn actief in het herstellen van een oud product en brengen het terug naar zijn originele conditie.
- Wij zijn actief in het gebruiken van onderdelen van een afgedankt product voor de productie van een nieuw product met dezelfde functie.
- Wij zijn actief in het gebruik van een afgedankt product, of onderdelen hiervan, voor gebruik van een nieuw product met een nieuwe functie.
- Wij zijn actief in het verwerken van materialen om hetzelfde hoogwaardige of laagwaardige kwaliteit te verkrijgen
- Wij zijn actief in het verkrijgen van energie als gevolg van het verbranden van materialen.

Radical Management Innovation

(7-point Likert scale, 0= Totally disagree, 7= Totally agree)

- Regels en procedures binnen onze organisatie zijn volledig vernieuwd
- Wij hebben volledig nieuwe taken en functies voor onze werknemers gecreëerd
- Onze organisatie heeft volledig nieuwe managementsystemen geïmplementeerd
- Het beleid omtrent compensatie is in de afgelopen drie jaar volledig vernieuwd

- De intra- en interdepartementale communicatiestructuur binnen onze organisatie is volledig vernieuwd
- De volledige organisatiestructuur is vernieuwd

Incremental Management Innovation

(7-point Likert scale, 0= Totally disagree, 7= Totally agree)

- Regels en procedures binnen onze organisatie worden regelmatig bijgewerkt.
- Wij brengen regelmatig wijzigingen aan in taken en functies van onze werknemers.
- Onze organisatie brengt regelmatig wijzigingen in onze managementsystemen.
- Het beleid omtrent tot compensatie wordt regelmatig bijgewerkt.
- De intra- en interdepartementale communicatiestructuur binnen onze organisatie wordt regelmatig geherstructureerd.
- Wij veranderen regelmatig elementen van de organisatiestructuur.

Appendix II: Validity

Convergent validity

Latent variable	Indicator variable	Standardized loadings	Square of standardized loadings	Sum of squared standardized loadings	Number of indicators	AVE*	Square root of AVE**
Radical MI	RMI1	0,900	0,810				
Radical MI	RMI2	0,878	0,771				
Radical MI	RMI3	0,807	0,651	4,139	6	0,690	0,831
Radical MI	RMI4	0,754	0,569				
Radical MI	RMI5	0,807	0,651				
Radical MI	RMI6	0,829	0,687				
Incremental MI	IMI1	0,830	0,689				
Incremental MI	IMI2	0,833	0,694				
Incremental MI	IMI3	0,828	0,686	4,157	6	0,693	0,832
Incremental MI	IMI4	0,751	0,564				
Incremental MI	IMI5	0,871	0,759				
Incremental MI	IMI6	0,875	0,766				

* Convergent validity must be more than 0.5
* Discriminant validity must be more than the latent variables correlation

Discriminant analysis: Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
IMI	0,827	1,095	9	47	0,384
RMI	0,754	1,702	9	47	0,115

Test Results		
Box's M		13,346
F	Approx.	0,687
	df1	15
	df2	700,698
	Sig.	0,799

Notes:
- Tests null hypothesis of equal population covariance matrices.
- a Some covariance matrices are singular and the usual procedure will not work. The non-singular groups will be tested against their own pooled within-groups covariance matrix. The log of its determinant is ,793.

Tests of Normality

	Shapiro-Wilk		
	Statistic	df	Sig.
CE Strategy	0,821	57	0,000
RMI	0,961	57	0,066
IMI	0,986	57	0,752

a Lilliefors Significance Correction

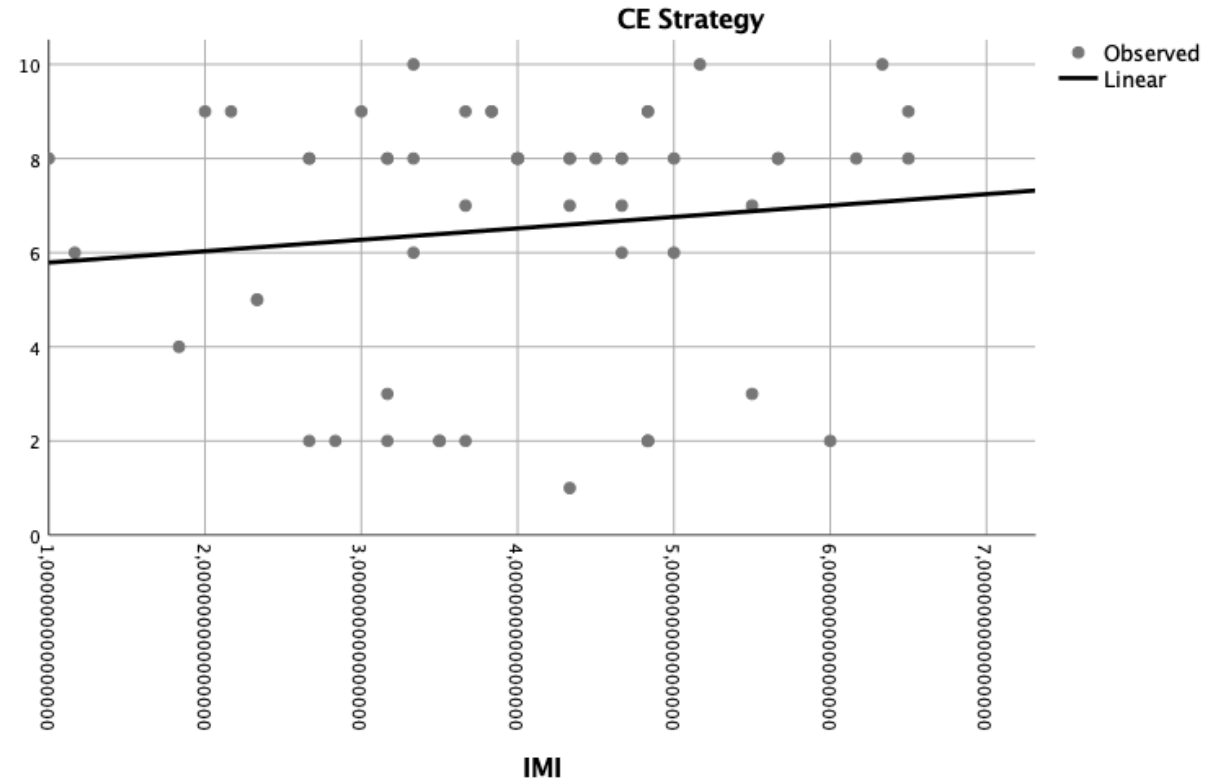
Linearity for Incremental MI

Model Summary and Parameter Estimates

Dependent Variable: CE Strategy

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	0,014	0,767	1	55	0,385	5,547	0,242

The independent variable is IMI.



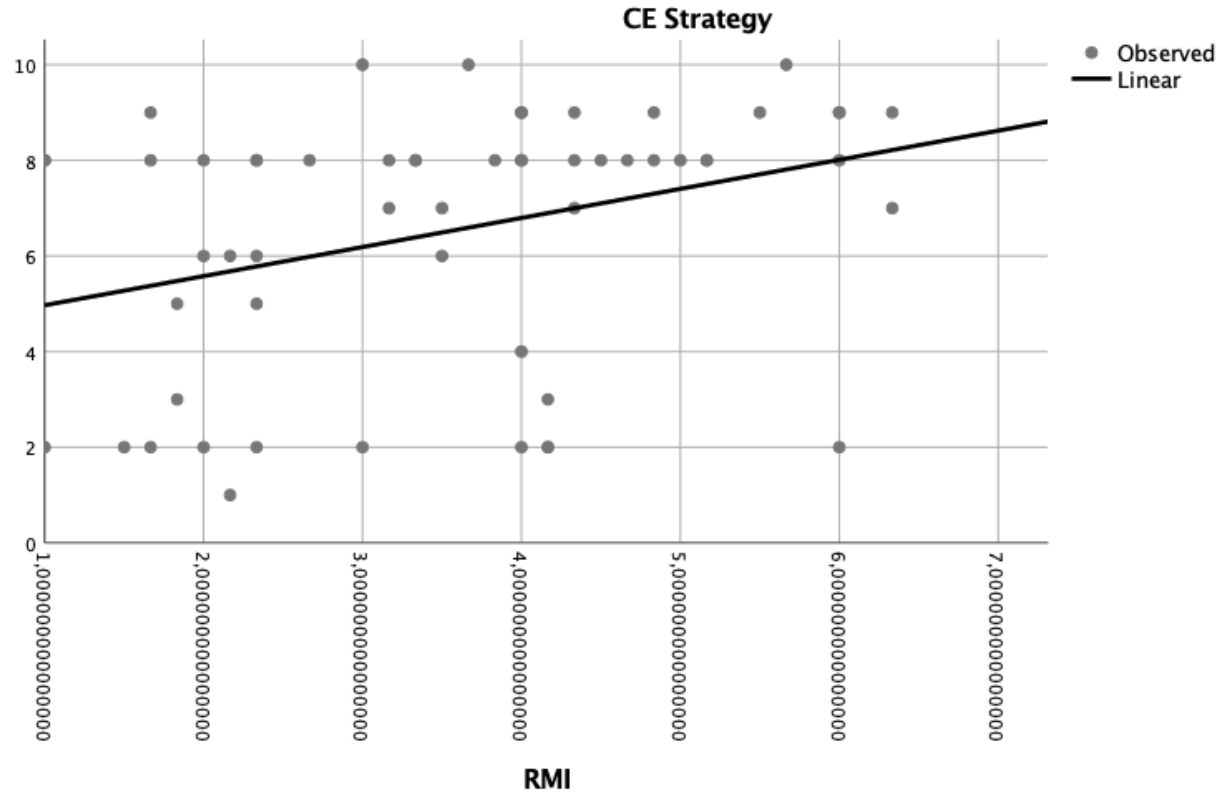
Linearity for Radical MI

Model Summary and Parameter Estimates

Dependent Variable: CES

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	0,113	7,014	1	55	0,011	4,361	0,608

The independent variable is RMI.



Appendix III: Ordinal Logistic Regression results

Ordinal Logistic Regression Model I: Parameter estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[CES = 1]	-4,48	1,95	5,29	1	0,022	-8,302	-0,661
	[CES = 2]	-1,26	1,94	0,42	1	0,515	-5,059	2,536
	[CES = 3]	-0,93	1,94	0,23	1	0,632	-4,735	2,877
	[CES = 4]	-0,78	1,94	0,16	1	0,689	-4,587	3,031
	[CES = 5]	-0,50	1,95	0,07	1	0,798	-4,311	3,313
	[CES = 6]	0,01	1,95	0,00	1	0,995	-3,801	3,824
	[CES = 7]	0,45	1,94	0,05	1	0,815	-3,354	4,261
	[CES = 8]	2,84	1,92	2,19	1	0,139	-0,924	6,612
	[CES = 9]	5,03	2,00	6,29	1	0,012	1,100	8,957
Location	[Gender=1]	-1,57	0,70	5,08	1	0,024	-2,931	-0,205
	[Gender=2]	0a	.	.	0	.	.	.
	[AgeClass=2]	3,29	1,76	3,49	1	0,062	-0,163	6,745
	[AgeClass=3]	3,07	1,72	3,20	1	0,074	-0,295	6,437
	[AgeClass=4]	3,18	1,81	3,08	1	0,079	-0,372	6,721
	[AgeClass=5]	2,70	2,02	1,79	1	0,180	-1,250	6,648
	[AgeClass=6]	0a	.	.	0	.	.	.
	[OrgAgeClass=1]	0,13	2,68	0,00	1	0,960	-5,114	5,381
	[OrgAgeClass=2]	-3,00	2,77	1,17	1	0,279	-8,435	2,436
	[OrgAgeClass=3]	0,88	2,65	0,11	1	0,740	-4,310	6,064
	[OrgAgeClass=4]	-2,64	2,51	1,10	1	0,294	-7,559	2,289
	[OrgAgeClass=5]	-2,55	2,60	0,97	1	0,326	-7,635	2,536
	[OrgAgeClass=6]	-1,11	2,95	0,14	1	0,707	-6,895	4,675
	[OrgAgeClass=7]	-1,24	2,13	0,34	1	0,560	-5,407	2,931
	[OrgAgeClass=9]	0a	.	.	0	.	.	.
	[#ofEmployees=1]	-1,73	2,73	0,40	1	0,526	-7,085	3,619
	[#ofEmployees=2]	1,60	2,62	0,38	1	0,540	-3,528	6,735
	[#ofEmployees=3]	-1,78	2,42	0,54	1	0,462	-6,521	2,962
	[#ofEmployees=4]	-1,01	1,02	0,97	1	0,325	-3,011	0,998
	[#ofEmployees=5]	-1,01	2,47	0,17	1	0,682	-5,840	3,822
	[#ofEmployees=6]	0,66	1,64	0,16	1	0,690	-2,566	3,875
	[#ofEmployees=7]	0a	.	.	0	.	.	.

Link function: Logit.
A This parameter is set to zero because it is redundant.

Ordinal Logistic Regression Model Ia: Parameter estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[CES = 1]	-2,86	2,25	1,61	1	0,204	-7,276	1,555
	[CES = 2]	0,40	2,26	0,03	1	0,860	-4,023	4,821
	[CES = 3]	0,74	2,26	0,11	1	0,744	-3,698	5,178
	[CES = 4]	0,90	2,27	0,16	1	0,692	-3,547	5,342
	[CES = 5]	1,20	2,27	0,28	1	0,598	-3,258	5,654
	[CES = 6]	1,75	2,28	0,59	1	0,442	-2,719	6,225
	[CES = 7]	2,23	2,29	0,95	1	0,330	-2,253	6,709
	[CES = 8]	4,64	2,30	4,07	1	0,044	0,131	9,147
	[CES = 9]	6,81	2,37	8,24	1	0,004	2,162	11,464
Location	IMI	0,36	0,26	1,96	1	0,162	-0,146	0,872
	[Gender=1]	-1,86	0,74	6,40	1	0,011	-3,308	-0,420
	[Gender=2]	0a	.	.	0	.	.	.
	[AgeClass=2]	3,75	1,80	4,35	1	0,037	0,227	7,281
	[AgeClass=3]	3,42	1,74	3,85	1	0,050	0,005	6,834
	[AgeClass=4]	3,28	1,82	3,23	1	0,073	-0,300	6,851
	[AgeClass=5]	3,16	2,05	2,37	1	0,123	-0,858	7,168
	[AgeClass=6]	0a	.	.	0	.	.	.
	[OrgAgeClass=1]	-0,24	2,70	0,01	1	0,930	-5,520	5,045
	[OrgAgeClass=2]	-2,88	2,80	1,06	1	0,304	-8,359	2,608
	[OrgAgeClass=3]	1,40	2,71	0,26	1	0,607	-3,924	6,714
	[OrgAgeClass=4]	-2,28	2,55	0,80	1	0,371	-7,268	2,713
	[OrgAgeClass=5]	-1,99	2,65	0,57	1	0,452	-7,195	3,206
	[OrgAgeClass=6]	-0,34	3,01	0,01	1	0,910	-6,248	5,566
	[OrgAgeClass=7]	-0,87	2,15	0,16	1	0,686	-5,093	3,351
	[OrgAgeClass=9]	0a	.	.	0	.	.	.
	[#ofEmployees=1]	-1,48	2,74	0,29	1	0,588	-6,853	3,885
	[#ofEmployees=2]	1,68	2,64	0,41	1	0,524	-3,487	6,850
	[#ofEmployees=3]	-2,13	2,45	0,75	1	0,385	-6,934	2,677
	[#ofEmployees=4]	-0,34	1,11	0,09	1	0,760	-2,517	1,837
	[#ofEmployees=5]	-1,49	2,50	0,35	1	0,553	-6,390	3,418
	[#ofEmployees=6]	1,11	1,67	0,44	1	0,508	-2,170	4,384
	[#ofEmployees=7]	0a	.	.	0	.	.	.
Link function: Logit.							0,204	-7,276

a This parameter is set to zero because it is redundant.

Ordinal Logistic Regression Model Ib: Parameter estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[CES = 1]	-1,63	2,20	0,55	1	0,458	-5,940	2,677
	[CES = 2]	1,87	2,26	0,68	1	0,408	-2,557	6,289
	[CES = 3]	2,24	2,27	0,97	1	0,325	-2,211	6,682
	[CES = 4]	2,40	2,27	1,11	1	0,292	-2,058	6,855
	[CES = 5]	2,70	2,28	1,40	1	0,237	-1,776	7,169
	[CES = 6]	3,26	2,29	2,02	1	0,156	-1,239	7,754
	[CES = 7]	3,75	2,30	2,65	1	0,104	-0,765	8,260
	[CES = 8]	6,31	2,34	7,26	1	0,007	1,719	10,901
	[CES = 9]	8,62	2,46	12,30	1	0,000	3,802	13,435
Location	RMI	0,65	0,25	7,00	1	0,008	0,170	1,139
	[Gender=1]	-1,21	0,71	2,91	1	0,088	-2,606	0,181
	[Gender=2]	0a	.	.	0	.	.	.
	[AgeClass=2]	3,99	1,81	4,86	1	0,028	0,443	7,544
	[AgeClass=3]	3,69	1,77	4,37	1	0,037	0,228	7,155
	[AgeClass=4]	3,57	1,84	3,76	1	0,052	-0,038	7,173
	[AgeClass=5]	3,86	2,08	3,43	1	0,064	-0,224	7,933
	[AgeClass=6]	0a	.	.	0	.	.	.
	[OrgAgeClass=1]	-0,32	2,75	0,01	1	0,908	-5,703	5,069
	[OrgAgeClass=2]	-2,40	2,87	0,70	1	0,402	-8,024	3,217
	[OrgAgeClass=3]	1,99	2,78	0,52	1	0,473	-3,449	7,435
	[OrgAgeClass=4]	-1,06	2,66	0,16	1	0,689	-6,267	4,140
	[OrgAgeClass=5]	-0,04	2,84	0,00	1	0,989	-5,605	5,528
	[OrgAgeClass=6]	0,51	3,08	0,03	1	0,868	-5,517	6,541
	[OrgAgeClass=7]	-0,85	2,16	0,15	1	0,695	-5,073	3,384
	[OrgAgeClass=9]	0a	.	.	0	.	.	.
	[#ofEmployees=1]	-1,77	2,79	0,40	1	0,526	-7,237	3,701
	[#ofEmployees=2]	0,67	2,72	0,06	1	0,805	-4,655	5,997
	[#ofEmployees=3]	-2,73	2,53	1,17	1	0,280	-7,696	2,230
	[#ofEmployees=4]	-0,16	1,06	0,02	1	0,879	-2,246	1,921
	[#ofEmployees=5]	-2,24	2,56	0,77	1	0,381	-7,252	2,769
	[#ofEmployees=6]	1,54	1,69	0,83	1	0,362	-1,768	4,840
	[#ofEmployees=7]	0a	.	.	0	.	.	.

Link function: Logit. -

a This parameter is set to zero because it is redundant.

Ordinal Logistic Regression Model 2: Parameter estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[CES = 1]	-1,45	2,33	0,39	1	0,53	-6,005	3,107
	[CES = 2]	2,05	2,39	0,74	1	0,390	-2,628	6,729
	[CES = 3]	2,42	2,40	1,02	1	0,313	-2,283	7,123
	[CES = 4]	2,58	2,40	1,16	1	0,283	-2,129	7,296
	[CES = 5]	2,89	2,41	1,43	1	0,232	-1,843	7,614
	[CES = 6]	3,45	2,42	2,03	1	0,154	-1,299	8,205
	[CES = 7]	3,95	2,43	2,63	1	0,105	-0,819	8,714
	[CES = 8]	6,50	2,47	6,91	1	0,009	1,655	11,352
	[CES = 9]	8,81	2,58	11,65	1	0,001	3,749	13,861
Location	RMI	0,62	0,27	5,17	1	0,023	0,086	1,156
	IMI	0,08	0,29	0,07	1	0,796	-0,496	0,647
	[Gender=1]	-1,30	0,77	2,84	1	0,092	-2,807	0,213
	[Gender=2]	0a	.	.	0	.	.	.
	[AgeClass=2]	4,07	1,83	4,95	1	0,026	0,483	7,647
	[AgeClass=3]	3,73	1,77	4,43	1	0,035	0,257	7,210
	[AgeClass=4]	3,58	1,84	3,76	1	0,052	-0,038	7,190
	[AgeClass=5]	3,90	2,09	3,48	1	0,062	-0,197	7,989
	[AgeClass=6]	0a	.	.	0	.	.	.
	[OrgAgeClass=1]	-0,38	2,75	0,02	1	0,892	-5,767	5,018
	[OrgAgeClass=2]	-2,42	2,87	0,71	1	0,399	-8,045	3,205
	[OrgAgeClass=3]	2,05	2,81	0,53	1	0,467	-3,462	7,554
	[OrgAgeClass=4]	-1,08	2,66	0,17	1	0,683	-6,293	4,125
	[OrgAgeClass=5]	-0,06	2,84	0,00	1	0,984	-5,632	5,517
	[OrgAgeClass=6]	0,58	3,11	0,04	1	0,852	-5,512	6,672
	[OrgAgeClass=7]	-0,80	2,18	0,13	1	0,714	-5,066	3,472
	[OrgAgeClass=9]	0a	.	.	0	.	.	.
	[#ofEmployees=1]	-1,72	2,79	0,38	1	0,539	-7,185	3,755
	[#ofEmployees=2]	0,74	2,72	0,07	1	0,786	-4,594	6,075
	[#ofEmployees=3]	-2,75	2,54	1,17	1	0,279	-7,728	2,225
	[#ofEmployees=4]	-0,06	1,12	0,00	1	0,957	-2,263	2,142
	[#ofEmployees=5]	-2,28	2,57	0,78	1	0,376	-7,312	2,762
	[#ofEmployees=6]	1,58	1,70	0,87	1	0,53	-6,005	3,107
	[#ofEmployees=7]	0a	.	.	0	0,390	-2,628	6,729

Link function: Logit.
a This parameter is set to zero because it is redundant.

Model Fitting Information

	Model	-2 Log Likelihood	Chi-Square	df	Sig.
Model 0	Intercept Only	183,721			
Model 0	Final	148,074	35,647	18	0,008
Model 1a	Intercept Only	213,119			
Model 1a	Final	175,399	37,719	19	0,006
Model 1b	Intercept Only	213,119			
Model 1b	Final	170,714	42,405	19	0,002
Model 2	Intercept Only	213,119			
Model 2	Final	170,646	42,473	20	0,002

Link function: Logit.

Goodness-of-Fit

		Chi-Square	df	Sig.
Model 0	Pearson	281,383	333	0,982
Model 0	Deviance	128,589	333	1
Model 1a	Pearson	410,106	476	0,987
Model 1a	Deviance	175,399	476	1
Model 1b	Pearson	536,494	476	0,028
Model 1b	Deviance	170,714	476	1
Model 2	Pearson	518,054	475	0,084
Model 2	Deviance	170,646	475	1

Link function: Logit.

		Pseudo R-Square
Model 0	Cox and Snell	0,465
Model 0	Nagelkerke	0,476
Model 0	McFadden	0,167
Model 1a	Cox and Snell	0,484
Model 1a	Nagelkerke	0,496
Model 1a	McFadden	0,177
Model 1b	Cox and Snell	0,525
Model 1b	Nagelkerke	0,538
Model 1b	McFadden	0,199
Model 2	Cox and Snell	0,525
Model 2	Nagelkerke	0,538
Model 2	McFadden	0,199

Link function: Logit.

Test of Parallel Lines

	Model	-2 Log Likelihood	Chi-Square	df	Sig.
Model 0	Null Hypothesis	148,074			
Model 0	General	77,230b	70,844c	144	1
Model 1a	Null Hypothesis	175,399			
Model 1a	General	75,552b	99,848c	152	1

Model 1b	Null Hypothesis		170,714			
Model 1b	General	,000b		170,714	152	0,142
Model 2	Null Hypothesis		170,646			
Model 2	General	83,797b		86,849c	160	1

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a Link function: Logit.

b The log-likelihood value cannot be further increased after maximum number of step-halving.

c The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

REFERENCES

Aboulamer, A. (2018). Adopting a circular business model improves market equity value. *Thunderbird International Business Review*, *60*(5), 765–769.

Antikainen, M., & Valkokari, K. (2016). A Framework for Sustainable Circular Business Model Innovation. *Technology Innovation Management Review*, *6*(7), 5–12.

Armbruster, H., Bikfalvi, A., Kinkel, S., & Lay, G. (2008). Organizational innovation: The challenge of measuring non-technical innovation in large-scale surveys. *Technovation*, *28*(10), 644–657.

Avraamidou, S., Baratsas, S. G., Tian, Y., & Pistikopoulos, E. N. (2020). Circular Economy - A challenge and an opportunity for Process Systems Engineering. *Computers and Chemical Engineering*, *133*, 106629.

Bain. (2018). Transforming business for a sustainable economy. Retrieved from https://www.bain.com/insights/transforming-business-for-a-sustainable-economy/

Barreiro-Gen, M., & Lozano, R. (2020). How circular is the circular economy? Analysing the implementation of circular economy in organisations. *Business Strategy and the Environment*, (June), 1–11.

BCG. (2018). Circular Economy, WBCSD, BCG. Retrieved from https://docs.wbcsd.org/2018/01/The_new_big_circle.pdf

Birkinshaw, J., Hamel, G., & Mol, M. J. (2008). Management innovation. *Academy of Management Review*, *33*(4), 825–845.

Birkinshaw, J., Hamel, G., Mol, M. J., Birkinshaw, J., & Mol, M. I. (2008). *Academy of Management*. *33*(4), 825–845.

Birkinshaw, J., & Mol, M. (2006). How management innovation happens. *MIT Sloan Management Review*, *47*(4), 81–88.

Blomsma, F., Pieroni, M., Kravchenko, M., Pigosso, D. C. A., Hildenbrand, J., Kristinsdottir, A. R., … McAloone, T. C. (2019). Developing a circular strategies framework for manufacturing companies to support circular economy-oriented innovation. *Journal of Cleaner Production*, *241*.

Bocken, N. M. P., Olivetti, E. A., Cullen, J. M., Potting, J., & Lifset, R. (2017). Taking the Circularity to the Next Level: A Special Issue on the Circular Economy. *Journal of Industrial Ecology*, *21*(3), 476–482.

Bocken, N. M. P., Ritala, P., & Huotari, P. (2017). The Circular Economy: Exploring the Introduction of the Concept Among S&P 500 Firms. *Journal of Industrial Ecology*, *21*(3), 487–490.

Bressanelli, G., Perona, M., & Saccani, N. (2019). Challenges in supply chain redesign for the Circular Economy: a literature review and a multiple case study. *International Journal of Production Research*, *57*(23), 7395–7422.

Buijs, J. (2003). Processes , from Linear Logic to Circular Chaos. *Design*, *12*(2), 76–93.

Buren van, N., Demmers, M., Heijden van der, R., & Witlox, F. (2016). Towards a circular economy: The role of Dutch logistics industries and governments. *Sustainability (Switzerland)*, *8*(7), 1–17.

Camisón, C., & López, A. V. (2010). An examination of the relationship between manufacturing flexibility and firm performance: The mediating role of innovation. *International Journal of Operations and Production Management*, *30*(8), 853–878.

Camisón, C., & Villar-López, A. (2014). Organizational innovation as an enabler of technological innovation capabilities and firm performance. *Journal of Business*

Research, *67*(1), 2891–2902.
Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin*, *56*(2), 81–105.
Cobo-Benita, J. R., Rodríguez-Segura, E., Ortiz-Marcos, I., & Ballesteros-Sánchez, L. (2016). Innovation projects performance: Analyzing the impact of organizational characteristics. *Journal of Business Research*, *69*(4), 1357–1360.
Damanpour, F., & Aravind, D. (2011). Managerial Innovation: Conceptions, Processes, and Antecedents Fariborz. *Management and Organization Review*, *8*(2), 423–454.
Damanpour, F., & Evan, W. M. (1984). Organizational Innovation and Performance : The Problem of " Organizational Lag " Author (s): Fariborz Damanpour and William M . Evan Source : Administrative Science Quarterly , Vol . 29 , No . 3 (Sep ., 1984), pp . 392-409 Published by : Sage Publica. *Administrative Science Quarterly*, *29*(3), 392–409.
Damanpour, F., Walker, R. M., & Avellaneda, C. N. (2009). Combinative effects of innovation types and organizational Performance: A longitudinal study of service organizations. *Journal of Management Studies*, *46*(4), 650–675.
Despeisse, M., Baumers, M., Brown, P., Charnley, F., Ford, S. J., Garmulewicz, A., … Rowley, J. (2017). Unlocking value for a circular economy through 3D printing: A research agenda. *Technological Forecasting and Social Change*, *115*, 75–84.
Doran, J. (2012). Are differing forms of innovation complements or substitutes? *European Journal of Innovation Management*, *15*(3), 351–371.
Ecopreneur.eu. (2019). *Final report. Circular Economy Update. Overview of Circular Economy in Europe*.
EU. (2019). Implementation of the Circular Economy Action Plan. In *European Commission*. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1551871195772&uri=CELEX:52019DC0190
Evangelista, R., & Vezzani, A. (2010). The economic impact of technological and organizational innovations. A firm-level analysis. *Research Policy*, *39*(10), 1253–1263.
Fernandes, S. da C., Pigosso, D. C. A., McAloone, T. C., & Rozenfeld, H. (2020). Towards product-service system oriented to circular economy: A systematic review of value proposition design approaches. *Journal of Cleaner Production*, *257*.
Foss, N. J., & Saebi, T. (2016). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go? *Journal of Management*, *43*(1), 200–227.
Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: A literature review. *Journal of Product Innovation Management*, *19*(2), 110–132. https://doi.org/10.1016/S0737-6782(01)00132-1
Gary Hamel. (2006). The why, what, and how of management innovation. *Harvard Business Review*, *84*(2), 72–84.
Gebauer, H. (2011). Exploring the contribution of management innovation to the evolution of dynamic capabilities. *Industrial Marketing Management*, *40*(8), 1238–1250. 3
Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2019). Circular Economy Sustainability Paradigm. *Journal of Cleaner Production*, *143*(June), 757–768.
Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, *114*, 11–32.
Grosse-Dunker, F., & Hansen, E. G. (2012). Product-service systems as enabler for sustainability oriented innovation: The case of Osram's off-grid lighting. *Technological, Managerial and Organizational Core Competencies: Dynamic Innovation and Sustainable*

Development, (January), 40–54.
Guide, V. D. R. (2000). Production planning and control for remanufacturing: industry practice and research needs. *Journal of Operations Management*, *18*(4), 467–483. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0272696300000346%5Cnpapers3://publication/doi/10.1016/S0272-6963(00)00034-6
Guldmann, E., & Huulgaard, R. D. (2020). Barriers to circular business model innovation: A multiple-case study. *Journal of Cleaner Production*, *243*, 118160.
Gunday, G., Ulusoy, G., Kilic, K., & Alpkan, L. (2011). Effects of innovation types on firm performance. *International Journal of Production Economics*, *133*(2), 662–676.
Hall, J., & Wagner, M. (2012). Integrating sustainability into firms' processes: Performance effects and the moderating role of business models and innovation. *Business Strategy and the Environment*, *21*(3), 183–196.
Hansen, M. B. (2010). Marketization and economic performance, Competitive tendering in the social sector. *Public Management Review*, *12*(2), 255–274.
Heyes, G., Sharmina, M., Mendoza, J. M. F., Gallego-Schmid, A., & Azapagic, A. (2018). Developing and implementing circular economy business models in service-oriented technology companies. *Journal of Cleaner Production*, *177*, 621–632.
Jayaraman, V. (2006). Production planning for closed-loop supply chains with product recovery and reuse: An analytical approach. *International Journal of Production Research*, *44*(5), 981–998.
Khanagha, S., Volberda, H., Sidhu, J., & Oshri, I. (2013). Management innovation and adoption of emerging technologies process innovation: An inter-organizational perspective. *European Management Review*, *10*(1), 51–67.
Khosravi, P., Newton, C., & Rezvani, A. (2019). review and meta-analysis of past decades of research. *European Management Journal*, *37*(6), 694–707.
Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*(September), 221–232.
Kjaer, L. L., Pigosso, D. C. A., Niero, M., Bech, N. M., & McAloone, T. C. (2019). Product/Service-Systems for a Circular Economy: The Route to Decoupling Economic Growth from Resource Consumption? *Journal of Industrial Ecology*, *23*(1), 22–35.
Koberg, C. S., Detienne, D. R., & Heppard, K. A. (2003). An empirical test of environmental, organizational, and process factors affecting incremental and radical innovation. *Journal of High Technology Management Research*, *14*(1), 21–45.
Kraus, S., Pohjola, M., & Koponen, A. (2012). Innovation in family firms: An empirical analysis linking organizational and managerial innovation to corporate success. *Review of Managerial Science*, *6*(3), 265–286.
Lam, A. (2004). Organizational innovation. In *Brunel University Brunel Research in Enterprise, Innovation, Sustainability, and Ethics*.
Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: A comprehensive review in context of manufacturing industry. *Journal of Cleaner Production*, *115*, 36–51.
Linder, M., & Williander, M. (2017). Circular Business Model Innovation: Inherent Uncertainties. *Business Strategy and the Environment*, *26*(2), 182–196.
McKinsey. (2020). Circular Economy. Retrieved from Website, examples of our work website: https://www.mckinsey.com/business-functions/sustainability/how-we-

help-clients/circular-economy
Mentink, B. (2014). Circular Business Model Innovation: A process framework and a tool for business model innovation in a circular economy. *Delft University of Technology*, 167. Retrieved from https://repository.tudelft.nl/islandora/object/uuid:c2554c91-8aaf-4fdd-91b7-4ca08e8ea621
Ministerie SZW. (2015). *Eindrapportage sector*.
Mohd Razali, N., & Bee Wah, Y. (2011). Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling tests. *Journal of Statistical Modeling and Analytics*, *2*(1), 21–33. Retrieved from http://instatmy.org.my/downloads/e-jurnal 2/3.pdf%0Ahttps://www.nrc.gov/docs/ML1714/ML17143A100.pdf
Mol, M. J., & Birkinshaw, J. (2009). The sources of management innovation: When firms introduce new management practices. *Journal of Business Research*, *62*(12), 1269–1280.
Montes, F. J. L., Ruiz Moreno, A., & García Morales, V. (2005). Influence of support leadership and teamwork cohesion on organizational learning, innovation and performance: An empirical examination. *Technovation*, *25*(10), 1159–1172.
Moraga, G., Huysveld, S., Mathieux, F., Blengini, G. A., Alaerts, L., Van Acker, K., … Dewulf, J. (2019). Circular economy indicators: What do they measure? *Resources, Conservation and Recycling*, *146*(April), 452–461.
Morseletto, P. (2020). Targets for a circular economy. *Resources, Conservation and Recycling*, *153*(October 2019), 104553.
Naranjo-Gil, D. (2009). The influence of environmental and organizational factors on innovation adoptions: Consequences for performance in public sector organizations. *Technovation*, *29*(12), 810–818. https://doi.org/10.1016/j.technovation.2009.07.003
Nieves, J. (2016). Outcomes of Management Innovation: An Empirical Analysis in the Services Industry. *European Management Review*, *13*(2), 125–136.
Nogueira, A., Ashton, W. S., & Teixeira, C. (2019). Expanding perceptions of the circular economy through design: Eight capitals as innovation lenses. *Resources, Conservation and Recycling*, *149*(November 2018), 566–576.
O'Connor, G. C. (1998). Market Learning and Radical Innovation: A Cross Case Comparison of Eight Radical Innovation Projects. *Journal of Product Innovation Management*, *15*(2), 151–166.
OECD. (2005). Third edition ORGANISATION FOR ECONOMIC COOPERATION. In *Communities*.
OECD. (2018). Defining innovation. Retrieved from OECD Innovation Strategy website: https://www.oecd.org/site/innovationstrategy/defininginnovation.htm
OECD. (2019). RE-CIRCLE. Retrieved from https://www.oecd.org/environment/indicators-modelling-outlooks/brochure-recircle-resource-efficiency-and-circular-economy.pdf
Okada, E. M. (2001). Trade-ins, Mental Accounting, and Product Replacement Decisions. *Journal of Consumer Research*, *27*(4), 433–446.
Osborne, J. W., & Waters, E. (2003). Four assumptions of multiple regression that researchers should always test. *Practical Assessment, Research and Evaluation*, *8*(2), 2002–2003.
Osterwalder, A., Pigneur, Y., Smith, A., & Movement, T. (2010). *Business Model Canvas*.
Parchomenko, A., Nelen, D., Gillabel, J., & Rechberger, H. (2019). Measuring the circular economy - A Multiple Correspondence Analysis of 63 metrics. *Journal of Cleaner Production*, *210*, 200–216.
PBL. (2019). *Circulaire economie in kaart*. 68. Retrieved from https://www.pbl.nl/publicaties/circulaire-economie-in-kaart

Perreault, W. D., & McCarthy, E. J. (2005). *Basic Marketing: A Global Managerial Approach*. New York: McGraw-Hill.

Pieroni, M. P. P., McAloone, T. C., & Pigosso, D. C. A. (2019). Business model innovation for circular economy and sustainability: A review of approaches. *Journal of Cleaner Production*, *215*, 198–216.

Pino, C., Felzensztein, C., Zwerg-Villegas, A. M., & Arias-Bolzmann, L. (2016). Non-technological innovations: Market performance of exporting firms in South America. *Journal of Business Research*, *69*(10), 4385–4393.

Planing, P. (2014). Business Model Innovation in a Circular Economy Reasons for Non-Acceptance of Circular Business Models. *Open Journal of Business Model Innovation*, 1–11.

Potting, J., Hekkert, M., Worrell, E., & Hanemaaijer, A. (2016). Circular Economy: Measuring innovation in the product chain - Policy report. *PBL Netherlands Environmental Assessment Agency*, (2544), 42.

Quinn, J. B., Mintzberg, H., & James, R. M. (1987). *Strategy Process: Concepts, Contexts and Cases*. Longman Higher Education.

Ranta, V., Aarikka-Stenroos, L., Ritala, P., & Mäkinen, S. J. (2018). Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. *Resources, Conservation and Recycling*, *135*(September 2017), 70–82.

Reh, L. (2013). Process engineering in circular economy. *Particuology*, *11*(2), 119–133. 1

Santibanez Gonzalez, E. D. R., Koh, L., & Leung, J. (2019). Towards a circular economy production system: trends and challenges for operations management. *International Journal of Production Research*, *57*(23), 7209–7218.

Santos-Vijande, M. L., & Álvarez-González, L. I. (2007). Innovativeness and organizational innovation in total quality oriented firms: The moderating role of market turbulence. *Technovation*, *27*(9), 514–532.

Schmidt, T., & Rammer, C. (2007). Non-Technological and Technological Innovation: Strange Bedfellows? *SSRN Electronic Journal*, (07).

Schumpeter, J. A. (1939). Business Cycles. *McGraw-Hill Book Company*, (1939), 461.

Schut, E., Machiel, C., & Mesman, M. (2015). Circular economy in the Dutch construction sector. In *National Institute for Public Health and the Environment*. Retrieved from https://www.rivm.nl/bibliotheek/rapporten/2016-0024.pdf

Scott, K. A., & Weaver, S. T. (2014). To Repair or Not to Repair: What is the Motivation? *Journal of Research for Consumers*, (26), 1–6.

Silva, D. A. L., Renó, G. W. S., Sevegnani, G., Sevegnani, T. B., & Truzzi, O. M. S. (2013). Comparison of disposable and returnable packaging: A case study of reverse logistics in Brazil. *Journal of Cleaner Production*, *47*, 377–387.

Sinha, R., Laurenti, R., Singh, J., Malmström, M. E., & Frostell, B. (2016). Identifying ways of closing the metal flow loop in the global mobile phone product system: A system dynamics modeling approach. *Resources, Conservation and Recycling*, *113*, 65–76.

Stephan, U., Patterson, M., Kelly, C., & Mair, J. (2016). Organizations Driving Positive Social Change: A Review and an Integrative Framework of Change Processes. *Journal of Management*, *42*(5), 1250–1281.

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Towards the circular economy. (2012). In *The Ellen MacArthur Foundation* (Vol. 40).

Tukker, A. (2015). Product services for a resource-efficient and circular economy - A review.

Journal of Cleaner Production, *97*, 76–91.
Vaccaro, I. G., Jansen, J. J. P., van den Bosch, F. A. J., & Volberda, H. W. (2012). Management innovation and leadership: The moderating role of organizational size. *Journal of Management Studies*, *49*(1), 28–51.
Verstraeten-Jochemsen, J., Keijzer, E., Van Harmelen, T., Kootstra, L., Kuindersma, P., & Koch, R. (2018). IMPACT: A Tool for R&D Management of Circular Economy Innovations. *Procedia CIRP*, *69*(May), 769–774.
Walker, R. M., Damanpour, F., & Devece, C. A. (2011). Management innovation and organizational performance: The mediating effect of performance management. *Journal of Public Administration Research and Theory*, *21*(2), 367–386.
Wengel, J., Nylund, A., Stoneman, P., Bellini, N., & Shapira, P. (2000). Analysis of empirical surveys on organisational innovation and lessons for future community innovation surveys. *Scientific Follow-up of the Community Innovation Survey (CIS) Project 98/191*.
Winston, A. (2019). What 1,000 CEOs Really Think About Climate Change and Inequality. *Harvard Business Review*, *2019*(September). Retrieved from https://hbr.org/2019/09/what-1000-ceos-really-think-about-climate-change-and-inequality
Yam, R. C. M., Lo, W., Tang, E. P. Y., & Lau, A. K. W. (2011). Analysis of sources of innovation, technological innovation capabilities, and performance: An empirical study of Hong Kong manufacturing industries. *Research Policy*, *40*(3), 391–402.