FEDERAL UNIVERSITY OF TECHNOLOGY - PARANÁ

POST-GRADUATION PROGRAM IN INDUSTRIAL ENGINEERING

MASTER OF INDUSTRIAL ENGINEERING

RODRIGO SALVADOR

DEFINING CRITERIA FOR BUSINESS MODEL CIRCULARITY ASSESSMENT

MASTER THESIS

PONTA GROSSA

2019

RODRIGO SALVADOR

DEFINING CRITERIA FOR BUSINESS MODEL CIRCULARITY ASSESSMENT

Master Thesis presented as a hurdle requirement to obtain the title of Master of Industrial Engineering at the Post-graduation Program in Industrial Engineering of the Federal University of Technology - Paraná.

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PONTA GROSSA

2019

Ficha catalográfica elaborada pelo Departamento de Biblioteca
da Universidade Tecnológica Federal do Paraná, Câmpus Ponta Grossa
n.47/19

S182 Salvador, Rodrigo

Defining criteria for business model circularity assessment. / Rodrigo Salvador, 2019.
166 f.; il. 30 cm.

Orientador: Prof. Dr. Antonio Carlos de Francisco.

Dissertação (Mestrado em Engenharia de Produção) - Programa de Pós-Graduação em Engenharia de Produção, Universidade Tecnológica Federal do Paraná, Ponta Grossa, 2019.

1. Negócios - Modelos. 2. Sustentabilidade. 3. Engenharia de produção. I. Francisco, Antonio Carlos de. II. Universidade Tecnológica Federal do Paraná. III. Título.

CDD 670.42

Elson Heraldo Ribeiro Junior. CRB-9/1413. 18/06/2019.

Federal University of Technology - Paraná Ponta Grossa Campus

Research and Post-Graduation Board

POST-GRADUATION PROGRAM IN INDUSTRIAL ENGINEERING

APPROVAL SHEET

Thesis Title Nº 341/2019

DEFINING CRITERIA FOR BUSINESS MODEL CIRCULARITY ASSESSMENT

by

Rodrigo Salvador

This thesis was presented at **1:00pm** on **June 13, 2019**, as a hurdle requirement to obtain the title of MASTER OF INDUSTRIAL ENGINEERING, with area of concentration of Industrial Management, of the Post-graduation Program in Industrial Engineering. The candidate was questioned by the Examination Board composed by the professors signed below. After deliberation, the Examination Board considered the thesis approved.

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To my mom, for the true example of
strength and kindness.

ACKNOWLEDGEMENTS

To God, for the strength and gifts.

To my mother, for all the love and for always having supported me every step of the way.

To my family, for understanding my absence and providing me with sublime joy and entertainment during this journey.

To my partner for life, for always being there for me, being my calmness and bringing me back to my element.

To my professor advisor, Professor Dr. Antonio Carlos de Francisco, for the friendship, all the wisdom and the guidance.

To my colleagues of the Sustainable Production Systems Laboratory (LESP), for all the assistance and camaraderie.

To the UTFPR, for providing the structure and making it possible to conduct this piece of research.

To the Coordination of Improvement of Higher Education Personnel (CAPES), for the financial support.

To all that somehow made part of my journey and contributed with something, as little as a smile, to help me or lighten up my day, my most sincere gratitude.

Success is a miserable teacher, it tempts intelligent people to believe they cannot lose. And it is an unreliable guide to the future

(Bill Gates)

ABSTRACT

SALVADOR, Rodrigo. **Defining criteria for business model circularity assessment**. 2019. 166 p. Thesis (Master of Industrial Engineering) - Federal University of Technology - Paraná, Ponta Grossa, 2019.

Existing resource consumption practices have been risking society's sustainable development. Linear business models can no longer be sustained. Therefore, circular business models should gain prominence and change the way society does business. The transition to a circular economy can be made by conceiving entirely new business models or adapting existing ones. Hence, determining the circularity of a business model is of unquestionable assistance to implement new or adapt/manage existing business models. Therefore, this thesis aimed to identify relevant criteria to measure business model circularity. To this end, a systematic literature review and background was conducted to map potential influencing factors of circular economy on business models. An initial list of influencing factors underwent a process of debugging, after which 33 influencing factors remained for validation. The importance of these 33 influencing factors for circular strategies within each of the 9 business model building blocks, identified in the business model Canvas, were validated using a Fuzzy approach, by means of a questionnaire, using a continuous scale of 7 points from UNIMPORTANT to EXTREMELY IMPORTANT, applied to specialists on circular business models. In total, 120 specialists were identified as potential respondents. It was registered 6 complete responses to the questionnaire, which were used to conduct the analysis for validation. For Customer Segments 28 influencing factors were considered at least FAIRLY IMPORTANT for measuring business model circularity, 26 for Value Proposition, 26 for Channels, 19 for Customer Relationships, 23 for Revenue Streams, 28 for Key Resources, 30 for Key Activities, 27 for Key Partnerships and 26 for Cost Structure. After validation, the validated influencing factors became criteria for business model circularity assessment. Throughout the 9 business model building blocks the criteria relate mostly to product-service systems and resource-saving strategies. These criteria indicate where companies should focus their efforts towards more circular practices. They also follow a generic approach, thus not being directed to any particular type of business model. The results in this thesis may be of interest to researchers, regarding the understanding of the usefulness and applicability of the criteria dealt with, to practitioners, regarding strategies to make businesses thrive on the circular business model perspective, and to governments, regarding the development of public policies and incentives for private companies to engage in circular practises.

Keywords: Business Model. Circular Business Model. Circular Economy. Circularity.

RESUMO

SALVADOR, Rodrigo. **Definição de critérios para avaliação de circularidade de modelos de negócio.** 2019. 166 f. Dissertação (Mestrado em Engenharia de Produção) - Universidade Tecnológica Federal do Paraná, Ponta Grossa, 2019.

Existentes práticas de consumo de recursos têm colocado em risco o desenvolvimento sustentável da sociedade. Modelos de negócio lineares não podem mais ser sustentados. Portanto, modelos de negócio circulares devem ganhar prominência e mudar o modo como a sociedade conduz seus negócios. A transição para uma economia circular pode ser realizada por meio da concepção de modelos de negócio inteiramente novos, bem como por meio da adaptação de modelos de negócio existentes. Neste contexto, determinar a circularidade de um modelo de negócio é de auxílio inquestionável para implementar novos ou adaptar/gerenciar modelos de negócio existentes. Portanto, esta dissertação visa identificar critérios relevantes para medir a circularidade de modelos de negócio. Para tanto, uma revisão bibliográfica sistemática foi realizada para identificar os potenciais fatores que influenciam a economia circular em modelos de negócio. Uma lista inicial de fatores de influência passou por um processo de depuração, após o qual 33 fatores de influência permaneceram para validação. A importância desses 33 fatores de influência para estratégias circulares dentro de cada um dos 9 pilares de modelos de negócio, identificados no modelo Canvas, foi validada usando uma abordagem *Fuzzy*, por meio de um questionário que utilizou uma escala contínua de 7 pontos de NÃO IMPORTANTE a EXTREMAMENTE IMPORTANTE, aplicado a especialistas em modelos de negócios circulares. No total, 120 especialistas foram identificados como potenciais respondentes. Foram registradas 6 respostas completas ao questionário, as quais foram utilizadas para realizar a análise de validação. Para Segmentos de Clientes 28 fatores de influência foram considerados pelo menos RAZOAVELMENTE IMPORTANTE para medir a circularidade de modelos de negócio, 26 para Proposição de Valor, 26 para Canais, 19 para Relacionamentos com Clientes, 23 para Fluxos de Receita, 28 para Recursos-Chave, 30 para Atividades-Chave, 27 para Parcerias-Chave e 26 para a Estrutura de Custos. Após a validação, os fatores de influência validados tornaram-se critérios para avaliação da circularidade de modelos de negócio. Ao longo dos nove pilares de modelos de negócio, os critérios se referem principalmente a sistemas de produto-serviço e estratégias de economia de recursos. Esses critérios indicam onde as empresas devem concentrar seus esforços em direção a práticas mais circulares. Eles também seguem uma abordagem genérica, não sendo, portanto, direcionados a qualquer tipo particular de modelo de negócio. Os resultados dessa dissertação podem ser de interesse para pesquisadores, no que diz respeito à compreensão da utilidade e aplicabilidade dos critérios tratados, a profissionais que atuam na área, em relação às estratégias para fazer os negócios prosperarem na perspectiva de modelos de negócios circulares e, aos governos, no que tange ao desenvolvimento de políticas públicas e incentivos para empresas privadas se envolverem em práticas circulares.

Palavras-chave: Modelo de Negócio. Modelo de Negócio Circular. Economia Circular. Circularidade.

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LIST OF ABBREVIATIONS AND ACRONYMS

BB	Building Block
BI	Business Innovation
BM	Business Model
BMBB	Business Model Building Block
BMI	Business Model Innovation
CAPES	*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*
CBM	Circular Business Model
CE	Circular Economy
COG	Center of Gravity
CSCM	Circular Supply Chain Management
DfX	Design for X
IF	Influencing Factor
IoT	Internet of Things
LBM	Linear Business Model
LESP	Sustainable Production Systems Laboratory
MF	Membership Function
PET	Polyethylene Terephthalate
PSS	Product-service System
R&D	Research and Development
SMEs	Small and Medium Enterprises
TBS	Take-back System
TFN	Triangular Fuzzy Number

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1 INTRODUCTION

Society is constantly seeking comfort and development, and to that end, it makes use of all possible resources. Humankind lives in a world of limited resources (SHARPE; AGARWAL, 2014); however, they do not always account for the consequences of their actions. The currently in-practice take-make-use-dispose, namely linear, business models (BM) affect the planet's well-being and human health (STAHEL, 2016), and have been leading society to exceed earth's resource capacity (STEFFEN *et al.* 2015). In a path to solve that concern, many schools of thought (Laws of Ecology, Regenerative Design, Industrial Ecology, Natural Capitalism, Cradle to Cradle, Biomimicry, Performance Economy, and the Blue Economy) have paved the way for the rise and evolution of the circular economy (CE) (BOCKEN *et al.* 2017).

In summary, CE preaches that human activities should follow nature's example. In nature, everything is an input to one/another process (SCHULTE, 2013), in a circular behaviour. Therefore, the way society runs economy should enable such behaviour, in a self-sustaining system, imitating natural processes. Lewandowski (2016) outlines that the transition to a CE requires organisations to introduce circularity to their BMs, evolving the way society does businesses. This is corroborated by the Ellen MacArthur Foundation, when BMs are identified as one of the building blocks (BB) of CE (EMF, 2013a; 2013b). However, CE itself is still an incipient field (MURRAY *et al.*, 2017), therefore, further research is needed to understand its implications and much work is needed to help it spread. It is argued that the incorporation of CE aspects to existing BMs can contribute to the referred transition and such incorporation may ease CE adoption, since it may be less radical and better accepted by both organizations and customers than conceptualizing completely new BMs.

Nonetheless, to allow incorporating CE principles into BMs, it is necessary to measure how circular a BM is and thereafter propose improvement measures that can be deployed into practical actions. The identification of the circularity status of a BM on its different aspects allows identifying what could be done to improve its circularity, consuming less of resources, generating less waste, and taking better advantage of the waste generated. To that end, defining aspects to measure circularity in BMs is of utmost relevance and no such approach has been observed or proposed in the existing literature. Therefore, the definition of what criteria can be used to measure circularity in BMs is an uncovered gap.

Considering the aforementioned, the present study will answer the following research question: **what criteria can be used to assess business model circularity?**

1.1 OBJECTIVES

1.1.1 General Objective

The general objective of the present piece of research is to identify relevant criteria to measure business model circularity.

1.1.2 Specific Objectives

i. Map potential Influencing Factors of Circular Economy on Business Models;
ii. Identify specialists involved in research on Circular Business Models worldwide;
iii. Validate, assisted by specialists in Circular Business Models, the relevance of the identified Influencing Factors of Circular Economy on Business Models;

1.2 JUSTIFICATION

Research on CE has grown tenfold over the last decade (Geissdoerfer *et al.*, 2017), showing the tremendous interest of the scientific community in the topic. However, Korhonen *et al.* (2018) argue that scientific research is still lagging behind practitioner and political engagement with CE, for which Ünal, Urbinati and Chiaroni (2018) comment on the urge for more academic involvement and collective efforts.

Since CE is yet relatively new, little work has been done by academics to investigate its implications, benefits and challenges to society, be it to businesses, people or the Earth. It is known that, on the one hand, there are challenges and barriers to its implementation (OGHAZI; MOSTAGHEL, 2018), however, on the other hand, there are enablers too (see RIZOS *et al.*, 2016; NUßHOLZ, 2018).

The business environment sees CE as a way to create value, reduce costs, generate revenue, and increase company resiliency and legitimacy (URBINATI *et al.*, 2017; MANNINEN *et al.*, 2018; ÜNAL; UBIRATI; CHIARONI, 2018). One potentially great concern companies might have is the possibility of ravaging profits by majorly taking into consideration environmental issues and disregarding economic ones. However, incorporating CE into a business using their own structure, their BM, can bring both environmental and economic benefits (BOCKEN *et al.*, 2016). CBMs intend on running circular systems on an economically viable way (BOCKEN *et al.*, 2016).

Furthermore, offers that are more circular can even increase customer dependency (ABDELKAFI; MAKHOTIN; POSSELT, 2013). There are examples of businesses offering solutions rather than products, hence catching customers' attention by pioneering. Early birds and successful examples are Uber, MUD Jeans (see MUDJEANS, 2019), and HOMIE (see HOMIE, 2019) (these examples are later addressed in section 2.2.4 - page 29). However, although entirely new BMs may facilitate CE adoption, those are not the only way through the referred transition, as existing BMs can also adapt their strategies. Moreover, as it can be noted, a crucial way to incorporate CE into the way society consumes resources and manages what is left at the end-of-life of production systems is designing new BMs (YANG *et al.*, 2018).

On those grounds, having assistance to help directing efforts towards greater circularity is of singular relevance where practical guidance is needed (URBINATI *et al.*, 2017). However, first, it is necessary to know where to act and how to assess circularity. Therefore, it is necessary to know what criteria can be used to assess the circularity of business models, thus companies can measure their business model circularity performance. Based on that, companies can keep and even strengthen the practices that contribute with good circularity indices and take quick action over the circularity criteria under which it is underperforming. One existing issue, though, is that there have not been found any studies determining the criteria under which business model circularity can be measured, neither has any researcher or practitioner pointed what criteria can be used to such end, being, this, a gap in the existing research on CBM.

Stemming from the aforementioned, the present piece of research expresses its relevance on the academic, operational and organizational aspects as presented hereafter.

Drawing on the academic relevance of this research, there will be a unique approach to adjoin two concepts that have been proved to be related (see for instance BOCKEN *et al.*, 2016) and relevant in today's business environment (see for instance LACY *et al.*, 2014), which are CE and BM, in the search for less harmful BMs.

CBMs are novel and little is known about how to conceive, implement or even identify opportunities to foment them. Urbinati *et al.* (2017) state that it is still a struggle for companies to adapt or create BMs, due to a lack of proper guidance. This piece of research will provide guidance concerning the identification of what criteria a business can use to measure its circularity performance. Moreover, this study is directed to organizations considering that they will be able to use the criteria identified here to assess and adapt their BMs towards greater circularity.

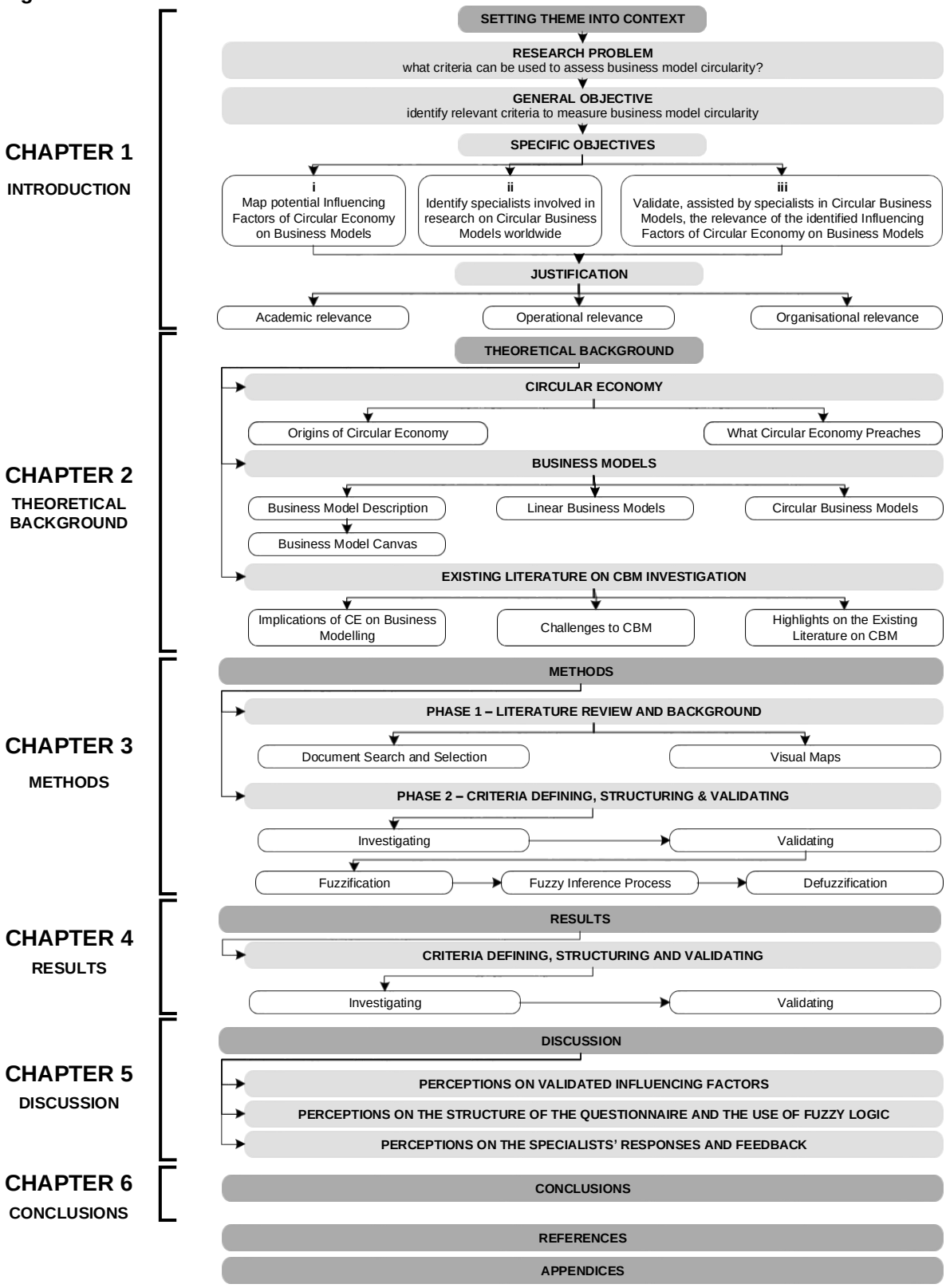
On top of it, actions that are more circular are tied to resource consumption, being this a critical environmental issue. Environmental practices need top management commitment (D'AMATO; ROOME, 2009), as they are usually deployed in a top-down approach and top management holds the influence on strategy setting and resource allocation (EPSTEIN; BUHOVAC, 2016). Moreover, according to scientific experience, unfortunately, literature has recognized lack of managerial support towards environmental practices (ZHU; GENG, 2013). Hence, a change to the organization's core (its BM) can be more effective towards a more circular economy.

Having argued on this thesis's relevance, section 1.3 presents its structure.

1.3 THESIS STRUCTURE

This section aims to present the overall structure of this thesis, showing what the reader can expect from each of the chapters in it. Figure 1 (page 17) summarizes the main content in each chapter. Chapter 1 presented the initial considerations on the subject. Chapter 2 lays the theoretical basis and background that support and justify the development of the present research, whereas Chapter 3 presents the methods for both the literature review and for defining, structuring and validating IFs, as well as a brief methodological background on Fuzzy Logic necessary for the Validation Stage. Chapter 4 presents the main results of this piece of research and Chapter 5, a further discussion on them. Lastly, Chapter 6 draws on the conclusions, limitations and suggestions for further research.

Figure 1 - Thesis Structure



Source: Author (2019)

As seen in Figure 1, the next section begins introducing the methods used to conduct the research.

2 THEORETICAL BACKGROUND

This chapter aims to lay the theoretical background that will be the foundation for this research, addressing the subjects of Circular Economy (CE), Business Models (BM) and Circular Business Models (CBM). The methods for conducting the literature review will be later presented in section 3.1 (page 53).

2.1 CIRCULAR ECONOMY (CE)

In a nutshell, CE is an economy where, besides narrowing input flows, waste is reduced by recapturing (whenever possible) its value when it would have been disposed of. It is widely recognized in the existing literature that a CE aims to switch from the linear, traditional, economic model to one that is restorative and regenerative by its very nature.

A seemingly well-accepted and widely used definition (see EMF, 2014; HOBSON, 2016; SCHUT *et al.*, 2016; CULLEN, 2017; GOLDBERG, 2017; MOREAU *et al.*, 2017; NIERO *et al.*, 2017; SKENE, 2018) of CE is the one provided by the Ellen MacArthur Foundation, which is a major body directed to accelerate the transition to CE (EMF 2012, p.7):

> "[CE is] an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."

Although CE has been more sheerly discussed from 2010, the concept has originated earlier and has been shaped and supported by many other concepts and schools of thought, as presented hereafter.

2.1.1 Origins of Circular Economy

CE is an incipient field (MURRAY *et al.*, 2017). It is believed that the concept of CE has been coined in the 1990s by Pearce and Turner (1990). However, concepts and elements that root CE had been observed even before then.

Boulding (1966) had already presented core characteristics of the concept of CE in his discourse “The Economics of the Coming Spaceship Earth” in 1966. Since then, CE has been shaped by different schools of thought, such as the Laws of Ecology (COMMONER, 1971), Regenerative Design (LYLE, 1996), Industrial Ecology (GRAEDEL; ALLENBY, 1995), Natural Capitalism (LOVINS; LOVINS; HAWKEN, 1999), Cradle to Cradle (MCDONOUGH; BRAUNGART, 2002), Biomimicry (BENYUS, 1997), Performance Economy (STAHEL, 2010), and the Blue Economy (PAULI, 2010).

The Laws of Ecology are four (COMMONER, 1971): (i) everything is connected to everything else, that is, processes impact one another; (ii) everything must go somewhere, that is, nothing disappears; (iii) nature knows best, that is, any man-made interventions are likely to be harmful to the environment and; (iv) there is no such thing as a free lunch, that is, a gain is won at a certain cost.

Regenerative Design is a systems theory that describes process-oriented systems whose sources can be restored, renewed or revitalized, thus, being regenerative (LYLE, 1996).

Industrial Ecology preaches imitation of living systems, studying energy and material flows of industrial processes encourages closing loops and using waste as input (GRAEDEL; ALLENBY, 1995).

Cradle to cradle, besides a framework is a certification process. It encourages the use of resources in infinite loops, eliminating waste, making technical cycles to mime biological ones (MCDONOUGH; BRAUNGART, 2002).

Biomimicry, in its very concept, suggests that human-made systems should imitate nature and have it as model (using nature as inspiration), measure (using nature as a standard to judge our actions) and mentor (using nature to be learned from and not exploited) (BENYUS, 1997).

The Performance Economy is based on the idea of closed-loop functional services, preaching that new and existing systems should seek product-life extension, long-life goods, reconditioning activities and waste prevention (STAHEL, 2010).

The Blue Economy stresses respect to nature, once again, using locally available resources in non-linear systems, just as in nature (PAULI, 2010).

In summary, CE focus is said to be minimising resource consumption and avoiding their leakage out of the system after the use phase (EMF, 2013a, b), seeking to preserve their value for as feasibly as possible (EU, 2015).

After all the influence exerted from the schools of thought, the current CE concept can be said to rest on four BBs, five fundamental principles and four sources of value creation, as presented in the next section. A highlighting remark is that the next section is based on structures and concepts provided by the Ellen MacArthur Foundation, for it has been highly evidenced in the existing literature to be the main body establishing concepts and providing practical guidance for the implementation and acceptance of CE worldwide.

2.1.2 What Circular Economy Preaches

Being influenced by all the schools of thought that gave origin to the current concept, the four BBs of CE are (i) Circular Economy Design, (ii) New BMs, (iii) Reverse Cycles and (iv) Enablers and Favourable System Conditions (EMF, 2013a, 2013b).

i. Circular Economy Design comprises the understanding and putting into practise concepts to achieve CE desired outcomes, seeking to reduce resource consumption and waste generation;
ii. New BMs encompass the introduction of CE key aspects to the way society does business. It takes place in order to externalise a cleaner value capture, encouraging businesses to deploy innovative circular practises;
iii. Reverse Cycles support the economics of circular design by enabling cascading and material return for value recapture. Among other measures, this can be done via reverse logistics and take-back systems;

iv. Enablers and Favourable System Conditions are the ones that can make CE happen, counterbalancing the ones that break it. Such agents and practises/actions include but are not limited to governmental regulation, partnerships along the supply chain, financial incentives and systems that allow scaling-up.

Within them, the Ellen MacArthur Foundation (EMF, 2013a, 2013b) and the international standard BS 8001 (BSI, 2017) preach that there are a few fundamental principles to a transition to a CE, which include:

a) Design out waste and pollution: biological, natural cycles do not present “waste” generation, since the cycles are designed in closed-loop systems. Therefore, technical cycles should follow the same lead. The BS 8001 treats this principle as Value Optimization (BSI, 2017), maintaining resources at their highest possible value at all times, by sharing, reducing idleness, etc., thus reducing any form of waste;
b) Build resilience through diversity: this principle lies on adaptivity. Systems should not only be designed to maximise throughput, but to mitigate fragility in face of diversity;
c) Use of renewable sources: even though one might fall on the concept of renewability (accounting for the rate of production/consumption of a resource to be considered renewable or not), a business should rely on the resources that are currently locally available and detach from non-renewable ones;
d) Think in systems: one should consider all possible interactions among the many activities, increasing flexibility, efficiency, and effectiveness, by spotting potential interactivity and, thus, value capture/recapture. The BS 8001 treats this same principle as Systems Thinking (BSI, 2017);
e) Cascading: so-called waste can be used in another cycle, which might generate waste that can be used in another one and so forth, until materials in the form of harmless waste will be returned to the biosphere. Cascading might include upcycling and downcycling initiatives.

Besides supporting the mentioned principles preached by the Ellen MacArthur Foundation, the BS 8001 (BSI, 2017) further preaches a few more principles to CE:

f) Innovation: organisations should always be aware of needs and opportunities to provide more sustainable solutions for businesses. This concept is partly addressed by “build resilience through diversity”;
g) Stewardship: individuals and organisations must hold responsibility for their activities / product or service offers throughout their entire life cycle;
h) Collaboration: internal and external collaboration is essential to effective exchanges and management or circular systems;
i) Transparency: having a clear and trustworthy behaviour, ensuring honest collaboration.

Considering those BBs and principles, a few opportunities of value generation can be identified, including (EMF, 2013a):

a) Cycling smaller (power of the inner circle): the smaller the cycle, the less must be changed for reuse; therefore, less of resources is used. In this context, Yang *et al.*, (2018) claim that inner circles should be prioritised over outer ones, therefore, (e.g.) reusing and recovering should come before recycling;
b) Cycling for longer (power of cycling longer): the greater number of cycles the resource participates in and the longer the resource stays on a cycle, the better. Thus, following the line of thought of Meroni (2008), CBM focus should shift from creating objects to offering solutions;
c) Cascaded uses (power of cascaded use): repurposing a resource whenever and wherever it can be used. To Moreno *et al.* (2016), in CE, the end-of-Life is expected to be replaced with restoration, which lies in the very roots of the concept;
d) Pure regenerative cycles (power of pure cycles): the use of uncontaminated resource streams facilitate recovery and repurpose. Therefore, circularity should be thought from the design (see MORENO *et al.*, 2016).

All these CE-incorporating opportunities have implications on existing systems. A few of these issues are presented in section 2.3.1 (page 39). As preached by one of the BBs of CE, new BMs are necessary to fully incorporate CE concepts into the economy. Therefore, it is of undeniable importance to get to know BM concepts

and how it is structured and conceived. To this end, the next chapter will present the BM concept, its BBs and a few issues on linear business models (LBMs) and circular business models (CBMs).

2.2 BUSINESS MODELS (BM)

The concept of BM became popular in the 1990s (ZOTT *et al.*, 2011), which by then was a synonym for pitching business ideas to investors in a simplified but comprehensive way. Even though there are several different definitions for a BM, it can be described as a simplified representation of business system elements and their interrelations, aiming to reveal the business strategy on value proposition, creation, delivery and capture.

A BM describes a company's value creation strategy (WIRTZ *et al.*, 2016). It defines how an organization will convert resources into economic value (TEECE, 2010) and, it has been identified as an important means of enabling and promoting circularity (BOCKEN *et al.*, 2016). In summary, a BM describes the way a company does business (MAGRETTA, 2002). It bridges the gap between an organisation's strategy and its operations (RANTA; AARIKKA-STENROOS; MAKINEN, 2018) by breaking down high-level strategies into realisable tasks (JING; JIANG, 2013). Yet, it needs to depict how value will be created for the customer while also delivering profit to investors; therefore, BMs comprise, mainly, three elements, which are (i) value proposition, (ii) value creation and delivery and (iii) value capture (RICHARDSON, 2008).

Value proposition is a statement on what value the business will offer to customers and other stakeholders (RICHARDSON, 2008).

Value creation and delivery refers to how value is created or co-created through the value network (resources, processes, infrastructure and partnerships), and how this will be delivered to stakeholders (channels/mechanisms for communication, sales and distribution) (PIERONI; PIGOSSO; MCALOONE, 2018).

Value capture describes how value is retained and/or recovered by the company, being transformed into results (PIERONI; PIGOSSO; MCALOONE, 2018), usually describing the revenue model (TUKKER, 2015).

A well-known and widely used tool to describe BMs is the BM Canvas, developed by Osterwalder and Pigneur (2010). As a state-of-the-art reference, the BM Canvas has been used for further conceptualizations on the BM literature, including CBMs and other sustainable BMs (see for instance BARQUET *et al.*, 2013; and HEYES *et al.*, 2018), being the most popular BM representation (TÄUSCHER; ABDELKAFI, 2017). Therefore, it will be used as a guide throughout this piece of research's development regarding the concepts and structure of BMs.

2.2.1 Using the Business Model Canvas Framework

The BM Canvas was chosen as the BM basis for structuring the Influencing Factors (IF). The motivations stem from the following reasons:

i. The BM Canvas was developed based on an in-depth academic research by Alexander Osterwalder for his doctoral dissertation (OSTERWALDER, 2004);
ii. Up until May 15, 2019, his dissertation (OSTERWALDER, 2004) had been cited 2,680[1] times and the book his dissertation originated "Business Model Generation" (OSTERWALDER; PIGNEUR, 2010), published in 2010, had been cited 9,188[1] times, thus showing the great acceptance and relevance of the knowledge generated;
iii. Besides having a large use in the BM area in general (see for instance DE MARCO *et al.*, 2017; ERLYANA; HARTONO, 2017), the BM Canvas has assisted the development of several further tools in the area of Sustainable Business Models (see for instance HOVESKOG *et al.*, 2018; KOZLOWSKI; SEARCY; BARDECKI, 2018; ROBINSON; CLOUTIER; EAKIN, 2017) and Circular Business Models (see for instance JOYCE; PAQUIN, 2016; HEYES *et al.*, 2018; RANTA; AARIKKA-STENROOS; MÄKINEN, 2018);
iv. It appears currently relevant, since much of the research using the BM Canvas has been conducted very recently, mainly regarding CBMs and BMs towards CE, where CE is an incipient field on its own.

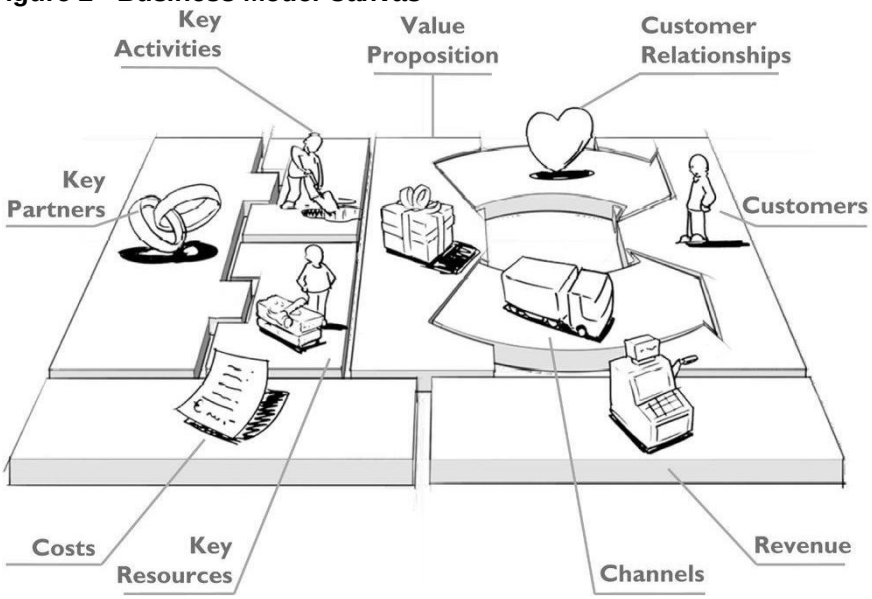
[1] Citations according to Google Scholar.

Having shown the reasons for choosing the BM Canvas as the basis for the BM theory and structure in the present thesis, the following section will present the description of the BM framework, thus using the BM Canvas.

2.2.2 BM Description

The BM Canvas lies the groundwork for a description of BMs, which comprise, basically, 9 BBs, being them (OSTERWALDER; PIGNEUR, 2010) (i) Customer Segments, (ii) Value Proposition, (iii) Channels, (iv) Customer Relationships, (v) Revenue Streams, (vi) Key Resources (vii), Key Activities, (vii) Key Partnerships and (ix) Cost Structure. The BM Canvas structure is illustrated in Figure 2.

Figure 2 - Business Model Canvas



Source: Osterwalder and Pigneur (2010)

(i) **Customer Segments**. This BB aims to identify to whom the value is being created. It defines the set or sets of customers to be reached by the value proposition. Among the possibilities, a business may aspire to reach (OSTERWALDER; PIGNEUR, 2010, p. 21): the mass market, niche market, segmented market, diversified market or focus on a multi-sided platform.

(ii) **Value Propositions**. It identifies what benefits are offered to a customer segment, what problem or problems (whether existing, real, or not) the product/service offered aims to solve, thus creating value to the customer. This can comprise one or

more offerings, including, but not limited to (OSTERWALDER; PIGNEUR, 2010, p. 23-25): newness, performance, customisation, “getting the job done”, design, brand/status, price, cost reduction, risk reduction, accessibility or convenience/usability.

(iii) **Channels**. This BB identifies the mechanisms and means value will be communicated, created, managed and delivered to customers. It mainly comprises the interface with the customer. This interaction, yet, takes place via five phases (OSTERWALDER; PIGNEUR, 2010, p. 27): awareness, evaluation, purchase, delivery and aftersales. Moreover, these channels can, yet, be either a company’s own or from a partner, as well as they can be either direct or indirect, as presented in Table 1.

Table 1 - Channel Types

Channel Types		
Own	Direct	Sales force
		Web sales
	Indirect	Own stores
Partner		Partner stores
		Wholesaler

Source: Osterwalder and Pigneur (2010, p. 27)

(iv) **Customer Relationships**. This BB aims to identify the types of relationships the business has with its customers, which can range from personal to automated. These may include (OSTERWALDER; PIGNEUR, 2010, p. 29): personal assistance, dedicated personal assistance, self-service, automated-service, communities and co-creation.

(v) **Revenue Streams**. This BB identifies a company’s cash flows due to the options of value offered by the company to customers and the customers’ counteraction by means of financial return. Revenue streams can be generated via (OSTERWALDER; PIGNEUR, 2010, p. 31-32): asset sale, usage fee, subscription fees, lending/renting/leasing, licensing, brokerage fees and advertising.

(vi) **Key Resources**. It identifies the resources that are essential to the business’s value proposition, creation, delivery and capture. These can be intellectual, physical, human or financial, being them the company’s own or from partners (OSTERWALDER; PIGNEUR, 2010, p. 35).

(vii) **Key Activities**. This BB identifies the essential activities related to the business's value proposition and all related actions needed for a successful operation. These activities, depending on the BM type may include (OSTERWALDER; PIGNEUR, 2010, p. 37) production, problem solving or platform/network.

(viii) **Key Partnerships**. It identifies the main partners of a business, depending on the business strategy. Strategic alliances between non-competitors, coopetition, joint ventures or buyer-supplier relationships might be created aiming to optimize and achieve economies of scale, reduce risk of uncertainty and/or acquire particular resources and activities (OSTERWALDER; PIGNEUR, 2010, p. 39).

(ix) **Cost Structure**. It identifies the most important, expressive, costs in the structure of the business. Many activities incur costs and many companies choose to design their businesses around a cost structure, therefore businesses might be cost-driven or value-driven (OSTERWALDER; PIGNEUR, 2010). Cost structures can be defined by fixed costs, variable costs, economies of scale or economies of scope (OSTERWALDER; PIGNEUR, 2010, p. 41).

2.2.2.1 Final Considerations of the Section

Research on BMs may cover a range of aspects and be directed towards different approaches. In the present thesis, therefore, the remaining theoretical background on BM will be directed to this piece of research's proposal, thus, embracing the link of BM to CE and related concepts. Thereafter, a few issues on LBMs and CBMs will be covered.

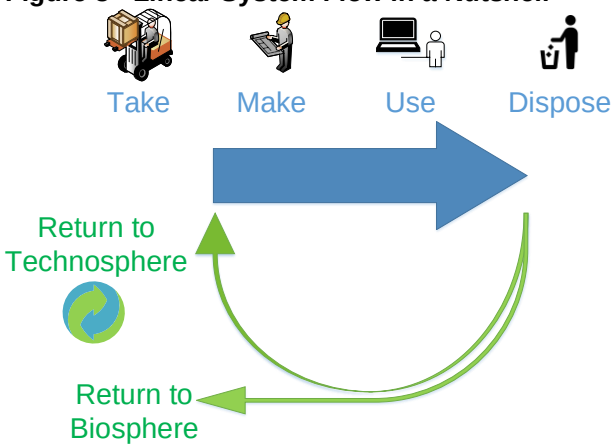
2.2.3 Linear Business Models

In LBMs, also identified as open-loop models (JOHANNSDOTTIR, 2014), value creation mainly takes place from virgin materials (STÅL; CORVELLEC, 2018). Bakker *et al.*, (2014, p. 31) state the guiding principles of LBM as being "design something, manufacture it at the lowest possible cost, sell it at the highest possible price and forget about it as soon as feasibly possible". LBMs assume that resources are (i) abundantly available, (ii) easy to source and (iii) cheap to dispose of (EU, 2015).

LBMs comprise forward supply chains, with the customer at the end of all processes (GUIDE JR.; VAN WASSENHOVE, 2006). Materials extracted from nature are transformed into products and after used and disposed of, they may end up in landfills, generating large amounts of waste or be incinerated (BRAUNGART *et al.*, 2007; MCDONOUGH, *et al.*, 2003). A few materials might be recycled following an end-of-pipe approach; however, products are usually not designed for recycling (JOHANNSDOTTIR, 2014). These systems can be described as cradle-to-grave, oppositely to cradle-to-cradle systems preached by Stahel (1993).

Nowadays, it is common knowledge that humankind has long been relying on linear systems and has been consuming existing resources at a faster rate than Earth is capable of renewing them. This has led to unprecedented amounts of waste in forms that the Earth cannot metabolise; at least not at the same rate waste is delivered to her. Figure 3 illustrates the overall resource flow in linear systems.

Figure 3 - Linear System Flow in a Nutshell



Source: Author (2019)

In the first half of the flow, large amounts of resources are taken, used to make products, those products are used, and what is left of them is disposed of as trash, for LBMs are not concerned with closing loops (see JOHANNSDOTTIR, 2014). In linear systems, that first half is designed to take place as fast as possible, thus financial economy can recycle. However, the second half, where waste is thrown at Earth, so she can resume the biological cycle of those resources, goes much slower. On top of it, marketing strategies have made customers keenly believe that new is best (HOPKINSON *et al.*, 2018). Adjoined with obsolescence, it makes consumption even more concerning.

LBMs still seem to be the *status quo* of most manufacturing industries (LINDER; WILLIANDER, 2017). In LBM, products are designed to last a single use and then lose their embedded value. Contrasting to it, CBMs seek to promote a higher level of utility (VELTE; STEINHILPER, 2016) where products have their economic and environmental values preserved for as long as possible.

Therefore, in several ways, it has been argued for the transition to businesses that are more circular; since academics (BRENNAN *et al.*, 2015) and practitioners (EMF, 2012) have noted and highlighted the need for developing novel BMs to enable the transition from the linear economy to a circular one (see GOYAL; ESPOSITO; KAPOOR, 2018; VELEVA; BODKIN, 2018).

2.2.4 Circular Business Models

Although the concept of CBMs has existed for some time, its first mention by scholars appears to have been made only in 2013 (OGHAZI; MOSTAGHEL, 2018). CBMs help reconcile resource efficiency with creation of commercial value, capitalising on both the environmental and economic value embedded in products (BOCKEN *et al.*, 2016).

There is no ideal BM to achieve circularity; therefore, tailored approaches are encouraged to pave the way to a CE (MORENO *et al.*, 2016). The value propositions of BMs have been changing from providing a physical product to rather delivering functionality via business innovation (BI) (LIEDER; ASIF; RASHID, 2017). Antikainen and Valkokari (2016) defend that shifting from a product-based to a service-based view is the most suitable approach towards a more circular economy, as MUD Jeans (MUD JEANS, 2019), Homie (HOMIE, 2019) and Uber (even if not intended to contribute to CE) set examples.

According to the view of Antikainen and Valkokari (2016), circularly economic businesses will offer immediate solutions to immediate problems rather than sell products of permanent ownership (ANTIKAINEN; VALKOKARI, 2016). Thus, the source of value will not remain idle until the next time it is used by a particular customer or group of customers, but a single source could keep producing value to multiple customers at the same time, or to different customers at different times, thus, by being

shared (where the strategy of Uber fits). This has been causing the concept of ownership to change over the past decade (ABOULAMER, 2017).

This retained ownership (by the provider) facilitates return flow of used products (ÖSTLIN *et al.*, 2008). When a service-based relationship is established, Aboulamer (2018) stresses 2 major advantages: (i) the producer holds control over the product and is able to recycle it more efficiently than a customer, and; (ii) the company has more control over a customer's experience, thus it might provide a better service. It could even be argued that customers would be more careful with products as not to be charged any fees for improper use, thus helping extend a product life cycle for even longer.

Furthermore, Aboulamer (2018) poses that this process also follows the natural trend of Millennials' behaviour, where people prefer the experience rather than succumb to the need of ownership.

For the purposes of this thesis, the definition of CBM taken as reference is the one from Nußholz (2017, p. 12), with a slight adjustment, as follows:

> "A circular business model is how a company creates, captures, and delivers value with the value creation logic designed to improve resource efficiency through contributing to extending useful life of products and parts (e.g., through long-life design, repair and remanufacturing) and closing material loops."

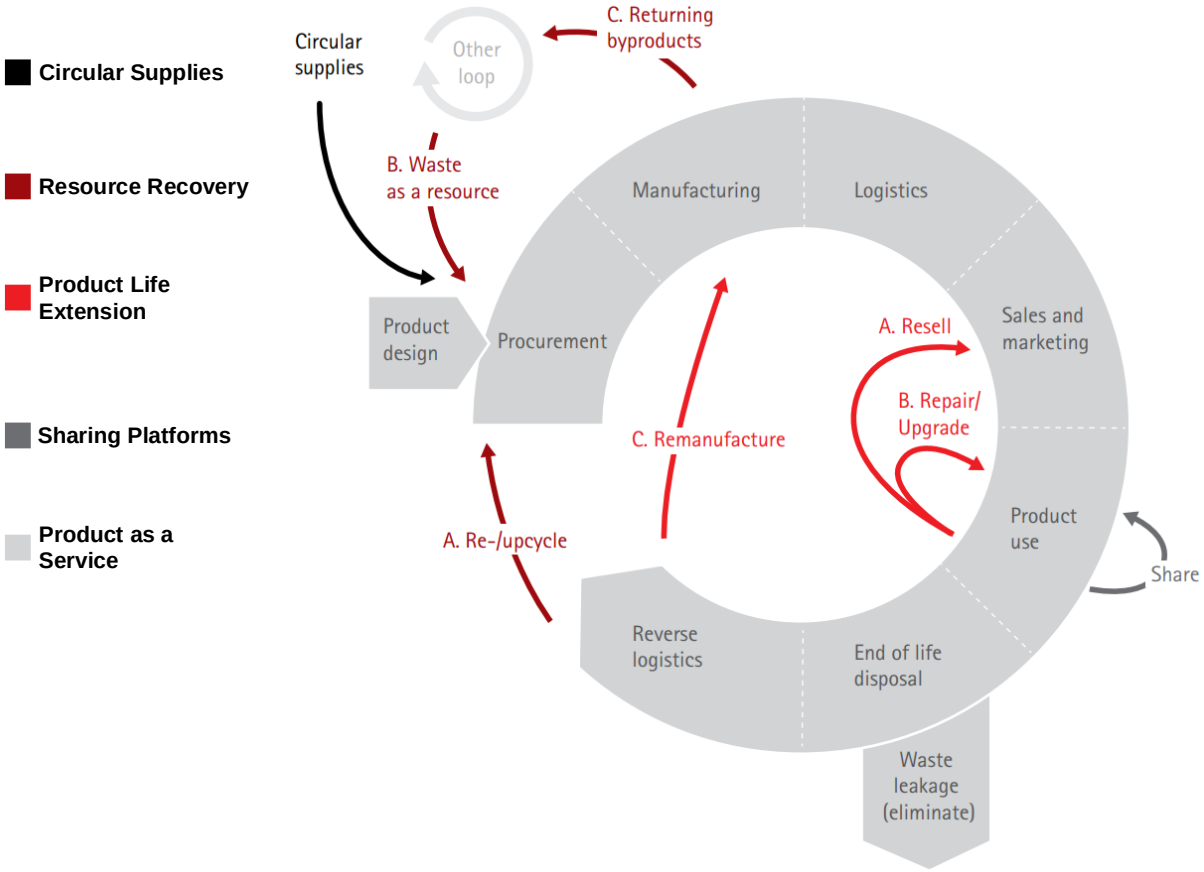
The researcher just would like to add that it does not seek closing only material loops, but more comprehensively, whole resource loops.

CE uses a "reduce" paradigm to drive take-make-dispose (linear) models towards take-make-reduce models, thus restricting the use of resources (GOYAL; ESPOSITO; KAPOOR, 2018); a "reuse" paradigm to drive LBMs towards share-reuse-prolong ones (TSE *et al.*, 2015), thus, extending product consumption before recycling (GOYAL; ESPOSITO; KAPOOR, 2018), and; a "recycle" paradigm to drive linear models towards take-make-recycle models, thus, recovering and reusing resource outputs (GOYAL; ESPOSITO; KAPOOR, 2018).

Some (such as LEWANDOWSKI, 2016) defend that CBM should be at the core of CE, for it helps promote longer lifetimes of entire products or their parts by reusing, repairing, remanufacturing and closing loops through successive cycles (NUßHOLZ, 2018).

Strategies to promote CBMs include the development of circular supplies, resource recovery, product life extension, the use of sharing platforms and PSS offers (LACY *et al.*, 2014). Figure 4 illustrates how these approaches can take place and a brief description of them is provided thereafter.

Figure 4 - Circular Business Model Strategies



Source: Lacy *et al.* (2014)

Circular supplies might make use of industrial symbiosis (internal and/or external exchanges) adjoined with partnerships along the company's supply chain assisting resource life and value extension. Resource recovery can take place during industrial symbiosis or after the use phase of a product, for example, in TBSs, bringing resources back to a new cycle, be it for reusing, remanufacturing, refurbishing or some other recovery strategy. Product life extension can happen via a series of actions, as building products to last, or offering repair options.

Moreover, sharing platforms may be a resourceful strategy for partnerships and for reducing communication distances once stakeholders can have access to a great deal of information on potential partners. PSS models can slow resource flows

by making companies hold ownership (rather than the consumer), thus companies will be keener to make long-lasting products and charging customers with greater responsibility over the product's maintenance, and customers will be more careful with products since they will be hold accountable for whatever happens to those.

One example of CBM, as aforementioned, is the one practised by the company MUD Jeans. The company offers jeans for lease. One can rent some jeans for a year on a subscription basis, paying €7.50 a month. There is also a membership fee of €29.00 that allows one to have up to three jeans under lease. After twelve months, the customer can keep the same jeans for another round of lease or get new jeans paying the same monthly fee. If the person decides not to keep the jeans, the company reports they might sell it as vintage (if in good conditions) or recycle it to make other products. The company still offers repair services if the jeans rip or tear, all under the same monthly fee. MUD Jeans highlights the importance of such practices in the fashion industry, where approximately two billion pairs of jeans are sold each year and less than 1% of materials used to produce clothing is used to produce new clothing (MUD JEANS, 2019).

Another example of current CBM is set by HOMIE. The company offers clothing washing services on a pay-per-use basis, promising to extend their business model to other appliances. The customer can rent a washing machine (on a minimum contract duration of 6 months) and only pay per wash, with no installation, delivery or repair fees. The washing machines used are said to be energy efficient (A+++) and, yet, use a built-in tracker to monitor the customer use, which is used to offer customer advice based on use patterns. Wash cycles vary from €0.75 (cold) to €2.50 (at 90° F). HOMIE also highlights its concern with resource use and affirms its commitment to a circular economy.

Another BM that also contributes to a CE is Uber, even though it was not designed intentionally for such contribution, but arguably rather by serendipity. The worldly known BM offers car sharing and pooling, where individuals can use their cars to provide transportation services in exchange for a payment. The service is similar to the ones offered by cabs. The two main difference are the network that connects all drivers and users, which allows quick and dynamic interaction, and the lower fees (compared to traditional cabs/taxis). Mainly due to the carpooling, there can be great resource saving and pollution reduction, by reducing resource idleness and overuse (due to sharing).

Besides individual actions, there are networks being developed in the realm of CE, seeking circular development, such as the CE100 (EMF, 2019) created and maintained by the Ellen MacArthur Foundation, where global companies unite to discuss and accelerate the transition to a CE. The network arranges workshops that provide both a collaborative and pre-competitive space for sharing knowledge and advancing individual agendas. Organisations that want to become a member of the CE100 network need to fill out an application where they are required to show how they can contribute to accelerating the transition to a CE.

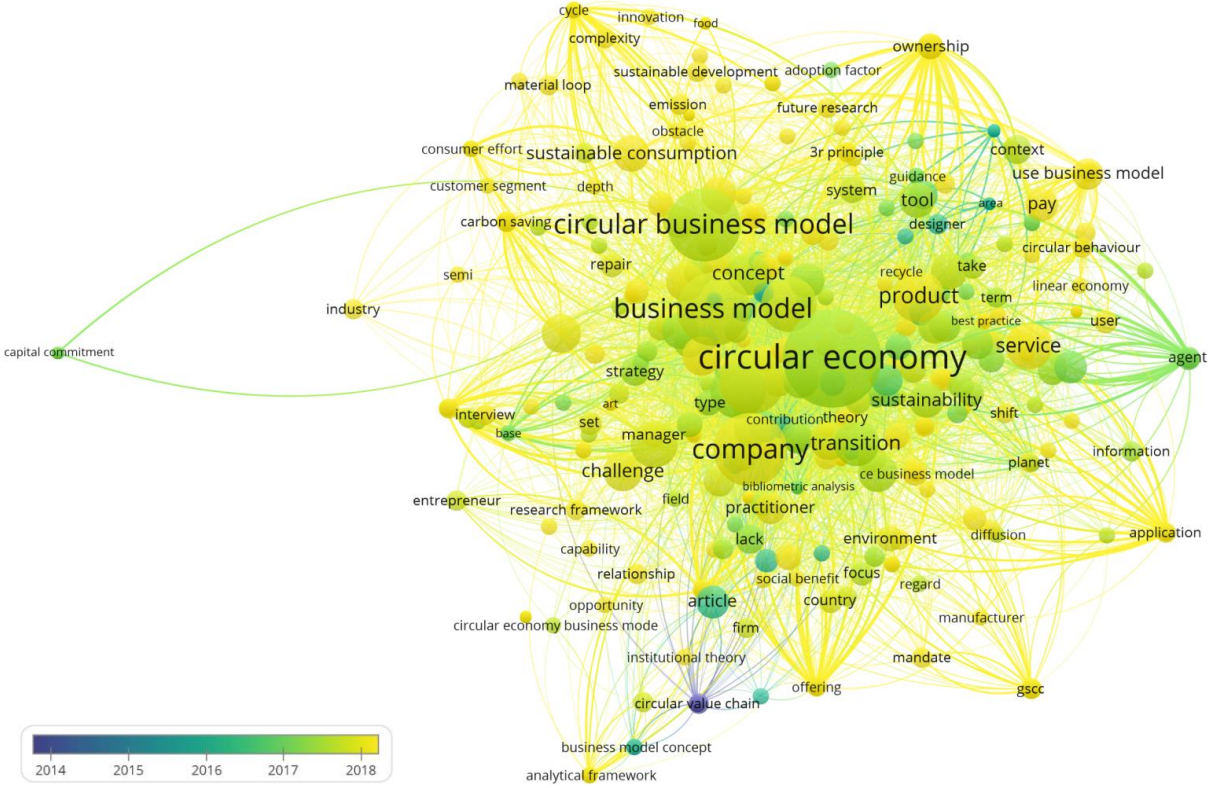
Few are the strategies developed, tested, launched or even just conceptualised towards CBMs. Seeking to unveil what has been done on this regard, the next section will present the main issues revealed by the literature review conducted in Phase 1 (see section 3.1 - page 53) of this piece of research.

2.3 EXISTING LITERATURE ON CBM INVESTIGATION

In the existing literature, CBMs have been investigated only very recently, as it can be observed in Figure 5, even though actions and practises towards them might have been deployed under other names in the past. This field, just as CE itself, is very incipient. Figure 5 (page 34) shows the main terms and their relationships within the 42 articles in the Final Portfolio and the articles that composed the Final Portfolio can be seen in Table 2 (page 34).

Besides the obvious topics of CBM and CE, the investigation on CBM includes various subtopics that are of essential consideration, such as design, service, customer, use business model; and topics that are somehow related to the theme. Furthermore, it is possible to note that besides the field being new, most of the research is very current, highlighting the recent concern with the theme. Some topic clusters under research include: sustainability, environmental management, implications to and from customers and circularity strategies. Very few studies have been found previously to 2015, as the theme is new and seems to be advancing; therefore, novel research is necessary and expected, as the potential for exploration seems to be evolving.

Figure 5 - Term co-occurrence map



Source: Author (2019)

Table 2 - Final Portfolio of Articles

Reference	Title	Journal
NUßHOLZ; RASMUSSEN; MILIOS (2019)	Circular building materials: Carbon saving potential and the role of business model innovation and public policy	Resources, Conservation and Recycling
TUNN *et al.* (2019)	Business models for sustainable consumption in the circular economy: An expert study	Journal of Cleaner Production
BOCKEN *et al.* (2018a)	Pay-per-use business models as a driver for sustainable consumption: Evidence from the case of HOMIE	Journal of Cleaner Production
BOCKEN; SCHUIT; KRAAIJENHAGEN (2018)	Experimenting with a circular business model: Lessons from eight cases	Environmental Innovation and Societal Transitions
BOTEZAT *et al.* (2018)	An Exploration of Circular Economy Practices and Performance Among Romanian Producers	Sustainability
BRESSANELLI *et al.* (2018)	Exploring how usage-focused business models enable circular economy through digital technologies	Sustainability (Switzerland)
COPANI; BEHNAM (2018)	Remanufacturing with upgrade PSS for new sustainable business models	CIRP Journal of Manufacturing Science and Technology
ESPOSITO; TSE; SOUFANI (2018)	Introducing a Circular Economy: NEW THINKING WITH NEW MANAGERIAL AND POLICY IMPLICATIONS	California Management Review

Reference	Title	Journal
FRISHAMMAR; PARIDA (2018)	Circular Business Model Transformation: A Roadmap for Incumbent Firms	California Management Review
GEISSDOERFER *et al.* (2018)	Business models and supply chains for the circular economy	Journal of Cleaner Production
GOYAL; ESPOSITO; KAPOOR (2018)	Circular economy business models in developing economies: Lessons from India on reduce, recycle, and reuse paradigms	Thunderbird International Business Review
HEYES *et al.* (2018)	Developing and implementing circular economy business models in service-oriented technology companies	Journal of Cleaner Production
HOPKINSON *et al.* (2018)	Managing a Complex Global Circular Economy Business Model: Opportunities and Challenges	California Management Review
JABBOUR (2018)	Going in circles: new business models for efficiency and value	Journal of Business Strategy
JUNNILA; OTTELIN; LEINIKKA (2018)	Influence of Reduced Ownership on the Environmental Benefits of the Circular Economy	Sustainability
LEVÄNEN; LYYTINEN; GATICA (2018)	Modelling the Interplay Between Institutions and Circular Economy Business Models: A Case Study of Battery Recycling in Finland and Chile	Ecological Economics
LÜDEKE-FREUND; GOLD; BOCKEN (2018)	A Review and Typology of Circular Economy Business Model Patterns	Journal of Industrial Ecology
MANNINEN *et al.* (2018)	Do circular economy business models capture intended environmental value propositions?	Journal of Cleaner Production
NUNEZ-CACHO *et al.* (2018)	Family Businesses Transitioning to a Circular Economy Model: The Case of "Mercadona"	Sustainability
NUßHOLZ (2018)	A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops	Journal of Cleaner Production
OGHAZI; MOSTAGHEL (2018)	Circular business model challenges and lessons learned-An industrial perspective	Sustainability (Switzerland)
PIERONI; PIGOSSO; MCALOONE (2018)	Sustainable Qualifying Criteria for Designing Circular Business Models	Procedia CIRP
RANTA; AARIKKA-STENROOS; MAKINEN (2018)	Creating value in the circular economy: A structured multiple-case analysis of business models	Journal of Cleaner Production
SOUSA-ZOMER *et al.* (2018)	Exploring the challenges for circular business implementation in manufacturing companies: An empirical investigation of a pay-per-use service provider	Resources Conservation and Recycling
STAL; CORVELLEC (2018)	A decoupling perspective on circular business model implementation: Illustrations from Swedish apparel	Journal of Cleaner Production
ÜNAL; URBINATI; CHIARONI (2018)	Managerial practices for designing circular economy business models: The case of an Italian SME in the office supply industry	Journal of Manufacturing Technology Management

Reference	Title	Journal
VELEVA; BODKIN (2018)	Corporate-entrepreneur collaborations to advance a circular economy	Journal of Cleaner Production
WASTLING; CHARNLEY; MORENO (2018)	Design for circular behaviour: Considering users in a circular economy	Sustainability (Switzerland)
YANG *et al.* (2018)	Product-service systems business models for circular supply chains	Production Planning and Control
ZUCCHELLA; PREVITALI (2018)	Circular business models for sustainable development: A “waste is food” restorative ecosystem	Business Strategy and the Environment
BRESSANELLI; PERONA; SACCANI (2017)	Reshaping the Washing Machine Industry through Circular Economy and Product-Service System Business Models	Procedia CIRP
LIEDER; ASIF; RASHID (2017)	Towards Circular Economy implementation: an agent-based simulation approach for business model changes	Autonomous Agents and Multi-Agent Systems
LINDER; WILLIANDER (2017)	Circular Business Model Innovation: Inherent Uncertainties	Business Strategy and the Environment
MICHELINI *et al.* (2017)	From Linear to Circular Economy: PSS Conducting the Transition	Procedia CIRP
NUßHOLZ (2017)	Circular Business Models: Defining a Concept and Framing an Emerging Research Field	Sustainability
URBINATI *et al.* (2017)	Towards a new taxonomy of circular economy business models	Journal of Cleaner Production
ANTIKAINEN; VALKOKARI (2016)	A Framework for Sustainable Circular Business Model Innovation	Technology Innovation Management Review
BOCKEN *et al.* (2016)	Product design and business model strategies for a circular economy	Journal of Industrial and Production Engineering
LEWANDOWSKI (2016)	Designing the business models for circular economy-towards the conceptual framework	Sustainability (Switzerland)
MORENO *et al.* (2016)	A conceptual framework for circular design	Sustainability (Switzerland)
RIZOS *et al.* (2016)	Implementation of circular economy business models by small and medium-sized enterprises (SMEs): Barriers and enablers	Sustainability (Switzerland)
ROOS (2014)	Business model innovation to create and capture resource value in future circular material chains	Resources

Source: Author (2019)

Considering the novelty of the referred investigation, it can be noted that circular value chain seems to have been the earliest addressed topic and addressed only then, whereas the business model concept remains quite recent. Sustainability concepts and approaches have been addressed in this literature body as well, such as

sustainable consumption, sustainability and sustainable development, within the "sustainability" cluster. Within sustainability, to the environmental dimension ("environmental management" cluster) of sustainability it seems to have been devoted a great effort, once emissions, the 3Rs (especially recycling), carbon savings, material loop and life cycle perspectives are addressed.

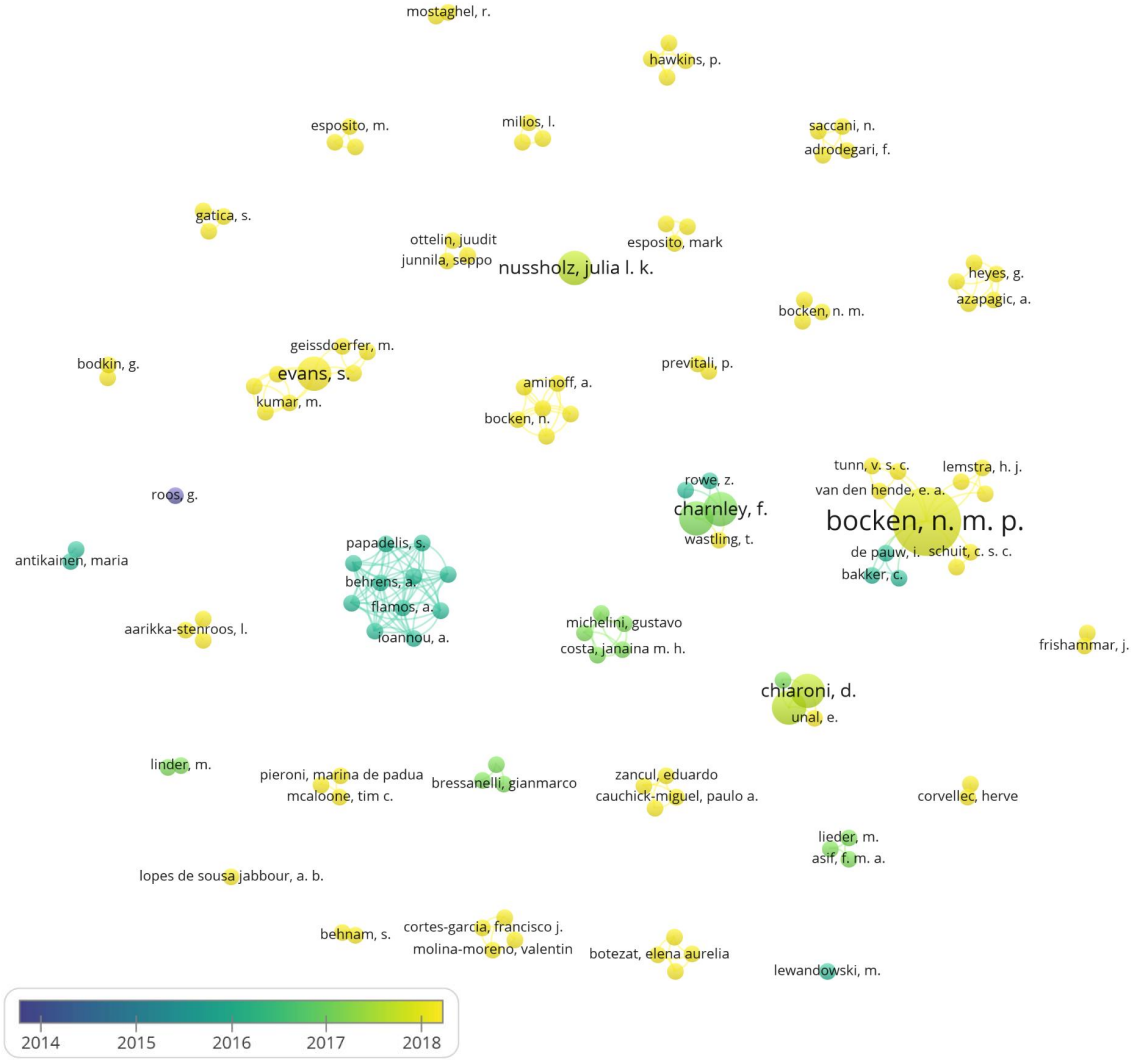
The consumer perspective ("implications to and from customers" cluster) also seems to have been given some attention, as consumer effort, customer segment, relationship and social benefit were some of the topics discussed. Moreover, strategies to be deployed when addressing CBMs were also identified ("circularity strategies" cluster), as ownership issues, obstacles, best practice, guidance, strategy, offering, repair, service, user, transition and shift were approached.

The main considerations identified in the current literature will be presented in Sections 2.3.1, 2.3.2 and 2.3.3. To help further this analysis, it can also be spotted the main researchers developing research on the theme, as shown in Figure 6 (page 38) (such information will be used further as it can be seen in section 3.2.2.2).

Undoubtedly, the main researcher working on the field is Bocken (see BOCKEN *et al.*, 2016; BOCKEN *et al.*, 2018; BOCKEN; SCHUIT; KRAAIJENHAGEN 2018; LÜDEKE-FREUND; GOLD; BOCKEN, 2018; MANNINEN *et al.*, 2018). The author has been doing research on sustainable business models, which includes circular business models and their many facets. Evans, Nußholz (spelled Nussholz in Figure 6 due to VOSviewer's features) and Charnley are other authors of highlight.

Evans has been doing research on circular supply chains and CBMs for supply chains (see GEISSDOERFER *et al.*, 2018; YANG *et al.*, 2018). Nußholz, in their turn, has been helping develop the topic of CBM (see NUßHOLZ, 2017) and formulating tools to aid managing value in CBMs (see NUßHOLZ, 2018). Charnley has been concerning a great issue in CBMs which is design (see MORENO *et al.*, 2016) and the area of circular behaviour (see WASTLING; CHARNLEY; MORENO, 2018).

Figure 6 - Co-authorship map



Source: Author (2019)

Moreover, little collaboration can be noted among researchers in the field. Bocken, yet small, has the biggest network. Therefore, it is noted that further collaborations are needed in order to spread, share, apply, reiterate and develop the knowledge created by past and current research on CBMs. Bearing this in mind and as aforementioned, the next sections present the main considerations identified in the existing literature.

Many authors regard changes in BM as important enablers of CE (see Nußholz, 2018). In order to reveal what has been done on the investigation of BMs towards CE, in a great deal to overcome some of the challenges presented afore, the next section presents the main instruments (including frameworks, models and tools), and discussions based on cases, that have been proposed and conducted.

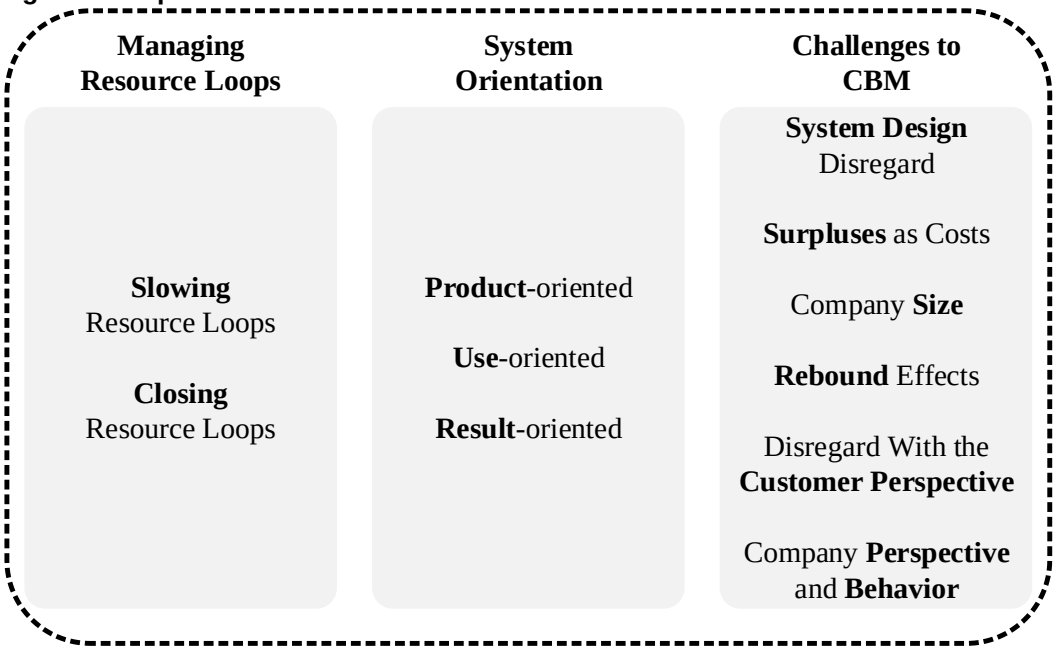
2.3.1 Implications of CE on Business Modelling

There are many elements to be accounted for when designing CE systems. Current, existing systems, are not entirely circular, if at all they consider the concept. The need for a transition to a fully circular economy has been heavily posed by many researchers and practitioners (see EMF, 2013a, 2013b; PLANING, 2015; LEWANDOWKI, 2016; KIRCHHERR; REIKE; HEKKERT, 2017; GOYAL; ESPOSITO; KAPOOR, 2018; VELEVA; BODKIN, 2018). The transition is not clear, and many features of current linear models will collide against the ones of circular models (HOPKINSON *et al.*, 2018).

The existing literature provides a few strategies and a handful of insights on the development of strategies that could be deployed seeking more circular BMs. The implementation of CE in BMs, existing or new, requires engaging in collaborative circular networks and partnering and developing suppliers, service suppliers, manufacturers, retailers and customers and, on top of it, understanding how to create value (LACY *et al.*, 2014).

Business Model Innovation (BMI) is of utmost importance for companies to keep up with ever changing society's needs and is highly regarded as a strategy to promote circularity (see BOCKEN *et al.*, 2014; SHARPE; AGARWAL, 2014; ANTIKAINEN; VOLKOKARI, 2016; OGHAZI; MOSTAGHEL, 2018; VELEVA; BODKIN, 2018; PIERONI; PIGOSSO; MCALOONE, 2018; YANG *et al.*, 2018), besides innovation having been identified by the BS 8001 as one of the principles of CE (BS, 2017). Planing (2014) claims BMI to be one fundamental BB on the transition towards CE (which already had been identified by the Ellen MacArthur Foundation (EMF, 2013a), being a significant step towards increased circularity, as it can be observed in many studies (see, for instance, ROOS, 2014; BOCKEN; SCHUIT; KRAAIJENHAGEN, 2018). The main implications of CE on BM are presented in Figure 7 (page 40) and discussed thereafter.

Figure 7 - Implications of CE on BM



Source: Author (2019)

Bocken *et al.* (2016) argue that CBMs can enable continuous reuse of products/materials (with renewable sources whenever and wherever possible) in an economically viable way. The authors' research shows that the ultimate effort towards CE is closing loops, whereas loop-narrowing efforts help and are designed to seek that ultimate goal. In that sense, Bocken *et al.* (2016) mention a few strategies that could be used to design/redesign CBM strategies, for both slowing and closing loops, as presented hereafter.

Slowing resource loops

a) Access and performance model

Potential life extension costs could be offset by additional revenue for using the product for longer. Examples of it are car sharing and product leasing.

Leasing and renting could reduce the use of virgin material and thus virgin material costs (VEZZOLI *et al.*, 2015), although they might be difficult to implement (STÅL; CORVELLEC, 2018), as they might imply in changes, often rather radical, to value network settings (TUKKER, 2015), consumer preferences (ARMSTRONG *et al.*, 2015) and might bring financial risks (LINDER; WILLIANDER, 2017).

b) Extending product value

Residual value could be explored. Examples of it are: remanufacturing of parts and TBSs.

The introduction of the concept of multiple cycles in a business would imply the value proposition to be changed from the very start and rethought along the whole life cycle (ARAUJO; SPRING, 2006). TBSs allow companies to exploit retained value and regain control of products (ÖSTLIN *et al.*, 2008, 2009). In such cases, Stål and Corvellec (2018) yet argue that companies that produce the goods, thus knowledgeable on their production processes, would be the best suited to capture such value. Moreover, Schenkel *et al.* (2015) argue that the life cycle of a product can be extended by permeating through more price-sensitive groups in subsequent cycles.

c) Classic long-life model

It focuses on delivering long product life. Examples of it are luxury products promising to last a lifetime or beyond, such as Rolex.

This is reiterated by Laubscher and Marinelli (2014), who stress that strategies on product design/material composition can be used towards maximising high quality and reuse. It might include other strategies, such as encourage sufficiency.

d) Encourage sufficiency

It seeks to reduce end-user consumption by providing related after-sale support, or aftermarket services (i.e., warranties, upgradability, and maintenance) (SCHENKEL *et al.*, 2015), thus extending the life cycle of the product. Examples of it include premium brands such as Patagonia.

Besides the environmental gains, on the economic side strategies such as offering greater reparability, upgradeability, making customers use the product for longer, even increase customer dependency (ABDELKAFI; MAKHOTIN; POSSELT, 2013).

Closing resource loops

a) Extending resource value

It focuses on the exploration of residual value of resources, such as collection of waste for repurposing. Examples of it are: activities such as relocating used polyethylene terephthalate (PET) bottles to produce clothes or carpets.

Laubscher and Marinelli (2014) defend that supply loops can be used towards maximising value creation and recreation from own assets and recycled/reused components.

b) Industrial symbiosis

Use of a process's residual outputs as feedstock to another. An example of it is residual wood chips of paper production to feed a boiler.

It may happen among processes within the same facilities or among different organizations (PATRÍCIO *et al.*, 2018). Martin and Harris (2018) claim that industrial symbiosis can contribute to regional sustainable development. Besides that, as it can be seen in Ormazabal *et al.* (2018), on top of the environmental gains, companies can gouge economic advantages.

All these strategies can take place in systems of diverse orientation, each one having a different circularity performance. On these grounds, Tukker (2004) identified three different PSSs, as hereafter addressed.

System Orientation

Tukker (2004) identified PSSs to be product-oriented, use-oriented or result-oriented.

a) Product-oriented

Product-oriented systems are mainly based on LBMs. In such systems, companies encourage the consumption of products (BRESSANELLI; PERONA; SACCANI, 2017). The more products are sold, the stronger the system gets. Tukker (2015) adds that small services (e.g. insurance, maintenance contracts) might be offered along with it (if, at all, offered).

b) Use-oriented

Use-oriented systems are service-based. Although the product still plays a central role, it is the company who holds ownership (TUKKER, 2015). Some of the strategies used include product leasing, renting, sharing and pooling.

c) Result-oriented

Also being service-based, here a result is offered, there being no pre-determined product (TUKKER, 2015). In result-oriented systems, producers are keener to design more durable products, as the profit centre is the function the product delivers rather than the product itself (EDBRING *et al.*, 2016). Contrary to product-oriented systems, where companies encourage the consumption of products, in result-oriented systems they are against it, for customers pay for the results they get and materials involved in the product are cost factors, being optimal to extend product life by deploying more effective cycling strategies (BRESSANELLI; PERONA; SACCANI, 2017).

Besides the aforementioned implications, other issues of concern have been mentioned in the literature, yielding challenges to the implementation of CBMs.

2.3.2 Challenges to CBM

Although compared to other approaches little has been done on the promotion of CBMs, many barriers and challenges to it can already be found in the literature. There are many challenges in the path to implement a CBM (OGHAZI; MOSTAGHEL, 2018). They include lack of supporting regulation, organizational, cultural, financial, economic and technological barriers, customer type and product category restrictions, fashion vulnerability, risk of cannibalization, return flow challenges, lack of channel control, confidentiality for individual firms, trust among partners, mutual benefits for all partners and increase of dependency to partners. A few highlighting issues are addressed in the following paragraphs.

System Design Disregard

Moreno *et al.* (2016) implies that design is one of the most affected phases of a product when it comes to applying CE and, it is often poorly regarded. This is a critical stage to establish closed-loop systems. However, as defended by Lüdeke-Freund, Gold and Bocken (2018) just closing loops *per se* is neglecting.

Surpluses as Costs

Material or energy surpluses are regarded by many businesses simply as costs, hence, these businesses struggle to see them as potentially useful inputs to others (or even to the business itself); therefore, the untiring search for narrow-minded, matter-of-factly, cost-reduction may hinder creative and effective loop-closing (LÜDEKE-FREUND; GOLD; BOCKEN, 2018), which is at the core of CE.

Company Size as a Limiting Factor

Company size can also play a decisive role in designing circular strategies. Veleva, Bodkin and Todorova (2017) highlight that small companies can offer greater flexibility and better customer service (i.e., customer support, repair, and maintenance), while big companies are able to reach global solutions (i.e., recycling and take-back).

There are, though, many barriers to be faced for the adoption of CE, mainly to Small and Medium Enterprises (SMEs). To name a few, Rizos *et al.* (2016) highlight the company's environmental culture, lack of capital, lack of government support as well as effective legislation, lack of information (on the benefits of CE), administrative burdens (related to greener business practises), lack of technical know-how and lack of technical support from the supply and demand networks.

Moreover, Rizos *et al.* (2016)'s piece of research shows that SMEs argue the main challenge to be the lack of support from the supply and demand networks, immediately followed by lack of capital, which includes lack of initial capital for investment, as well as lack of incentives (incentives/funding) and the potential need for investment on Research and Development (R&D).

Rebound Effects

Besides the limits to material recycling are rebound effects (see NUßHOLZ, 2017), which cannot be neglected. One of the main warnings come from Antikainen and Valkokari (2016), on the possibility of a rebound effect due to overuse, thus offsetting the effect of the initial measure, in the case of service or solution-based models.

Disregard with the Customer Perspective

Kirchherr, Reike and Hekkert (2017) also highlight that to include CE concerns in BMs, the customer perspective needs to be taken into consideration. They will be the ultimate judge and will make or break the business's strategy. Besides, the authors report it has been widely neglected. BMs are supposed to take customers' perspectives and desires into account in the first place, for these are conceptualized to meet their demands. However, Kirchherr, Reike and Hekkert (2017) hypothesise that many times, perspectives or aspects of a given concept may be so self-evident that are just left aside, which can lead to blurred interpretations. However, as reported by Oghazi and Mostaghel (2018), BMs often have issues in relation with customer. Wastling, Charnley and Moreno (2018) evidence that the customer role has been disregarded in the CE literature. CE measures might be incorporated into existing BMs neglecting the relationships of these new characteristics with the previously existing ones and they might end up clashing.

Company Perspective and Behaviour

It is possible to perceive from DiMaggio and Powell (1983) that the drivers and barriers to CBMs are institutional, rather than functional, that is, there is knowledge and technology available for use, however the limits are much likely posed by the organization and the BM it adopts. Evans *et al.* (2017) argue that BMI is still challenging due to lack of case studies. Therefore, companies do not understand how innovation could and should take place, and what the outcomes would be.

Another issue of concern, as observed in the study of Stål and Corvellec (2018), is whether companies choose to adopt circular practices because they really want to engage in a more circular conduct, or because they only want to imply they care about the issue. This is crucial to properly address the changes necessary in the case of a real adoption, once "just for a good image" adoption could result in poorly implemented measures that could ruin the business.

Mitigating Drawbacks

Companies have started to realise the benefits that can be achieved from CE adoption. These may include diversified revenue streams, reduction in disposal costs and risks, the ability to attract and retain talent and improved brand reputation and

these, in fact, end up working as drivers of CE (VELEVA; BODKIN; TODOROVA, 2017).

Nonetheless, to profit from such benefits it is necessary to create new or redesign the current BMs. Veleva and Bodkin (2018) stress that launching new BMs incorporating CE requires leveraging values of knowledge and intangible benefits, as it goes beyond only incorporating environmental and social benefits to return on investment.

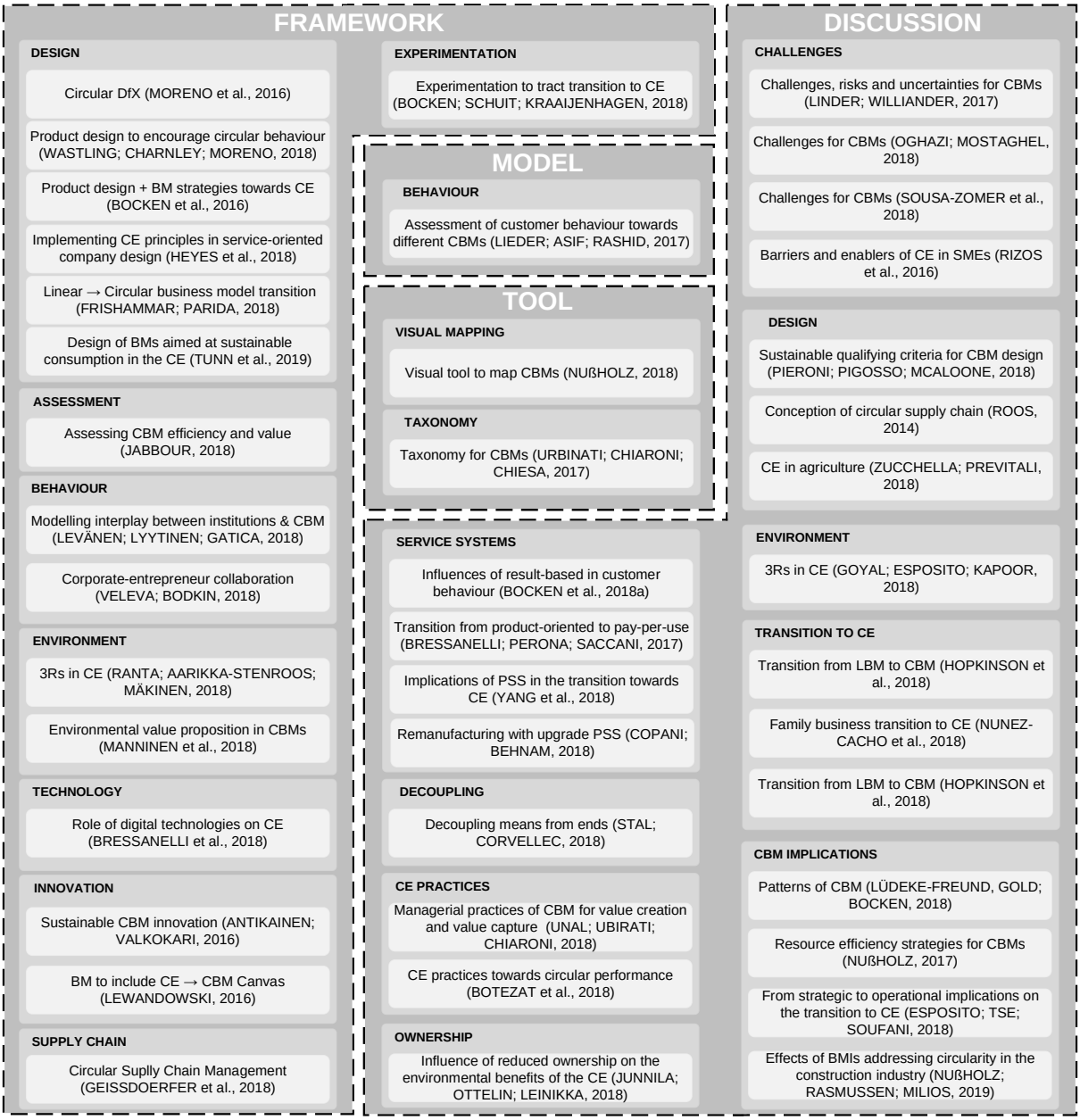
Many authors regard changes in BM as important enablers of CE (see NUßHOLZ, 2018). In order to reveal what has been done on the investigation of BMs towards CE, in a great deal to overcome some of the challenges presented afore, the next section presents the main instruments (including frameworks, models and tools) and discussions based on cases that have been proposed and conducted, presenting the state-of-the-art in CBM investigation.

2.3.3 Highlights on the Existing Literature on CBM

In the existing literature, it is possible to find instruments such as frameworks, models and tools that seek paving the way to CE implementation. A brief display of the ones found relevant by means of the systematic literature review conducted are presented in Figure 8 (page 47).

A great deal of studies dedicated to CBMs seem to be aimed at proposing frameworks, a highlighting term observed in Figure 5 (page 34). These frameworks intend on relating and incorporating CE aspects into different characteristics of businesses, such as conceiving innovative sustainable BMs (see ANTIKAINEN; VALKOKARI, 2016), as well as acting on several design strategies, such as product design (see BOCKEN *et al.*, 2016), circular design for X (see MORENO *et al.*, 2016), circular supply chain management (CSCM) (see GEISSDOERFER *et al.*, 2018), circular behaviour (see WASTLING; CHARNLEY; MORENO, 2018) and Ecodesign (see HEYES *et al.*, 2018).

Figure 8 - Literature Review Highlights



Source: Author (2019)

Others address collaboration issues (see VELEVA; BODKIN, 2018) and the interplay between institutions and CBMs (see LEVÄNEN; LYYTINEN; GATICA, 2018). Others yet, work mostly on environmental issues, such as the use of the 3Rs (see RANTA; AARIKKA-STENROOS; MAKINEN, 2018) or means to assess whether circular BMs capture intended environmental value propositions (MANNINEN *et al.*, 2018). On top of it, circular approaches extending the pure BM concept towards CE can be observed (see LEWANDOWSKI, 2016), just as well as the role of experimentation in the transition towards CE (see BOCKEN; SCHUIT;

KRAAIJENHAGEN, 2018; FRISHAMMAR; PARIDA, 2018), the role of digital technologies in usage-focused BM towards CE (BRESSANELLI *et al.*, 2018) and approaches aiming to assess BM efficiency and value (JABBOUR, 2018).

As existing approaches seem to be more conceptual than practical and replicable, not as many models as frameworks have been observed. The one observed, just so-called model, was developed by Lieder, Asif and Rashid (2017) who developed a model to assess customer behaviour before different BMs.

A set of tools could also be observed, addressing different concepts and applied to different industries. Tools found in the literature include a visual tool to map BMs (see NUßHOLZ, 2018) and a taxonomy for CBMs (see URBINATI *et al.*, 2017).

On top of it, many cases also have been presented and valuable questions and implications have been brought to light in several discussions by researchers in the last five years. These include a decoupling perspective, of means from ends, towards CE (see STÅL; CORVELLEC, 2018), the blur on what resource efficiency strategies classify a BM as circular (see NUßHOLZ, 2017) and patterns of CBMs (see LÜDEKE-FREUND; GOLD; BOCKEN, 2018). Moreover, many challenges (see OGHAZI; MOSTAGHEL, 2018; SOUSA-ZOMER *et al.*, 2018), risks and uncertainties (see LINDER; WILLIANDER, 2017) and barriers faced by organisations who wish to engage in CBM (RIZOS *et al.*, 2016) have been presented.

Furthermore, the conception of circular supply chains has been discussed (see ROOS, 2014), as well as implications and characteristics of new BMs such as in agriculture (see ZUCCHELLA; PREVITALI, 2018). On top of it, the transition to CE has been investigated, and some of its implications (ESPOSITO; TSE; SOUFANI, 2018), be it in family businesses (see NÚÑEZ-CACHO *et al.*, 2018), or other industrial businesses including the printing, imaging and documenting industry (see HOPKINSON *et al.*, 2018), a washing machine business (see BRESSANELLI; PERONA; SACCANI; 2017), the construction industry (NUßHOLZ; RASMUSSEN; MILIOS, 2019) and whole systems such as the implications of PSS BM in the transition towards CE (see COPANI; BEHNAM, 2018; YANG *et al.*, 2018), or the influence of result-based models on a more sustainable behaviour (BOCKEN *et al.*, 2018). Nevertheless, it also has been devoted some effort to the role of the 3Rs towards CE (see GOYAL; ESPOSITO; KAPOOR, 2018), as well as to identifying sustainable qualifying criteria for designing CBMs (see PIERONI; PIGOSSO; MCALOONE, 2018) and business models aimed at sustainable consumption (TUNN *et al.*, 2019).

Investigation of practices towards CE, from managerial to operational (BOTEZAT *et al.*, 2018; ÜNAL; UBIRATI; CHIARONI, 2018) and the influence of reduced ownership on the environmental benefits of the CE (JUNNILA; OTTELIN; LEINIKKA, 2018) have also been addressed.

As it can be seen, many are the factors that need to be considered when studying either CE or BMs. They are not always simple to identify and interpret, carrying a great deal of subjectivity on how they can be addressed and managed, thus being fuzzy. To address this issue, a brief background on Fuzzy Logic is presented in the next Chapter.

3 METHODS

Regarding the methodological procedures, according to Gil (1991), this piece of research is classified into what is presented in Table 3.

Table 3 - Research Classification

Criteria	Classification	Reason
Object	Field	The criteria are observed occurring spontaneously and will be destined for practical field applications
Nature	Applied	The research aims to generate knowledge for practical application directed to solving a specific problem. It aims solving a concrete and immediate problem, involving truths and local interests (to CE)
Problem approach	Qualitative	It involves the interpretation of phenomena and attribution of meanings
Objectives	Exploratory	It aims to provide greater familiarity with a problem seeking to explicit it and, later, further the analysis
Technical procedures	Survey	It aims at direct knowledge of the reality to identify decision factors for measuring circularity based on specialists' opinions (by means of surveys)

Source: Author (2019), based on Gil (1991)

On top of it, Table 4 show the links of this thesis' theoretical elements to the accomplishment of the specific objectives.

Table 4 - Main Authors and Contributions to the Specific Objectives per Theoretical and Methodological Background Topic

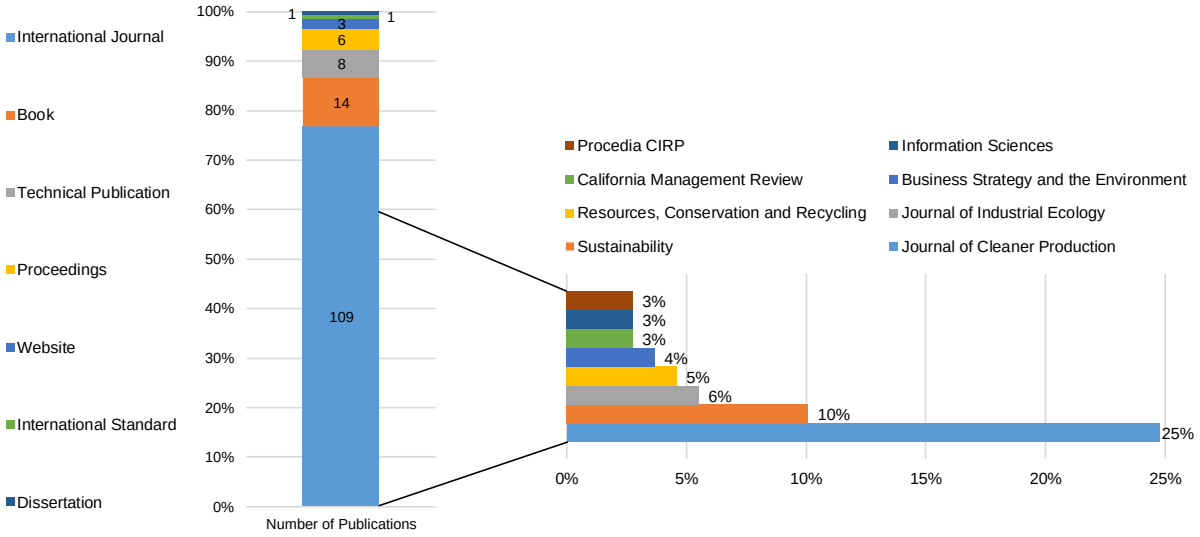
Theoretical Background Topic	Main Authors	Related Specific Objective
2.1. CIRCULAR ECONOMY (CE)	BSI (2017); EMF (2014, 2013a, 2013b, 2012); PAULI (2010); STAHEL (2010); BENYUS (2002); MCDONOUGH; BRAUNGART (2002); LOVINS; LOVINS; HAWKEN (1999); GRAEDEL; ALLENBY (1995); COMMONER (1971); LYLE (1996)	i. Map potential Influencing Factors of Circular Economy on Business Models
2.1.1. Origins of Circular Economy		
2.1.2. What Circular Economy Preaches		
2.2. BUSINESS MODELS (BM)	GOYAL; ESPOSITO; KAPOOR (2018); PIERONI; PIGOSSO; MCALOONE (2018); NUßHOLZ (2018); STAL; CORVELLEC (2018); NUßHOLZ (2017); BOCKEN *et al.* (2016); TUKKER (2015); OSTERWALDER; PIGNEUR (2010); HEYES *et al.* (2008); RICHARDSON (2008); OSTWERWALDER (2004)	i. Map potential Influencing Factors of Circular Economy on Business Models
2.2.1. Using the BM Canvas Structure		
2.2.2. BM Description		
2.2.3. Linear Business Models		
2.2.4. Circular Business Models (CBM)		

Theoretical Background Topic	Main Authors	Related Specific Objective
2.3. EXISTING LITERATURE ON CBM INVESTIGATION 2.3.1. Implications of CE on Business Modelling 2.3.2. Challenges to CBM 2.3.3. Highlights on the Existing Literature on CBM	BOCKEN *et al.* (2018a, 2018b); GEISSDOERFER *et al.* (2018); LÜDEKE-FREUND; GOLD; BOCKEN (2018); MANNINEN *et al.* (2018); YANG *et al.* (2018); NUßHOLZ (2018); NUßHOLZ (2017); BOCKEN *et al.* (2016); MORENO *et al.* (2016); WASTLING; CHARNLEY; MORENO (2016); TUKKER (2015); LACY *et al.* (2014); EMF (2013a, 2013b); TUKKER (2004)	i. Map potential Influencing Factors of Circular Economy on Business Models ii. Identify specialists involved in research on Circular Business Models worldwide
3.2.2.1. Structuring scheme for IF relevance validation by specialists (Fuzzy Logic)	MAHMOUD (2018); KANNAN; JABBOUR; JABBOUR (2014); LEEWWIJCK; KERRE (1999); MENDEL (1995); ZADEH (1975a, b, c, 1965)	iii. Validate, assisted by specialists in Circular Business Models, the relevance of the identified Influencing Factors of Circular Economy on Business Models

Source: Author (2019)

As it could be seen in Chapter 2 (and can be seen in section 3.2.2.1), other authors also feature the theoretical and methodological backgrounds, however the ones presented in Table 4 were the ones who provided the most significant contribution. In addition, Figure 9 shows the sources used in this thesis and points the main journals that provided the most references to the present research.

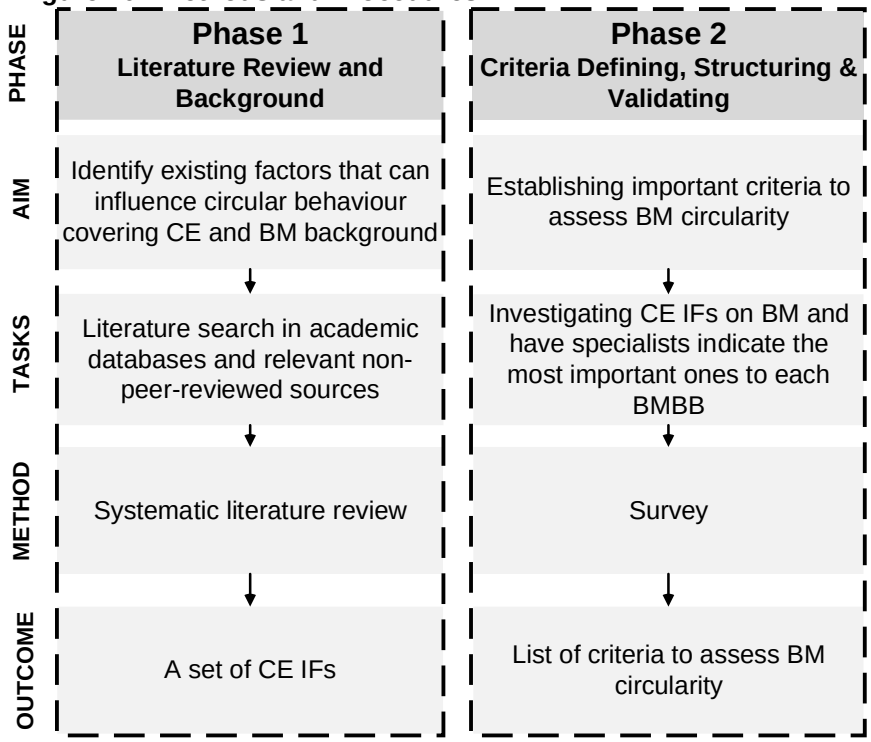
Figure 9 - Statistics of References



Approximately 77% of the references used in the present thesis were from international journals. The main journal, providing 25% of all references in this thesis was the Journal of Cleaner Production, followed by Sustainability, Journal of Industrial Ecology, and Resources, Conservation and Recycling, which shows the relevance of the addressed theme in the sustainability and resource-saving area.

Following the aforementioned characteristics, this piece of research has been majorly developed in two Phases. Phase 1 comprises the literature review; Phase 2 comprises defining and identifying, structuring and validating the criteria to be used for BM circularity assessment. These two Phases are shown in Figure 10.

Figure 10 - Methods and Procedures



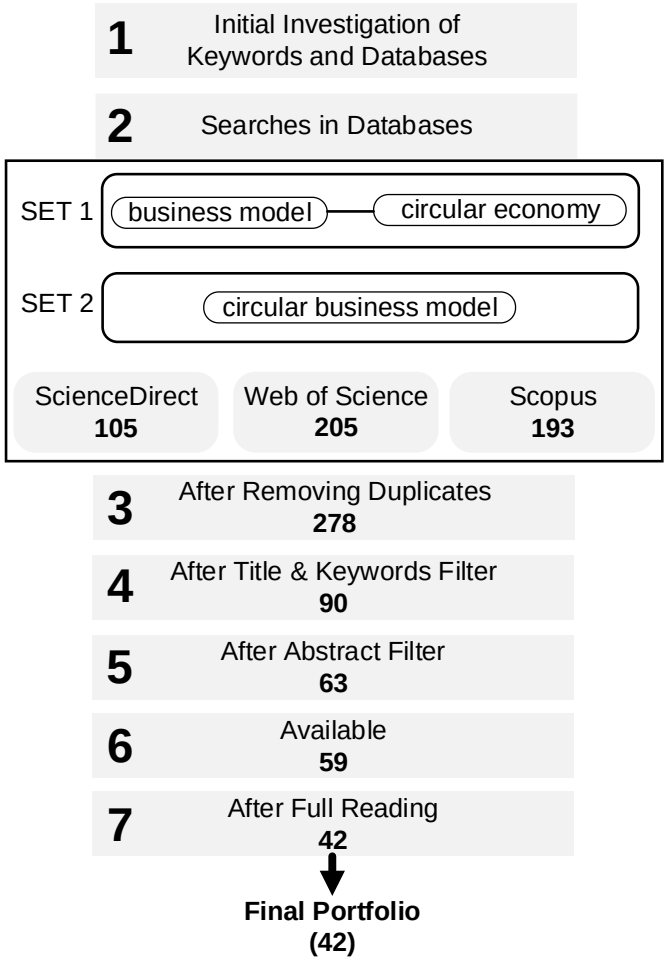
Source: Author (2019)

The 2 Phases are indispensable for a satisfactory process for identifying the relevant (important) criteria. These Phases are addressed hereafter.

3.1 METHODS FOR THE LITERATURE REVIEW AND BACKGROUND - PHASE 1

The literature review and the analyses were conducted in Steps. The Steps for retrieval and selection of documents for the systematic literature review are presented in Figure 11.

Figure 11 - Methods for Retrieval and Selection of Documents



Source: Author (2019)

Step 1. An initial investigation was conducted in the databases available at the Periodical Database of *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES). Following this study's objective, the investigation comprised all possible combinations and variations of the keywords "circular economy" and "business model" using Boolean operators and wildcards. Sets of documents found in the databases were randomly selected and used to construct co-occurrence maps assisted by the software tool VOSviewer. This was done to investigate and identify

potential variations of the keywords that were not being used. It allowed defining all variations of keywords to be used in the final search. Moreover, during the search, all databases present in the CAPES Periodical Database were observed and the ones that returned the most significant number of relevant articles (assessed by screening) were selected to conduct the final search. As noted, the initial investigation was done mainly based on qualitative aspects and the researcher's previous experience.

The databases selected to conduct the final search were ScienceDirect, Scopus and Web of Science. The keywords selected to conduct the final search were "business model" (and potential variations), "circular economy" (and potential variations), and "circular business model" (and potential variations). The combinations used in the final search (including the potential variations mentioned) can be observed in Step 2.

Step 2. After defining the keywords and databases, the final search was done using two sets of keywords in each selected database. The search was conducted on January 9, 2019. Set 1 comprised the combination of "business model" with "circular economy". Set 2 comprised the keyword "circular business model". All variations of the referred keywords were used in each individual search (see Table 6 - page 55). In each database, a different query was used in order to comply with the search requirements and limitations. The setting used for all searches in each database can be seen in Table 5.

Table 5 - Final Search Settings

Database	ScienceDirect	Scopus	Web of Science
Database within	Not applicable	Not applicable	All databases
Type of search	Advanced	Advanced	Advanced
Language	English	English	English
	Portuguese	Portuguese	Portuguese
Document Type	Research Articles	Article	Article
	Review Articles	Review	Review
Time-delimitation	all years available	all years available	all years available (1945 onwards)
Fields	Title, Abstract and Keywords	Title, Abstract and Keywords	Topic

Source: Author (2019)

Only documents in English and Portuguese were searched, comprising only articles (original and review, published and in press) in peer-reviewed journals, hence avoiding grey literature. No temporal delimitation was applied, as the searches sought

to cover all available peer-reviewed literature on the topics. The queries used for the searches in each database are presented in Table 6. For the searches on the ScienceDirect database, three subqueries needed to be created, as the database allowed only 8 Boolean operators per search.

Table 6 - Queries used for the Final Search in Databases

Set	Database	Query		
SET 1 & SET 2	ScienceDirect	Sub-query	a	(“business model” OR “business’ model” OR “businesses model” OR “business models” OR “business’ models” OR “businesses models”) AND (“circular economy” OR “CE” OR “industrial ecology”)
			b	(“business model” OR “business’ model” OR “businesses model” OR “business models” OR “business’ models” OR “businesses models”) AND (“IE” OR “industrial symbiosis” OR “industrial symbioses”)
			c	(“circular business model” OR “circular business’ model” OR “circular businesses model” OR “circular business models” OR “circular business’ models” OR “circular businesses models”)
	Scopus	TITLE-ABS-KEY((("business* model*") AND ("circular economy" OR "CE" OR "industrial ecology" OR "IE" OR "industrial symbios*"))OR ("circular business* model*")) AND (LIMIT-TO (DOCTYPE,"ar") OR LIMIT-TO (DOCTYPE,"re") OR LIMIT-TO (DOCTYPE,"ip")) AND (LIMIT-TO (LANGUAGE,"English"))		
	Web of Science	TS=((("business* model*") AND ("circular economy" OR "CE" OR "industrial ecology" OR "IE" OR "industrial symbios*")) OR ("circular business* model*"))		

Source: Author (2019)

In all databases the possible variations of the keywords were used, however, a few acronyms were found not to be viable for the search, once they are used in a range of fields to represent several unrelated terms, thus returning a large number of undesirable materials. They are BM (found in the initial investigation and in dictionaries of acronyms to be of excessively broad use), IS (which might even return results simply related to the verb to be) and CBM (which use was not observed in the initial investigation and, on top of it, it was also found in dictionaries of acronyms to be of excessively broad use, thus returning a great deal of unrelated material).

After retrieving the documents from the databases, 105 from ScienceDirect, 205 from the Web of Science and 193 from Scopus, the reference manager software tool EndNote X6 and Excel spreadsheets were used to manage the references.

Step 3. All documents from the three databases were united and using the EndNote software tool, all duplicate documents were excluded.

Step 4. After excluding the duplicates, a title and keywords filter was applied. All titles and keywords were read, and all documents found not related to the topics under research were excluded.

Step 5. Similarly to Step 4, in this Step, the abstracts of the remaining documents were read, and the documents found not related to the topics under research were excluded.

Step 6. At this point, it was attempted to retrieve the full papers. For the ones not found available using the access provided by the CAPES Periodical Database, the researcher retrieved contact information of the corresponding author and tried to contact the person. As no answer had been received up to the moment the research was finished, the papers were ruled out.

Step 7. The remaining, available, documents went on full reading in order to provide the theoretical basis for this piece of research and the state-of-the-art on the theme. After fully read, a few articles were found not suitable to the purpose of this piece of research, for reasons as not having a strong relationship with this piece of research's topics, presenting blurred or recognizably mistaken interpretations, as well as for presenting overly shallow approaches or not significantly contributing to the topics/themes considering the previously existing literature. The remaining articles went on to comprise the Final Portfolio. The articles in the Final portfolio can be seen in Table 2 (page 26).

Aside from the described search and selection of documents, much of the work on CE has been developed by non-academic players (SCHUT *et al.*, 2016), therefore, oftentimes the supporting literature is not peer-reviewed. It needs to be noted that no systematic search was undertaken for documents that were not peer-reviewed. A highlighting strategy, though, is that the researcher used cross-referencing from a snowballing approach (from the Final Portfolio), therefore, most non-peer-reviewed documents were observed in the peer-reviewed material.

All the mentioned material was used to lay the theoretical background of the present piece of research (see Chapter 2).

To help visually summarise some important issues from the documents gathered for the literature review, visual maps of co-occurrence of keywords and of co-authorship were created, as presented in section 3.1.2.

3.1.1 Literature Review Intent

The purpose of Sets 1 and 2 was threefold: (i) building on the state-of-the art literature on CBMs, to (ii) unveil the main issues of current concern on CBM investigation for business model circularity adoption, implementation and management, and (iii) identify the specialists involved in research on CBMs worldwide.

To help the mentioned investigation, visual maps were built.

3.1.2 Visual Maps

Visual maps were created using the software tool VOSviewer v. 1.6.5 for both the Sets 1 and 2 together. The settings used in the software tool are described hereafter.

i. Keyword co-occurrence map
    a. Map based on: text data;
    b. Fields: title and abstract;
    c. Counting method: full counting;
    d. Minimum number of occurrences of a term: 1;
    e. Number of terms selected: total number of items;
    f. Show: all items.

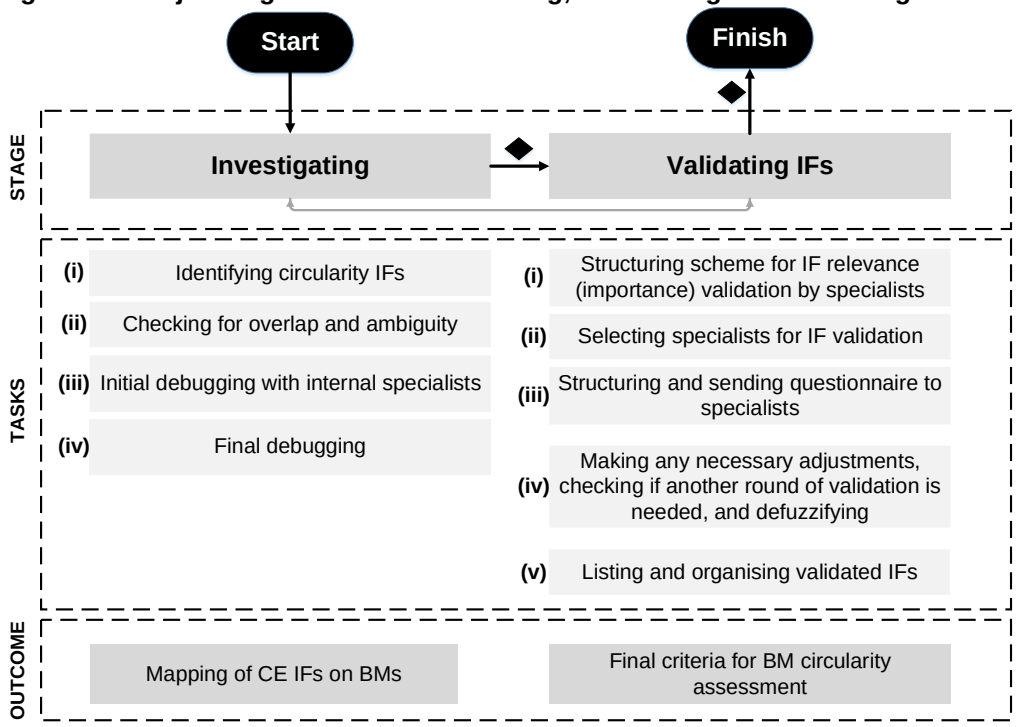
ii. Authorship co-occurrence map
    a. Map based on: bibliographic data;
    b. Type of analysis: co-authorship;
    c. Unit of analysis: authors;
    d. Counting method: full counting;
    e. Minimum number of documents of an author: 1;
    f. Number of authors selected: total number of authors;
    g. Show: all items.

The maps were done using as reference the 42 articles that remained at the end of the selection Steps described in the beginning of section 3.1 for Sets 1 and 2.

3.2 METHODS FOR CRITERIA DEFINING, STRUCTURING & VALIDATING - PHASE 2

Following the literature review, a few major Stages were followed to define, structure and validate the criteria to be used in the tool, as presented in Figure 12 and described thereafter.

Figure 12 - Major Stages for Criteria Defining, Structuring and Validating



Source: Own Authorship (2019)

***Remark**. It is necessary to highlight that between the two Stages there was a Stage gate (◆) where all information was verified and it was checked whether all Steps within that Stage had been completed, otherwise, the research would not proceed to the next Stage. In addition, for the sake of completeness, it was established an iterative flow among all Stages (see arrows in grey between Stages in Figure 12), in order to allow potential changes to be made. Hence, if flaws, inconsistencies, lack of information or any other issues had been spotted (at any stage) the researcher might have gone go back and/or forth to any other Stage to correct it, answering the research needs.*

3.2.1 INVESTIGATING

This stage comprised a few Steps to organise the findings from the literature review, background and other relevant sources. The Steps are described hereafter.

3.2.1.1(i) Identifying circularity IFs

Identifying in the existing literature and other relevant sources such as publications from the Ellen MacArthur Foundation, Accenture and the BS 8001, potential CE IFs. This initial investigation covered any aspects, actions, practices, activities, concepts or elements of any other nature that might work as factors of influence of CE on any systems. This mapping included double-counted, ambiguous and/or cloudy terms. Therefore, this initial investigation went through Step (ii).

3.2.1.2(ii) Checking for overlap and ambiguity

After the initial investigation in Step (i) the potential IFs went through a round of checking for double counting, ambiguity, lack of clarity and overlaps among the IFs. Overly similar aspects were merged to avoid such overlapping/double counting assessment. Similar (or identical) aspects might have been treated differently by different authors/researchers/practitioners, although concerning the same issues and having the same meaning. Therefore, all aspects went through pair analyses (against one another) to verify whether they should be merged or excluded.

3.2.1.3(iii) Initial debugging with internal specialists

After checking for overlap and ambiguity, the list of remaining IFs was organised into a small questionnaire (see Appendix A) which aim was threefold: (a) to infer whether each criterion was considered to be strategic, tactic of operational (thus later on allowing the researcher establish a *nexus* among the related IFs); (b) whether any IFs could still be merged with any other IFs, and; (c) which IFs were related to one another (thus allowing establishing a sort of hierarchy or dependence among related IFs).

A group of 6 specialists was selected for this Step. They comprised post-graduation students (2 Doctoral and 4 Master's students) from the post-graduation program in Industrial Engineering of the Federal University of Technology - Paraná, Ponta Grossa campus, which were part of the Sustainable Productions Systems Laboratory (LESP) and were developing research on CE.

After the internal specialists returned the questionnaire, the researcher assessed all responses individually and collectively to conduct the debugging, thus merging the pointed criteria and structuring them on a dependence-like chain. This allowed identifying one "dominant" IF within a set that would make it easier to express the idea that the set represented, allowing to identify possible upstream and downstream actions that could derive from it. For example, within the set "narrowing resource flows - conducting dematerialisation - virtualising", the IF "conducting dematerialisation" was thought to be the dominant IF, for it would allow the reader to identify that virtualisation could be derived from it, and that it could be part of strategies for narrowing resource flows. If virtualisation were chosen, the idea would be too narrow and if narrowing resource flows were chosen, too broad.

Moreover, the researcher had further insights based on the opinions of the internal specialists' responses in this Step, thus a final debugging was conducted, as presented in the next section.

3.2.1.4(iv) Final debugging

The final debugging comprised another round of analysis over the remaining IFs where the researcher looked to conduct a final check on the IF sets and further integrate related IFs until all dominant criteria (one from each set) could not be integrated/merged.

The list of the final criteria (to move onto the Validation Step) can be seen in Table 8 (page 68).

Having identified the necessary IFs, they were validated using a questionnaire gathering the opinion of specialists, as addressed in the next Stage (Validating IFs).

3.2.2 VALIDATING

After having mapped the CE IFs, their importance on each BMBB was validated with the assistance of specialists, by means of a questionnaire. To allow for such, a validation scheme was structured and followed.

3.2.2.1(i) Structuring scheme for IF relevance validation by specialists

Firstly, a scheme was defined to conduct the validation. The validation occurred on a qualitative basis, using a Ffuzzy approach to define which IFs were important to each BMBB.

In the decision-making process, decision-makers need to interact with many variables and assess the trade-offs among them. Nonetheless, human thinking cannot be said to be discrete in nature. Moreover, Govindan and Murugesan (2011) state that exact numerical values are inadequate to model human judgement. In this context, it emerges the Fuzzy Logic, which was early addressed by Zadeh (1965) and comprises a solution to dealing with “problems in which the source of imprecision is the absence of sharply defined criteria of class membership rather than the presence of random variables” (Zadeh, 1965, p. 339). As pointed by the author, the notion of a fuzzy set is nonstatistical in nature. In summary, it can be used for modelling logical reasoning containing vaguely, imprecise statements.

To introduce the fundaments of Fuzzy Logic, first, one needs to be made aware of a few definitions, as established by Zadeh (1965, p. 339).

Definition 1: *Fuzzy set*. A fuzzy set (class) A in X is characterized by a membership (characteristic) function (MF) $f_A(x)$ which associates with each point in X a real number in the interval [0, 1], with the value of $f_A(x)$ at x representing the "grade of membership" of x in A.

Definition 2: *Fuzzy number*. It is a number with an imprecise measurement and can be thought of as a function whose domain is a set between [0,1].

Given the two definitions, one way to treat uncertainties is using Triangular Fuzzy Numbers (TFN) (KANNAN; JABBOUR; JABBOUR, 2014).

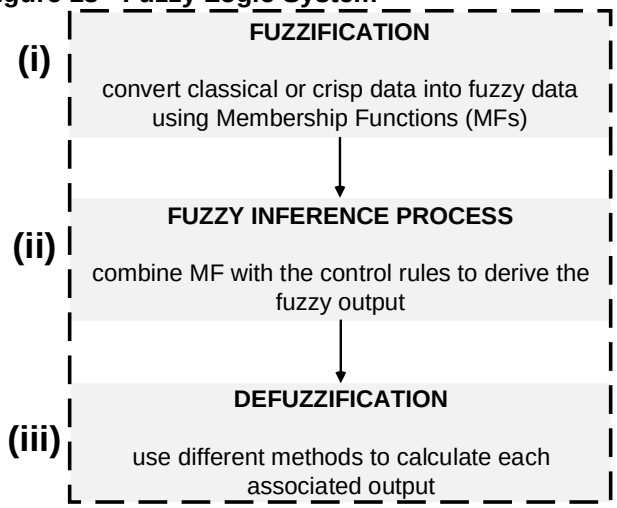
A fuzzy number is an especial case of a fuzzy set that defines a fuzzy interval in the real numbers, $\mathbb{R}$. To a real number to which precise value is not exactly known,

this number is defined by means of a fuzzy interval. A fuzzy interval is usually represented by two extreme points a and c (a minimum and a maximum) and a middle b (the most probable value) as (a, b, c). Therefore, a TFN can be described by $A = (a, b, c)$, with an MF:

$$\mu_A(x) = \begin{cases} 0, & \\ \dfrac{x-a}{b-a}, & a < x \leq b \\ \dfrac{c-x}{c-b}, & b < x \leq c \\ 0, & \end{cases} \qquad \textbf{Eq. (1)}$$

Establishing a membership of an element to a set is part of the first Step of the Fuzzy Logic System, as illustrated in Figure 13 and further addressed thereafter.

Figure 13 - Fuzzy Logic System



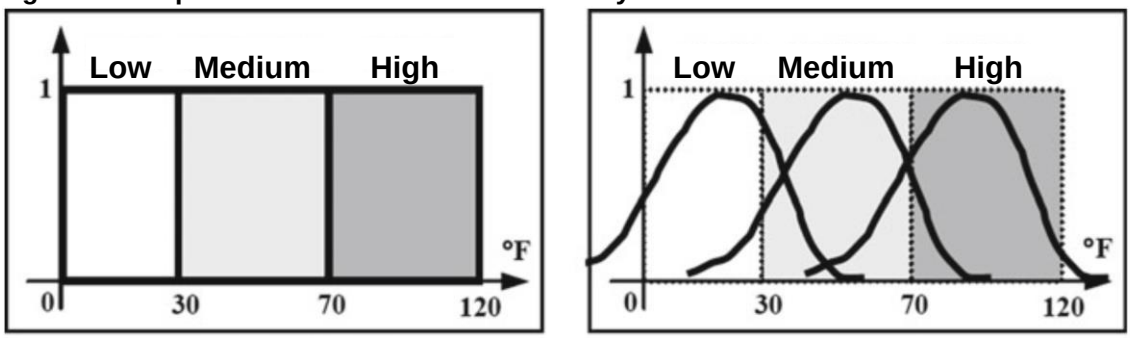
Source: Adapted from Mendel (1995)

(i) Fuzzification

In this Step, membership functions (MF) are used to translate crisp or classical data into fuzzy data. The differences between classical and fuzzy data are illustrated in Figure 14 (page 63).

Moreover, when fuzzifying an input, one might make use of Linguistic Variables. Linguistic Variables comprise primary terms (e.g., young, old, tall, short, etc.) and might make use of connectives (e.g., and, or, neither, etc.) and/or hedges (e.g., extremely, very much, more or less, little, etc.), which are all context-dependent and hold influence over the behaviour of fuzzy sets (see Zadeh, 1975a).

Figure 14 - Representations of classical and fuzzy sets



a) Classical Set **b) Fuzzy Set**

Source: Mahmoud (2018)

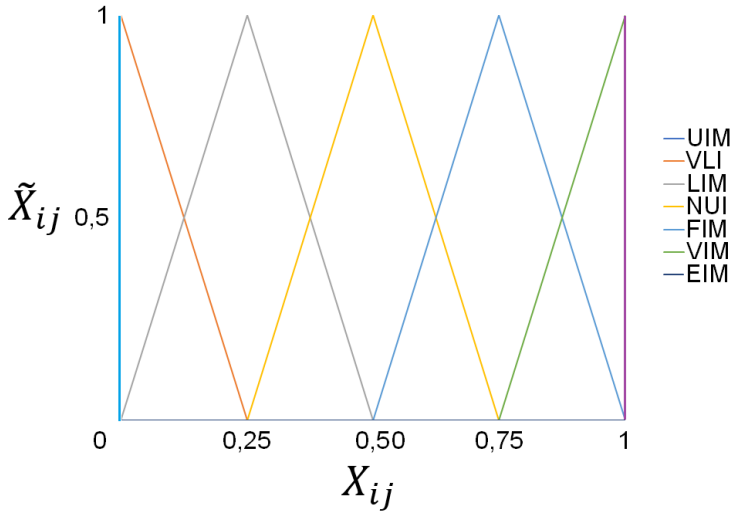
Based on the fuzzy logic, TFN, linguistic variables and much of the work of Zadeh (see Zadeh, 1965, 1975a, b, c), one MF using linguistic variables might be defined as shown in Table 7 and illustrated in Figure 15 (page 63).

Table 7 - Fuzzy Linguistic Variable Scale

Acronym	Linguistic Variable	TFN
UIM	Unimportant	(0 , 0 , 0)
VLI	Very Little Important	(0 , 0 , 0.25)
LIM	Little Important	(0 , 0.25 , 0.5)
NUI	Neither Unimportant nor Important	(0.25 , 0.5 , 0.75)
FIM	Fairly Important	(0.5 , 0.75 , 1)
VIM	Very Important	(0.75 , 1 , 1)
EIM	Extremely Important	(1 , 1 , 1)

Source: Author (2019)

Figure 15 - Triangular Association Function



Source: Author (2019)

After fuzzifying, there might be rules to be applied to the inputs (inference) to generate the desired outputs.

(ii) Fuzzy Inference Process

There might be rules to help limit the fuzzy sets and generate the outputs. This phase is not addressed in the present thesis, as it will not play a role in this research.

After the Fuzzy Inference Process is finished, the output needs to go through Defuzzification.

(iii) Deffuzification

There is a number of methods for defuzzification. However, as stated by Leekwijck and Kerre (1999), probably the best operator is the Centre of Gravity (COG). Basically, it computes the centre of gravity under the area of the MF and can be calculated using Eq. (2) (adapted from LEEKWIJCK; KERRE, 1999).

$$COG(A) = \sum_{x_{min}}^{x_{max}} x\mu_A(x) \Big/ \sum_{x_{min}}^{x_{max}} \mu_A(x) \qquad \textbf{Eq. (2)}$$

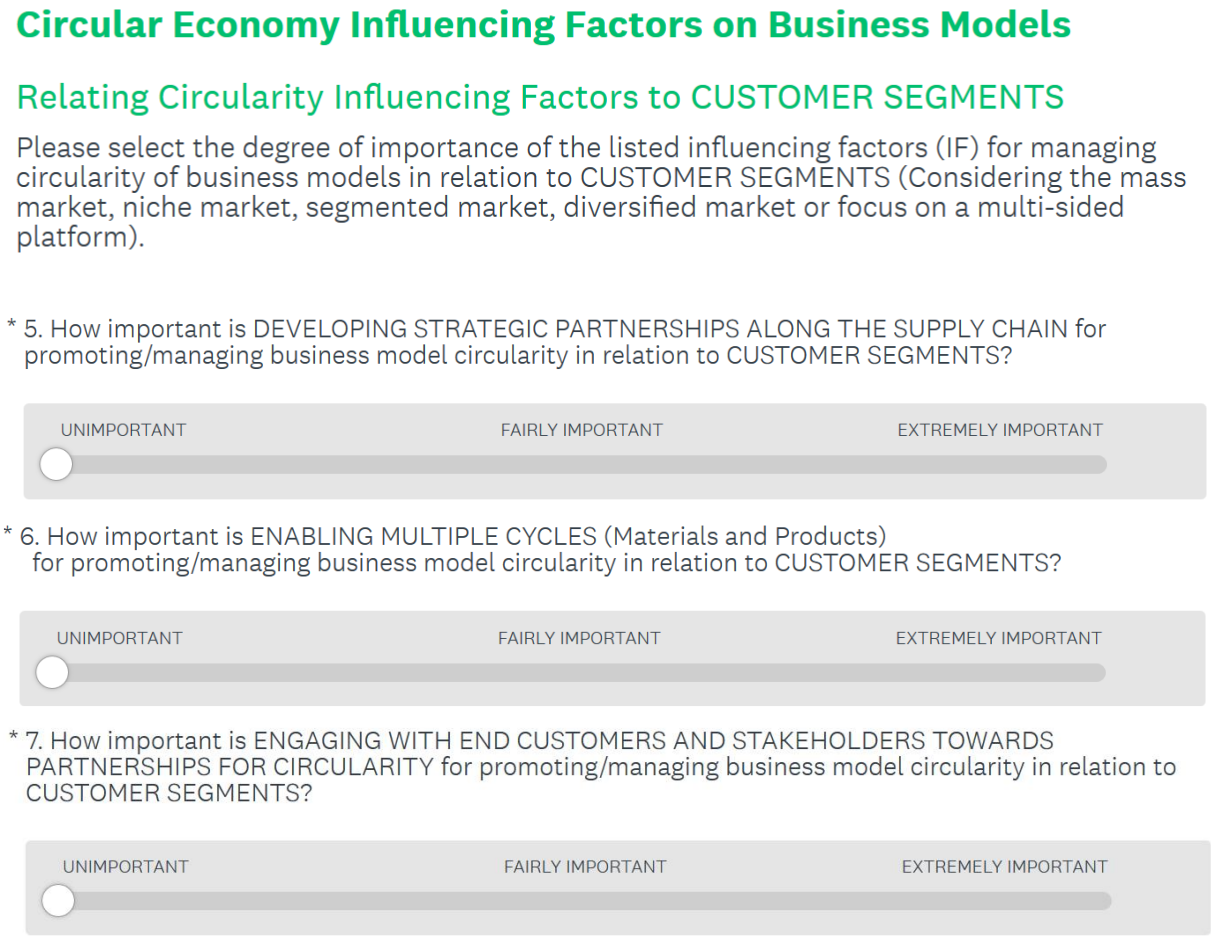
It, then, allows translating the fuzzy output back to a Linguistic Variable.

All this background on Fuzzy Logic was used to structure the scheme for validation, which comprised the application of a questionnaire, using Linguistic Variables, to CE specialists.

The questionnaire structure can be seen in Appendix B and is exemplified in Figure 16 (page 65).

The questionnaire was built using the IFs identified from the literature review and background on CE as IFs on BM. These IFs were presented to specialists (selected according to the procedures described in the next section (3.2.2.2)) and were judged on their importance for circularity in BMs. This pertinence was judged based on Linguistic Variables (as observed in Figure 16). Specialists attributed a membership grade to each of the IFs in relation to a given BMBB on a continuous 7-point scale, from *Unimportant* to *Extremely Important*.

Figure 16 - Questionnaire Sample Questions



Source: Own Authorship (2019)

A 7-point scale was chosen for it allows working with TFN changing the range of the MF on a 0.25 interval, as it could be seen in Figure 15 (page 63). Besides, the reason for using Fuzzy Logic in this validation was to avoid greater error in judgement, as many times done with surveys and questionnaires using discrete scales. Decision-makers often use discrete scales and disclose an averaged value as their output. Using Fuzzy would be a less mistaken way of performing such judgement. On a mathematical approach, to an assessment that is considerably simple in nature, the referred 7-point scale (besides the reason aforementioned) was thought by the researcher to be reliable and representative of the issue being considered. Although averaging specialists' inputs and using a Fuzzy approach would likely produce similar results, the Fuzzy approach was considered an alternative that would deliver finer results.

Thus, the results were fuzzified using the MF described in Eq. (1) and based on the Linguistic Variables and TFN in Table 7 (page 63).

After having defined the strategy for having the IFs validated, the next section will draw on the strategy for selecting the specialists.

3.2.2.2(ii) Selecting specialists for IF validation

The specialists chosen for validating the IFs were the authors identified in the literature review. All identified co-authors in the documents of the Final Portfolio after the systematic literature review, were included in the list of specialists.

To get in touch with these specialists, the researcher tried to retrieve the emails of the referred specialists in several forms, searching on the websites of the institutions these researchers work for, on the online websites ResearchGate and LinkedIn, and any other online tool/website that allowed retrieving such information. No systematic procedure was set to be followed, though.

A total of 120 specialists was identified, being the co-authors of the 42 publications in the Final Portfolio. The majority of them were university and college professors, some were researchers in private and government institutions, and a few others were industry practitioners. The researcher's perception on the specialists' responses and their feedback can be seen in section 5.3 (page 95).

3.2.2.3(iii) Structuring and sending questionnaire to specialists

The questionnaire was structured on the online platform SurveyMonkey and the link to the questionnaire was sent to the selected specialists adjoined with an invitation briefly explaining the intent of the research and the reason for them to having been selected.

As addressed in Step (i), the questionnaire was structured in a way to verify how important a certain IF is for circularity in a certain BMBB. The questionnaire can be found in Appendix B.

Potential respondents were contacted on April 19, 2019. A reminder email was sent to the potential respondents who had neither contacted the researcher nor answered the questionnaire on April 27, 2019. Moreover, all potential respondents who had provided partial responses were contacted back 1 or 2 business day after they started filling out the questionnaire, when the researcher highlighted the importance of

their contribution and reminded them that partial responses could not be incorporated into the final analysis. The questionnaire remained open until June 16, 2019.

3.2.2.4(iv) Making any necessary adjustments, checking if another round of validation is needed and defuzzifying

After having the completed questionnaires, the researcher assessed the specialists' feedback and their answers to check if any adjustments to the list of IFs or another round of validation were necessary. As no adjustments were necessary, it was proceeded to defuzzifying the fuzzified inputs to check suitability of the IFs, given the specialists' opinions (following the procedures described in section 3.2.2.1).

3.2.2.5(v) Listing and organising validated IFs

After finishing the assessment of the specialists' feedback, a list of all BMBBs with their related relevant (important) IFs was organised.

The IFs considered validated were the ones that after defuzzification fell on one of the following sets: FAIRLY IMPORTANT, VERY IMPORTANT and EXTREMELY IMPORTANT to each of the BMBBs.

As the judgement was made by specialists on CE, any IF considered at least FAIRLY IMPORTANT by them (given the Fuzzy approach used in the present thesis) would very likely impact BM circularity, thus not being able to be disregarded.

Having presented all the methodological procedures used in this thesis, the next chapter will start presenting the main results of this research.

4 CRITERIA DEFINING, STRUCTURING AND VALIDATING

This chapter shows the results of the process described in the Methods Chapter (Chapter 3), starting with the identification of the IFs in the literature, their structuring and validation assisted by specialists. The next section begins showing the identified Influencing Factors structured according to the methods addressed in section 3.2.1.

4.1 INVESTIGATING

During the investigation, several factors that have the potential to influence organisational strategies towards the implementation or management of business model circularity were identified. An initial list including all identified IFs (without merging or excluding duplicates) accounted for 186 IFs.

After checking for overlap and ambiguity (see section 3.2.1.2 - page 59) there were 83 IFs for debugging (the 83 IFs can be seen in Appendix A - Table A.1). After debugging (initial + final), many IFs were excluded or integrated/merged. At the end of this process, there were 33 IFs left for validation. The list of the 33 IFs can be seen in Table 8, together with the literature that supports each of them.

Table 8 - List of Influencing Factors for Validation

ID	Influencing Factor	Supporting Literature
1	Developing Strategic Partnerships Along the Supply Chain	GEISSDOERFER *et al.* (2018); BSI (2017); LACY *et al.* (2014)
2	Enabling Multiple Cycles (Materials and Products)	GEISSDOERFER *et al.* (2018); BSI (2017); LACY *et al.* (2014)
3	Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	GEISSDOERFER *et al.* (2018); BSI (2017); LACY *et al.* (2014)
4	Designing Out Waste	GEISSDOERFER *et al.* (2018); BSI (2017); LACY *et al.* (2014)
5	Conducting Industrial Symbiosis	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)

ID	Influencing Factor	Supporting Literature
6	Conducting Material/Resource Recovery	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)
7	Promoting Reuse	GOYAL; ESPOSITO; KAPOOR (2018); JABBOUR (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); RANTA; AARIKKA-STENROOS; MAKINEN (2018); WASTLING; CHARNLEY; MORENO (2018); BSI (2017); EMF (2013a,b); GEISSDOERFER *et al.* (2017); EUROPEAN COMMISSION (2016); LACY *et al.* (2014); ALLWOOD *et al.* (2011)
8	Conducting Recycling / Secondary Material Use	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)
9	Conducting Reconditioning	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)
10	Reducing Material Leakage	JABBOUR (2018); VELEVA; BODKIN (2018); NUßHOLZ (2017)
11	Conducting Resource Regeneration/Restoration	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)
12	Conducting Replacement of Non-Renewable with Renewable Resources	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)
13	Promoting Environmentally Friendly Material Usage-Driven Practises (i.e., Natural, Recyclable, Durable, Easy to Separate)	UNAL; UBIRATI; CHIARONI (2018)
14	Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018);YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)
15	Extending Resource Value	BOCKEN *et al.* (2016)
16	Extending Product Life	VELEVA; BODKIN (2018)
17	Establishing Take-Back Systems	ESPOSITO; TSE; SOUFANI (2018); RANTA; AARIKKA-STENROOS; MAKINEN (2018); STÅL; CORVELLEC (2018); WASTLING; CHARNLEY; MORENO (2018); BSI (2017)

ID	Influencing Factor	Supporting Literature
18	Establishing Product-Service Systems (PSS)	TUNN *et al.* (2019); BOCKEN *et al.* (2018); ESPOSITO; WASTLING; CHARNLEY; MORENO (2018); TSE; SOUFANI (2018); UNAL; UBIRATI; CHIARONI (2018); VASANTHA; ROY; CORNEY (2015); BOCKEN *et al.* (2014)
19	Conducting Refurbishment	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)
20	Conducting Remanufacturing	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)
21	Using “Building (Products) to Last” Strategies	COPANI; BEHNAM (2018); BSI (2017)
22	Establishing Product Care Policies	GEISSDOERFER *et al.* (2018); BSI (2017); LACY *et al.* (2014)
23	Establishing Performance Agreement (Product-Service Systems)	GEISSDOERFER *et al.* (2018); BSI (2017); LACY *et al.* (2014)
24	Offering Refilling	ESPOSITO; TSE; SOUFANI (2018)
25	Offering Repair and Maintenance	ESPOSITO; TSE; SOUFANI (2018); JABBOUR (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); WASTLING; CHARNLEY; MORENO (2018); BSI (2017); GEISSDOERFER *et al.* (2017); BAKKER *et al.* (2014); LACY *et al.* (2014)
26	Offering Upgrade	ESPOSITO; TSE; SOUFANI (2018); JABBOUR (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); WASTLING; CHARNLEY; MORENO (2018); BSI (2017); GEISSDOERFER *et al.* (2017); BAKKER *et al.* (2014); LACY *et al.* (2014)
27	Conducting Dematerialisation	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)
28	Integrating Industry 4.0 Features to Increase Circularity	FRISHAMMAR; PARIDA (2018)
29	Promoting the Use of Internet of Things (IoT)	BRESSANELLI; PERONA; SACCANI (2017); KANG *et al.* (2016)
30	Using Cloud Manufacturing	KANG *et al.* (2016)
31	Using Additive Manufacturing	COPANI; BEHNAM (2018); BSI (2017)
32	Conquering Ecological Labels and Certifications	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)

ID	Influencing Factor	Supporting Literature
33	Conducting Green Purchasing	GEISSDOERFER *et al.* (2018); LUDEKE-FREUND; GOLD; BOCKEN (2018); YANG *et al.* (2018); ZUCCHELLA; PREVITALI (2018); BOCKEN *et al.* (2016); EUROPEAN COMMISSION (2016); WILLSKYTT *et al.* (2016)

Source: Author (2019)

The IFs in Table 8 were the ones found by the researcher to be easier to understand and identify within a set of interrelated IFs, thus afore treated as dominant IFs.

Having listed the potential IFs of CE on BM, the (i) specific objective (*Map potential Influencing Factors of Circular Economy on Business Models*) has been accomplished.

The aim of each IF and a few strategies that can be deployed from them, thus "how they can take place", are presented hereafter, helping better understand the set they represent, upstream and downstream actions and their relationships with other IFs.

1. Developing Strategic Partnerships Along the Supply Chain

It aims to engage in and develop strategic partnerships throughout the entire supply chain. This is undeniably important for resilient CBMs. Reliable partners (both upstream and downstream) help a business conduct its activities with greater security and this feeling is passed on to customers. In CBMs, the relationship between providers and customers should be much closer and stronger than in LBMs, since their ties will very unlikely cease after sale/signing a contract.

Moreover, this does not only concern having reliable partners, but finding the right ones. Strategies on this regard can include identifying and engaging with companies towards industrial symbiosis, and developing a broad network to strengthen partnerships on taking better advantage of the resources that are locally available and improving resource availability.

2. Enabling Multiple Cycles (Materials and Products)

It aims to promote and practice actions that allow the deployment of multiple cycles. Strategies on this regard can include promoting design for X (DfX) (e.g., design for recycling, design for remanufacturing and reuse, design for disassembly, and

design for environment), sharing, offering PSSs, and any other strategies that allow resources to be put back to use when one of its life cycles has reached an end.

3. **Engaging With End Customers and Stakeholders Towards Partnerships for Circularity**

It aims to engage stakeholders in actions that promote CE. Strategies on this regard include the various ways to seek support from stakeholders, by establishing effective communication with them, seeking customer cooperation and promoting consumer awareness, for example. Keeping stakeholders aware of the business's activities can increase collaboration and active participation towards a more circular conduct.

4. **Designing Out Waste**

It aims to design, plan, how, when, where waste will leave the system. Strategies on this regard can include reducing material leakage, thus once again DfX strategies are regarded; planning and strategizing how to be responsible about waste generation, avoiding wherever and whenever possible to generate it and when generated, know exactly what to do with it, planning where to reuse it, or how to recycle it, or to whom/where direct it in a way it does not become a liability, thus not just transferring responsibility, but owning it, making the best effort to close a cycle.

5. **Conducting Industrial Symbiosis**

It aims to adjoin two or more organisations on an exchange partnership. In relation to CE, it might majorly regard waste exchange. Strategies on this regard include material/waste exchange facilitated by waste exchange platforms, which are gaining prominence with the advance in cloud data and communication technologies.

6. **Conducting Material/Resource Recovery**

It aims to recover a resource/material after a use cycle. Strategies on this regard include recycling, cascading and repurposing. Recycling embeds upcycling and downcycling, and a range of activities for waste collection and reintegration (upstream and/or downstream). Cascaded uses might be of whole products or of resources. Products might be used for different users at the end of each of their cycles as a whole product, reaching a different market niche for example, and cascaded resources might be upcycled or downcycled, for instance. Repurposing can be embedded in cascading when the strategy is the previously described, or when products/resources are used for different purposes by the same or different users.

7. **Promoting Reuse**

It aims to make the product/resource be used for another use cycle without reprocess, that is, without changes. Strategies on this regard include PSSs, which would well reflect it, hence products are leased based on a contract for a period and, if in good shape by the end of the lease, those can go on another cycle.

8. Conducting Recycling / Secondary Material Use

It aims to make a product/resource serve another use cycle, giving it the same or a new purpose. This process can happen indefinitely until the product/resource can no longer serve the desired purpose. As these do not come from primary sources, that is, it is not the first time they are being used, they can be said to be secondary material. Strategies on this regard include the use of reverse logistics for collection of used products, and the subsequent use of the entire product or its parts to produce the same or other products.

9. Conducting Reconditioning

It aims to give a product at least the same conditions of use it had when new. Strategies on this regard can include a range of operations depending on the type of product, such as the replacement of parts or restoration of functionalities.

10. Reducing Material Leakage

It aims to reduce the amount of material that leaves a system. Strategies on this regard can include offering lease/rent options and reducing emissions (of all sort).

11. Conducting Resource Regeneration/Restoration

It aims to promote resource regeneration or restoration. Strategies on this regard can include the replacement of scarce resources by alternative ones, and caring for their sources aiming to preserve them.

12. Conducting Replacement of Non-Renewable with Renewable Resources

It aims to replace non-renewable resources with renewable ones. Being one of the most straightforward strategies, strategies on this regard can include substituting (or replacing) non-renewable resources with renewables ones. It may be in relation to energy sources or material input to a manufacturing process.

13. Promoting Environmentally Friendly Material Usage-Driven Practises (i.e., Natural, Recyclable, Durable, Easy to Separate)

It aims to promote practises/technologies that prioritise natural, recyclable, durable and/or easy to separate resources over the ones that do not have such characteristics. Strategies on this regard can include the substitution of non-renewable

for renewable sources, in manufacturing processes and energy generation, or giving preference for materials that facilitate disassembly, for instance.

14. **Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))**

It aims to conduct practises that seek optimising resource efficiency. Strategies on this regard can include saving material (input) and/or energy and optimising transportation means by, for instance, increasing the load factor.

15. **Extending Resource Value**

It aims to make resource value last longer before leaving the system. Strategies on this regard can include upcycling, thus maintaining or even increasing resource value by making it an input to another product, or other practises that allow similar result.

16. **Extending Product Life**

It aims to make products last longer. Strategies on this regard include the offer of PSSs, offering repair, maintenance, refurbishment and/or reconditioning.

17. **Establishing Take-Back Systems**

It aims to establish systems where the producer holds responsibility over the product at its end-of-life. Strategies on this regard include the use of reverse logistics and other practises that promote the collection of end-of-life products for correct destination.

18. **Establishing Product-Service Systems (PSS)**

It aims to promote responsible temporary use rather than customer ownership of a product. Strategies on this regard include lease/rent of products where the producer holds ownership and the user pays per use (be it for time, result or performance).

19. **Conducting Refurbishment**

It aims to better the aesthetics of a product, with no focus on functionality. Strategies on this regard highly depend on the type of product under consideration.

20. **Conducting Remanufacturing**

It aims to give a used product its original or a superior performance by making any necessary adjustments. Strategies on this regard highly depend on the type of product under consideration, but might include dismantling and replacing of parts/modules.

21. Using “Building (Products) to Last” Strategies

It aims to design long lasting products. Strategies on this regard can include the use of high quality materials and offering good options for repair/maintenance.

22. Establishing Product Care Policies

It aims to maintain product integrity. Strategies on this regard can include contract clauses charging users for mishandling.

23. Establishing Performance Agreement (Product-Service Systems)

It aims to ensure that products have a minimum performance. Strategies on this regard can include clauses charging producers in case minimum performance not be achieved.

24. Offering Refilling

It aims to avoid unnecessary use of resources with structure/packaging for use. A global strategy on this regard include offering a new set or amount of consumable product to a consumer in a simpler package, when the consumer already has the structure/package necessary for use.

25. Offering Repair and Maintenance

It aims to increase/extend a product’s useful life by offering restauration options. Strategies on this regard can include maintenance services or repair options, be it at the producer or the customer’s expense, according to pre-established agreements.

26. Offering Upgrade

It aims to enhance parts/characteristics of a product or offer another product, thus offering a superior experience to the user/consumer. Strategies on this regard can include replacements of parts/modules or the replacement of an entire product for one of superior performance (in a lease system, for instance).

27. Conducting Dematerialisation

It aims to replace material structures with virtual ones. Strategies on this regard can include the extinction of a physical store and the subsequent offer of an online one.

28. Integrating Industry 4.0 Features to Increase Circularity

It aims to promote enhanced communication among equipment/systems in order to slow, narrow or close resource flows. Strategies on this regard can include the use of robotics in manufacturing processes to reduce waste.

29. Promoting the Use of Internet of Things (IoT)

It aims to optimise resource use by enhancing equipment interactivity. Strategies on this regard can include the use of sensors in crop irrigation, avoiding excessive use of water, or the use of sensors to monitor equipment performance in manufacturing, thus helping extend resource life/value by avoiding breakages and mishandling.

30. Using Cloud Manufacturing

It aims to optimise resource use by enhancing collaboration and communication. Strategies on this regard can include the collaboration of different companies in the same or different geographic locations to produce or assemble a product.

31. Using Additive Manufacturing

It aims to optimise resource use by avoiding waste generation. Strategies on this regard can include the use of 3D printing in manufacturing.

32. Conquering Ecological Labels and Certifications

It aims to promote more responsible (e.g. ethical or environmental) conduct. Strategies on this regard can include pursuing ecological labels that are pertinent to the product or products the company offers.

33. Conducting Green Purchasing

It aims to embed more environmentally responsible practises in the purchase process. Strategies on this regard can include developing methods to select more environmentally friendly materials and requiring ecological/green labels from partner companies.

Other strategies than the ones just mentioned for each IF can be deployed in order to make use of the IFs towards greater circularity. After having defined the IFs, they were validated for each BMBB, as shown in section 4.2.

4.2 VALIDATING

All IFs presented in section 4.1 were used to structure the questionnaire for validation. The set of 33 IFs were presented to the specialists to verify their importance to each of the 9 BMBBs in the BM Canvas framework.

For validation, as described in section 3.2.2.2 (page 66), the specialists were the authors identified in the literature review. A list containing the names of all specialists the researcher has tried contact is provided in Appendix C (Table C.1 - page 162). Hence, accomplishing the (ii) specific objective (*Identify specialists involved in research on Circular Business Models worldwide*).

After defuzzifying, using the COG, all the validated IFs are shown in Appendix D (Table D.1 - page 165). As it can be seen in Table D.1, according to the specialists, most IFs played an important (either FAIRLY IMPORTANT or VERY IMPORTANT) part in measuring business model circularity. As presented in section 3.2.2.5 (page 67), IFs that after deffuzification fell on the groups FAIRLY IMPORTANT, VERY IMPORTANT or EXTREMELY IMPORTANT, were considered valid for measuring business model circularity. In the following sections, the IFs validated to each BMBB will be addressed in further detail.

4.2.1 Customer segments

For Customer Segments, 28 of the 33 IFs were considered either VERY IMPORTANT or FAIRLY IMPORTANT, hence, are valid for measuring business model circularity according to the collective opinion of the specialists who provided complete responses, as it can be seen in Table 9.

Table 9 - Validated IFs for Customer Segments

Influencing Factor	Membership Function
Enabling Multiple Cycles (Materials and Products)	VIM
Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	VIM
Promoting Reuse	VIM
Conducting Replacement of Non-Renewable with Renewable Resources	VIM
Promoting Environmentally Friendly Material Usage-Driven Practises (i.e., Natural, Recyclable, Durable, Easy to Separate)	VIM
Extending Product Life	VIM
Establishing Take-Back Systems	VIM
Establishing Product-Service Systems (PSS)	VIM
Establishing Performance Agreement (Product-Service Systems)	VIM
Offering Refilling	VIM
Offering Repair and Maintenance	VIM
Offering Upgrade	VIM
Promoting the Use of Internet of Things (IoT)	VIM

Influencing Factor	Membership Function
Developing Strategic Partnerships Along the Supply Chain	FIM
Designing Out Waste	FIM
Conducting Material/Resource Recovery	FIM
Conducting Recycling / Secondary Material Use	FIM
Conducting Reconditioning	FIM
Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))	FIM
Extending Resource Value	FIM
Conducting Refurbishment	FIM
Using “Building (Products) to Last” Strategies	FIM
Establishing Product Care Policies	FIM
Conducting Dematerialisation	FIM
Integrating Industry 4.0 Features to Increase Circularity	FIM
Using Cloud Manufacturing	FIM
Conquering Ecological Labels and Certifications	FIM
Conducting Green Purchasing	FIM

Legend: FIM **- Fairly Important,** VIM **- Very Important**

IFs that were considered VERY IMPORTANT were the ones who had a direct link to customer engagement and/or helped sharpen customer perception on a more conscious use of resources and more environmentally friendly conduct. These included strategies for customer engagement, resource saving (e.g., reuse and giving preference to renewable resources), cleaner production (e.g., DfX strategies, the use of the IoT, and environmentally friendly material usage), and use of strategies that would capture customers looking for a more sustainable conduct (e.g., by means of the use of PSSs, and features as refilling, repair, maintenance, upgrade, performance agreement, and strategies for extending product life, establishing take-back systems and enabling multiple cycles).

IFs considered FAIRLY IMPORTANT comprised strategies that involved waste management (e.g. designing out waste, recycling, and reconditioning), actions that assist resource conservation (e.g. material recovery, resource efficiency optimization, and refurbishment), the use of digital and highly technological strategies (e.g. industry 4.0 features, cloud manufacturing and dematerialisation), promotion of longer product life (e.g. building products to last, extending resource value, and establishing product care policies), and building a trustworthy and resilient conduct (e.g. conquering ecological labels, conducting green purchasing, and developing strategic partnerships).

NEITHER UNIMPORTANT NOR IMPORTANT IFs for Customer Segments were conducting industrial symbiosis, reducing material leakage, conducting resource regeneration/restoration, conducting remanufacturing, and using additive manufacturing.

4.2.2 Value propositions

For Value Propositions, 26 of the 33 IFs were considered either VERY IMPORTANT or FAIRLY IMPORTANT, hence, are valid for measuring business model circularity according to the collective opinion of the specialists who provided complete responses, as it can be seen in Table 10 (page 80).

IFs considered VERY IMPORTANT were related to the establishment of partnerships and seeking engagement (both with customers and stakeholders along the supply chain), strategies that promote resource conservation while offering positive alternatives to consumers (e.g. reuse and establishing preference for renewable resources), in addition to more environmentally-friendly conduct (e.g. designing out waste and promoting environmentally friendly material usage-driven practises).

FAIRLY IMPORTANT IFs included the offer of PSSs and their related activities (e.g. repair, upgrade, product care policies and performance agreement) and features (e.g. extending product life and resource value), also resource conservation/strategies (e.g. establishment of take-back systems, enabling multiple cycles, resource regeneration/restoration, material recovery, resource efficiency strategies, recycling, refurbishment, reconditioning, remanufacturing and “build to last” strategies), industry 4.0 features (e.g. IoT), as well as conducting green purchasing.

NEITHER UNIMPORTANT NOR IMPORTANT IFs for Value Propositions were industrial symbiosis, reducing material leakage, refilling, conducting dematerialisation, using cloud manufacturing and additive manufacturing, as well as conquering ecological labels and certifications.

Table 10 - Validated IFs for Value Propositions

Influencing Factor	Membership Function
Developing Strategic Partnerships Along the Supply Chain	VIM
Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	VIM
Designing Out Waste	VIM
Promoting Reuse	VIM
Conducting Replacement of Non-Renewable with Renewable Resources	VIM
Promoting Environmentally Friendly Material Usage-Driven Practises (i.e., Natural, Recyclable, Durable, Easy to Separate)	VIM
Enabling Multiple Cycles (Materials and Products)	FIM
Conducting Material/Resource Recovery	FIM
Conducting Recycling / Secondary Material Use	FIM
Conducting Reconditioning	FIM
Conducting Resource Regeneration/Restoration	FIM
Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))	FIM
Extending Resource Value	FIM
Extending Product Life	FIM
Establishing Take-Back Systems	FIM
Establishing Product-Service Systems (PSS)	FIM
Conducting Refurbishment	FIM
Conducting Remanufacturing	FIM
Using “Building (Products) to Last” Strategies	FIM
Establishing Product Care Policies	FIM
Establishing Performance Agreement (Product-Service Systems)	FIM
Offering Repair and Maintenance	FIM
Offering Upgrade	FIM
Integrating Industry 4.0 Features to Increase Circularity	FIM
Promoting the Use of Internet of Things (IoT)	FIM
Conducting Green Purchasing	FIM

Legend: FIM **- Fairly Important,** VIM **- Very Important**

4.2.3 Channels

For Channels, 26 of the 33 IFs were considered either VERY IMPORTANT or FAIRLY IMPORTANT, hence, are valid for measuring business model circularity according to the collective opinion of the specialists who provided complete responses, as it can be seen in Table 11 (page 81).

Table 11 - Validated IFs for Channels

Influencing Factor	Membership Function
Developing Strategic Partnerships Along the Supply Chain	VIM
Enabling Multiple Cycles (Materials and Products)	VIM
Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	VIM
Designing Out Waste	VIM
Conducting Material/Resource Recovery	VIM
Promoting Reuse	VIM
Conducting Replacement of Non-Renewable with Renewable Resources	VIM
Establishing Take-Back Systems	VIM
Promoting the Use of Internet of Things (IoT)	VIM
Conducting Industrial Symbiosis	FIM
Conducting Recycling / Secondary Material Use	FIM
Conducting Reconditioning	FIM
Reducing Material Leakage	FIM
Promoting Environmentally Friendly Material Usage-Driven Practises (i.e., Natural, Recyclable, Durable, Easy to Separate)	FIM
Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))	FIM
Establishing Product-Service Systems (PSS)	FIM
Conducting Refurbishment	FIM
Conducting Remanufacturing	FIM
Establishing Performance Agreement (Product-Service Systems)	FIM
Offering Repair and Maintenance	FIM
Offering Upgrade	FIM
Conducting Dematerialisation	FIM
Integrating Industry 4.0 Features to Increase Circularity	FIM
Using Cloud Manufacturing	FIM
Using Additive Manufacturing	FIM
Conducting Green Purchasing	FIM

Legend: FIM **- Fairly Important,** VIM **- Very Important**

IFs considered VERY IMPORTANT for Channels were the ones related to the relationships built throughout the whole business structure (e.g. partnerships along the supply chain, and engaging end customers), strategies for resource saving and optimization (e.g. designing out waste, material recovery, reuse, and giving preference to renewable resources), establishing take-back systems, and enabling multiple cycles, as well as making use of IoT.

FAIRLY IMPORTANT IFs also included some features related to PSSs and resource-saving (reconditioning, refurbishment, remanufacturing, repair and maintenance, upgrading, establishing performance agreement), environmentally friendly material usage-driven practises (e.g. reducing material leakage, promoting

recycling and resource efficiency strategies), in addition to dematerialisation, industry 4.0-related practises (e.g. additive and cloud manufacturing) and green purchasing.

A few IFs were considered NEITHER UNIMPORTANT NOR IMPORTANT for Channels, they were conducting resource regeneration/restoration, extending resource value, extending product life, using “build to last” strategies, establishing product care policies, offering refilling, and conquering ecological labels and certifications.

4.2.4 Customer relationships

For Customer Relationships, the BB with the least valid IFs, only 19 of the 33 IFs were considered either VERY IMPORTANT or FAIRLY IMPORTANT, hence, are valid for measuring business model circularity according to the collective opinion of the specialists who provided complete responses, as it can be seen in Table 12.

Table 12 - Validated IFs for Customer Relationships

Influencing Factor	Membership Function
Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	VIM
Establishing Take-Back Systems	VIM
Establishing Product-Service Systems (PSS)	VIM
Establishing Performance Agreement (Product-Service Systems)	VIM
Offering Repair and Maintenance	VIM
Offering Upgrade	VIM
Promoting the Use of Internet of Things (IoT)	VIM
Designing Out Waste	FIM
Promoting Reuse	FIM
Promoting Environmentally Friendly Material Usage-Driven Practises (i.e., Natural, Recyclable, Durable, Easy to Separate)	FIM
Extending Product Life	FIM
Conducting Refurbishment	FIM
Conducting Remanufacturing	FIM
Using “Building (Products) to Last” Strategies	FIM
Establishing Product Care Policies	FIM
Offering Refilling	FIM
Conducting Dematerialisation	FIM
Integrating Industry 4.0 Features to Increase Circularity	FIM
Conquering Ecological Labels and Certifications	FIM

Legend: FIM **- Fairly Important,** VIM **- Very Important**

IFs considered VERY IMPORTANT were the ones related to results a customer can get out of a product system (e.g. PSSs, performance agreement, repair, maintenance, and upgrade). It also encompasses customer and other stakeholders' engagement and activities/practises that require customer engagement and participation (e.g. take-back systems), and the use of the IoT.

The ones considered FAIRLY IMPORTANT were strategies for resource-saving (e.g. designing out waste, reuse, environmentally-friendly material usage-driven practises), further features of PSSs (e.g. extending product life, conducting refurbishment and remanufacturing, offering refilling, establishing product care policies, as well as "build to last" strategies), industry 4.0 features and dematerialisation, in addition to conquering ecological labels and certifications.

NEITHER UNIMPORTANT NOR IMPORTANT IFs for Customer Relationships included enabling multiple cycles, conducting industrial symbiosis, material recovery, recycling, reconditioning, reducing material leakage, resource restoration, replacing non-renewable for renewable resources, resource efficiency strategies, extending resource value, using cloud and additive manufacturing, and conducting green purchasing.

Lastly, developing strategic partnerships along the supply chain has been identified as being of LITTLE IMPORTANCE for Customer Relationships.

4.2.5 Revenue streams

For Revenue Streams, 23 of the 33 IFs were considered either VERY IMPORTANT or FAIRLY IMPORTANT, hence, are valid for measuring business model circularity according to the collective opinion of the specialists who provided complete responses, as it can be seen in Table 13 (page 84).

VERY IMPORTANT IFs for included the ones related to partnerships (e.g. engaging with end customers), practises that might directly or indirectly affect the revenue system by saving resources (e.g. enabling multiple cycles, conducting reuse, and resource efficiency strategies), in addition to PSS practises (e.g. offering repair, maintenance and upgrade, and establishing performance agreement).

Table 13 - Validated IFs for Revenue Streams

Influencing Factor	Membership Function
Enabling Multiple Cycles (Materials and Products)	VIM
Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	VIM
Promoting Reuse	VIM
Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))	VIM
Establishing Performance Agreement (Product-Service Systems)	VIM
Offering Repair and Maintenance	VIM
Offering Upgrade	VIM
Developing Strategic Partnerships Along the Supply Chain	FIM
Designing Out Waste	FIM
Conducting Industrial Symbiosis	FIM
Conducting Material/Resource Recovery	FIM
Conducting Recycling / Secondary Material Use	FIM
Conducting Reconditioning	FIM
Conducting Resource Regeneration/Restoration	FIM
Extending Resource Value	FIM
Extending Product Life	FIM
Establishing Product-Service Systems (PSS)	FIM
Conducting Refurbishment	FIM
Conducting Remanufacturing	FIM
Establishing Product Care Policies	FIM
Offering Refilling	FIM
Promoting the Use of Internet of Things (IoT)	FIM
Using Additive Manufacturing	FIM

Legend: FIM **- Fairly Important,** VIM **- Very Important**

FAIRLY IMPORTANT IFs have a similar approach, including practises that need stakeholder engagement (e.g. developing strategic partnerships along the supply chain, conducting industrial symbiosis, recycling, establishment of PSSs, product care policies, as well as refilling), strategies to optimise resource use and/or promote resource-saving (e.g. designing out waste, conducting material recovery, resource restoration, reconditioning, refurbishment, extending product life and resource value), in addition to using industry 4.0 features (e.g. IoT, and additive manufacturing).

Reducing material leakage, replacing non-renewable for renewable resources, environmentally friendly material usage-driven practises, establishing TBSs, building to last strategies, dematerialisation, industry 4.0 features, cloud manufacturing, conquering ecological labels and certifications, and green purchasing were considered NEITHER UNIMPORTANT NOR IMPORTANT IFs for Revenue Streams.

4.2.6 Key resources

For Key Resources, 28 of the 33 IFs were considered either VERY IMPORTANT or FAIRLY IMPORTANT, hence, are valid for measuring business model circularity according to the collective opinion of the specialists who provided complete responses, as it can be seen in Table 14.

Table 14 - Validated IFs for Key Resources

Influencing Factor	Membership Function
Developing Strategic Partnerships Along the Supply Chain	VIM
Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))	VIM
Offering Repair and Maintenance	VIM
Conducting Dematerialisation	VIM
Enabling Multiple Cycles (Materials and Products)	FIM
Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	FIM
Designing Out Waste	FIM
Conducting Industrial Symbiosis	FIM
Conducting Material/Resource Recovery	FIM
Promoting Reuse	FIM
Conducting Recycling / Secondary Material Use	FIM
Conducting Reconditioning	FIM
Reducing Material Leakage	FIM
Conducting Replacement of Non-Renewable with Renewable Resources	FIM
Extending Resource Value	FIM
Extending Product Life	FIM
Establishing Take-Back Systems	FIM
Establishing Product-Service Systems (PSS)	FIM
Conducting Refurbishment	FIM
Conducting Remanufacturing	FIM
Using “Building (Products) to Last” Strategies	FIM
Establishing Product Care Policies	FIM
Offering Refilling	FIM
Offering Upgrade	FIM
Integrating Industry 4.0 Features to Increase Circularity	FIM
Promoting the Use of Internet of Things (IoT)	FIM
Using Cloud Manufacturing	FIM
Using Additive Manufacturing	FIM

Legend: FIM **- Fairly Important,** VIM **- Very Important**

Only a few IFs were considered VERY IMPORTANT, those include the development of strategic partnerships along the supply chain, strategies that assist

resource conservation (e.g. resource efficiency strategies, and repair and maintenance) and dematerialisation.

Various IFs were considered FAIRLY IMPORTANT including strategies that would make CBMs possible in tactic and operational perspectives (e.g. enabling multiple cycles, designing out waste, reducing material leakage, replacing non-renewable with renewable resources, conducting industrial symbiosis, resource recovery, reuse, recycling, reconditioning, replacing non-renewable with renewable resources, refurbishment, and remanufacturing), also in a more strategic perspective (e.g. engaging with multiple stakeholders, establishing PSSs, extending product life and resource value, product care policies, refilling and upgrade, establishing take-back systems, and “build to last” strategies), and also the use of industry 4.0 strategies (e.g. IoT, cloud and additive manufacturing).

Resource regeneration, the promotion of environmentally friendly material usage-driven practises, establishing performance agreement (e.g. in PSSs), conquering ecological labels and conducting green purchasing were considered NEITHER UNIMPORTANT NOR IMPORTANT for Key Resources.

4.2.7 Key activities

For Key Activities, the BMBB with the greatest number of valid IFs, 30 of the 33 IFs were considered either VERY IMPORTANT or FAIRLY IMPORTANT, hence, are valid for measuring business model circularity according to the collective opinion of the specialists who provided complete responses, as it can be seen in Table 15 (page 87).

IFs considered VERY IMPORTANT for Key activities were practises related to resource conservation and saving (e.g. designing out waste, replacing non-renewable resources with renewable ones, resource efficiency strategies and remanufacturing), strategic actions that need stakeholder engagement (e.g. developing strategic partnerships along the supply chain, enabling multiple cycles and establishing take-back systems), as well as PSS-based offers (e.g. repair, maintenance and upgrade).

Table 15 - Validated IFs for Key Activities

Influencing Factor	Membership Function
Developing Strategic Partnerships Along the Supply Chain	VIM
Enabling Multiple Cycles (Materials and Products)	VIM
Designing Out Waste	VIM
Conducting Replacement of Non-Renewable with Renewable Resources	VIM
Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))	VIM
Establishing Take-Back Systems	VIM
Conducting Remanufacturing	VIM
Offering Repair and Maintenance	VIM
Offering Upgrade	VIM
Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	FIM
Conducting Industrial Symbiosis	FIM
Conducting Material/Resource Recovery	FIM
Promoting Reuse	FIM
Conducting Recycling / Secondary Material Use	FIM
Conducting Reconditioning	FIM
Reducing Material Leakage	FIM
Conducting Resource Regeneration/Restoration	FIM
Promoting Environmentally Friendly Material Usage-Driven Practises (i.e., Natural, Recyclable, Durable, Easy to Separate)	FIM
Extending Resource Value	FIM
Extending Product Life	FIM
Establishing Product-Service Systems (PSS)	FIM
Conducting Refurbishment	FIM
Using “Building (Products) to Last” Strategies	FIM
Offering Refilling	FIM
Conducting Dematerialisation	FIM
Integrating Industry 4.0 Features to Increase Circularity	FIM
Promoting the Use of Internet of Things (IoT)	FIM
Using Cloud Manufacturing	FIM
Using Additive Manufacturing	FIM
Conducting Green Purchasing	FIM

Legend: FIM **- Fairly Important,** VIM **- Very Important**

FAILRY IMPORTANT IFs also included stakeholder engagement (e.g. engaging with end customers and stakeholders towards partnerships for circularity), resource saving strategies (e.g. industrial symbiosis, material recovery, reuse, recycling, resource restoration, environmentally friendly material usage-driven practises, and extending resource value), as well as waste management (e.g. reducing material leakage), offering customer benefits by means of PSS-based activities (e.g. extending product life, conducting “build to last” strategies, refurbishment, and refilling),

besides dematerialisation, using industry 4.0 features (e.g. IoT, cloud and additive manufacturing) and conducting green purchasing.

Establishing product care policies and performance agreement, as well as conquering ecological labels and certifications were considered NEITHER UNIMPORTANT NOR IMPORTANT for Key activities.

4.2.8 Key partnerships

For Key Partnerships, 27 of the 33 IFs were considered either VERY IMPORTANT or FAIRLY IMPORTANT, hence, are valid for measuring business model circularity according to the collective opinion of the specialists who provided complete responses, as it can be seen in Table 16 (page 89).

VERY IMPORTANT IFs for Key partnerships were undoubtedly the ones that involved stakeholder engagement (e.g. developing strategic partnerships along the supply chain, engaging with end customers and stakeholders), as well as activities that assist resource saving and require higher-degree involvement from all parties (e.g. enabling multiple cycles, conducting industrial symbiosis, recycling, establishing take-back systems, as well PSSs, and performance agreement), and industry 4.0 features (e.g. IoT, cloud and additive manufacturing).

IFs FAIRLY IMPORTANT also included resource saving practises that need stakeholder participation both by assisting that the product be correctly managed at the end-of-life, by accepting products made from secondary sources and engaging with resource-saving practises (e.g. resource recovery, reuse, reconditioning, resource restoration, refurbishment, remanufacturing, repair, maintenance, refilling, upgrade, and establishing product care policies). Moreover, it included IFs that showed the need for greater partnerships along the chain of supply in order to increase circularity (e.g. replacement of non-renewable with renewable resources, establishing friendly usage-driven material practices, extending resource value and product life, and conducting green purchasing).

A few IFs were considered NEITHER UNIMPORTANT NOR IMPORTANT, they were designing out waste, reducing material leakage, conducting dematerialisation, resource efficiency strategies, using “build to last” strategies, and conquering ecological labels and certifications.

Table 16 - Validated IFs for Key Partnerships

Influencing Factor	Membership Function
Developing Strategic Partnerships Along the Supply Chain	VIM
Enabling Multiple Cycles (Materials and Products)	VIM
Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	VIM
Conducting Industrial Symbiosis	VIM
Conducting Recycling / Secondary Material Use	VIM
Establishing Take-Back Systems	VIM
Establishing Product-Service Systems (PSS)	VIM
Establishing Performance Agreement (Product-Service Systems)	VIM
Integrating Industry 4.0 Features to Increase Circularity	VIM
Promoting the Use of Internet of Things (IoT)	VIM
Using Cloud Manufacturing	VIM
Using Additive Manufacturing	VIM
Conducting Material/Resource Recovery	FIM
Promoting Reuse	FIM
Conducting Reconditioning	FIM
Conducting Resource Regeneration/Restoration	FIM
Conducting Replacement of Non-Renewable with Renewable Resources	FIM
Promoting Environmentally Friendly Material Usage-Driven Practises (i.e., Natural, Recyclable, Durable, Easy to Separate)	FIM
Extending Resource Value	FIM
Extending Product Life	FIM
Conducting Refurbishment	FIM
Conducting Remanufacturing	FIM
Establishing Product Care Policies	FIM
Offering Refilling	FIM
Offering Repair and Maintenance	FIM
Offering Upgrade	FIM
Conducting Green Purchasing	FIM

Legend: FIM **- Fairly Important,** VIM **- Very Important**

4.2.9 Cost structure

For Cost Structure, 26 of the 33 IFs were considered either VERY IMPORTANT or FAIRLY IMPORTANT, hence, are valid for measuring business model circularity according to the collective opinion of the specialists who provided complete responses, as it can be seen in Table 17 (page 90).

Table 17 - Validated IFs for Cost Structure

Influencing Factor	Membership Function
Developing Strategic Partnerships Along the Supply Chain	VIM
Enabling Multiple Cycles (Materials and Products)	VIM
Conducting Industrial Symbiosis	VIM
Conducting Material/Resource Recovery	VIM
Promoting Reuse	VIM
Reducing Material Leakage	VIM
Conducting Resource Regeneration/Restoration	VIM
Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))	VIM
Conducting Remanufacturing	VIM
Using “Building (Products) to Last” Strategies	VIM
Promoting the Use of Internet of Things (IoT)	VIM
Using Cloud Manufacturing	VIM
Using Additive Manufacturing	VIM
Designing Out Waste	FIM
Conducting Recycling / Secondary Material Use	FIM
Conducting Reconditioning	FIM
Extending Resource Value	FIM
Extending Product Life	FIM
Establishing Take-Back Systems	FIM
Establishing Product-Service Systems (PSS)	FIM
Conducting Refurbishment	FIM
Offering Refilling	FIM
Offering Repair and Maintenance	FIM
Offering Upgrade	FIM
Integrating Industry 4.0 Features to Increase Circularity	FIM
Conducting Green Purchasing	FIM

Legend: FIM **- Fairly Important,** VIM **- Very Important**

VERY IMPORTANT IFs for Cost Structure were the ones related to developing strategic partnerships along the supply chain, strategies that need end-of-life products to move horizontally or back up the chain (enabling multiple cycles, industrial symbiosis, material recovery, reuse and remanufacturing), as well as probable investments in resource-saving strategies (e.g. reducing material leakage, resource restoration, resource efficiency, and “build to last” strategies) and investment in greater technological assistance (e.g. IoT, cloud and additive manufacturing).

FAIRLY IMPORTANT IFs also included resource-saving investments (e.g. designing out waste, recycling, reconditioning and refurbishment), practise involving customer sensitisation and participation (e.g. PSSs, refilling, repair, maintenance,

upgrade, extending resource value and product life, and take-back systems), as well as integrating industry 4.0 features and conducting green purchasing.

NEITHER UNIMPORTANT NOR IMPORTANT IFs for Cost Structure included engaging with end customers and stakeholders towards partnerships for circularity, conducting replacement of non-renewable with renewable resources, promoting environmentally friendly material usage-driven practises, establishing product care policies and performance agreement, conducting dematerialisation, and conquering ecological labels and certifications.

4.2.10 Final considerations on validating

Observing the procedures described in section 3.2.2.4, for the respondents who provided complete answers, none of them indicated any further IFs that should be considered in any of the BMBBs, and thus, no extra round of validation was conducted.

The IFs considered validated are, from now on, considered as criteria that can be used for assessing business model circularity.

Therefore, the (iii) specific objective (*Validate, assisted by specialists in Circular Business Models, the relevance of the identified Influencing Factors of Circular Economy on Business Models*) was accomplished.

5 DISCUSSION

This Chapter presents a brief discussion on three aspects of the researcher's perception: (i) on the validated IFs, (ii) on the strategy used for validation of the IFs, and (iii) on the specialists' responses and their feedback, as addressed in the following sections.

5.1 PERCEPTIONS ON VALIDATED INFLUENCING FACTORS

For Customer Segments, validated IFs would assist identifying strategies that capture different customers. CBM customers involve individuals that paced up with the shift towards more circular initiatives, such as those offered by PSSs. CBMs, in this case, could also capture lower income or less sensitive customers when applying strategies such as downcycling. Besides, it could help focus on specific customer types, such as individuals who would prefer second-hand products (e.g. reuse and recycling), who would accept products after going through resource-saving strategies (e.g. remanufacturing and reconditioning), or that would give preference or would even pay more for products with certified precedence (e.g. via ecological labels).

For Value Propositions, validated IFs would assist defining strategies to identify and express value for different customers. Stakeholder engagement is necessary to propose (and deliver) value. In the case of CBMs, value would be related to the closing, slowing and/or narrowing resource loops, and finding strategies to express them to customers. What's more, value propositions should include resource-saving practises while providing customers with some benefit, in order to maintain business's health.

For Channels, validated IFs would assist establishing efficient communication and exchange means with stakeholders, such as when delivering physical and/or immaterial value (via the business value proposition) and the partnerships necessary to put into practise the referred value proposition. Most importantly, the BMBB Channels would likely be greatly influenced by PSSs, take-back systems, resource exchange routes and strategic partnerships (which could either facilitate or difficult CBM practises).

For Customer Relationships, validated IFs would assist the definition and management of customer interaction means. As for PSSs, Customer Relationships would be much closer than those of product-systems or entire LBMs. CBMs allow for and require greater interaction along the entire life cycle of the resource, needing customer awareness and participation to realise resource-saving practises.

For Revenue Streams, validated IFs would be mainly represented by leasing/renting activities, as in PSSs and their related activities; in addition to activities that facilitate the management of these revenue streams, such as partnerships along the supply chain (allowing the business to increase competitiveness) and increasing customer awareness.

For Key Resources, validated IFs would reflect the business competencies towards resource-saving practises. Key Resources in CBMs would include the knowledge and technology necessary to propose, create, deliver and capture circular value, that is, every resource (material, intellectual and human) needed to put into practise strategies for closing, slowing or narrowing resource loops.

For Key Activities, validated IFs would relate to material production activities, necessary for the production of goods and the offer of services. Main activities would be related to the enabling of resource-saving practises, being operational (manufacturing and customer service), tactical (designing paths for closing loops, by means of the management of physical resources and the establishment of strategic partnerships for resource exchange, and/or management of production equipment and personnel) and strategic (proposing circular value or increasing the circularity of current value proposition); comprising manufacturing, problem solving and platform/network solutions.

For Key Partnerships, validated IFs would include upstream and downstream alternatives for engaging with several stakeholders to pursue greater circularity. Key partnerships upstream the supply chain would include the ones that allow greater (in number) and more advantageous resource exchange (in terms of quality, monetary cost and opportunity cost), greater responsiveness and resilience. Key partnerships downstream would include the ones that allow greater customer reach, take-back opportunities, and advantageous revenue strategies, besides customer awareness and engagement to allow closing loops.

For Cost Structure, validated IFs would include the ones related to activities, resources and partnerships that influence the economy of the business. Hence,

practises that would greatly impact the cost structure would be customer engagement towards accepting circular value propositions and their participation in take-back systems, further partnerships along the supply chain to make loops close, acquisition of resources, including human (thus intellectual) and material (equipment/technology), that allow putting into practise circular strategies (towards resource-saving).

5.2 PERCEPTIONS ON THE STRUCTURE OF THE QUESTIONNAIRE AND THE USE OF FUZZY LOGIC

The Fuzzy Logic was used in this research for greater mathematical correctness and reliability. As mentioned earlier, the use of a discrete scale would likely provide a very similar result to the one using Fuzzy Logic in the case of this research; however, it would arguably be slightly less precise, as the continuous scale allowed respondents to choose subjective values based on the Linguistic Variables used (see section 0).

Moreover, the results found in the present research were very specific to the structure used in the questionnaire and the Linguistic Variables and hedges presented to specialists for validation. Furthermore, the specialists' expertise on the subject (business model circularity) as well as its specific topics (circular economy and business model) would heavily weigh on their perception on the IFs towards CBM, thus carrying undeniable subjectivity. On these grounds, the use of Fuzzy Logic demonstrates its relevance, as its intent is said to be assisting decision-making on subjective matters.

The researcher was contacted by a few specialists arguing on the subjectivity underlying the questionnaire, when the researcher, then, further explained the intent of the questionnaire structure and the use of the Fuzzy Logic to treat the questionnaire outputs and the specialists agreed upon the issue. Further comments on the specialists' feedback are provided in section 5.3 (page 95).

In this research, it was used the Fuzzy Logic to account for the subjectivity present in the specialists' judgement. Until the moment this research was conducted, there were 6 complete responses to the questionnaire. Several factors led to this number. The set of responses reflects the specialists' perception on the importance of each of the IFs to each of the BMBBs. A smaller or greater number of responses could have changed the IFs that were validated to each BMBB. All IFs can be used to

measure business model circularity; however, some might be more important than others to a specific BMBB. A greater number of responses would likely provide more solid results; however, the researcher considers the inputs given by the respondents who gave complete answers of high relevance, since they showed interest and commitment to advancing research on CBM.

The answers, as also pointed by some specialists (see section 5.3), required a great deal of thought and analysis. Nonetheless, each IF can be highly context-dependent for each BMBB. The specialists gave their answers based on their knowledge and expertise on the subject, however, their very same previous experience and knowledge on the subject might have caused them to be biased towards a specific type of CBM or towards a specific IF. Furthermore, still based on their expertise, specialists might have put more criticism upon a certain IF towards one or more BMBBs, as well as upon a certain BMBB regarding one or more IFs. The same might have happened because of specialists' lack of expertise or awareness on one or more topics. These uncertainties cannot be ruled out and are unlikely to be extinguished from this type of research.

5.3 PERCEPTIONS ON THE SPECIALISTS' RESPONSES AND THEIR FEEDBACK

As seen in section 3.2.2.2 (page 66) and listed in Appendix C (Table C.1 - page 162), 120 specialists were identified as potential respondents to the questionnaire aiming to validate the IFs. Trying to find their contact information, there was one Brazilian researcher whose contact information could not be found. Therefore, the number of potential respondents went down to 119. An overview of the contact with the specialists can be seen in Table 18 (page 96) and some of the issues are discussed thereafter.

Ten of the specialists could only be found on LinkedIn, however, it was necessary to send them an invitation and that it be accepted before it was possible to send them a message. Only two of them accepted the invitation, thus allowing the questionnaire to be sent to them. Hence, the number of potential respondents went down to 111.

Table 18 - Feedback on Contact with Specialists

Contact Means	Strategy/Reason	Number of Specialists
Contact Information Not Found		1
LinkedIn	Did not accept invitation	8
	Contacted via LinkedIn	2
	Total Contacted	2
	Complete responses	**0**
ResearchGate	Contacted via ResearchGate message	3
	Total contacted	3
	Complete responses	**0**
Email	Neither answered nor contacted back	66
	Out of office	7
	On maternity Leave	2
	Will not answer (several reasons)	15
	Partial response	10
	Total contacted	106
	Complete responses	**6**

Source: Author (2019)

Three of the specialists were found on ResearchGate and the questionnaire was sent to them via the referred online platform. The three of them could be contacted, since it was not necessary to send an invitation on ResearchGate to be able to contact someone, as it can be done by just following their profile on the network.

The remaining 106 specialists were contacted via email. The only complete answers to the questionnaire resulted from the contacts made by email. Most of them did not answer and had not made contact up to the moment this research was finished. Aside from the complete responses, some researchers, although did not fill out the questionnaire, sent their feedback. The referred feedback comprised messages of various natures, as addressed in the next paragraphs.

Sixty-six of the specialists contacted by email, the 3 specialists contacted via ResearchGate, and the 2 specialists contacted via LinkedIn, did not answer the questionnaire, neither contacted back the researcher. One cannot be certain of the reasons that led to this outcome; however, these might have included lack of available time, disinterest in the research theme, change of research focus (which might not currently include CBM or even CE), and having forgotten to answer the questionnaire.

These reasons could not be overcome by any strategies deployed by the researcher, except for the last one; therefore, 8 days after the first contact, a reminder was sent to all specialists contacted the first time that had neither answered the questionnaire nor contacted the researcher.

The contact with some specialists returned automatic responses, such as two that were on maternity leave and 7 that were out of office, for different reasons, many times not specified.

Aside from the automatic responses, some specialists contacted the researcher giving their support and explaining the reasons they could not answer the questionnaire.

Reasons often included that there were many questions to be answered and lack of time available for taking the survey in the near future. A few others were more specific, expressing their opinions and criticism on the approach. A few responses are quoted and commented on in the following paragraphs.

"*Hi Rodrigo, I tried but these are way too many questions and the answers are also highly context-dependent (in some cases, a certain situation is highly important, in others it is not). I don't think I can answer your survey in any objective way.*" (Contact from specialist A).

After thanking the specialist A's feedback it was explained to them that regarding the subjectivity, the researcher was using Fuzzy Logic to manage such issue, thus the use of a continuous scale. Moreover, the subjectivity was the main reason why it was decided to seek specialists' opinions on the matter. The researcher could have chosen the criteria for each building block by himself, but then, it would have been entirely the researcher's opinion/view.

Another specialist asked if they could answer the questions via a skype meeting, as follows.

"*Thank you very much for your interest. I am open to help you, but would prefer a short Skype interview so you can ask the questions iso of typing so many questions.*" (Contact from specialist B).

To which the researcher explained the structure of the questionnaire and told the specialist B there were only a few open-ended questions, 4 about personal information (Name, Institution, Country and Email) and 1 at the end of the page of each building block, the remaining questions would only require rolling a bar. Furthermore, it would introduce a heavy bias to the research, since if the researcher registered the

specialist B's answers on this type of questionnaire, it would have been the researcher's perception of the specialist's opinion (once it would have been the researcher rolling the bar according to what the specialist said).

Others, yet, informed that they were not specialized in CBM to give valid responses.

"*I am not an expert on business models. I study the environmental footprints of consumers, and have examined the impacts of sharing/circular economy from this perspective. I could provide guidance for governments or legislation, but not so much for business.*" (Contact from specialist C).

"*I cannot see myself as an expert on this topic, and thus, I cannot answer your request.*" (Contact from specialist D).

As the contact was made considering all co-authors in publications related to CBMs, a few authors might have been involved in them for their expertise in subjects related to CBMs or another subject involved in the research but not exactly CBMs.

Moreover, further concerns were raised by another specialist, who gave the most complete feedback.

"*it is too long and repetitive. Having the same 33 criteria over the 8 business model blocks seems to lose its meaning. Are all 33 criteria equally relevant for all 8 BM blocks? I found that some of them had nothing to do, for instance, with the "customer segment". On the other hand, the survey allows the opportunity to register a "0" value, but then again a criterion might be irrelevant and not unimportant* […] *the grading system is not very well calibrated. You use continuous values from 0 to 600. That made it very hard to assign the real weight to each statement. By rolling the bar (from not important to important), usually people will stop at the point where they feel it represents their opinion. However, that point is interpreted with a value (e.g. 357). This shows some accuracy in measurement that the person taking the survey probably did not intend to specify. After all, there is a difference between 350 and 360… which the rolling bar does not take into account. It's very easy for the hand to slip a bit. I would recommend the use of defined scale (e.g. 0 - 1 - 2 - 3 - 4 - 5 - 6), also known as a Likert scale. This would assist responders to be more accurate and you could analyse details and nuances in data later, when you do a statistical analysis of the results.*" (Contact from specialist E).

After thanking the specialist E on the feedback, the researcher argued on the repetitive structure stating that all criteria were kept for all business model building

blocks exactly for the purpose of having scientific backup. Every answer depended on one's point of view and knowledge on the subject. Someone might think a certain criterion is important (relevant) because they can think of a way to use that criterion to increase circularity regarding a certain business model building block; but then again, it is subjective and it depends on a range of factors. If the researcher had chosen different criteria for the different building blocks (making sort of a pre-filter), it would have been only the researcher's opinion, thus not reflecting the opinion of a team of specialists.

Addressing another point in the specialist E's feedback, to take the subjectivity into consideration, it was decided to use Fuzzy Logic to treat the data, hence the use of a continuous scale. A Likert scale would have been simpler, however, it would not have allowed considering the subjectivity as well. If a simple mean had been used, for example, and a certain criterion resulted in something like 4.32, this would not have been accurate, since it could not have been said the degree of importance to be 4.32 because it had not been given respondents the opportunity to choose anywhere between 4 and 5. The Fuzzy Logic allows one that, thus the use of a continuous scale between the Linguistic Variables.

The researcher, then, asked specialist E's opinion on hiding the box that showed the crisp value being assigned to the IF as the respondent rolled the bar, thus the respondent would not have the temptation to make a number round, for example. The specialist advised the researcher on doing so. Hence, the box was hidden.

Moreover, after this round of contact with the specialist E, they provided further feedback on the use of the Fuzzy Logic.

"*Thank you for your explanation. It is an interesting approach to use fuzzy logic to account for the subjectivity of respondents. This could bring an extra layer of discussion of your results and increase the validity and acceptance of conclusions.*" (Contact from specialist E).

Another specialist shed a light on the difficulty to give sufficient thinking to all the referred issues.

"*I started completing your questionnaire and although it is clear you have put lots of work on it I found it very difficult to answer all these questions and give sufficient thinking to them. I stopped in question 50 since I realised it would be impossible to answer 300 questions and provide reliable answers. Having competed the first 50 I also realised that most of the answers would be between "fairly imprtant" and*

"extremely important" and variations from this scale would be rare." (Contact from specialist F).

The researcher agreed with specialist F, arguing on the importance of having different views, thus by having a set of specialists to validate the analysis. The choice of which IFs were relevant to each BMBB could have been done solely by the researcher, however, the representativeness would not have been the same.

Another specialist also argued on the high context-dependence of the IFs to each BMBB.

"*I am having some difficulties in replying to some of the questions, because I think that business models and business model innovation are very dependent and vary a lot with context. When replying to the questionnaire, I had the impression that the options are too rigid. For instance, now I am on the question 45 below:*

45. How important is PROMOTING REUSE for promoting/managing business model circularity in relation to VALUE PROPOSITIONS?

I would say that this is very dependent on circumstances and the strategic choices/context of the company and even the specific sector or country.

To explain myself, for example, I have applied my research project to develop business models for circular economy in 7 companies. From those, I would say that for 1 of them the answer would be 'extremely important', because their customers were requiring reuse, and they had already lost sales opportunities due to the absence of reuse practices enabled by the value proposition. Their customers, were B2B companies and interested in reducing costs, that is why they wanted to reuse products, and this 'reuse potential' had to expressed in the value proposition.

However, for the other companies, the value proposition would not need to explicitly promote reuse. It would need to explicitly mention 'take back', because the customer has to be aware before they engage with the offering that she/he has to collaborate with returning products, or better even if the return is 'advertised' as something in the lines of: "we take the burden of dealing with end-of-life products from your hands…."." (Contact from specialist G).

The researcher thanked specialist G for the feedback and agreed that the IFs are context-dependent and told specialist G that the researcher had received emails from other specialists raising the same concern. The researcher explained this was going to be a limitation of the research, as the intent was to build a generic structure to allow measuring business model circularity that could be applied to any business

model. Further approaches could include specifying the set of criteria directing it to different sectors/industries, thus assessing which criteria fit the sector and to what extent. However, by then, it was aimed to be generic/general. Furthermore, the researcher agreed on the difficulty and the indecisiveness specialists get to when facing each of the questions. That was the main reason why the researcher sought the assistance of specialists and decided to use the continuous scale to account for the subjectivity using Fuzzy Logic afterwards to treat the data.

Finally, the researcher advised specialist G to estimate a general (mean) value that would represent the importance of the IF towards the implementation and management of circular practices, based on the specialists' knowledge and expertise.

Other specialists expressed their undivided attention and willingness to cooperate. Offering further collaboration and asking permission to extend the invitation to other colleagues doing research on CE to collaborate in the research by answering the questionnaire.

"*Your PhD project seems very relevant and I am looking forward to staying in the loop.*" (Contact from specialist I).

"*Interesting and important topic.*" (Contact from specialist J).

"*I will certainly answer your questionnaire. […] I think we should join efforts to continue doing research, each one from their position in circular economy, and make a paradigm shift.*" (Contact from specialist K).

Moreover, some specialists sent a few inquiries, expressed their interest and told the researcher they would make an effort to answer the questionnaire later, as at the time they could not allot the time to carefully go through the questionnaire.

The profiles of respondents (comprising the 6 specialists that provided full responses) seem to be quite scattered, which brings an interesting tone to the survey results. Respondents include researchers and practitioners from 5 different countries located in Europe. Moreover, they include Professors, Doctors, Masters and Doctoral students in Mechanical Engineering, Industrial Engineering, Science, and Business Administration.

All of them seem to do research on specific subjects related to environmental issues besides their concern with circular business models, which brings another layer of knowledge to their contributions. In the last years, they seem to have been shifting or incorporating to their research focus, research on CE and its related aspects, including the establishment of business models and PSSs, the study of CE implications

to operations, transportation, supply chain in general and customer relationship/acceptance, as well as strategies for scaling up CE.

6 CONCLUSIONS

The objective of this thesis was achieved by identifying and validating, with the assistance of specialists, IFs that can be used to measure business model circularity.

These IFs can be used in further approaches to finding ways to structure tools, methods, and frameworks to measure and manage business model circularity issues. They also point some of the most important factors that influence business model circularity, based on the BM Canvas building blocks, indicating where companies should focus their efforts towards more circular practices.

The IFs were identified via a literature review on circular business models and subsequent analysis of all existing literature deemed relevant (peer reviewed papers in international journals, publications from worldwide institutions well known for helping accelerate the transition to a CE, and an international standard - the BS 8001 - aimed at implementing CE practises) to help determine business model circularity, available up until January 2019. Identified IFs underwent a process of debugging, and the remaining IFs (33) were then validated by specialists (all authors identified in the literature review, being them mostly researchers from education-based organisations, but also private company founders and employees, and government employees).

The main IFs validated to each BMBB were Establishing Take-back Systems, for (i) Customer Segments; Engaging with end Customers and Stakeholders Towards Partnerships for Circularity, for (ii) Value Propositions, (iv) Customer Relationships and (v) Revenue Streams; Developing Strategic Partnerships along the Supply Chain, for (iii) Channels, (vi) Key Resources, (vii) Key Activities, and (viii) Key Partnerships, and; Conducting Material/Resource Recovery, for (ix) Cost Structure.

As highlighting strategies, companies could Establish Take-back Systems by designing appropriate reverse logistic routes and programs, partnering with several stakeholders along the supply chain and even maybe coupling reverse logistics with industrial symbiosis, where the product, after use, can go to another company and this other company can provide a different resource in exchange. Engaging with Customers and Stakeholders Towards Partnerships for Circularity can take place by promoting customer awareness by means of public campaigns stressing the importance/relevance of CE-friendly products, and; building local, regional, and national networks for resource, knowledge and technology exchange and collective support (e.g. the CE 100, from the Ellen MacArthur Foundation). Developing Strategic

Partnerships along the Supply Chain can be done by several means, depending on the company type, structure, hierarchy, size (and so on); nevertheless, besides the strategy just mentioned for Establishing TBSs, strategies on this regard could include identifying possible companies which partnership would potentially allow closing the loop of a certain resource, and; companies with complementing circular offers (e.g. my company's offer: high energy-demanding appliance service; my partner company's offer: renewable energy service) to allow offering greater value and also encouraging customers to engage in circular behaviour. Conducting Material/Resource Recovery could include designing brand-new products from materials that are considered waste/garbage (e.g. the tennis shoes from ocean plastic manufactured by Adidas) (this strategy on its own can already be considered for conducting material/resource recovery), and offering their use/result as a service (e.g. PSSs).

The IFs identified and validated here follow a generic approach, thus not being directed to any particular type of business model, but being a general representation of the important factors that need to be considered in business model circularity, based on the BM Canvas framework. Specific applications might exclude some of the IFs here validated, as well as might show the need to include further (more specific) IFs to assess circularity of a given BM, or BMs of a certain industry segment, for instance.

These IFs were identified and validated given the need to assess business model circularity. It is necessary to identify ways to propose, implement and manage business model circularity, as the world has already had its fair share of LBMs and have been suffering with the excessive resource consumption. In order to seek effective ways to close, slow or narrow resource flows, companies need to know where and how to act. Hence, the IFs validated in this thesis shed a light on these issues (where - the BMBB, and; how - the IF).

Nevertheless, circularity on its own cannot be said to be exclusively positive. As earlier addressed in this thesis, there might be rebound effects, and circular approaches might even bring more severe environmental impacts. For instance, the offer of secondary products (made from non-virgin material) can cause the need to lower prices for these products to be competitive, which might incite people to shift their consumption towards these products (in theory, this is somewhat what is intended), which makes people save some money, which they will spend elsewhere, thus increasing overall consumption. Moreover, resource recovering strategies for some products might result in greater environmental impacts, since reprocessing,

remanufacturing, refurbishing, or any other strategies, might require, for instance, greater energy than manufacturing a new product, be it due to the manufacturing itself or the transportation necessary for reverse logistics (for example). The takeaway here, in fact, is that the IFs identified in this thesis should not be used alone, but jointly with critical and analytical thinking, as well as tools, methods and frameworks that allow designing purposeful circular systems, which can really contribute to resource-saving and to lowering environmental impacts.

Moreover, the IFs validated in this thesis are said to be timeless, however, they are valid under the current BM conditions observed worldwide. Potential future changes in the world economy and resource availability/consumption might make CBMs stricter on the strategies towards resource use, thus, some IFs might not be important or might need change/adjustment to reflect their importance for measuring business model circularity either generally or within a given context.

Researchers, practitioners and governments can make use of the IFs validated here. In addition, these parties are entitled, may have the means, and may be interested in proposing and developing methods or instruments to measure business model circularity. Researchers might have greater interest in the issues behind each IF, why and what makes it important for circularity, helping understand their usefulness and applicability; whereas practitioners might have greater interest in what they can get out of making use of the IFs identified here, how they can make businesses thrive on a CBM perspective, and how they can make businesses less harmful, but without disregarding their economic basis. Governments, in their turn, may be interested in using them to direct public policies and develop incentives for private companies to engage in circular practises. Furthermore, approaches that are more global can unite researchers, practitioners and government in more focused and stronger actions developing worldwide networks to assist knowledge and technology sharing/transfer towards a more circular economy.

Opportunities on CBMs can be said to follow a lean perspective, hence, avoiding waste generation, or taking advantage of it when avoidance does not seem possible, seeking to get the most value out of it, environment and economy wise. According to organisations such as the Ellen MacArthur Foundation, companies that implement circular economy practises might find savings by the figure of millions of dollars a year. These figures, nevertheless, will highly depend on the type of business, its size, the revenue model and the customer segment it serves.

A few limitations to this study can be pointed. The number of respondents was small compared to the population dealt with. There were 6 respondents out of 111. This can lead to a premature conclusion of which IFs have the greatest importance for measuring business model circularity. The counterpoint to this limitation is that the respondents who provided complete answers were considered highly committed to research on CBM and would try to give the most unbiased responses based on their knowledge and expertise. Another limitation is the genericity of the set of IFs. Generic/general approaches are unlikely to fit all systems that might somehow be able to make use of them. The IFs identified and validated in this thesis were thought and designed to be general and did not intend to represent any one specific type of business model or to lean towards any specific building block. This is an initial investigation as research on CBMs can be said to be in its infancy, there being much more research to potentially contribute to this literature and practise body in the coming years and decades. To counterpoint this limitation, it is argued that the IFs are generic but potentially specifiable. As mentioned in section 3.2.1.3 (page 59), the IFs that composed the questionnaire for validation were the ones thought to better represent a set of related IFs. More specific approaches can further be tailored to the related IFs within a set in order to better represent a specific type of CBM, or directed to one BMBB.

Further research based on the present thesis and on CBMs can be expected to use the IFs validated in the present thesis to propose tools to assess business model circularity aiming to provide a quick analysis of the circularity status of businesses. Also, it could be expected that the proposed IFs go through further rounds of validation or that responses of other specialists in CBM be incorporated to the analysis made here and that both results be compared. Moreover, as already mentioned, depending on future economic scenarios, further IFs can be proposed and the same methods be used for validation, so that all validated IFs be incorporated to a more representative circularity assessment given the context that encouraged the consideration of the new IFs.

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APPENDIX A - Questionnaire for Initial Debugging

Table A.1 - Questionnaire for Initial Debugging

CRITERIA DEBUGGING

Name:

RETURN THIS TO
**********@mail.com

INSTRUCTIONS

***** Mark an X in the adequate field identifying whether the criterion is S**trategic (S)** (that is, it requires long-term planning and is realised by the top management, being of a more strategic nature and needing the entire organisation to be involved), **Tactic (T)** (that is, it requires medium-term planning, bridging strategic and operational actions, is generally realised by managers and requires more limited involvement, for example, at a departmental level) or **Operational (O)** (that is, it requires short-term planning, being of a more operational nature and being directly related to daily actions).

** If the assessed criterion is equal or extremely similar to any other criteria on the list, so that they can be unified/merged, identify the similar criterion's ID

******* If the criterion can be directly related to another criteria (upstream or downstream), please inform the criterion/criteria's ID

ID	CRITERION UNDER ASSESSMENT	* Strategic (S)	* Tactic (T)	* Operational (O)	** The criterion is equal or extremely similar to the following criterion/criteria (inform ID)	*** The criterion can be integrated to the following criterion/criteria (Inform ID)
1	additive manufacturing					
2	adopting a stewardship role					
3	avoiding product misuse / damaging behaviour					
4	building (products) to last					
5	cascading and repurposing					
6	closing resource flows/loops					
7	collaborating					
8	creating value from waste					
9	delivering functionality rather than ownership					
10	dematerializing					
11	design for X (DfX) (design for recycling, design for remanufacturing and reuse, design for disassembly, and design for environment)					
12	designing circular supply chains					
13	designing out waste					
14	developing scale up solutions					
15	downcycling					
16	ecolabels and certifications					
17	encouraging sufficiency					
18	engaging with end customers and stakeholders					
19	establishing effective communication with stakeholders					

20	establishing performance agreement (Product-as-a-Service (PSS) business model)					
21	establishing product care policies					
22	establishing product-service systems (PSS)					
23	establishing resource efficiency strategies (optimization of resources (saving energy, optimizing transportation means, etc))					
24	establishing result-oriented (Pay per service unit, Functional result) revenue models					
25	establishing take-back systems					
26	establishing waste management practises					
27	extending resource value					
28	green purchasing					
29	improving efficiency					
30	influencing consumer awareness					
31	innovation					
32	integrating industry 4.0 features					
33	leasing/renting					
34	managing company's environmental culture					
35	managing correct disposal/recycling					
36	managing customer cooperation					
37	maximising material and energy efficiency					
38	minimising resource use					
39	narrowing resource flows/loops					
40	offering refilling					
41	offering repair and maintenance					
42	preventing waste generation					
43	promoting a sharing economy					
44	promoting environmentally friendly material usage-driven practises (i.e., natural, recyclable, durable, easy to separate)					
45	promoting external resource (e.g.: waste) exchange					
46	promoting industrial symbiosis (waste exchange)					
47	promoting internal environmental management					
48	promoting internal resource (e.g.: waste) improvements					
49	promoting material/resource recovery					
50	promoting multiple cycles (materials and products)					
51	promoting online waste exchange platform					
52	promoting pay-per-use					
53	promoting product life extension					
54	promoting product value extension					
55	promoting reconditioning					
56	promoting recycling / secondary material use					
57	promoting refurbishment					
58	promoting remanufacturing					
59	promoting renewability					
60	promoting replacement of non-recyclable with recyclable materials					

61	promoting replacement of non-renewable with renewable resources					
62	promoting resource regeneration/restoration					
63	promoting reuse (products and services) (second-hand) and redistribution					
64	promoting reverse logistics					
65	promoting scalability and replicability					
66	promoting strategic partnerships along the supply chain					
67	promoting substitution with renewables and natural processes					
68	promoting the use of internet of things (IoT)					
69	promoting use-oriented (renting, leasing, subscription) systems					
70	promoting zero waste commitment					
71	reducing emissions					
72	reducing material leakage					
73	replacing resource input					
74	seeking support from stakeholders					
75	sharing					
76	slowing resource flows/loops					
77	stakeholder commitment					
78	understanding the local culture					
79	upcycling					
80	upgrading					
81	using cloud manufacturing					
82	virtualising					
83	waste collection and reintegration (upstream and or downstream)					
In case there are other criteria that can be used to assess business model circularity that were not included in the list above, please list them in the next rows, conducting the same assessment as the previous criteria on the list						

Source: Author (2019)

APPENDIX B - Questionnaire for IF Validation

Table B.1 - Questionnaire for IF Validation

Circular Economy Influencing Factors on Business Models

Identification

No personal information of any respondents will be disclosed to third parties. This section serves the purpose of keeping record of respondents' demographics and contact information in case of further queries.

Full Name (First, Middle and Last Name) (for identification in literature citations)

Institution/Organisation

Country

Email address

Relating Circularity Influencing Factors to CUSTOMER SEGMENTS

Please select the degree of importance of the listed influencing factors (IF) for managing circularity of business models in relation to CUSTOMER SEGMENTS (Considering the mass market, niche market, segmented market, diversified market or focus on a multi-sided platform).

How important is DEVELOPING STRATEGIC PARTNERSHIPS ALONG THE SUPPLY CHAIN to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENABLING MULTIPLE CYCLES (Materials and Products) to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENGAGING WITH END CUSTOMERS AND STAKEHOLDERS TOWARDS PARTNERSHIPS FOR CIRCULARITY to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

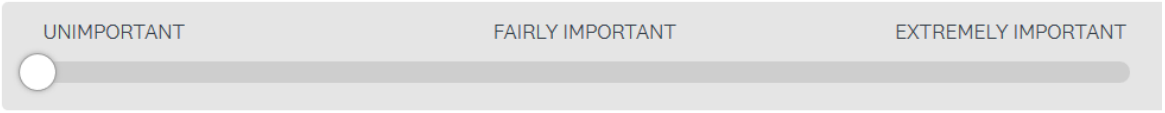
How important is DESIGNING OUT WASTE to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING INDUSTRIAL SYMBIOSIS to CUSTOMER SEGMENTS?

How important is CONDUCTING MATERIAL/RESOURCE RECOVERY to CUSTOMER SEGMENTS?

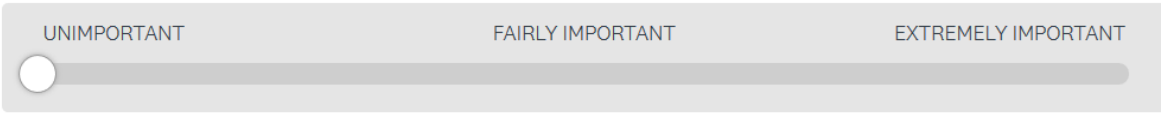
How important is PROMOTING REUSE to CUSTOMER SEGMENTS?



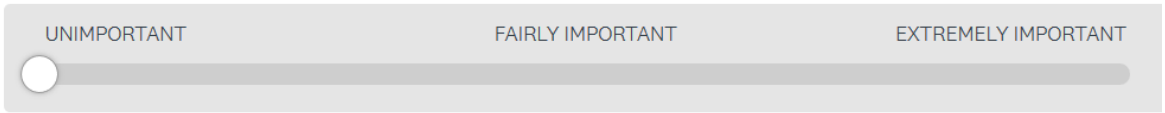
How important is CONDUCTING RECYCLING / SECONDARY MATERIAL USE to CUSTOMER SEGMENTS?

How important is CONDUCTING RECONDITIONING to CUSTOMER SEGMENTS?

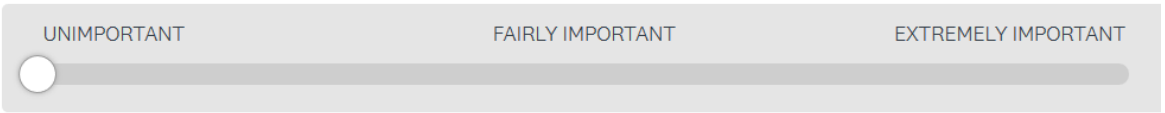
How important is REDUCING MATERIAL LEAKAGE to CUSTOMER SEGMENTS?



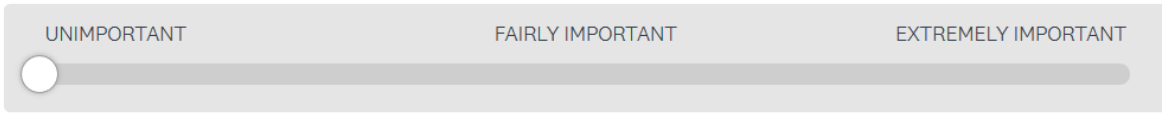
How important is CONDUCTING RESOURCE REGENERATION/RESTORATION to CUSTOMER SEGMENTS?



How important is CONDUCTING REPLACEMENT OF NON-RENEWABLE WITH RENEWABLE RESOURCES to CUSTOMER SEGMENTS?



How important is PROMOTING ENVIRONMENTALLY FRIENDLY MATERIAL USAGE-DRIVEN PRACTISES (i.e., Natural, Recyclable, Durable, Easy to Separate) to CUSTOMER SEGMENTS?



How important is CONDUCTING RESOURCE EFFICIENCY STRATEGIES (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc)) to CUSTOMER SEGMENTS?

How important is EXTENDING RESOURCE VALUE to CUSTOMER SEGMENTS?

How important is EXTENDING PRODUCT LIFE to CUSTOMER SEGMENTS?

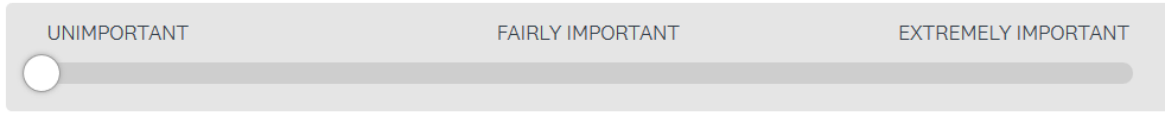
How important is ESTABLISHING TAKE-BACK SYSTEMS to CUSTOMER SEGMENTS?

How important is ESTABLISHING PRODUCT-SERVICE SYSTEMS (PSS) to CUSTOMER SEGMENTS?

How important is CONDUCTING REFURBISHMENT to CUSTOMER SEGMENTS?

How important is CONDUCTING REMANUFACTURING to CUSTOMER SEGMENTS?

How important is USING “BUILDING (Products) TO LAST” STRATEGIES to CUSTOMER SEGMENTS?



How important is ESTABLISHING PRODUCT CARE POLICIES to CUSTOMER SEGMENTS?

How important is ESTABLISHING PERFORMANCE AGREEMENT (Product-Service Systems) to CUSTOMER SEGMENTS?

How important is OFFERING REFILLING to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING REPAIR AND MAINTENANCE to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING UPGRADE to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING DEMATERIALISATION to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is INTEGRATING INDUSTRY 4.0 FEATURES TO INCREASE CIRCULARITY to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING THE USE OF INTERNET OF THINGS (IoT) to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING CLOUD MANUFACTURING to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING ADDITIVE MANUFACTURING to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONQUERING ECOLOGICAL LABELS AND CERTIFICATIONS to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING GREEN PURCHASING to CUSTOMER SEGMENTS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

Are there any other Influencing Factors that should be considered for promoting/managing business model circularity in relation to CUSTOMER SEGMENTS? (If yes, please list them below and separate them with semicolons)

Relating Circularity Influencing Factors to VALUE PROPOSITIONS

Please select the degree of importance of the listed influencing factors (IF) for managing circularity of business models in relation to VALUE PROPOSITIONS (Considering newness, performance, customisation, “getting the job done”, design, brand/status, price, cost reduction, risk reduction, accessibility or convenience/usability).

How important is DEVELOPING STRATEGIC PARTNERSHIPS ALONG THE SUPPLY CHAIN to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENABLING MULTIPLE CYCLES (Materials and Products) to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENGAGING WITH END CUSTOMERS AND STAKEHOLDERS TOWARDS PARTNERSHIPS FOR CIRCULARITY to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is DESIGNING OUT WASTE to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING INDUSTRIAL SYMBIOSIS to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING MATERIAL/RESOURCE RECOVERY to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING REUSE to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECYCLING / SECONDARY MATERIAL USE to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECONDITIONING to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is REDUCING MATERIAL LEAKAGE to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE REGENERATION/RESTORATION to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REPLACEMENT OF NON-RENEWABLE WITH RENEWABLE RESOURCES to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING ENVIRONMENTALLY FRIENDLY MATERIAL USAGE-DRIVEN PRACTISES (i.e., Natural, Recyclable, Durable, Easy to Separate) to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE EFFICIENCY STRATEGIES (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc)) to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING RESOURCE VALUE to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING PRODUCT LIFE to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

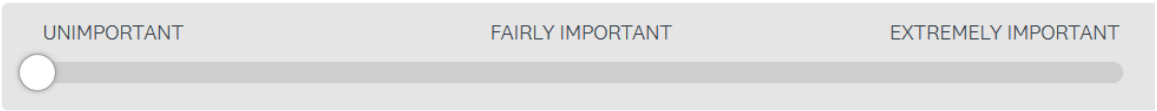
How important is ESTABLISHING TAKE-BACK SYSTEMS to VALUE PROPOSITIONS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT-SERVICE SYSTEMS (PSS) to VALUE PROPOSITIONS?

How important is CONDUCTING REFURBISHMENT to VALUE PROPOSITIONS?

How important is CONDUCTING REMANUFACTURING to VALUE PROPOSITIONS?



How important is USING “BUILDING (Products) TO LAST” STRATEGIES to VALUE PROPOSITIONS?

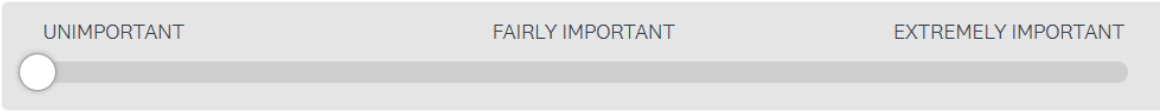
How important is ESTABLISHING PRODUCT CARE POLICIES to VALUE PROPOSITIONS?

How important is ESTABLISHING PERFORMANCE AGREEMENT (Product-Service Systems) to VALUE PROPOSITIONS?

How important is OFFERING REFILLING to VALUE PROPOSITIONS?

How important is OFFERING REPAIR AND MAINTENANCE to VALUE PROPOSITIONS?

How important is OFFERING UPGRADE to VALUE PROPOSITIONS?



How important is CONDUCTING DEMATERIALISATION to VALUE PROPOSITIONS?

How important is INTEGRATING INDUSTRY 4.0 FEATURES TO INCREASE CIRCULARITY to VALUE PROPOSITIONS?

How important is PROMOTING THE USE OF INTERNET OF THINGS (IoT) to VALUE PROPOSITIONS?

How important is USING CLOUD MANUFACTURING to VALUE PROPOSITIONS?

How important is USING ADDITIVE MANUFACTURING to VALUE PROPOSITIONS?

How important is CONQUERING ECOLOGICAL LABELS AND CERTIFICATIONS to VALUE PROPOSITIONS?

How important is CONDUCTING GREEN PURCHASING to VALUE PROPOSITIONS?

Are there any other Influencing Factors that should be considered for promoting/managing business model circularity in relation to VALUE PROPOSITIONS? (If yes, please list them below and separate them with semicolons)

Relating Circularity Influencing Factors to CHANNELS

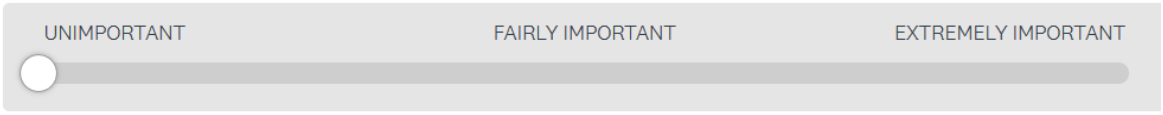
Please select the degree of importance of the listed influencing factors (IF) for managing circularity of business models in relation to CHANNELS (Considering the phases of awareness, evaluation, purchase, delivery and aftersales, for direct or indirect, own or partnered channels).

How important is DEVELOPING STRATEGIC PARTNERSHIPS ALONG THE SUPPLY CHAIN to CHANNELS?

How important is ENABLING MULTIPLE CYCLES (Materials and Products) to CHANNELS?

How important is ENGAGING WITH END CUSTOMERS AND STAKEHOLDERS TOWARDS PARTNERSHIPS FOR CIRCULARITY to CHANNELS?

How important is DESIGNING OUT WASTE to CHANNELS?



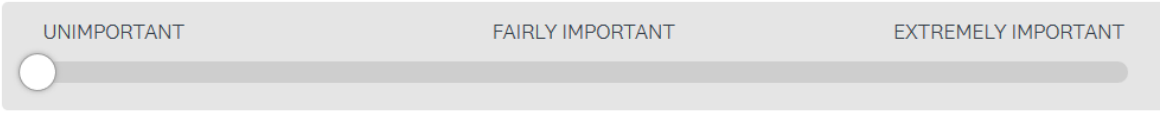
How important is CONDUCTING INDUSTRIAL SYMBIOSIS to CHANNELS?

How important is CONDUCTING MATERIAL/RESOURCE RECOVERY to CHANNELS?

How important is PROMOTING REUSE to CHANNELS?

How important is CONDUCTING RECYCLING / SECONDARY MATERIAL USE to CHANNELS?

How important is CONDUCTING RECONDITIONING to CHANNELS?



How important is REDUCING MATERIAL LEAKAGE to CHANNELS?

How important is CONDUCTING RESOURCE REGENERATION/RESTORATION to CHANNELS?

How important is CONDUCTING REPLACEMENT OF NON-RENEWABLE WITH RENEWABLE RESOURCES to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING ENVIRONMENTALLY FRIENDLY MATERIAL USAGE-DRIVEN PRACTISES (i.e., Natural, Recyclable, Durable, Easy to Separate) to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE EFFICIENCY STRATEGIES (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc)) to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING RESOURCE VALUE to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING PRODUCT LIFE to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING TAKE-BACK SYSTEMS to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT-SERVICE SYSTEMS (PSS) to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REFURBISHMENT to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REMANUFACTURING to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING “BUILDING (Products) TO LAST” STRATEGIES to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT CARE POLICIES to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PERFORMANCE AGREEMENT (Product-Service Systems) to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING REFILLING to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING REPAIR AND MAINTENANCE to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING UPGRADE to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING DEMATERIALISATION to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is INTEGRATING INDUSTRY 4.0 FEATURES TO INCREASE CIRCULARITY to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING THE USE OF INTERNET OF THINGS (IoT) to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING CLOUD MANUFACTURING to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING ADDITIVE MANUFACTURING to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONQUERING ECOLOGICAL LABELS AND CERTIFICATIONS to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING GREEN PURCHASING to CHANNELS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

Are there any other Influencing Factors that should be considered for promoting/managing business model circularity in relation to CHANNELS? (If yes, please list them below and separate them with semicolons)

Relating Circularity Influencing Factors to CUSTOMER RELATIONSHIPS

Please select the degree of importance of the listed influencing factors (IF) for managing circularity of business models in relation to CUSTOMER RELATIONSHIPS (Considering personal assistance, dedicated personal assistance, self-service, automated-service, communities and co-creation).

How important is DEVELOPING STRATEGIC PARTNERSHIPS ALONG THE SUPPLY CHAIN to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENABLING MULTIPLE CYCLES (Materials and Products) to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENGAGING WITH END CUSTOMERS AND STAKEHOLDERS TOWARDS PARTNERSHIPS FOR CIRCULARITY to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is DESIGNING OUT WASTE to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING INDUSTRIAL SYMBIOSIS to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING MATERIAL/RESOURCE RECOVERY to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING REUSE to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECYCLING / SECONDARY MATERIAL USE to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECONDITIONING to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is REDUCING MATERIAL LEAKAGE to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE REGENERATION/RESTORATION to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REPLACEMENT OF NON-RENEWABLE WITH RENEWABLE RESOURCES to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING ENVIRONMENTALLY FRIENDLY MATERIAL USAGE-DRIVEN PRACTISES (i.e., Natural, Recyclable, Durable, Easy to Separate) to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE EFFICIENCY STRATEGIES (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc)) to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING RESOURCE VALUE to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING PRODUCT LIFE to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING TAKE-BACK SYSTEMS to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT-SERVICE SYSTEMS (PSS) to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REFURBISHMENT to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REMANUFACTURING to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING “BUILDING (Products) TO LAST” STRATEGIES to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT CARE POLICIES to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PERFORMANCE AGREEMENT (Product-Service Systems) to CUSTOMER RELATIONSHIPS?

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How important is OFFERING REFILLING to CUSTOMER RELATIONSHIPS?

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How important is OFFERING REPAIR AND MAINTENANCE to CUSTOMER RELATIONSHIPS?

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How important is OFFERING UPGRADE to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING DEMATERIALISATION to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is INTEGRATING INDUSTRY 4.0 FEATURES TO INCREASE CIRCULARITY to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING THE USE OF INTERNET OF THINGS (IoT) to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING CLOUD MANUFACTURING to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING ADDITIVE MANUFACTURING to CUSTOMER RELATIONSHIPS?

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How important is CONQUERING ECOLOGICAL LABELS AND CERTIFICATIONS to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING GREEN PURCHASING to CUSTOMER RELATIONSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

Are there any other Influencing Factors that should be considered for promoting/managing business model circularity in relation to CUSTOMER RELATIONSHIPS? (If yes, please list them below and separate them with semicolons)

Relating Circularity Influencing Factors to REVENUE STREAMS

Please select the degree of importance of the listed influencing factors (IF) for managing circularity of business models in relation to REVENUE STREAMS (Considering asset sale, usage fee, subscription fees, lending/renting/leasing, licensing, brokerage fees and advertising).

How important is DEVELOPING STRATEGIC PARTNERSHIPS ALONG THE SUPPLY CHAIN to REVENUE STREAMS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENABLING MULTIPLE CYCLES (Materials and Products) to REVENUE STREAMS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENGAGING WITH END CUSTOMERS AND STAKEHOLDERS TOWARDS PARTNERSHIPS FOR CIRCULARITY to REVENUE STREAMS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is DESIGNING OUT WASTE to REVENUE STREAMS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING INDUSTRIAL SYMBIOSIS to REVENUE STREAMS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING MATERIAL/RESOURCE RECOVERY to REVENUE STREAMS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING REUSE to REVENUE STREAMS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECYCLING / SECONDARY MATERIAL USE to REVENUE STREAMS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECONDITIONING to REVENUE STREAMS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is REDUCING MATERIAL LEAKAGE to REVENUE STREAMS?

How important is CONDUCTING RESOURCE REGENERATION/RESTORATION to REVENUE STREAMS?

How important is CONDUCTING REPLACEMENT OF NON-RENEWABLE WITH RENEWABLE RESOURCES to REVENUE STREAMS?

How important is PROMOTING ENVIRONMENTALLY FRIENDLY MATERIAL USAGE-DRIVEN PRACTISES (i.e., Natural, Recyclable, Durable, Easy to Separate) to REVENUE STREAMS?

How important is CONDUCTING RESOURCE EFFICIENCY STRATEGIES (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc)) to REVENUE STREAMS?

How important is EXTENDING RESOURCE VALUE to REVENUE STREAMS?

How important is EXTENDING PRODUCT LIFE to REVENUE STREAMS?

How important is ESTABLISHING TAKE-BACK SYSTEMS to REVENUE STREAMS?

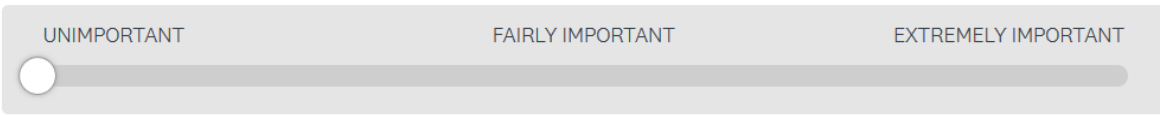
How important is ESTABLISHING PRODUCT-SERVICE SYSTEMS (PSS) to REVENUE STREAMS?

How important is CONDUCTING REFURBISHMENT to REVENUE STREAMS?

How important is CONDUCTING REMANUFACTURING to REVENUE STREAMS?

How important is USING “BUILDING (Products) TO LAST” STRATEGIES to REVENUE STREAMS?

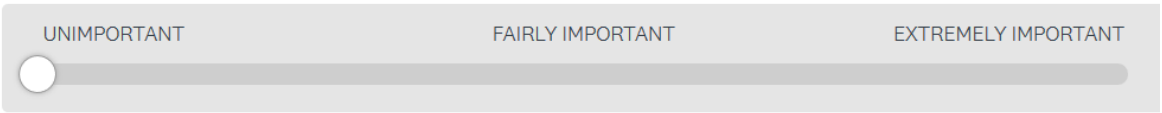
How important is ESTABLISHING PRODUCT CARE POLICIES to REVENUE STREAMS?



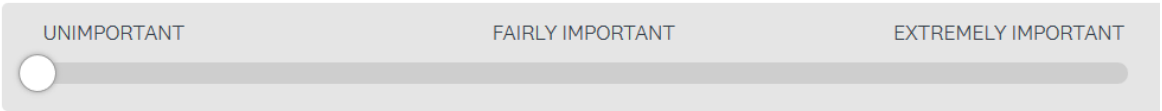
How important is ESTABLISHING PERFORMANCE AGREEMENT (Product-Service Systems) to REVENUE STREAMS?

How important is OFFERING REFILLING to REVENUE STREAMS?

How important is OFFERING REPAIR AND MAINTENANCE to REVENUE STREAMS?



How important is OFFERING UPGRADE to REVENUE STREAMS?

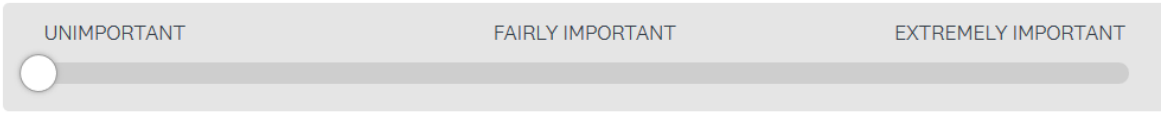


How important is CONDUCTING DEMATERIALISATION to REVENUE STREAMS?

How important is INTEGRATING INDUSTRY 4.0 FEATURES TO INCREASE CIRCULARITY to REVENUE STREAMS?

How important is PROMOTING THE USE OF INTERNET OF THINGS (IoT) to REVENUE STREAMS?

How important is USING CLOUD MANUFACTURING to REVENUE STREAMS?



How important is USING ADDITIVE MANUFACTURING to REVENUE STREAMS?

How important is CONQUERING ECOLOGICAL LABELS AND CERTIFICATIONS to REVENUE STREAMS?

How important is CONDUCTING GREEN PURCHASING to REVENUE STREAMS?

Are there any other Influencing Factors that should be considered for promoting/managing business model circularity in relation to REVENUE STREAMS? (If yes, please list them below and separate them with semicolons)

Relating Circularity Influencing Factors to KEY RESOURCES

Please select the degree of importance of the listed influencing factors (IF) for managing circularity of business models in relation to KEY RESOURCES (Considering intellectual, physical, human or financial resources, being them the company's own or from partners).

How important is DEVELOPING STRATEGIC PARTNERSHIPS ALONG THE SUPPLY CHAIN to KEY RESOURCES?

How important is ENABLING MULTIPLE CYCLES (Materials and Products) to KEY RESOURCES?

How important is ENGAGING WITH END CUSTOMERS AND STAKEHOLDERS TOWARDS PARTNERSHIPS FOR CIRCULARITY to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is DESIGNING OUT WASTE to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING INDUSTRIAL SYMBIOSIS to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING MATERIAL/RESOURCE RECOVERY to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING REUSE to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECYCLING / SECONDARY MATERIAL USE to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECONDITIONING to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is REDUCING MATERIAL LEAKAGE to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE REGENERATION/RESTORATION to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REPLACEMENT OF NON-RENEWABLE WITH RENEWABLE RESOURCES to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING ENVIRONMENTALLY FRIENDLY MATERIAL USAGE-DRIVEN PRACTISES (i.e., Natural, Recyclable, Durable, Easy to Separate) to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE EFFICIENCY STRATEGIES (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc)) to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING RESOURCE VALUE to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING PRODUCT LIFE to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING TAKE-BACK SYSTEMS to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT-SERVICE SYSTEMS (PSS) to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REFURBISHMENT to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REMANUFACTURING to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING “BUILDING (Products) TO LAST” STRATEGIES to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT CARE POLICIES to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PERFORMANCE AGREEMENT (Product-Service Systems) to KEY RESOURCES?

How important is OFFERING REFILLING to KEY RESOURCES?

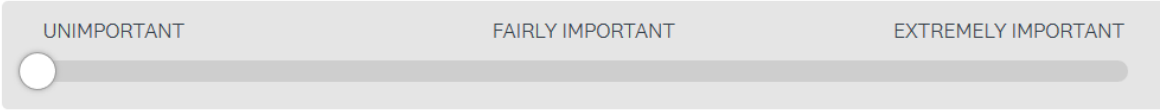
How important is OFFERING REPAIR AND MAINTENANCE to KEY RESOURCES?

How important is OFFERING UPGRADE to KEY RESOURCES?

How important is CONDUCTING DEMATERIALISATION to KEY RESOURCES?

How important is INTEGRATING INDUSTRY 4.0 FEATURES TO INCREASE CIRCULARITY to KEY RESOURCES?

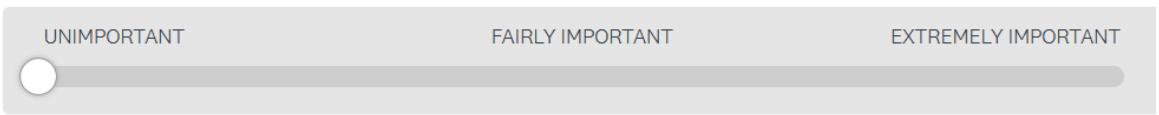
How important is PROMOTING THE USE OF INTERNET OF THINGS (IoT) to KEY RESOURCES?



How important is USING CLOUD MANUFACTURING to KEY RESOURCES?

How important is USING ADDITIVE MANUFACTURING to KEY RESOURCES?

How important is CONQUERING ECOLOGICAL LABELS AND CERTIFICATIONS to KEY RESOURCES?



How important is CONDUCTING GREEN PURCHASING to KEY RESOURCES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

Are there any other Influencing Factors that should be considered for promoting/managing business model circularity in relation to KEY RESOURCES? (If yes, please list them below and separate them with semicolons)

Relating Circularity Influencing Factors to KEY ACTIVITIES

Please select the degree of importance of the listed influencing factors (IF) for managing circularity of business models in relation to KEY ACTIVITIES (Considering all Key Activities for (e.g.) production, problem solving or platform/network).

How important is DEVELOPING STRATEGIC PARTNERSHIPS ALONG THE SUPPLY CHAIN to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENABLING MULTIPLE CYCLES (Materials and Products) to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENGAGING WITH END CUSTOMERS AND STAKEHOLDERS TOWARDS PARTNERSHIPS FOR CIRCULARITY to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is DESIGNING OUT WASTE to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING INDUSTRIAL SYMBIOSIS to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING MATERIAL/RESOURCE RECOVERY to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING REUSE to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECYCLING / SECONDARY MATERIAL USE to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECONDITIONING to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is REDUCING MATERIAL LEAKAGE to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE REGENERATION/RESTORATION to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REPLACEMENT OF NON-RENEWABLE WITH RENEWABLE RESOURCES to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING ENVIRONMENTALLY FRIENDLY MATERIAL USAGE-DRIVEN PRACTISES (i.e., Natural, Recyclable, Durable, Easy to Separate) to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE EFFICIENCY STRATEGIES (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc)) to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING RESOURCE VALUE to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is EXTENDING PRODUCT LIFE to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING TAKE-BACK SYSTEMS to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT-SERVICE SYSTEMS (PSS) to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REFURBISHMENT to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REMANUFACTURING to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING “BUILDING (Products) TO LAST” STRATEGIES to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT CARE POLICIES to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PERFORMANCE AGREEMENT (Product-Service Systems) to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING REFILLING to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING REPAIR AND MAINTENANCE to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING UPGRADE to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING DEMATERIALISATION to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is INTEGRATING INDUSTRY 4.0 FEATURES TO INCREASE CIRCULARITY to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING THE USE OF INTERNET OF THINGS (IoT) to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING CLOUD MANUFACTURING to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING ADDITIVE MANUFACTURING to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONQUERING ECOLOGICAL LABELS AND CERTIFICATIONS to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING GREEN PURCHASING to KEY ACTIVITIES?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

Are there any other Influencing Factors that should be considered for promoting/managing business model circularity in relation to KEY ACTIVITIES? (If yes, please list them below and separate them with semicolons)

Relating Circularity Influencing Factors to KEY PARTNERSHIPS

Please select the degree of importance of the listed influencing factors (IF) for managing circularity of business models in relation to KEY PARTNERSHIPS (Considering all Key Partnerships including (e.g.) strategic alliances with non-competitors, coopetition, joint-ventures or buyer-supplier relationships).

How important is DEVELOPING STRATEGIC PARTNERSHIPS ALONG THE SUPPLY CHAIN to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENABLING MULTIPLE CYCLES (Materials and Products) to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENGAGING WITH END CUSTOMERS AND STAKEHOLDERS TOWARDS PARTNERSHIPS FOR CIRCULARITY to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is DESIGNING OUT WASTE to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING INDUSTRIAL SYMBIOSIS to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING MATERIAL/RESOURCE RECOVERY to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING REUSE to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

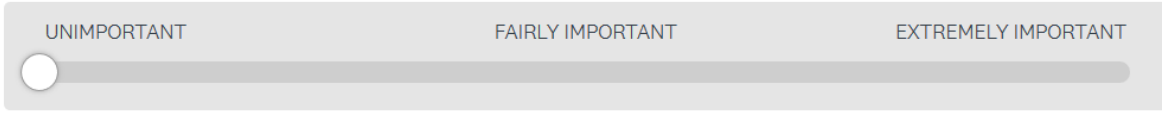
How important is CONDUCTING RECYCLING / SECONDARY MATERIAL USE to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECONDITIONING to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is REDUCING MATERIAL LEAKAGE to KEY PARTNERSHIPS?



How important is CONDUCTING RESOURCE REGENERATION/RESTORATION to KEY PARTNERSHIPS?

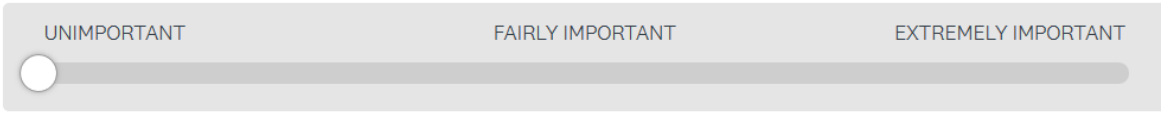
How important is CONDUCTING REPLACEMENT OF NON-RENEWABLE WITH RENEWABLE RESOURCES to KEY PARTNERSHIPS?

How important is PROMOTING ENVIRONMENTALLY FRIENDLY MATERIAL USAGE-DRIVEN PRACTISES (i.e., Natural, Recyclable, Durable, Easy to Separate) to KEY PARTNERSHIPS?

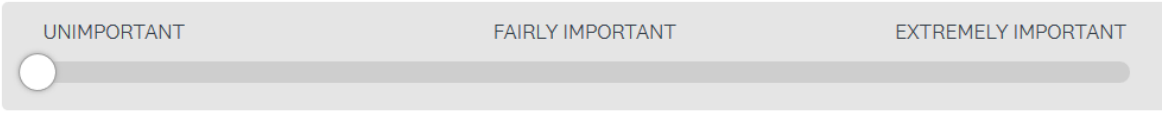
How important is CONDUCTING RESOURCE EFFICIENCY STRATEGIES (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc)) to KEY PARTNERSHIPS?

How important is EXTENDING RESOURCE VALUE to KEY PARTNERSHIPS?

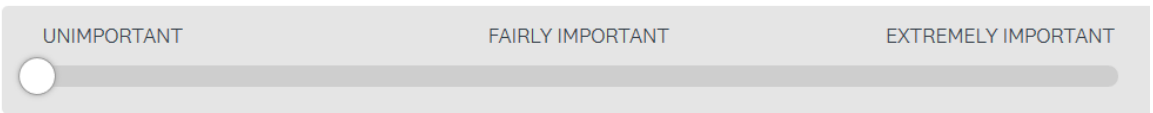
How important is EXTENDING PRODUCT LIFE to KEY PARTNERSHIPS?



How important is ESTABLISHING TAKE-BACK SYSTEMS to KEY PARTNERSHIPS?



How important is ESTABLISHING PRODUCT-SERVICE SYSTEMS (PSS) to KEY PARTNERSHIPS?



How important is CONDUCTING REFURBISHMENT to KEY PARTNERSHIPS?

How important is CONDUCTING REMANUFACTURING to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING “BUILDING (Products) TO LAST” STRATEGIES to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PRODUCT CARE POLICIES to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PERFORMANCE AGREEMENT (Product-Service Systems) to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING REFILLING to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING REPAIR AND MAINTENANCE to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING UPGRADE to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING DEMATERIALISATION to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is INTEGRATING INDUSTRY 4.0 FEATURES TO INCREASE CIRCULARITY to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING THE USE OF INTERNET OF THINGS (IoT) to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING CLOUD MANUFACTURING to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING ADDITIVE MANUFACTURING to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONQUERING ECOLOGICAL LABELS AND CERTIFICATIONS to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING GREEN PURCHASING to KEY PARTNERSHIPS?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

Are there any other Influencing Factors that should be considered for promoting/managing business model circularity in relation to KEY PARTNERSHIPS? (If yes, please list them below and separate them with semicolons)

Relating Circularity Influencing Factors to COST STRUCTURE

Please select the degree of importance of the listed influencing factors (IF) for managing circularity of business models in relation to COST STRUCTURE (Considering (e.g.) fixed costs, variable costs, economies of scale or economies of scope).

How important is DEVELOPING STRATEGIC PARTNERSHIPS ALONG THE SUPPLY CHAIN to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENABLING MULTIPLE CYCLES (Materials and Products) to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ENGAGING WITH END CUSTOMERS AND STAKEHOLDERS TOWARDS PARTNERSHIPS FOR CIRCULARITY to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is DESIGNING OUT WASTE to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING INDUSTRIAL SYMBIOSIS to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING MATERIAL/RESOURCE RECOVERY to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING REUSE to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECYCLING / SECONDARY MATERIAL USE to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RECONDITIONING to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is REDUCING MATERIAL LEAKAGE to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING RESOURCE REGENERATION/RESTORATION to COST STRUCTURE?

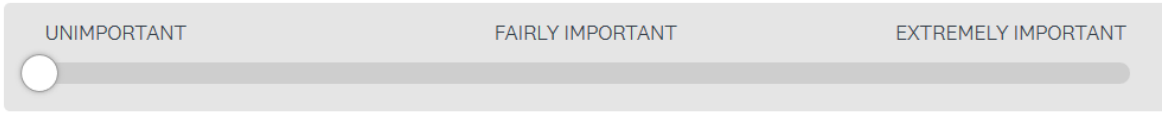
UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING REPLACEMENT OF NON-RENEWABLE WITH RENEWABLE RESOURCES to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING ENVIRONMENTALLY FRIENDLY MATERIAL USAGE-DRIVEN PRACTISES (i.e., Natural, Recyclable, Durable, Easy to Separate) to COST STRUCTURE?

How important is CONDUCTING RESOURCE EFFICIENCY STRATEGIES (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc)) to COST STRUCTURE?



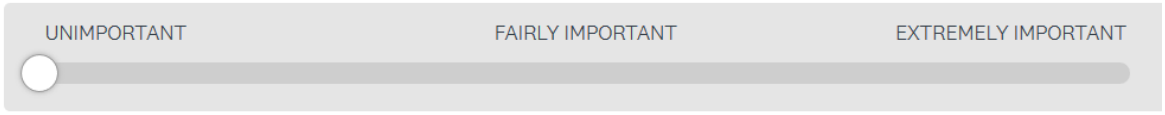
How important is EXTENDING RESOURCE VALUE to COST STRUCTURE?

How important is EXTENDING PRODUCT LIFE to COST STRUCTURE?

How important is ESTABLISHING TAKE-BACK SYSTEMS to COST STRUCTURE?

How important is ESTABLISHING PRODUCT-SERVICE SYSTEMS (PSS) to COST STRUCTURE?

How important is CONDUCTING REFURBISHMENT to COST STRUCTURE?



How important is CONDUCTING REMANUFACTURING to COST STRUCTURE?

How important is USING “BUILDING (Products) TO LAST” STRATEGIES to COST STRUCTURE?

How important is ESTABLISHING PRODUCT CARE POLICIES to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is ESTABLISHING PERFORMANCE AGREEMENT (Product-Service Systems) to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING REFILLING to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING REPAIR AND MAINTENANCE to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is OFFERING UPGRADE to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONDUCTING DEMATERIALISATION to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is INTEGRATING INDUSTRY 4.0 FEATURES TO INCREASE CIRCULARITY to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is PROMOTING THE USE OF INTERNET OF THINGS (IoT) to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING CLOUD MANUFACTURING to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is USING ADDITIVE MANUFACTURING to COST STRUCTURE?

UNIMPORTANT FAIRLY IMPORTANT EXTREMELY IMPORTANT

How important is CONQUERING ECOLOGICAL LABELS AND CERTIFICATIONS to COST STRUCTURE?

How important is CONDUCTING GREEN PURCHASING to COST STRUCTURE?

Are there any other Influencing Factors that should be considered for promoting/managing business model circularity in relation to COST STRUCTURE? (If yes, please list them below and separate them with semicolons)

Source: Author (2019)

APPENDIX C - List of Specialists for IF Validation

Table C.1 - List of Specialists the Researcher has Tried to Contact

Specialist's Name		
Adisa Azapagic	Gustavo Michelini	Palie Smart
Aldo R. Ometto	Helena Dahlbo	Paulo Augusto Cauchick Miguel
Alejandro Gallego-Schmid	Herman I. Stål	Pedro Núñez-Cacho
Alexandros Flamos	Hervé Corvellec	Pejvak Oghazi
Amir Rashid	Hidde-Jan Lemstra	Peter Hopkinson
Amit Kapoor	Ingrid De Pauw	Philip Hawkins
Ana Beatriz Lopes de Sousa Jabbour	Jan P. L. Schoormans	Pietro Previtali
Anastasia Ioannou	Janaina M.H. Costa	Rana Mostaghel
Anca Otilia Dodescu	Jarkko Levänen	Renata Nobre da Cunha
Andrea Urbinati	Joan Manuel F. Mendoza	Renato Nunes Moraes
Anna Aminoff	Johan Frishammar	Riina Antikainen
Antonella Zucchella	Julia L. K. Nußholz	Roberto Rinaldi
Arno Behrens	Juudit Ottelin	Ruth Mugge
Bram van der Grinten	KaisaManninen	Saku J. Mäkinen
Christiaan Kraaijenhagen	Katri Valkokari	Sandeep Goyal
Carolina De los Rios	Khaled Soufani	Sandra Naomi Morioka
Cheyenne S.C. Schuit	Laura Leinikka	Sarah Behnam
Colin A. Bom	Leena Aarikka-Stenroos	Sebastian Gatica
Conny Bakker	Leonidas Milios	Sebastian Văduva
Corrado Topi	Lucas Magalhães	Seppo Junnila
Daniela Cristina Antelmi Pigosso	Marco Perona	Silvia Liana Fotea
Davide Chiaroni	Marcus Linder	Sirkka Koskela
Eduardo Zancul	Maria Antikainen	Sotiris Papadelis
Elena Aurelia Botezat	Maria Sharmina	Stefan Gold
Ellis A. van den Hende	Mariale Moreno	Steve Evans
Enes Ünal	Mariale Moreno	Tatu Lyytinen
Erwin Hofman	Marina de Pádua Pieroni	Terence Tse
Farazee M. A. Asif	Mark Esposito	Terri Kafyeke
Federico Adrodegari	Mark Jolly	Thayla T. Sousa-Zomer
Fiona Charnley	Markus Zils	Thomas Wastling
Fiona Charnley	Marly Monteiro de Carvalho	Tim C. McAloone
Florian Ludeke-Freund	Martin Geissdoerfer	Valentín Molina-Moreno
Francisco A. Corpas-Iglesias	Martin Hirschnitz-Garbers	Valtteri Ranta
Francisco J. Cortés-García	Mateusz Lewandowski	Vasileios Rizos
Freja Nygaard Rasmussen	Mats Williander	Vesela Veleva
Gavin Bodkin	Michael Lieder	Vinit Parida
Giacomo Copani	Miying Yang	Vittorio Chiesa

Specialist's Name		
Gianmarco Bressanelli	Mukesh Kumar	Vivian S. C. Tunn
Göran Roos	Nancy M.P. Bocken	Wytze van der Gaast
Graeme Heyes	Nicola Saccani	Zoe Rowe

Source: Author (2019)

APPENDIX D - List of Specialists for IF Validation

Table D.1 - Validated Influencing Factors

Influencing Factor (IF)	Customer Segments	Value Proposition	Channels	Customer Relationships	Revenue Streams	Key Resources	Key Activities	Key Partnerships	Cost Structure
Developing Strategic Partnerships Along the Supply Chain	FIM	VIM	VIM	LIM	FIM	VIM	VIM	VIM	VIM
Enabling Multiple Cycles (Materials and Products)	VIM	FIM	VIM	NUI	VIM	FIM	VIM	VIM	VIM
Engaging With End Customers and Stakeholders Towards Partnerships for Circularity	VIM	VIM	VIM	VIM	VIM	FIM	FIM	VIM	NUI
Designing Out Waste	FIM	VIM	VIM	FIM	FIM	FIM	VIM	NUI	FIM
Conducting Industrial Symbiosis	NUI	NUI	FIM	NUI	FIM	FIM	FIM	VIM	VIM
Conducting Material/Resource Recovery	FIM	FIM	VIM	NUI	FIM	FIM	FIM	FIM	VIM
Promoting Reuse	VIM	VIM	VIM	FIM	VIM	FIM	FIM	FIM	VIM
Conducting Recycling / Secondary Material Use	FIM	FIM	FIM	NUI	FIM	FIM	FIM	VIM	FIM
Conducting Reconditioning	FIM	FIM	FIM	NUI	FIM	FIM	FIM	FIM	FIM
Reducing Material Leakage	NUI	NUI	FIM	NUI	NUI	FIM	FIM	NUI	VIM
Conducting Resource Regeneration/Restoration	NUI	FIM	NUI	NUI	FIM	NUI	FIM	FIM	VIM
Conducting Replacement of Non-Renewable with Renewable Resources	VIM	VIM	VIM	NUI	NUI	FIM	VIM	FIM	NUI
Promoting Environmentally Friendly Material Usage-Driven Practises (i.e., Natural, Recyclable, Durable, Easy to Separate)	VIM	VIM	FIM	FIM	NUI	NUI	FIM	FIM	NUI
Conducting Resource Efficiency Strategies (Optimisation of Resources (Saving Material and Energy, Optimising Transportation Means, etc.))	FIM	FIM	FIM	NUI	VIM	VIM	VIM	NUI	VIM
Extending Resource Value	FIM	FIM	NUI	NUI	FIM	FIM	FIM	FIM	FIM
Extending Product Life	VIM	FIM	NUI	FIM	FIM	FIM	FIM	FIM	FIM
Establishing Take-Back Systems	VIM	FIM	VIM	VIM	NUI	FIM	VIM	VIM	FIM
Establishing Product-Service Systems (PSS)	VIM	FIM	FIM	VIM	FIM	FIM	FIM	VIM	FIM

Influencing Factor (IF)	Customer Segments	Value Proposition	Channels	Customer Relationships	Revenue Streams	Key Resources	Key Activities	Key Partnerships	Cost Structure
Conducting Refurbishment	FIM	FIM	FIM	FIM	FIM	FIM	FIM	FIM	FIM
Conducting Remanufacturing	NUI	FIM	FIM	FIM	FIM	FIM	VIM	FIM	VIM
Using “Building (Products) to Last” Strategies	FIM	FIM	NUI	FIM	NUI	FIM	FIM	NUI	VIM
Establishing Product Care Policies	FIM	FIM	NUI	FIM	FIM	FIM	NUI	FIM	NUI
Establishing Performance Agreement (Product-Service Systems)	VIM	FIM	FIM	VIM	VIM	NUI	NUI	VIM	NUI
Offering Refilling	VIM	NUI	NUI	FIM	FIM	FIM	FIM	FIM	FIM
Offering Repair and Maintenance	VIM	FIM	FIM	VIM	VIM	VIM	VIM	FIM	FIM
Offering Upgrade	VIM	FIM	FIM	VIM	VIM	FIM	VIM	FIM	FIM
Conducting Dematerialisation	FIM	NUI	FIM	FIM	NUI	VIM	FIM	NUI	NUI
Integrating Industry 4.0 Features to Increase Circularity	FIM	FIM	FIM	FIM	NUI	FIM	FIM	VIM	FIM
Promoting the Use of Internet of Things (IoT)	VIM	FIM	VIM	VIM	FIM	FIM	FIM	VIM	VIM
Using Cloud Manufacturing	FIM	NUI	FIM	NUI	NUI	FIM	FIM	VIM	VIM
Using Additive Manufacturing	NUI	NUI	FIM	NUI	FIM	FIM	FIM	VIM	VIM
Conquering Ecological Labels and Certifications	FIM	NUI	NUI	FIM	NUI	NUI	NUI	NUI	NUI
Conducting Green Purchasing	FIM	FIM	FIM	NUI	NUI	NUI	FIM	FIM	FIM

Legend: UIM **- Unimportant,** VLI **- Very Little Important,** LIM **- Little Important,** NUI **- Neither Unimportant nor Important,** FIM **- Fairly Important,** VIM **- Very Important,** EIM **- Extremely Important**

Source: Author (2019)