Circular Business Models

Innovation Journeys towards a Circular Economy

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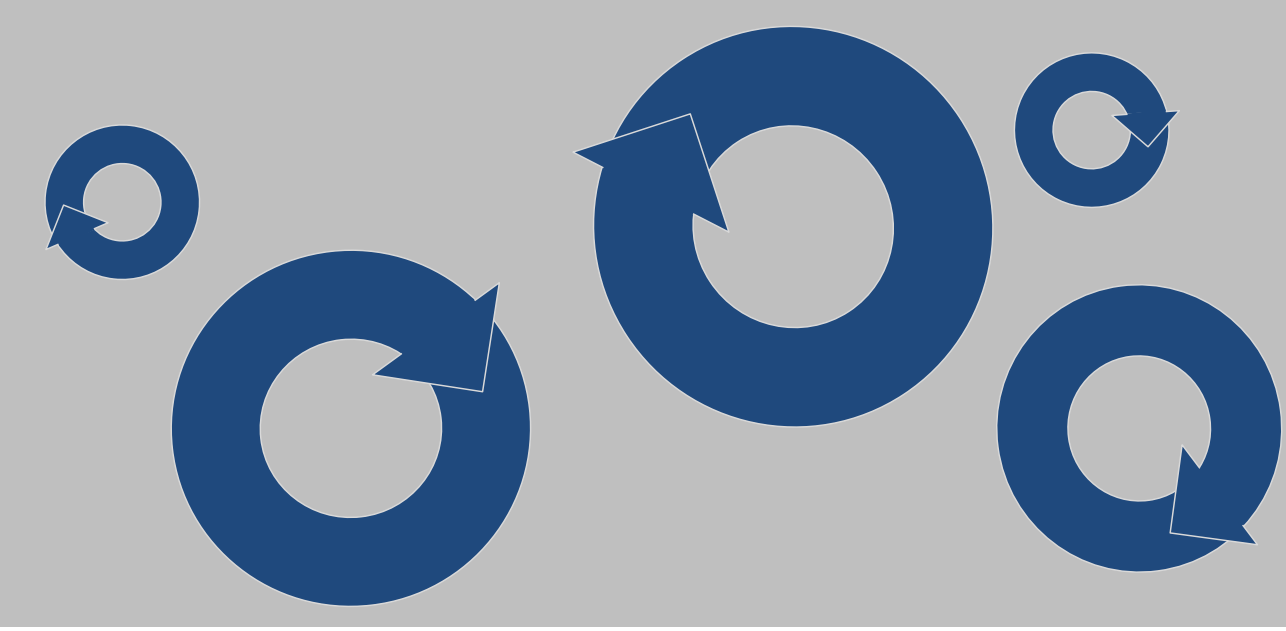

CIRCULAR BUSINESS MODELS

INNOVATION JOURNEYS TOWARDS
A CIRCULAR ECONOMY

BY
EVA GULDMANN

DISSERTATION SUBMITTED 2018

AALBORG UNIVERSITY
DENMARK

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by

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CV

Eva Guldmann (1976) is a PhD Fellow at the Department of Planning, Aalborg University. She holds a MSc in Engineering from the Technical University of Denmark in the field of Planning and Management and has more than ten years of industry experience.

Eva has worked with business intelligence and project management at companies such as LEGO Company and Bang & Olufsen, and her educational background and career has provided her with insight into the areas of research and development, procurement, marketing, sales and supply chain management.

Eva's research focuses on implementation of circular economy at the company level. This includes research into circular business models, business model innovation, the journey towards a circular economy, the role of business experimentation and other tools in circular business model innovation, as well as barriers to such innovation. Her research includes action research to co-create knowledge with industry, practice reviews and other qualitative research methods.

SUMMARY

In this PhD dissertation, the development of circular business models in companies is investigated. That is, the development of business models that align with a circular economy and seek to narrow, slow and close resource loops. Chapter 1 outlines the need for more radical approaches to integrate sustainability into the core of companies and shows that sustainable business model innovation is one possible avenue. However, there is a limited understanding of how companies can transition from their existing business paradigm to a more sustainable paradigm, in other words, there is a limited understanding of the business model innovation for sustainability processes and few guidelines to support companies in the journey. This research focuses on circular business model innovation, a type of sustainable business model innovation, and examines the main research question: *How can companies in different settings engage in circular business model innovation?*

The research takes its point of departure in a compilation of circular business models in operation that demonstrates that these are already implemented in different industries today and that a plethora of possible circular business model configurations exists. The compilation is available in the background report *Best Practice Examples of Circular Business Models*, published by the Danish Environmental Protection Agency.

Apart from the desk research conducted for the preparation of this collection of best practice examples, the main research method is action research in which a number of case companies are introduced to the circular economy and engage in circular business model innovation in collaboration with the researchers to generate and refine circular business model ideas. The details of this research design are described in Chapter 2.

The unfolding of the circular business model innovation process in eight of the case companies and preliminary results from the action research in these companies is described in the second background report *Towards Circular Business Models - Experiences from Eight Danish Companies,* also published by the Danish Environmental Protection Agency.

Empirical data from action research in a total of 13 case companies is analysed from different perspectives to examine four sub-questions pertaining to the main research question, the first of which is: *What are the barriers to circular business model innovation?* This question is investigated in Chapter 4 in a study which establishes multiple barriers to circular business model innovation and shows that these are found at the levels of employees, organisations, value chains and institutions.

The second sub-question relates to the facilitation of the innovation process and asks: *What could a design thinking framework tailored to circular business model innovation look like and what is the potential impact of such a framework?* These questions are addressed in Chapter 5 in a study which demonstrates that an adapted design thinking framework is useful in supporting the circular business model innovation process. The framework developed is accompanied by a few tools created specifically to support the circular business model innovation, which consist of a circular economy system diagram, idea maps, principles for circular business models, a collection of best practice examples and a circular business model canvas, most of which are found to be helpful in the innovation process.

The third sub-question asks: *How does the company setting affect the circular business model innovation process?* It is investigated in Chapter 6, where a model of three types of circular business model innovation is developed based on the literature and empirical data from research in the case companies. The model takes its point of departure in three different company settings defined by the existing business model type (i.e. linear or circular); the employees driving the circular business model innovation (i.e. staff or management); and the company's sustainability strategy (i.e. aimed at balancing profitable business and environmental improvements; at being more sustainable than competitors; or at having a net positive impact). The three different foundations for circular business model innovation result in dissimilar innovation processes in terms of the goal of the innovation process, the internal and external stakeholders involved, the characteristics of the experimentation that is conducted and the level of business model improvement that is achievable.

The analysis of barriers to circular business model innovation indicates that company size and customer segments do not influence, in a systematic way, the number or type of barriers that case companies encounter. Thus, all case companies experience barriers at the organisational, the value chain and at the institutional levels, and all but the circular start-ups also experience barriers at the employee level.

The final sub-question – *how can circular business model innovation support the overall organisational journey towards circular economy?* – is examined in Chapter 7. Based on in-depth analysis of one of the large case companies, the examinations demonstrate that circular business model innovation activities organised around experimentation can create transformation spaces that help reframe, i.e. unfreeze, locked-in structures and mind-sets. Together with complementary external events, the circular business model innovation activities can support the company's circular economy journey, i.e. a gradual move towards an integration of the circular economy paradigm in the company.

Findings are summed up in the conclusion in Chapter 8, and, building on the exploration of the sub-questions, the main research question – *how can companies in different settings engage in circular business model innovation?* – is answered.

A 'design thinking' inspired strategy to the innovation process centred around experimentation is found to be useful in all case companies regardless of the company setting, but the specific organisation of the process has to be adjusted to fit the individual company. For instance, the larger companies typically need to spend considerable time clarifying the company's position on circular economy, which the smaller companies do not.

Internal and external experimentation is found to be central to the circular business model innovation process, as it can facilitate a gradual reframing, i.e. an unfreezing, of old mind-sets and structures that could otherwise hinder a shift towards circular business models. The circular business model innovation process in the case companies can be organised into three categories: internal, hybrid and systemic circular business model innovation, each of which is related to a particular foundation for this kind of innovation.

Internal circular business model innovation is typical for companies that have a linear business model; that seek to balance profitable business and environmental improvement through well-established eco-efficiency methods; and where individual staff members drive the innovation process. The goal of this type of circular business model innovation is to get acquainted with circular economy and circular business model principles and commence internal dialogue oriented at clarifying the company position on circular business models. The circular business model innovation may result in the conception of an *internal circular business model* that narrows and closes resource loops within the company or within its existing value chain, but the business model of the core business is not affected by this.

The case company Danfoss, a large mechatronics company, exemplify this kind of innovation process. After a period of internal dialogue and experimentation with circular business model ideas, Danfoss is current investigating the opportunities for implementing an internal circular business model in the manufacturing department.

Hybrid circular business model innovation is linked to companies where the business model is linear; the aim is to become more sustainable than competitors through continuous improvements of the environmental performance; and the circular business model innovation process is driven by management. The generation of circular business model ideas that are tested through internal and external experimentation may result in a *hybrid circular business model* that slows and closes resource loops.

A hybrid circular business model innovation process is found, for instance, at case company KnowledgeCotton Apparel, a small men's fashion company. The business model idea that was developed during the research collaboration thus combines the current linear business model based on sales of new apparel with new circular repair services, sales of second-hand clothes and clothing recycling.

Systemic circular business model innovation is characteristic of companies whose core business is already circular; where the company aspires to have a net positive impact on society and actively pursues this objective via close collaboration with value chain partners; and where management drives the circular business model innovation process. The innovation process is characterised by a high degree of experimentation with external stakeholders through which the existing circular business model is refined to close, narrow and slow resource loops in a more optimal way.

The case company Better World Fashion, a circular fashion start-up, exemplifies this type of business model innovation. The company is based on leasing and sales of leather jackets made from recycled leather, has developed the remanufacturing processes in close collaboration with suppliers and progressively refines the existing circular business model to attain, for example, higher resource efficiency and closer interaction with the customers.

In sum, not all companies have the same foundation for circular business model innovation and the result of engaging in this kind of innovation will not necessarily be an integration of circular economy principles into the company's business model. Instead, the innovation process can facilitate a gradual change towards the integration of circular economy into the core business.

Organising the circular business model innovation in a flexible manner around internal and external experimentation inspired by design thinking principles and applying the developed tools resulted in the generation of more than 100 ideas to integrate into new circular business models in just a subset of the case companies, some of which were developed further and tested. Moreover, most case companies continue to work with circular business model innovation today, even after the research collaboration has ended. These are indications of the usefulness of the approach outlined to the innovation process.

This research focuses mainly on early-stage circular business model innovation and circular economy journeys, since the innovation process was initiated in most of the case companies *qua* the research collaboration. It would thus be relevant to include later stages of the innovation process, such as market testing, full-scale implementation and ongoing refinement of the circular business models in future research to attain a more complete view of the innovation process in its entirety. The research is also delimited to a primarily company-internal perspective on the innovation process, and it would be interesting to expand future research to consider the influence of a wider range of factors on the development of circular business models, for instance the importance of collaboration with value chain partners and customers or the importance of legislation and product-specific standards.

DANSK RESUMÉ

Denne afhandling handler om udvikling af cirkulære forretningsmodeller, som er forretningsmodeller, der støtter op om en cirkulær økonomi ved at indsnævre, bremse og lukke ressourcekredsløb. Kapitel 1 peger på behovet for at en ny tilgang til at sikre en bæredygtig udvikling, hvor bæredygtighed integreres i virksomhedernes kerne ved at nytænke forretningsmodellen. Udviklingen af nye og radikalt mere bæredygtige forretningsmodeller kræver et paradigmeskifte i virksomhederne, men der er begrænset viden om hvordan virksomheder kan lave dette skifte. Der er, med andre ord, begrænset forståelse af de processer, der knytter sig til udviklingen af bæredygtige forretningsmodeller og kun få guidelines virksomhederne kan støtte sig til på rejsen. Afhandlingen fokuserer på cirkulære forretningsmodeller, som er en særlig form for bæredygtig forretningsmodel, og undersøger hovedspørgsmålet:

Hvordan kan udviklingen af cirkulære forretningsmodeller initieres i virksomheder med forskelligt udgangspunkt herfor?

Forskningen tager udgangspunkt i en undersøgelse af praksis inden for cirkulære forretningsmodeller, som kan findes i baggrundsrapporten *Best Practice Examples of Circular Business Models*, der er publiceret af Miljøstyrelsen. Denne samling af cirkulære forretningsmodeller i drift viser, at der findes mange forskellige konfigurationer af cirkulære forretningsmodeller, og at de allerede er implementeret i forskellige industrier.

Bortset fra ovennævnte baggrundsrapport, som er udarbejdet på baggrund af eksisterende data ved hjælp af skrivebordsforskning, er case-baseret aktionsforskning det væsentligste metodiske fundament for undersøgelse af forskningsspørgsmålet. Vi har således introduceret langt størstedelen af de deltagende case-virksomheder til cirkulær økonomi og i samarbejde med virksomhederne undersøgt, hvorvidt der kunne være potentialer i cirkulære forretningsmodeller for den enkelte virksomhed. Vi har således sammen startet en innovationsproces, hvor virksomhederne har skabt ideer til cirkulære forretningsmodeller, har videreudviklet en eller to af disse idéer og har testet disse af via interne og eksterne eksperimenter. Detaljerne omkring forskningsdesignet er beskrevet i kapitel 2.

Den anden baggrundsrapport, *Towards Circular Business Models - Experiences from Eight Danish Companies,* som også er udgivet af Miljøstyrelsen, beskriver samarbejdet og foreløbige resultater i otte af case-virksomhederne og giver et indblik i hvordan udviklingen af cirkulære forretningsmodeller forløb i hver af disse otte virksomheder.

I afhandlingen analyseres empiriske data fra aktionsforskning i 13 case-virksomheder fra forskellige perspektiver for at undersøge fire underspørgsmål. Det første spørgsmål lyder: *Hvilke udfordringer oplever virksomhederne i udviklingen af cirkulære forretningsmodeller?* Dette spørgsmål afdækkes i kapitel 4 igennem en analyse af udvalgte case-virksomheder. Analysen identificerer en række barrierer, som virksomhederne støder på i løbet af udviklingsprocessen på medarbejder-, organisations-, værdikæde- og institutionelt niveau.

Det andet underspørgsmål handler om facilitering af innovationsprocessen: *Hvordan kan en 'design thinking' tilgang til innovation tilpasses til udviklingen af cirkulær forretningsmodeller, og hvad er effekten af at tage sådan en tilgang til innovationsprocessen?* Dette spørgsmål besvares i kapitel 5, hvor der udvikles en faseopdelt model, der også beskriver værktøjer, som kan støtte innovationsprocessen frem mod nye cirkulære forretningsmodeller. Værktøjerne omfatter et diagram over ressourcekredsløb i den cirkulære økonomi, en liste med principper for cirkulære forretningsmodeller, en samling af best practice eksempler på cirkulære forretningsmodeller og et værktøj til at skabe overblik over idéer til nye forretningsmodeller.

Det tredje underspørgsmål, *hvordan påvirker virksomhedernes forskellige udgangspunkter udviklingen af cirkulære forretningsmodeller?* søges besvaret i kapitel 6. Her udvikles, på baggrund af litteraturen og empiriske data fra forskningssamarbejdet med case-virksomhederne, en model, der beskriver tre forskellige kategorier af innovationsprocessen hen mod udviklingen af cirkulære forretningsmodeller med hver deres karakteristika. Modellen definerer udgangspunktet for udviklingsprocessen ved den eksisterende forretningsmodel og bæredygtighedsstrategi samt hvem der driver innovationsprocessen. Det viser sig at udgangspunktet påvirker hvilke interessenter, der involveres internt og eksternt, hvilke eksperimenter, der gennemføres i innovationsprocessen, målet med innovationsprocessen og hvilken grad af forbedringer af forretningsmodellen, der kan opnås.

Analysen af udfordringer i forbindelse med udviklingsprocessen, som blev omtalt tidligere, viser i øvrigt at case-virksomhedernes størrelse og om den er B2C eller B2B virksomhed ikke er afgørende for det antal barrierer eller typen af barrierer en virksomhed oplever. Det viser sig derimod, at alle case-virksomhederne oplever barrierer på medarbejder-, organisations-, værdikæde- og institutionelt niveau, bortset fra cirkulære opstartsvirksomheder, som ikke oplever barrierer på medarbejderniveauet.

Det fjerde og sidste underspørgsmål, *hvordan kan innovationsarbejdet i forbindelse med udviklingen af cirkulære forretningsmodeller støtte op om virksomhedens overordnede rejse mod en cirkulær økonomi?* undersøges i kapitel 7. En dybdegående analyse af én af de store case-virksomheder viser, at eksperimenter i forbindelse

med udviklingen af cirkulære forretningsmodeller, kan skabe 'forandringsrum', der hjælper med at løsne op for fastlåste organisatoriske strukturer og indstillinger hos medarbejderne. Sammen med eksterne begivenheder, der bl.a. påvirker de institutionelle rammer, kan innovationsarbejdet på den måde støtte virksomhedens rejse mode en cirkulær økonomi.

Resultaterne samles i konklusionen i kapitel 8, hvor de benyttes til at svare på hovedspørgsmålet: *Hvordan kan udviklingen af cirkulære forretningsmodeller initieres i virksomheder med forskelligt udgangspunkt herfor?*

Forskningsresultaterne viser, at en innovationsstrategi inspireret af 'design thinking', hvor der bl.a. er fokus på at eksperimentere, viser sig at være relevant for alle case-virksomhederne, uanset hvilket udgangspunkt de har for at indgå i udviklingsarbejdet med cirkulære forretningsmodeller. Den specifikke organisering af processen skal imidlertid tilpasses den enkelte virksomhed; eksempelvis har de større virksomheder ofte behov for at bruge tid på at afklare virksomhedens holdning til cirkulær økonomi inden, eller i parallel med, de egentlige udviklingsaktiviteter i modsætning til de mindre virksomheder. Interne og eksterne eksperimenter viser sig at være væsentlige for udviklingen af nye cirkulære forretningsmodeller, da eksperimenterne kan støtte op om en gradvis optøning af fastlåste indstillinger og strukturer, der ellers kunne hindre udviklingen af nye forretningsmodeller. Desuden kan innovationsprocessen hen imod cirkulære forretningsmodeller, som nævnt tidligere, inddeles i tre kategorier, som vi kalder intern, hybrid og systemisk innovation.

Intern innovation ses i virksomheder med en lineær forretningsmodel, hvor virksomheden bruger veletablerede redskaber i miljøarbejdet og løbende afvejer miljøforbedringer op imod økonomisk overskud og hvor medarbejdere driver udviklingsprocessen. Målet for denne type innovationsarbejde er at blive bekendt med cirkulær økonomi og med principperne for cirkulære forretningsmodeller, at få en fornemmelse for muligheder og udfordringer ved et skifte til cirkulære forretningsmodeller og at igangsætte en intern dialog der skal afklare om cirkulær økonomi er et koncept virksomheden ser som væsentligt for dens forretning fremover og derfor vil investere tid i at integrere i forretningen. Innovationsarbejdet kan resultere i udarbejdelsen af en *intern cirkulær forretningsmodel*, en betegnelse der bruges om integrationen af procedurer i virksomheden, der indsnævrer og lukker ressourcekredsløb uden at virksomhedens kerneforretning påvirkes heraf.

Innovationsprocessen hos case-virksomheden Danfoss er et eksempel på denne type innovation. I løbet af forskningssamarbejdet har virksomheden eksperimenteret med udviklingen af cirkulære forretningsmodeller på forskellig vis og har haft en løbende intern dialog, der gradvist har bidraget til at afklare Danfoss' position i forhold cirkulære forretningsmodeller. Det foreløbige resultat heraf er, at virksomheden har sat gang i udviklingen af en intern cirkulær forretningsmodel, der skal implementeres i produktionsafdelingen.

Hybrid innovation betegner en anden type innovationsproces hen imod cirkulære forretningsmodeller. Den findes hos virksomheder, hvor forretningsmodellen er lineær, hvor målet med miljøarbejdet er at være mere bæredygtig end konkurrenterne, hvilket opnås gennem løbende forbedringer af miljøindsatsen, og hvor ledelsen driver innovationsarbejdet. Denne type innovationsproces kan bidrage til at afklare forretningspotentialerne ved cirkulære forretningsmodeller ved at der genereres idéer til forretningsmodeller, som kan bremse og lukke ressourcekredsløb. Idéer som dernæst testes gennem intern og ekstern eksperimenteren. Virksomheder med dette udgangspunkt er i en god position til at skabe cirkulære servicer og/eller produktdesign, som integreres med kerneforretningens lineære forretningsmodel for derigennem at opnå en *hybrid cirkulær forretningsmodel*, som kombinerer lineære og cirkulære forretningsmodelelementer.

En forretningsmodel af denne type ses for eksempel i case-virksomheden KnowledgeCotton Apparel, der beskæftiger sig med herremode. De idéer til udviklingen af en ny forretningsmodel, der blev genereret i løbet af forskningssamarbejdet i denne virksomhed, kombinerer således den nuværende lineære forretningsmodel, som er baseret på salg af nyt herretøj, med cirkulære servicer som reparation, salg af brugt tøj og indsamling af tøj til genanvendelse.

Endelig er *systemisk innovation* karakteristisk for virksomheder, hvis forretningsmodel allerede er cirkulær, hvor virksomheden ønsker at have en positiv indflydelse på samfundet og aktivt forfølger dette mål gennem tæt samarbejde med partnere i værdikæden og hvor ledelsen driver innovationsarbejdet. Innovationsarbejdet i denne type udviklingsproces er præget af en høj grad af eksperimenteren sammen med eksterne interessenter. Erfaringerne herfra bruges til at forbedre den eksisterende cirkulære forretningsmodel successivt og indsnævre, bremse og lukke ressourcekredsløb på en mere optimal måde og derigennem skabe en *systemisk cirkulær forretningsmodel*.

Den danske cirkulære opstartsvirksomhed Better World Fashion, der er baseret på leasing og salg af jakker af genbrugt læder, er et eksempel på denne type innovationsproces. Virksomheden har udviklet genfremstillingsprocesserne i tæt samarbejde med de, der syr jakkerne, og Better World Fashion forbedrer løbende forretningsmodellen med henblik på eksempelvis højere ressourceeffektivitet eller tættere kontakt til kunderne.

For at opsummere, så har virksomhederne forskelligt udgangspunkt for udviklingen af cirkulære forretningsmodeller og resultatet af at initiere denne form for udviklingsproces er ikke nødvendigvis en integration af cirkulære principper i den forretningsmodel kerneforretningen benytter sig af. I stedet kan en innovationsproces, som er tilpasset den enkelte virksomhed, facilitere en gradvis bevægelse hen imod integrationen af cirkulære principper i kerneforretningen.

Innovationssamarbejdet med case-virksomhederne byggede på en fleksibel organisering af udviklingsarbejdet, inspireret af 'design thinking' og med fokus på eksperimenter. Anvendelsen af denne tilgang i kombination med de udviklede redskaber resulterede i generering af mere end 100 idéer til integration i cirkulære forretningsmodeller blandt en delmængde af case-virksomhederne, og nogle af disse idéer blev videreudviklet og testet på forskellig vis. Desuden, har de fleste case-virksomheder valgt at arbejde videre med cirkulær forretningsudvikling efter afslutning af forsknings- og innovationssamarbejdet. Disse resultater indikerer at den beskrevne tilgang til innovationsprocessen var hensigtsmæssig.

Forskningen i denne afhandling fokuserer primært på de tidlige stadier af udviklingen af cirkulær forretningsmodeller og rejsen mod en cirkulær økonomi, da det var samarbejdet med forskerne, der initierede innovationsprocessen i de fleste af case-virksomhederne. Det ville derfor være gavnligt at inkludere senere stadier af innovationsprocessen så som markedstest, udrulning og løbende forbedring af den cirkulære forretningsmodel i fremtidig forskning, sådan at der kan skabes en fyldestgørende forståelse af innovationsprocessen i sin helhed. Forskningen tager desuden et virksomheds-internt perspektiv på innovationsprocessen, og det ville være interessant at udvide fremtidig forskning til at inkludere andre perspektiver. Eksempelvis ved at afdække hvilken betydning innovationssamarbejder med partnere i værdikæden og kunder har for udviklingen af cirkulære forretningsmodeller i virksomhederne eller hvilken betydning lovgivning og produktspecifikke standarder har.

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Eva Guldmann

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CHAPTER 1. INTRODUCTION

The problem field and the main research question are introduced in this chapter, and the three key concepts that the research is built upon are defined, namely circular economy, circular business models and circular business model innovation. The introduction is based on articles C, D and F and book chapter E.

1.1. FROM MANUFACTURING EFFICIENCY TO NEW BUSINESS MODELS

Human activities and resource consumption already induce climate change and diminish natural capital at a rate faster than it can be replenished, resulting in a deterioration of the ecological systems upon which our societies depend (Earth Overshoot Day, 2017; WWF, 2016). With a rising global population and a larger part of the population moving into the middle class, these problems will continue to grow unless swift action is taken (WBCSD, 2010; Earth Overshoot Day, 2017).

The need for sustainable development was acknowledged decades ago, for instance by the World Commission on Environment and Development (WCED), which made clear the necessity of changing the way we consume and produce goods and emphasised the key role of companies in this endeavour (WCED, 1987). Elkington (1997) later suggested that companies employ a triple bottom line in which equal attention is given to economic prosperity, environmental protection and social equity as a means of supporting a shift to sustainable development.

Companies can adopt different strategies to integrate economic, environmental and social sustainability in their business. These strategies can be divided into three categories (see Figure 1-1), each associated with a certain level of modifications to the existing business model (Adams et al., 2016; Schaltegger et al., 2012). The first category of sustainability strategy, denoted 'operational optimisation', aims to optimise efficiency in manufacturing and in other business operations to minimise harm to the environment, typically as a response to regulatory stimuli or driven by economic benefit from improved efficiencies. The innovation for sustainability at companies with this strategy is oriented at the use of cleaner production, efficiency improvements and eco-design of products, which require little, if any, changes to the business model (Adams et al., 2016; Schaltegger et al., 2012). More than two-thirds of all companies have adopted this incremental, technical innovation for sustainability strategy, while less than a third have taken additional steps to arrive at the second category of strategy, denoted 'organisational transformation' (Adams et al., 2016).

The organisational transformation strategy represents a shift in mindset regarding sustainability and the company's purpose in society from doing less harm (in the first category) to creating value for multiple stakeholders (Adams et al., 2016). Practices employed include lifecycle thinking and environmental management systems that are more embedded in the culture of the company than the operational optimisations in the first category of sustainability strategy. The organisational transformation strategy encompasses collaboration with direct stakeholders up and down the value chain such as customers and suppliers to create mutual value through novel products, services or business models. Sustainable supply chain management operationalised via environmental management certifications or supplier codes of conduct is a case in point (Adams et al., 2016). Occasional changes to one or more elements of the existing business model to improve its sustainability are typical at companies with this kind of sustainability strategy, but the core business is not challenged in connection with these changes (Schaltegger et al., 2012).

Figure 1-1. Sustainability strategies. Adapted from Adams et al. (2016) and Schaltegger et al. (2012).

The predominantly incremental product, process and technological innovations that the operational optimisation and organisational transformation strategies produce, move companies in the right direction, but are considered insufficient to transform industry and society towards sustainable development (Abdelkafi and Täuscher, 2016; Ceschin and Gaziulusoy, 2016; Short et al., 2014). Instead, more radical innovation that integrates sustainability into the core of the business model is needed (Bocken et al., 2014), corresponding to the third category of sustainability strategy, 'systems building'.

Companies with a 'systems building' strategy collaborate with multiple stakeholders to create novel products, services or business models that induce system-level changes, and the goal for the company is to ultimately have a net positive impact on

society (Adams et al., 2016). Sustainability is an integral part of the business model for this group of companies and they are open to more fundamental changes to their business model including changes to the revenue logic of the core business (Schaltegger et al., 2012). However, the number of companies that have adopted this kind of strategy up to now is still limited (Adams et al., 2016).

The description of the different sustainability strategies has demonstrated that changes to the business model is an increasingly important element in the innovation for sustainability activities moving from the first to the second and from the second to the third category of sustainability strategy. Such sustainable business model innovation, which can encompass both the product and service innovation to which Adams et al. (2016) refer, is considered an avenue to the aforementioned integration of sustainability into the core business (Abdelkafi and Täuscher, 2016; Short et al., 2014; Schaltegger et al., 2012) and a driver for industry transformation and socio-technical changes (Bocken et al., 2013; Boons and Lüdeke-Freund, 2013; Geissdoerfer et al., 2017b, 2016; Porter, 2002; Short et al., 2014).

This dissertation focuses on circular business model innovation (CBMI), a type of sustainable business model innovation concerned with the development of business models that build on circular economy (CE) principles, denoted circular business models (CBMs) (Bocken et al., 2014; Linder and Williander, 2017; Nußholz, 2017). CE is an emerging sustainability paradigm that aligns with the third category of sustainability strategy (Adams et al., 2016) and, albeit primarily integrating the economic and environmental pillars of sustainability (Geissdoerfer et al., 2017a), CBMI is thus a potential driver for a move to the next level of business sustainability.

1.2. MAIN RESEARCH QUESTION

Technologies, tools and guidelines to support the companies that have adopted the first two categories of sustainability strategy are readily available, e.g. cleaner production technologies, eco-design guidelines and environmental management systems (see e.g. Kørnøv et al., 2007).

However, developing and implementing new circular business models to integrate sustainability at the core of a company is different from implementing end-of-pipe technologies and new procedures at the operational level (in the first two categories of sustainability strategy), and there is a lack of scholarly studies covering the innovation for sustainability processes in companies that have adopted the third kind of sustainability strategy (Adams et al., 2016). The result is a limited understanding of the business model innovation for sustainability process (Roome and Louche, 2016) and few tools available to support companies in the process (Geissdoerfer et al., 2016). Moreover, the emerging CBMI literature does not address whether different company settings, e.g. in terms of the existing sustainability strategy, affect

how the CBMI process is best organised or the outcome from it. To address these weaknesses in the literature the main research question of this dissertation is:

How can companies in different settings engage in circular business model innovation?

I applied an action research methodology to examine this question, collaborating with a number of companies to develop new circular business models. The research was built upon three conceptual pillars, i.e. CE, CBM and CBMI, which are presented briefly in the following sections and elaborated upon in reports A and B; articles C, D and F; and in book chapter E.

1.3. CIRCULAR ECONOMY

A linear economy has been the prevalent economic model since the Industrial Revolution in the late 18th century. In the linear economy, virgin raw materials are extracted and processed into products that then are sold to customers, who use them for a given time, depending on the type of product, before ultimately disposing of them. The disposed products are landfilled or incinerated with little attempt to recover the products or embedded materials (Ellen MacArthur Foundation, 2013).

In contrast, a circular economy is one that is ideally *'restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles'* (Ellen MacArthur Foundation, 2012, p. 2). The system diagram in Figure 1-2 offers an illustration of the basic technical and biological resource loops of a CE.

A CE is comprised of activities that reduce, reuse and recycle materials in our production, distribution and consumption systems (Murray et al., 2017) in ways that narrow, close or slow resource loops (Bocken et al., 2016; Stahel, 1981). Not all activities, however, contribute to integrating sustainability at the core of the company.

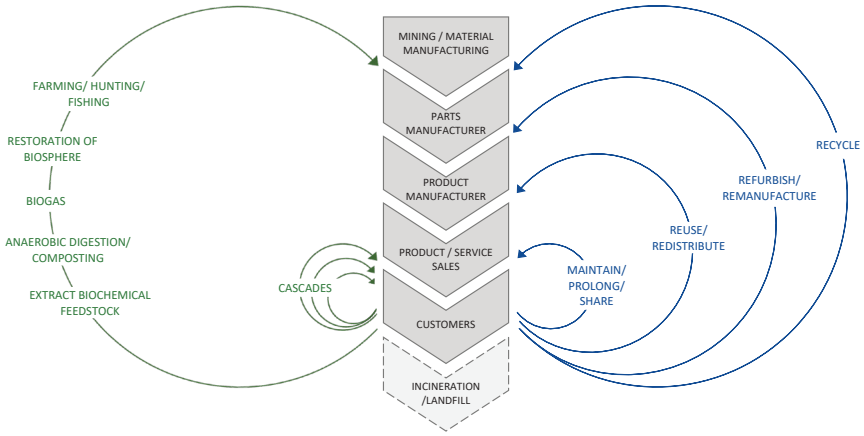

Figure 1-2. Circular economy system diagram. Adapted from Ellen MacArthur Foundation (2015).

Narrowing resource loops is about *'reducing resource use associated with the product and production process'* (Bocken et al., 2016, p. 310), which means it is a strategy that *'does not influence the speed of the flow of products and does not involve any service loops (e.g. repair)'* (Bocken et al., 2016, p. 310). A narrowing of resource loops does not demand any business model innovation and is a strategy implemented at the operational level of several companies today in the form of cleaner and lean manufacturing and dematerialisation in product design.

Resource loops are *closed* by recycling post-use materials and re-injecting them into the production system to attain a circular flow of materials (Bocken et al., 2016; Stahel, 2010). Recycling is a strategy that builds on the outermost (cf. Figure 1-2) and least advantageous resource loop (Ellen MacArthur Foundation, 2013).

Slowing resource loops is a third strategy based on an extended and/or intensified product utilisation period that slows the flow of resources through the economy (Bocken et al., 2016). This strategy builds on the inner resource loops of a CE by facilitating sharing, offering maintenance, reuse/redistribution services or refurbishment/remanufacturing/retrofitting services (Bocken et al., 2016; Ellen MacArthur Foundation, 2013; 2015).

The outcome of narrowing and of slowing resource loops could be the same, namely fewer resources flowing through the economy, but as noted by Bocken et al. (2016, p. 310) *'(...) "slowing" invokes a different relationship with time, whereas "narrowing" accepts the speed of resource flows'* and considering only a narrowing of flows carries the risk of leading to *'further speeding up of linear resource flows (selling more of a more efficient product), resulting in very little overall savings'* (2016, p. 310).

A more efficient use of resources is a relevant supplement to strategies that either close or slow resource loops, but, as explained previously, this strategy does not in itself qualify as a strategy for circulating products and materials and thus for moving towards a CE nor does a narrowing strategy in itself integrate sustainability at the core of a company.

On a similar note, systems and markets for recycled materials are partly in place today and although much more could be done in terms of improving product designs for more efficient recycling, in terms of using more recycled materials and in terms of building more resilient networks around the recycling of materials (Singh and Ordoñez, 2016), recycling strategies are predominantly implemented at an operational level of the company (i.e. at the first level of Figure 1-1) similar to a narrowing strategy.

This means, that neither strategies to narrow nor closed resource loops are optimally positioned to usher in the radical changes needed to bring sustainability into the core of companies and to move towards sustainable development. A sustainability strategy aimed at slowing resource loops, on the other hand, will tend to move sustainability to a strategic level of the company via new CBMs.

1.4. CIRCULAR BUSINESS MODELS

A business model is a blueprint of how a company does business (Magretta, 2002; Osterwalder and Pigneur, 2010; Richardson, 2008; Teece, 2010) and consists of a minimum of three fundamental elements:

1. A *value proposition* (i.e. the product and service offering)
2. A *value creation and delivery system* that enables the company to generate products and service offerings and deliver them to customers by building on the company's internal resources and capabilities, its value chain, activity system, business processes, suppliers, partners, and customers
3. A *value capture system* that enables the company to generate turnover and profit from its revenue sources, and describes the economics of the business (Richardson, 2008)

The components of a business model are outlined in a slightly different way by Osterwalder and Pigneur (2010), but their elements associate with the elements Richardson (2008) suggests and can be visualised using a business model canvas (cf. Figure 1-3).

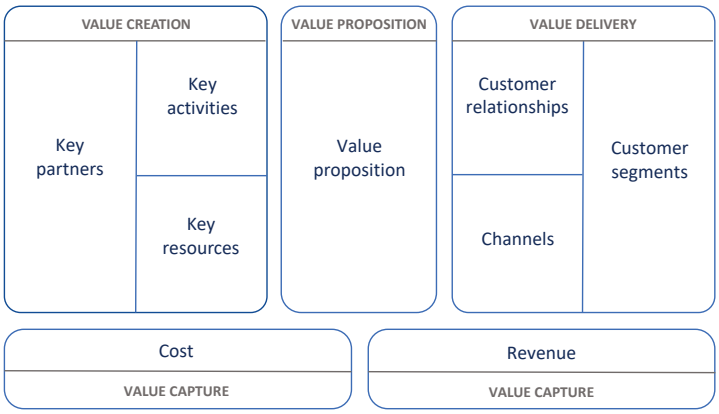

Figure 1-3. Business Model Canvas. Adapted from Osterwalder and Pigneur (2010) and Richardson (2008).

The business model elements are described in the following way by Osterwalder and Pigneur (2010, p. 16-17):

- *'An organisation serves one or several customer segments*
- *It seeks to solve customer problems and satisfy customer needs with value propositions*
- *Value propositions are delivered to customers through communication, distribution and sales channels*
- *Customer relationships are maintained with each customer segment*
- *Revenue streams result from value propositions successfully offered to customers*
- *Key resources are the assets required to offer and deliver the previously described elements...*
- *...by performing a number of key activities*
- *Some activities are outsourced [to key partners] and some resources are acquired outside the enterprise [from other key partners]*
- *The business model elements result in the cost structure'.*

A business model configured in line with the prevailing take-make-dispose paradigm (Ellen MacArthur Foundation, 2013) is a linear business model, which is by far the most typical today. Linear business models create economic value only for the actors in the value chain (i.e. the focal firm and its partners, suppliers and customers) (Amit and Zott, 2010). By contrast, a sustainable business model entails a broader understanding of value and stakeholders because it *'captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organisational boundaries'* (Schaltegger et al., 2016, p. 6).

A CBM is a particular type of sustainable business model (Adams et al., 2016; Bocken et al., 2014; Geissdoerfer et al., 2018) that integrates environmental and economic value creation by preserving the embedded value of products at the highest possible level of utility (Velte and Steinhilper, 2016; Webster, 2015) via business model strategies that either slow or close resource loops and possibly supplement the model with a narrowing of loops as outlined previously.

CBMs are instrumental in attaining a CE (Bakker et al., 2014b; Lieder and Rashid, 2016; Nußholz, 2017) but the adoption of CBMs denotes a significant shift in business logic from generating profits from one-time sales of goods to generating profits from a continual flow of reused products or materials over time (Bakker et al., 2014a) and capitalising on the value embedded in used products (Bocken et al., 2016; Linder and Williander, 2017).

The exploitation of the residual value of products after use necessitates a return flow from users to manufacturers, which is enabled by, for example, product design features that allow for repairs, reuse, remanufacturing, etc. (Bakker et al., 2014a; Bundgaard, 2016) as well as by take-back and leasing schemes (Linder and Williander, 2017; Stål and Corvellec, 2018). Activities related to a CBM do not have to be operated by the focal company itself (Linder and Williander, 2017); instead, CBMs often encompass a network of value chain partners (Krystofik et al., 2017; Schenkel et al., 2015; Wells and Seitz, 2015; Whalen and Nußholz, 2016).

1.5. CIRCULAR BUSINESS MODEL INNOVATION

To develop and ultimately implement these new business models, companies must engage in a process of business model innovation (e.g. Mitchell and Coles, 2003; Osterwalder and Pigneur, 2010). In start-ups, the process results in the design of an entirely new business model, whereas in incumbents the process is concerned with rethinking and redesigning the current business model (Amit and Zott, 2010).

Via business model innovation, companies develop business models that integrate CE principles relating to the slowing and closing of resource loops (Nußholz, 2017, 2018), and this innovation is recognised as an important element in the shift towards a CE in the literature (Bakker et al. 2014b; Planing, 2015).

In the CBMI process, the configuration of the nine individual business model elements illustrated in Figure 1-3 is considered along with how the elements should work together to integrate CE principles and provide economic and environmental value to multiple stakeholders (e.g. Geissdoerfer et al., 2018; Nußholz, 2017, 2018). Business model innovation is a distinct innovation discipline separate from other kinds of innovation such as product and process innovation (Amit and Zott, 2010), but

because products and processes are integral parts of the business model blueprint, it can certainly involve those elements, too.

The CBMI is organised around a business logic which creates and recreates value along the product lifecycle with less environmental impact and which replaces the traditional, linear economy-based, single-use business logic (Nußholz, 2018). The business model must be designed carefully because it *'needs to consider how business model elements are configured to support each of the envisioned cycles for value preservation and utilisation'* (Nußholz, 2018, p. 187), in other words, the value creation architecture has to be established for every time a product enters a resource loop.

In this dissertation, circular business model innovation (CBMI) includes not only the concrete business model redesign activities but the entire process of considering what areas of an incumbent would benefit from a CBM, generating CBM ideas within those areas and selecting from among those a few ideas to develop and test.

CBMI, as any innovation, takes place within a given social, organisational and individual setting which shapes the process (Hargadon, 2014; Stål and Corvellec, 2018), and lock-in at the organisational, technological, industrial, societal and institutional level (Unruh, 2002; Doganova and Karnøe, 2012) is likely to influence the innovation process. Not least in the case of CBMs for slowing resource loops, which often will break with the dominant business logic (Chesbrough, 2010; Schaltegger et al., 2012) and existing market structures to create more systemic solutions that integrate the new CE business paradigm. The dimensions of the company setting that were most prominently considered in this dissertation are described in more detail in section 2.1.1.

Due to lock-ins, CBMI for slowing resource loops was expected to be challenging for the case companies in this dissertation. Yet, at the time this research commenced in 2014, few guidelines were available for engaging in this sort of innovation and as a result, the research began with a review of the practice state-of-the-art on CBMs (see report A) that later became part of the toolbox for CBMI work in the case companies. Today, guidelines to assist in CBMI have emerged mostly within the grey literature (e.g. Achterberg et al., 2016; Kraaijenhagen et al., 2016; Bocken et al., 2016; Ellen MacArthur Foundation and IDEO, 2016), but there continues to be a scarcity of studies relating to how companies can develop and implement CBMs at a strategic level (Adams et al., 2016). As described earlier, this dissertation takes steps to contribute to such understanding.

REFERENCES

Abdelkafi, N., Täuscher, K., 2016. Business models for sustainability from a system dynamics perspective. Organ. Environ. 29, 74–96. https://doi.org/10.1177/1086026615592930.

Achterberg, E., Hinfelaar, J., Bocken, N.M.P., 2016. Master circular business models with the Value Hill. [pdf] Available at: https://www.circle-economy.com/case/master-circular-business-with-the-value-hill/#.W2QxEi2B3BI [Accessed August 3, 2018].

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., Overy, P., 2016. Sustainability-oriented innovation: a systematic review. Int. J. Manag. Rev. 18, 180–205. https://doi.org/10.1111/ijmr.12068.

Amit, R., Zott, C., 2010. Business model innovation: Creating value in times of change. IDEAS Work. Pap. Ser. from RePEc.

Bakker, C., den Hollander, M., van Hinte, E., Zijlstra, Y., 2014a. Products that last - product design for circular business models, first ed. TU Delft, Delft, Netherlands.

Bakker, C.A., Wang, F., Huisman, J., den Hollander, M.C., 2014b. Products that go round: exploring product life extension through design. J. Clean. Prod. 69, 10–16. https://doi.org/http://dx.doi.org/10.1016/j.jclepro.2014.01.028.

Bundgaard, A.M., 2016. Ecodesign for a circular economy: regulating and designing electrical and electronic equipment. [PhD dissertation] Aalborg Universitetsforlag, Aalborg, Denmark. https://doi.org/10.5278/vbn.phd.engsci.00159.

Blomsma, F., Brennan, G., 2017. The emergence of circular economy: a new framing around prolonging resource productivity. J. Ind. Ecol. 21, 603–614. https://doi.org/10.1111/jiec.12603.

Bocken, N.M.P., Short, S., Rana, P., Evans, S., 2013. A value mapping tool for sustainable business modelling. Corp. Gov. 13, 482–497. https://doi.org/10.1108/CG-06-2013-0078.

Bocken, N.M.P., Bakker, C., de Pauw, I., van der Grinten, B., 2016. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 33, 308–320. https://doi.org/10.1080/21681015.2016.1172124.

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. J. Clean. Prod. 65, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039.

Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. J. Clean. Prod. 45, 9–19. https://doi.org/10.1016/j.jclepro.2012.07.007.

Ceschin, F., Gaziulusoy, I., 2016. Evolution of design for sustainability: from product design to design for system innovations and transitions. Des. Stud. 47, 118–163. https://doi.org/10.1016/j.destud.2016.09.002.

Chesbrough, H., 2010. Business model innovation: opportunities and barriers. Long Range Plann. 43, 354–363. https://doi.org/10.1016/j.lrp.2009.07.010.

Doganova, L., Karnøe, P., 2012. The innovator's struggle to assemble environmental concerns to economic worth: Report to Grundfos New Business. Grundfos New Business.

Earth Overshoot Day, 2017. Past Earth overshoot days. Available at: http://www.overshootday.org/newsroom/past-earth-overshoot-days/ [Accessed November 7, 2017].

Elkington, J., 1997. Cannibals with forks: the triple bottom line of 21st century business. John Wiley and Sons Ltd, UK.

Ellen MacArthur Foundation, 2015. Towards a circular economy: business rationale for an accelerated transition. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/TCE_Ellen-MacArthur-Foundation_9-Dec-2015.pdf [Accessed July 19, 2018].

Ellen MacArthur Foundation, 2013. Towards the circular economy vol. 2: opportunities for the consumer goods sector. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE_Report-2013.pdf [Accessed September 6, 2018].

Ellen MacArthur Foundation, 2012. Towards the circular economy Vol. 1: an economic and business rationale for an accelerated transition. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf [Accessed July 19, 2018].

Ellen MacArthur Foundation, IDEO, 2016. The Circular Design Guide. Available at: https://www.circulardesignguide.com [Accessed August 3, 2018].

Geissdoerfer, M., Bocken, N.M.P., Hultink, E.J., 2016. Design thinking to enhance the sustainable business modelling process – a workshop based on a value mapping

process. J. Clean. Prod. 135, 1218–1232. http://dx.doi.org/10.1016/j.jclepro.2016.07.020.

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E., 2017a. The circular economy – a new sustainability paradigm? J. Clean. Prod. 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Geissdoerfer, M., Savaget, P., Evans, S., 2017b. The Cambridge business model innovation process. Procedia Manuf. 8, 262–269. https://doi.org/10.1016/j.promfg.2017.02.033.

Geissdoerfer, M., Morioka, S.N., de Carvalho, M.M., Evans, S., 2018. Business models and supply chains for the circular economy. J. Clean. Prod. 190, 712–721.

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007.

Hargadon, A.B., 2014. Brokerage and Innovation, in: M. Dodgson, D.M. Gann and N. Phillips (eds.), The Oxford Handbook of Innovation Management. Oxford University Press, New York, pp. 163–180.

Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005.

Kraaijenhagen, C., van Oppen, C., Bocken, B., 2016. Circular Business: Collaborate and Circulate, first ed. Circular Collaboration, The Netherlands.

Krystofik, M., Wagner, J., Gaustad, G., 2015. Leveraging intellectual property rights to encourage green product design and remanufacturing for sustainable waste management. Resour. Conserv. Recycl. 97.

Kørnøv, L., Thrane, M., Remmen, A., Lund, H. (eds.), 2007. Tools for sustainable development. Aalborg Universitetsforlag, Aalborg, Denmark.

Lieder, M., Rashid, A., 2016. Towards circular economy implementation: a comprehensive review in context of manufacturing industry. J. Clean. Prod. 115, 36–51. https://doi.org/10.1016/j.jclepro.2015.12.042.

Linder, M., Williander, M., 2017. Circular business model innovation: inherent uncertainties. Bus. Strateg. Environ. 26, 182–196. https://doi.org/10.1002/bse.1906.

Magretta, J., 2002. Why business models matter. Harv. Bus. Rev. 80, 86–92.

Mitchell, D., Coles, C., 2003. The ultimate competitive advantage of continuing business model innovation. J. Bus. Strategy 24, 15–21.

Murray, A., Skene, K., Haynes, K., 2017. The circular economy: an interdisciplinary exploration of the concept and application in a global context. J. Bus. Ethics 140, 369–380. https://doi.org/10.1007/s10551-015-2693-2.

Nußholz, J.L.K., 2018. A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops. J. Clean. Prod. 197, 185–194.

Nußholz, J.L.K., 2017. Circular business models: defining a concept and framing an emerging research field. Sustainability 9, 1810. https://doi.org/https://doi.org/10.3390/su9101810.

Osterwalder, A., Pigneur, Y., 2010. Business model generation: a handbook for visionaries, game changers, and challengers, first ed. John Wiley & Sons, New Jersey, US.

Planing, P., 2015. Business model innovation in a circular economy reasons for non-acceptance of circular business models. Open J. Bus. Model Innov. 1-11.

Porter, M.E., 2002. The competitive advantage of corporate philanthropy. Harv. Bus. Rev. 80, 56-68.

Roome, N., Louche, C., 2016. Journeying Toward Business Models for Sustainability: A Conceptual Model Found Inside the Black Box of Organisational Transformation. Organ. Environ. 29, 11-35. https://doi.org/10.1177/1086026615595084.

Richardson, J., 2008. The business model: an integrative framework for strategy execution. Strateg. Chang. 17, 133–144. https://doi.org/10.1002/jsc.821

Schaltegger, S., Hansen, E.G., Lüdeke-Freund, F., 2016. Business models for sustainability: origins, present research, and future avenues (Editorial Article). Organ. Environ. 29, 3–10. https://doi.org/10.1177/1086026615599806

Schaltegger, S., Lüdeke-Freund, F., Hansen, E.G., 2012. Business cases for sustainability and the role of business model innovation: developing a conceptual framework. Int. J. Innov. Sustain. Dev. 6, 95–119.

Schenkel, M., Caniëls, M.C., Krikke, H., van der Laan, E., 2015. Understanding value creation in closed loop supply chains: past findings and future directions. J. Manuf. Syst. 37, 729-745.

Short, S.W., Bocken, N.M.P., Barlow, C.Y., Chertow, M.R., 2014. From refining sugar to growing tomatoes. J. Ind. Ecol. 18, 603–618. https://doi.org/10.1111/jiec.12171

Singh, J., Ordoñez, I., 2016. Resource recovery from post-consumer waste: important lessons for the upcoming circular economy. J. Clean. Prod. 134, 342–353. https://doi.org/10.1016/j.jclepro.2015.12.020

Stahel, W., 1981. The product-life factor, in: S.G. Orr (ed.), An inquiry into the nature of sustainable societies: The role of the private sector. HARC, Houston, TX, pp. 72–96.

Stahel, W.R., 2010. The performance economy. Palgrave Macmillan Hampshire, UK.

Stål, H.I., Corvellec, H., 2018. A decoupling perspective on circular business model implementation: illustrations from Swedish apparel. J. Clean. Prod. 171, 630–643. https://doi.org/10.1016/j.jclepro.2017.09.249

Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Plann. 43, 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Unruh, G.C., 2002. Escaping carbon lock-in. Energy Policy 30, 317–325.

Velte, C.J., Steinhilper, R., 2016. Complexity in a circular economy: a need for rethinking complexity management strategies, in: World Congress on Engineering, London, UK, 29 June–1 July.

WBCSD, 2010. Vision 2050: The new agenda for business. World Business Council for Sustainable Development, Conches-Geneva, Switzerland. [pdf] Available at: https://docs.wbcsd.org/2018/02/Vision2050.pdf [Accessed September 6, 2018].

WCED - World Commission on Environment and Development, 1987. Our common future. Oxford University Press, Oxford, UK.

Webster, K., 2017. The Circular Economy: A Wealth of Flows, second ed. Ellen MacArthur Foundation Publishing, Cowes, UK.

Wells, P., Seitz, M., 2005. Business models and closed-loop supply chains: a typology. Supply Chain Manag.: Int. J. 10 (4), 249-251.

Whalen, K., Nussholz, J., 2016. Building extended value chains: lessons from Swedish ICT repair and resale 'gap exploiters' for original equipment manufacturers, in: Electronics goes green 2016. Frauenhofer IZM, Berlin.

WWF, 2016. Living planet report 2016: Summary. [pdf] Available at: http://d2ouvy59p0dg6k.cloudfront.net/downloads/lpr_2016_summary_web.pdf [Accessed September 6, 2018].

CHAPTER 2. METHODS

An overview of the overriding methodological choices in the research is presented in this chapter. The specific methods applied to analyse the empirical data from different perspectives is elaborated in the corresponding articles C, D and F and in book chapter E, which can be found in chapters 4-7.

2.1. RESEARCH DESIGN

A key factor influencing the conduct of social research is the choice between a quantitative and a qualitative research strategy (Bryman, 2012); this dissertation is based on qualitative research. In line with most qualitative research, the epistemological worldview of the dissertation is interpretivist, meaning that the social world (including an organisation) is perceived as constructed by the actors and *'emphasis is placed on the ways in which individuals interpret their world*' (Bryman 2012, p. 36). The constructivist orientation further implies that the research aims to understand organisational behaviour rather than explaining it through causal reasoning (Bryman 2012) (cf. Table 2-1)

	Quantitative	**Qualitative**
Principal orientation to the role of theory in relation to research	Deductive; testing of theory	Inductive; generation of theory
Epistemological orientation	Natural science model, in particular positivism	Interpretivism
Ontological orientation	Objectivism	Constructionism

Table 2-1. Key differences between quantitative and qualitative research (Bryman, 2012, p. 36).

Two consecutive, longitudinal, multiple-case studies constituted the main research design. The case studies were designed as exploratory because fairly little academic literature was available on CBMI when the research began and because I was interested in uncovering what key themes would emerge in relation to the CBMI processes in the case companies. The approach was, in other words, inductive rather than deductive (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Bryman, 2012).

Because CE was a new phenomenon in the business community when the research commenced in 2014, most companies were unfamiliar with the notion of CE. To accommodate this particular setting, I combined a longitudinal, multiple-case study design with action research that enabled me to:

1. Introduce the notion of CE and CBMs to the companies and observe how company participants reacted in words and actions
2. Get closely familiar with the company setting including if and where the participants identified CBM potentials
3. Experiment with different tools and formats for the development of new CBMs in close collaboration with the participants

Collaboration with the companies was based on action research in line with the method of engaged scholarship advocated by Van de Ven and Johnson (2006). They define engaged scholarship as *'a collaborative form of inquiry in which academics and practitioners leverage their different perspectives and competencies to coproduce knowledge about a complex problem or phenomenon that exists under conditions of uncertainty found in the world'* (Van de Ven and Johnson, 2006, p. 803). It is a type of research in which the researcher acts as a proactive and visible change agent and uses practical interventions as a mode of inquiry (as opposed to a detached observation or a 'fly on the wall' mode) (Van de Ven and Johnson 2006) to advance theory and practice in a given domain.

The interventions to which Van de Ven and Johnson (2006) refer could be characterised as move-testing experiments, which are experiments where a possible end is in mind as opposed to exploratory experiments, in which an action is undertaken only to see what follows (Schön, 1983, pp. 128–68). The experimentation tested different formats for the organisation of the CBMI process and different tools to support it. The formats we experimented with arose from the company settings and followed a few basic guidelines:

1. The CBMI process was flexible and adapted to the individual case company to fit the company setting and the concrete CBM that the company was most interested in examining.
2. The CBMI process strove for cross-departmental involvement because CBMI is an activity that influence multiple, if not all, parts of a company. Ideally, stakeholders were involved from all relevant departments.
3. Involving customers or suppliers from the existing or potential new supply chains was a means of ensuring the perspectives of key outside stakeholders were represented in the developed CBMs and was a way of testing the appropriateness of specific ideas and of getting input for further development of the ideas.

As examples of how the specific format was decided upon in the individual case company, I discussed the opportunity of inviting stakeholders from other parts of the company for a cross-organisational seminar with e.g. Danfoss and Gabriel, of asking customers about their opinion of certain CBM ideas with e.g. KnowledgeCotton Apparel and of involving potential new partners in the innovation process with e.g. Schilder and Brown. Company participants would respond positively or suggest other

formats, and this dialogue continued throughout the collaboration with each case company. As an exception, the toolbox was specified a priori, although which tools to apply and in what order was not.

2.1.1. INDUCTIVE CASE STUDIES

The overall research process was closely associated with the inductive case study methodology suggested by Eisenhardt (1989). Her approach to empirical data takes inspiration from grounded theory (Strauss and Glaser, 1967; Strauss, 1987) in contrast to the more deductive approach advocated by other case study researchers such as Yin (2014) and Steenhuis and de Bruijn (2006). As an example, Yin stresses the importance of thorough literature reviews before entering the field to determine what theories to test in the case study, whereas Eisenhardt suggests that only few or no constructs are specified a priori based on the literature because relevant themes and constructs will emerge from the data.

Eisenhardt's point of departure is the researcher as an objective observer, which is different from the approach taken in this dissertation, where the researcher acted as a change agent experimenting with different interventions alongside company participants (Van de Ven, 2007). I found that adapting Eisenhardt's framework worked well in the engaged scholarship setting, where Eisenhardt's a priori constructs, for instance, translated into an a priori specified toolbox (cf. section 2.1.3) and a few guidelines for carrying out the CBMI (cf. section 2.1). The first three columns of Table 2-2 thus outline Eisenhardt's process of building theory from case studies while the fourth column describes how the suggested process steps were applied or adapted in this dissertation.

Step	Activities	Purpose	Application in this dissertation
Getting started	Definition of research question	Focuses efforts	Defined preliminary research questions
	Possibly a priori constructs	Provides better grounding of construct measures	Toolbox and guidelines for CBMI process to experiment with was designed a priori
Selecting cases	Neither theory nor hypotheses	Retains theoretical flexibility	Selection was not based on theory or hypotheses
	Specified population	Constrains extraneous variation and sharpens external validity	Primarily worked with manufacturing and wholesale companies, i.e. companies designing and selling physical products
	Theoretical, not random, sampling	Focuses efforts on theoretically useful cases-i.e., those that replicate or extend theory by filling conceptual categories	Selected cases from different industries and of different size to explore impact from these factors
Crafting instruments and protocols	Multiple data collection methods	Strengthens grounding of theory by triangulation of evidence	Used participant-observation, unstructured and semi-structured interviews, document analysis
	Qualitative and quantitative data combined	Synergistic view of evidence	Focused on qualitative data
	Multiple investigators	Fosters divergent perspectives and strengthens grounding	One primary investigator in the first study, multiple investigators in the second study
Entering the field	Overlap data collection and analysis, including field notes	Speeds analyses and reveals helpful adjustments to data collection	Overlapped data collection and analysis in an iterative process
	Flexible and opportunistic data collection methods	Allows investigators to take advantage of emergent themes and unique case features	Emergent themes were organised into research sub-questions that were examined closer

Analysing data	Within-case analysis	Gains familiarity with data and preliminary theory generation	Within case analysis (in e.g. report B and article F) to carefully study the individual case company data
	Cross-case pattern search using divergent techniques	Forces investigators to look beyond initial impressions and see evidence thru multiple lenses	Cross-case analysis (e.g. in article C and book chapter E) to compare company patterns
Shaping hypotheses	Iterative tabulation of evidence for each construct	Sharpens construct definition, validity, and measurability	Iterative tabulation of data applied at all stages of the predominantly inductive data analysis
	Replication, not sampling, logic across cases	Confirms, extends, and sharpens theory	Cases represented different industries, company sizes and company sustainability stages to investigate theoretical and literal replication across cases
	Search evidence for 'why' behind relationships	Builds internal validity	Understanding 'why' was an integral part of trying to understand each case in its own right as well as similarities and differences between cases
Enfolding literature	Comparison with conflicting literature	Builds internal validity, raises theoretical level, and sharpens construct definitions	The peer-review processes of the articles and the book chapter provided a related critical assessment of data validity and fit with the literature
	Comparison with similar literature	Sharpens generalisability, improves construct definition, and raises theoretical level	Applied different theoretical lenses to examine emerging themes and the fit with the literature
Reaching closure	Theoretical saturation when possible	Ends process when marginal improvement becomes small	Saturation expected regarding early stages of CBMI process as a result of the longitudinal research design and multiple cases

Table 2-2. Process of building theory from case study research (Eisenhardt, 1989) and how the process was adapted in this dissertation.

2.1.2. TOOLBOX FOR THE INNOVATION PROCESSES

As part of developing the case study protocol (Yin, 2014), a few basic tools to support the CBMI process in the companies were developed, i.e. an a priori specified toolbox. As mentioned, little literature was available on CBMI when the research was prepared in the beginning of 2014, and consequently the toolbox was based on early reports published by the Ellen MacArthur Foundation (2012, 2013) and a practice review of CBMs in operation compiled through desk research (cf. report A).

The tools were selected to support all stages of the innovation process, as well as striking a balance between instruments that were sufficiently general to work in all participating companies yet detailed enough to convey the principles and potentials of the CE in a comprehensive way, which would enable idea generation and concrete discussions. The toolbox consisted of the following elements:

- CE system diagram: The diagram intends to illustrate the biological and technical resource loops that can be targeted via CBMs and is illustrated in Figure 1-3.
- Idea map: The system diagram also was used for clustering and visualising CBM ideas according to the resource loops of the diagram. When applied in this manner it was termed an Idea map (see report B for examples of Idea maps).
- CBM principles: The five principles are described in detail in article C. In short, they concern the value of inner circles, circling longer, cascaded use, pure flows and sustainable inputs (Ellen MacArthur Foundation, 2013). They were included in the toolbox to demonstrate what principles could and should be considered in relation to new CBMs.
- Best practice examples of CBMs: This is a case collection of CBMs in operation, corresponding to report A. The idea was to provide relevant and inspiring examples to engage companies in the CBMI process, a method used in earlier research to facilitate sustainable business thinking (Bocken et al., 2015).
- Circular business model canvas: This business model template was intended to guide the business model innovation process as suggested by other authors (e.g. Bocken et al., 2015; Chesbrough, 2010) and to ensure all relevant elements of the new business models were considered in the innovation process (cf. Figure 5-2).

In addition to the CBMI-specific toolbox, a selection of general techniques was applied, such as brainstorming sessions, customer interviews and surveys, economic calculations, competitor analysis, trend analysis, examining best available technology, etc., based on the ad hoc needs that emerged from the innovation processes.

2.1.3. DELIMITING COMPANY SETTING

Throughout the dissertation I refer to the company setting, which is a term I use primarily to denote the company-internal setting (cf. Figure 2-1) including aspects such as the goods sold by the company and the supporting business model configuration; the company's sustainability strategy; its business development strategies; and the characteristics of the actors that participated in the CBMI (e.g. owners, top managers, employees from a corporate function).

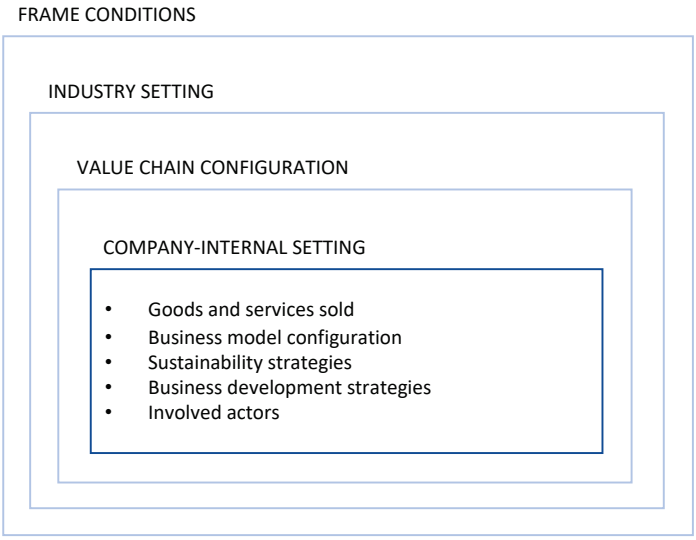

Figure 2-1. The company setting. Inspired by Johnson and Scholes (1999).

These aspects were particularly interesting because they directly influenced the CBMI processes. The other layers of Figure 2-1, e.g. the frame conditions, the competitive rivalry in the industry, the value chain configuration and its distribution of power, of course influenced the company and the CBMI as well, but these aspects were only dealt with peripherally in the present research (e.g. in article C).

2.2. ORGANISATION OF THE RESEARCH

The two multiple-case studies were organised in two research projects: The Closing Material Loops project was conducted 2014–2016, and the Business Models for Sustainable Production project started in 2015 and continues to the end of 2018.

2.2.1. CLOSING MATERIAL LOOPS

The case selection for the study was based on theoretical sampling (Eisenhardt, 1989) to intentionally include companies of different types. The broad foundation of companies was intended to support an understanding of CBMI across company categories in the exploratory study. Eleven companies of different sizes were invited to participate in the research; all were sustainability oriented, albeit having different sustainability strategies (focused on for instance sustainable sourcing or energy efficiency).

To enrol companies in the research project, we applied a flexible model for the collaboration:

- Companies would sign up for getting introduced to CE and CBMs as a minimum.
- If the companies found CBMs interesting and wanted to learn more, we would collaborate to examine where CBMs might be relevant to the company and generate CBM ideas.
- The specific format of the CBMI process, including what stakeholders to involve, what area of the business to focus on, the type of CBMs to examine more closely and the tempo of the CBMI, was determined in collaboration with the case companies as the process unfolded.

Nine companies signed up for the project, but because one went bankrupt, a total of eight companies were included in this study: Schilder and Brown, Grundfos, Danfoss, Kuvatek, KnowledgeCotton Apparel, Gabriel, Siemens Wind Power (after a recent fusion, the company is now called Siemens Gamesa Renewable Energy), and AVV.

Seven of these companies are manufacturing or wholesale companies that design their own products and either manufacture them inhouse or at suppliers' facilities; only AVV is a waste company. The CBM innovation activities in six of these companies took on such proportion that the company is categorised as a primary case company, i.e. a case company in which I did a significant quantity of research. In contrast, at Siemens Wind Power, an industrial PhD was hired to work with CE in the company at the beginning of the Closing Material Loops projects, which meant that the CBM activities in Siemens Wind Power were driven by the industrial PhD. I continued to follow the CBMI activities in the company via interaction with the industrial PhD, who was affiliated with my research group, and Siemens Wind Power's CBMI activities during 2014–2016 are documented in report B. My personal involvement in the company was small, however, and the company is thus classified as a secondary case company.

On a similar note, AVV is a waste company that was included in the research as it was expected to be advantageous to allow for co-creation of CBMs between the

manufacturing/wholesale companies and the waste company, thus integrating different perspectives on a given CBM under development. However, since the business models that were developed in the manufacturing or wholesale companies built on a diversion of their goods from the waste stream, product recapturing happened directly from the customers, and the mentioned co-creation of CBMs proved less relevant. Because AVV at the same time primarily was interested in mapping out how current company activities fit into the CE, as opposed to engaging in CBM innovation, my interaction with the company during the research project was small; therefore, AVV is categorised as a secondary case company in Table 2-3 that provides an overview of case companies in the research.

2.2.2. BUSINESS MODELS FOR SUSTAINABLE PRODUCTION

Ultimately, the seven manufacturing or wholesale companies that I started to work with during the Closing Material Loops project supplied the majority of the empirical data for the dissertation. Not least because four of these manufacturing and wholesale companies also were part of the second multiple-case study in the Business Models for Sustainable Production project in 2015–2018, where I continued to collaborate with them.

In the Closing Material Loops project, I largely conducted the research alone, albeit supported by and sparring with my supervisor Arne Remmen concurrently. In the Business Models for Sustainable Production project, eight researchers were involved along with 20 companies. The researchers were divided into two research teams at the Aalborg and the Copenhagen campuses of Aalborg University respectively, and in this research project I continued to work with Danfoss, Kuvatek, KnowledgeCotton Apparel and Gabriel, while adding A Man of Value to the list of primary case companies. In this project, I collaborated with a co-researcher on the CBMI processes in the case companies in the form of post-doc Rikke Dorothea Huulgaard and my main supervisor professor Arne Remmen.

A few other case companies from this research project were included in some of the data analyses. In paper C, these extra case companies (i.e. Better World Fashion, Højer Møbler, Mogens Hansen Møbler, Everrest) are included in an analysis of barriers to CBMI. The empirical data pertaining these companies was supplied primarily by the co-researchers that conducted the research in these companies, although I participated in single work meetings or seminars with them. The data was organised into an analytical framework that I had developed and was refined during conversations with the co-researchers, and I subsequently conducted the data analyses. In book chapter E, Better World Fashion again was included as a case company. These four extra case companies are catalogued as secondary case companies in Table 2-3.

Name of research project	**Closing Material Loops**	**Business Models for Sustainable Production**
Timing	2014–2016	2016–2018
Primary case companies	Schilder and Brown	-
	Grundfos	-
	Danfoss	Danfoss (cont.)
	Kuvatek	Kuvatek (cont.)
	KnowledgeCotton Apparel	KnowledgeCotton Apparel (cont.)
	Gabriel	Gabriel (cont.)
	-	A Man of Value
Secondary case companies	Siemens Wind Power	-
	AVV	-
	-	Better World Fashion
	-	Mogens Hansen Møbler
	-	Everrest
	-	Højer Møbler
Number of case companies	6 primary 2 secondary	5 primary 4 secondary

Table 2-3. Primary and secondary case companies.

2.2.3. CASE COMPANY SELECTION

Overall, the research design was organised to gain insight into the CBMI process from a broad range of companies to get a feel for the differences that might exist between the integration of CE in organisations of different types and the factors at play in each type of organisation.

According to Eisenhardt (1989), 4–10 cases in a study is typically appropriate for the generation of theory from a multiple-case study, whereas Yin (2014) suggests two cases can be enough but mentions up to six cases as appropriate. I was interested in getting as broad and nuanced an understanding of the implementation of CE as possible. Thus, it was natural to include multiple cases. Another, more practical, reason for including multiple cases was the voluntary elements of the collaboration agreements with the companies. The companies signed up to get introduced to CE only, whether they would continue working with the theme afterwards, was up to the companies. The extent of research that would be conducted in each company was thus not known from the onset of the project.

The case companies were selected to represent small, medium and large companies in the first research project and to also include start-ups in the second study (i.e. theoretical sampling (Eisenhardt, 1989)) which allowed for comparison of data across categories. Having more companies of each size in all but the medium-size category further allowed for comparison of data between companies of the same size (cf. e.g. report B and article C).

2.3. COLLECTION OF EMPIRICAL DATA

The main sources of evidence were unstructured interviews conducted during the interactions with the companies and participant-observations during these interactions (cf. Table 2-4).

Source of evidence	**Description or examples**	**Application in this dissertation**
Participant-observation	The mode of data collection whereby a case study researcher becomes involved in the activities of the case being studied	Engaged with the companies in workshops and meetings and kept a research log with field notes relating to each event
Unstructured interview	Informal interviews that resemble guided conversations rather than structured queries	Made suggestions and asked participants questions during workshops and meetings and noted reactions to these
Semi-structured interviews	Interview type, also known as formal interviews, where the researcher has a list of themes and questions to be covered, although theses may vary from interview to interview	Used to attain data relating to specific themes in a few case companies
Documents	Letters, emails, personal notes, agendas, meeting minutes, progress reports, news clippings etc.	Saved agendas and meeting minutes from company workshops and meetings; email-correspondence with company contacts; company-internal emails; company reports, pamphlets and websites; news clippings online and in physical newsletters and stored these in electronic and physical folders for each case company

Table 2-4. Sources of evidence in the case studies. Adapted from Yin (2014) and Saunders et al. (2009).

In two of the large companies, Danfoss and Grundfos, the unstructured interviews and the participant-observations were supplemented with semi-structured interviews to examine more closely the interaction between the concrete CBMI activities and the organisational CE journey. These interviews were conducted with employees that were not directly, or only briefly, involved in the CBMI process, which meant the unstructured interviewing that typically requires close and continuous interaction with the interviewees was an unfitting format for this part of the data collection.

Documents also were compiled as part of the research process. These constituted documents generated as part of the research (e.g. meeting minutes, field notes) as well as official documents such as company websites and sustainability reports. The field notes and documents were organised into a case study database (Yin, 2014) that consisted of electronic and physical folders containing the material that related to each case company.

2.4. DATA ANALYSIS AND EMERGENT THEMES

Data analysis took place in parallel to and beyond data collection. I typically reviewed my field notes before a company interaction to form an impression of how the process was going and decide on an agenda, tools to apply or questions to ask for the coming company interaction. Overall, this procedure was inspired by Kolb's (1984) experiential inquiry cycles. In the first step of the cycle, I prepared a basic toolbox based on CE literature and a CBM practice state-of-the-art. I then introduced the companies to CE and engaged in CBMI, including generation of CBM ideas and experiments to test BM assumptions, in cooperation with the internal actors. As a third step, I collected data via participant observation, informal and formal interviews, and documenting events that took place at and between meetings. Finally, I reflected on findings from the interventions and adjusted accordingly the approach and choice of tools for the subsequent company meeting. These cycles of reviewing and adding to field notes (after each interaction) meant I reflected on the unfolding process in each case company on an ongoing basis during the collaboration period.

After the first study concluded in 2016, I prepared a case report describing the eight company processes and some preliminary cross-case analyses. Probably because of the inductive approach and the large amount of data, writing the chronologies and doing preliminary cross-case analysis took considerable time. First, I drafted case histories, describing each company on its own terms and without regard for the process in the other companies. Case histories are descriptions characterised by temporal presentation (Pettigrew, 1997, 1990); these were compiled from field notes, minutes of meetings, official documents, etc., applying data triangulation where possible (Yin, 2014). This step took about six months.

Subsequently, these cases were developed into analytical chronologies through multiple iterations over the course of additional six months. Analytical chronologies are case descriptions that aim *'to get on top of the data, to clarify sequences across levels of analysis, suggest causal linkages between levels of analysis, and establish early analytical themes'* (Pettigrew, 1990, p. 280). The analytical chronologies were between three and nine single-spaced pages in length and comprised a preliminary within- and cross-case analysis that pointed to some conceptual similarities and differences between the CBMI processes in the companies (O'Connor et al., 2003; Eisenhardt, 1989; Pettigrew 1997, 1990). The resulting report is included in the dissertation as report B and can be found in Appendix B.

The analytical chronologies and associated preliminary cross-case analyses proved particularly important for the beginning summation of key themes that emerged from the first multiple-case study (i.e. the Closing Material Loops project). The subsequent multiple-case study (i.e. the Business Models for Sustainable Production project) involved six researchers from my research group, and here weekly project meetings, during which we discussed the case companies and their progress, were instrumental in identifying additional themes to examine more closely. The themes that arose from these processes resulted in four sub-questions that highlight specific aspects of the main research question.

2.4.1. RESEARCH SUB-QUESTIONS

It was clear from both case studies that the companies experienced multiple barriers to the CBMI process and there seemed to be similarities. Motivated by this, I found it interesting to outline the barriers and examine, if they were indeed similar, which resulted in the first sub-question:

(1) What are the barriers to circular business model innovation?

This question was examined in article C, building on case companies from both the Closing Material Loops and the Business Models for Sustainable Production studies.

The fluid, chaotic nature that was typical of the CBMI process was another emergent theme. It led our research team to consider different frameworks that might capture the nature of the process. Design thinking was one framework that was considered, and it struck me as a potentially relevant framework to describe and support the CBMI processes. The appropriateness of a design thinking approach to CBMI, as well as of the toolbox that was devised at the beginning of the research (cf. section 2.1.1), consequently was examined in article D via data from the Closing Material Loops study to answer the second sub-question:

(2) What could a design thinking framework tailored to circular business model innovation look like, and what is the potential impact of such a framework?

The multiple-case studies were designed to be exploratory with the intention to study the CBM innovation process in different company settings. This proved a viable setup because the empirical data revealed that the companies' innovation processes differed in certain ways. This theme resulted in the third sub-question, which was examined in book chapter E:

(3) How does the company setting affect the circular business model innovation process?

Finally, the CBMI activities seemed to link with an overall transformation of the organisation towards CE that became the theme of the fourth and final sub-question:

(4) How can circular business model innovation activities support the overall organisational journey towards circular economy?

The question was the key theme of article F, in which we studied the CBMI and the journey of a single case company in more detail. It also was examined in part in article D, which summarised key characteristics of the observed CBMI processes including their interaction with the overall CE journey.

Table 3-2 presents an overview of how the studies carried out in the articles and the book chapter link with the research sub-questions.

The abundance and richness of empirical data from the two multiple-case studies mean that other themes could be examined based on the data. Although this issue usually would be considered less pressing in working with quantitative data, a similar point was made by Davis (cited in Bryman, 2012, p. 621) in relation to a large survey: *'There are so many questions which might be asked, so many correlations which can be run, so many ways in which the findings can be organised, as so few rules or precedents for making these choices that a thousand different studies could come out of the same data'*.

The research sub-questions examined relevant dimensions of the main research question, however, the concrete themes that caught my attention in the data analysis process, are likely to be influenced by my background as a trained engineer and industry professional and by other factors affecting my preunderstanding, i.e. my knowledge, insight and experiences (Gummesson, 2000), of the problem field before I engaged in the research. Likewise, the backgrounds and preunderstandings of my co-researchers in the Business Models for Sustainable Production project, with whom I discussed the empirical data on multiple occasions, also are likely to have influenced which themes were ultimately examined more closely.

2.5. GENERALISATION FROM CASE STUDY RESEARCH

The research questions were addressed via action research in a case study setting. Despite being grounded in a particular context, case study research may provide insights that are applicable outside that context, as Yin (2014, p. 41) explains: *'generalisations, principles, or lessons learned from a case study may potentially apply to a variety of situations, far beyond any strict definition of the hypothetical population of "like-cases" represented by the original case'*. This transferability of results is attained via analytic generalisation that seeks second-order inferences (Yin, 2014), and Yin notes that *'analytic generalisation may be based on either (a) corroborating, modifying, rejecting, or otherwise advancing theoretical concepts that you referenced in designing your case study or (b) new concepts that arose upon the completion of your case study'* (2014, p. 41).

The former mode of generalisation links with the theoretical lenses that are applied to the data in articles C, D and F and book chapter E, although these theories were not referenced when the study was designed but instead after the identification of themes (similar to Yin's notion of 'concepts') arose from the data. The latter mode of generalisation links with the overall inductive approach, in which theory nevertheless was enfolded (in line with Eisenhardt's recommendations). Both modes of generalisation were thus applied in this research, albeit in adapted formats.

Eisenhardt argues that case studies can be used for generating middle-range theories. These are theories that *'attempt to understand and explain a limited aspect of social life'* (Bryman 2012, p. 22), and this type of theory does not have the general applicability of grand theories but apply to specific domains and raise above empirical findings in their abstraction level (Bryman 2012) similar to what Yin refers to as second-order inferences. Flyvbjerg (2006) concurs with the possibility of generalising from case studies but notes that *'formal generalisation is overvalued as a source of scientific development, whereas "the force of example" is underestimated'* (p. 228).

In this dissertation, the developed theories (i.e. the frameworks offered in article D and book chapter E) aim to understand and explain aspects of CBMI in an organisational context and, although the developed frameworks qualify as middle-range theory, the main contribution of the research may well be the description and analysis of the CBMI processes in the case companies, which provide concrete examples of CBMI processes that helps researchers and practitioners improve their understanding of the innovation process, which is in line with Flyvbjerg's preference for 'the force of example'.

Generalisability of case studies relates to the case selection (Flyvbjerg, 2006). In this research, the context of manufacturing and wholesale companies has been in focus. Only in report B, where the co-founding partner of the research, the Danish Environmental Protection Agency, required a description of all eight case companies,

was a company of a different type, namely waste company AVV included in the analyses. The manufacturing and wholesale companies all designed their own products and either manufactured (most parts of) them in their own facilities or had the products manufactured at suppliers' facilities; in other words, these companies designed, manufactured and sold physical products. Within this group of companies, a maximum variation strategy (Flyvbjerg, 2006) was applied. Thus, companies in different industries, of different size and serving different customer segments were included. It is within this group of companies that the research results are expected to have external validity (Bryman, 2012), whereas other types of companies, e.g. service companies, are likely to have other CBMI processes. Consider, for example, how service companies with little or no investments in facilities may experience different barriers to the CBMI process (cf. article C) than manufacturing and wholesale companies with internal or external production.

My perspective on the conversion from linear to CBMs has been the journey that companies make from the introduction to CE and onwards: getting introduced to CE and CBMs, initiating CBMI and CBM testing in most case companies. This focus on the early stages of the CBMI process means that the research does not provide insight into later stages, such as small-scale market testing and large-scale implementation.

The chosen perspective of company actions in relation to CBMI and the participants' perceptions of the process means that other interesting perspectives were only peripherally touched upon as these themes arose in the company collaboration processes. Examples of such themes are:

- How customers may or may not support the introduction of CBMs for example by adopting different servitisation models.
- How company-network-based innovation may support a conversion to new business models.
- How CBMs influence the environmental, social and economic performance of companies.
- How regulation can inhibit or promote the adoption of CBMs.

Such themes certainly would be interesting to examine closer but this was not possible in a PhD project of three year's duration. Instead, my PhD project has focused on getting a rich understanding of the transformation towards CE primarily from the perspective of companies unfamiliar with CE.

REFERENCES

Blomsma, F., Brennan, G., 2017. The emergence of circular economy: a new framing around prolonging resource productivity. J. Ind. Ecol. 21, 603–614. https://doi.org/10.1111/jiec.12603

Bocken, N.M.P., Rana, P., Short, S.W., 2015. Value mapping for sustainable business thinking. J. Ind. Prod. Eng. 32, 67–81. https://doi.org/10.1080/21681015.2014.1000399

Bryman, A., 2012. Social research methods, fourth ed. Oxford : Oxford University Press.

Chesbrough, H., 2010. Business model innovation: opportunities and barriers. Long Range Plann. 43, 354–363. https://doi.org/10.1016/j.lrp.2009.07.010

Eisenhardt, K.M., 1989. Building theories from case study research. Acad. Manag. Rev. 14, 532–550.

Eisenhardt, K., Graebner, M., 2007. theory buidling from cases: opportunities and challenges. Acad. Manag. J. 50, 25–32.

Ellen MacArthur Foundation, 2013. Towards the circular economy vol. 2: opportunities for the consumer goods sector. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE_Report-2013.pdf [Accessed September 6, 2018].

Ellen MacArthur Foundation, 2012. Towards the circular economy vol. 1: an economic and business rationale for an accelerated transition. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf [Accessed July 19, 2018].

Flyvbjerg, B., 2006. Five misunderstandings about case-study research. Qual. Inq. 12, 219–245. https://doi.org/10.1177/1077800405284363

Gummesson, E., 2000. Qualitative methods in management research, second ed. Sage, Thousand Oaks.

Johnson, G., Scholes, K., 1999. Exploring corporate strategy, fifth ed. Prentice Hall, Hertfordshire.

Kolb, David A., 1984. Experiential learning : experience as the source of learning and development, vol. 1. Prentice-Hall, Englewood Cliffs.

O'Connor, G.C., Rice, M.P., Peters, L. & Veryzer, R.W. (2003), Managing interdisciplinary, longitudinal research teams: extending grounded theory-building methodologies, Organ. Sci., 14, 353–373.

Pettigrew, A.M., 1997. What is a processual analysis? Scand. J. Manag. 13, 337–348.

Pettigrew, A.M., 1990. Longitudinal field research on change: theory and practice. Organ. Sci. 1, 267–292.

Saunders, M., Lewis, P., Thornhill, A., 2009. research methods for business students, fifth ed. Prentice Hall, Harlow.

Schön, D.A., 1983. The reflective practitioner: how professionals think in action. Basic Books, New York.

Steenhuis, H.J., de Bruijn, E.J., 2006. Building theories from case study research: the progressive case study, in: OM in the New World Uncertainties. Proceedings (CD-ROM) of the 17th Annual Conference of POMS, 28 April - 1 May 2006, Boston, USA.

Strauss, A. (1987) Qualitative analysis for social scientists. Cambridge University Press, Cambridge.

Strauss, A., Glaser, B., 1967. The discovery of grounded theory: strategies of qualitative research, Wiedenfeld and Nicholson, London.

Van de Ven, A.H., 2007. Engaged scholarship: a guide for organizational and social research. Oxford University Press, New York, US.

Van de Ven, A.H., Johnson, P.E., 2006. Knowledge for theory and practice. Acad. Manag. Rev. 31, 802–21.

Yin, R.K., 2014. Case Study Research: Design and Methods, Fifth ed. SAGE Publications, Thousand Oaks, US.

CHAPTER 3. STRUCTURE OF THE DISSERTATION

The dissertation is based on two reports, three articles and a book chapter that are published or in the process of getting published. An overview of how they contributed to the dissertation as background material or to the examination of the research questions is provided in this chapter.

3.1. OVERVIEW OF REPORTS, ARTICLES AND BOOK CHAPTER

Technical reports A and B constitute background material and represent my journey into the problem field, while articles C, D and F and book chapter E examine research sub-questions. Table 3-1 and 3-2 present overviews of the status of these manuscripts and their contribution to the thesis, which are described in more detail in the following.

Report A is an evaluation of CBMs in operation that was used as a 'tool' in the collaboration with the companies to give inspiration and examples from the collection of cases. It also provided an overview of the range of possible CBMs and a learning space for an initial categorisation of CBMs based on the resource loops depicted in Figure 1-2. The technical report was written by me and published by the Danish Environmental Protection Agency in 2016.

Report B describes the CBMI process in the eight Closing Material Loops case companies and contains preliminary within-case and cross-case analyses, which helped me get on top of the myriad data and pointed to some emerging themes, such as differences between the CBMI process in small and large companies. It is a technical report on findings in the Closing Material Loops project to the Danish Environmental Protection Agency and to the general public. I was the principal author of the report to which my main supervisor Professor Arne Remmen contributed. It was written in parallel with the research collaboration with the case companies in 2015–2017, although final graphical editing meant it was not published until early 2018 via the homepage of the Environmental Protection Agency.

Article C directly addresses the first research sub-question regarding the barriers that the case companies experienced during the CBMI. It sums up, compares and draws on empirical data from both primary and secondary case companies to have a broad foundation for the overview and analysis of the barriers. In the article, a cross-case analysis is conducted to look for patterns relating to company size and customer segment. Parts of the empirical data for this article were derived from my co-

researchers on the Business Models for Sustainable Production project, namely my co-author Post Doc Rikke Dorothea Huulgaard, Professor Arne Remmen as well as PhD Fellows Edward Vingwe and Heidi Simone Kristensen. The version of the article presented in this dissertation has been revised twice in the process towards publication in Journal of Cleaner Production.

Publication	Authors	Title	Publication status
Technical report A	Guldmann	Best Practice Examples of Circular Business Models	Report published 2016 via the Danish Environmental Protection Agency
Technical report B	Guldmann and Remmen	Towards Circular Business Models: Experiences in Eight Danish Companies	Report published 2018 via the Danish Environmental Protection Agency
Article C	Guldmann and Huulgaard	Barriers to Circular Business Model Innovation	Article has been through two revisions with Journal of Cleaner Production
Article D	Guldmann, Bocken and Brezet	Circular Business Model Innovation and Organisational Transformation	Article has been revised once based on peer-review feedback and is resubmitted to Journal of Business Models
Book chapter E	Guldmann and Huulgaard	Circular Business Model Innovation for Sustainable Development	Chapter is accepted for publication in the book Innovation for Sustainability: Business Transformations Towards a Better World
Article F	Huulgaard, Guldmann and Kerndrup	The Circular Economy Journey: How Transformation Spaces Can Support Organisational Change	Article will be submitted to Journal of Cleaner Production

Table 3-1. Overview of the reports, articles and book chapter included in this dissertation.

In a response to sub-question two, article D examines the relevance of taking a design thinking approach to CBMI and the usefulness of the CBMI toolbox that was developed as a preparation for the research collaboration with the case companies (cf. section 2.1.3). The paper builds on insights from the six primary case companies in the Closing Material Loops project to develop an innovation framework adapted to the CBMI context. I collaborated with professors Nancy M.P. Bocken and Han Brezet on this article, which has been revised based on peer-review and resubmitted to Journal of Business Models.

Text	Focus	Outcome	Location
Technical report A	Initial theoretical and practical consideration of the problem field Classification of business models according to resource loops	Practice state-of-the-art on CBMs A tool for the CBM innovation toolbox	Biblio-graphical data in Appendix A
Technical report B	Immersion in the empirical data Preliminary within-case and cross-case analyses	Case descriptions in the form of analytical chronologies Identification of emergent themes	Biblio-graphical data in Appendix B
Article C	The challenges encountered in CBMI Summarising barriers at four socio-technical levels Investigating resemblances between CBMI and radical innovation Examining similarities and differences between case companies through cross-case analyses	Answer to sub-question one: *What are the barriers to circular business model innovation?*	Chapter 4
Article D	The nature of the CBMI process Comparing the CBMI processes to the design thinking literature and deriving an adapted framework for CBMI	Answer to sub-question two: *What could a design thinking framework tailored to CBMI look like and what is the potential impact of such a framework?* And in part to question four (see below)	Chapter 5
Book chapter E	Factors of relevance for the CBMI process and its outcome Combining and extending existing conceptual frameworks to examine the link between company setting and the CBMI process	Answer to sub-question three: *How does the company setting affect the circular business model innovation process?*	Chapter 6
Article F	The link between internal CBMI activities, external events and the journey to CE Mapping out a timeline of events and analysing the role of two transformation spaces in inducing change towards CE	Answer to sub-question four: *How can circular business model innovation activities support the overall organisational journey towards circular economy?*	Chapter 7

Table 3-2. Contribution to the dissertation from individual reports, articles and the book chapter.

Book chapter E, addresses how the company setting affects the CBMI process and thus relates to sub-question three. In the chapter, we develop a model outlining three types of CBMI process that are linked to the specific company setting. It was written in cooperation with Rikke Dorothea Huulgaard, and it was accepted for the book

Innovation for Sustainability: Business Transformations Towards a Better World, edited by Nancy Bocken, Paavo Ritala, Laura Albareda and Robert Verburg and due for publication by Palgrave Macmillan in mid-2019.

The final article, F, examines the interplay between the CBMI process and the overall company journey towards a CE. The article examines the role of two concrete CBMI interventions in the CE journey of one of the large case companies, Danfoss. The article, along with article D, thus addresses sub-question four. I am a second author on this article, which was co-authored with Rikke Dorothea Huulgaard and associate professor Søren Kerndrup and will be submitted to Journal of Cleaner Production.

The three articles and the book chapter all feature introductions that lead up to the research question that is examined in the individual manuscripts as well as a methods section, which describes the overall research design of the multiple-case studies. These sections of the texts are closely related to the introduction and the general methods presented in chapters 1 and 2, and thus may be browsed through. The specific methods applied for data analyses in the texts nevertheless vary and are thus commendable of closer study.

The findings from the individual manuscripts are summed up and discussed in relation to the research questions in the conclusion in chapter 8, which also offers suggestions for future research.

CHAPTER 4. BARRIERS TO CIRCULAR BUSINESS MODEL INNOVATION

Chapter four addresses the first sub-question, i.e. *what barriers do companies encounter in circular business model innovation?* It consists of article C:

BARRIERS TO CIRCULAR BUSINESS MODEL INNOVATION - A MULTIPLE-CASE STUDY

by Eva Guldmann and Rikke Dorothea Huulgaard, Aalborg University.

The article was resubmitted to Journal of Cleaner Production in May, 2018 after undergoing two rounds of revisions: First based on feedback from guest editor of the special issue, assistant professor Jaco Quist, Delft University of Technology, and subsequently based on peer-review feedback.

ABSTRACT

The concept of circular economy has been suggested as a possible avenue to sustainable development. However, the adoption of circular business models at a company level, which is a key element in the transition to a circular economy, has been slow. The purpose of this paper is to provide an overview of the barriers that hinder adoption of circular business models, which is important to enable their large-scale uptake.

The study employs action research in relation to a multiple-case study of the circular business model innovation process in 12 diverse companies to provide empirically grounded insights into the barriers to circular business model innovation and compares these to barriers previously identified in the literature.

The study confirms that barriers exist at all socio-technical levels, i.e. the institutional, value chain, organisational and employee levels and shows that most barriers are encountered by companies at the organisational level, followed by the value chain level, the employee level, and the institutional level. The study identifies additional barriers compared to barriers in the emerging literature on circular business model innovation and related streams of literature.

The paper takes steps to clarify the conceptualisation of circular business models and suggests a classification of circular business models along a continuum from incremental to radical innovation. The study demonstrates correspondence between barriers to circular business model innovation and barriers to radical innovation, which suggests that cross-pollination between the circular business model innovation literature and the radical innovation literature could be beneficial.

KEYWORDS: *Circular business models; Circular business model innovation; Barriers; Radical innovation; Multiple-case study.*

4.1. INTRODUCTION

A circular economy (CE) has been proposed as an alternative to the current linear economy that could promote a much needed shift towards sustainable development (Adams et al., 2016; World Economic Forum, 2014; Geissdoerfer et al., 2017). A CE is an economy that is *'restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles*' (Ellen MacArthur Foundation,

2012, p. 2). It is comprised of activities that reduce, reuse and recycle materials in our production, distribution and consumption systems (Murray et al., 2017).

To arrive at such a regenerative economy, companies need to change the way they operate (Bocken et al., 2016a) through the adoption of circular business models (CBMs) (Nußholz, 2017). The company-level implementation of CE, including the challenges associated with a transition to CBMs, nevertheless remains under-researched (Blomsma and Brennan, 2017; Franco, 2017; Ghisellini et al., 2016; Lieder and Rashid, 2016; Roome and Louche, 2016; Urbinati et al., 2017), resulting in a lack of operational frameworks for, and knowledge about, circular business model innovation (CBMI) processes (Urbinati et al., 2017), which delays the transition to sustainable development (Boons et al., 2013) and the uptake of CBMs (Linder and Williander, 2017).

Pinpointing which factors constrain CBMI activities in companies is an important step towards empowering practitioners, policy makers and researchers to devise solutions to overcome these barriers and potentially accelerate the adoption of CBMs (de Jesus and Mendonça, 2018; Hölzl and Janger, 2012; Oghazi and Mostaghel, 2018).

Previous reviews of the literature regarding CBMI barriers have drawn on the literature from a range of CBMI-related research fields (e.g. Linder and Williander, 2017; Rizos et al., 2016), and only few studies specifically on CBMI barriers have been reported in the literature. Thus, it has remained unclear whether barriers compiled from these related streams of literature (e.g. closed-loop manufacturing, remanufacturing, and product–service system literature) are in accordance with the barriers experienced in CBMI.

The emerging CBMI-specific literature has, furthermore, focused on the study of individual cases (e.g. Linder and Williander, 2017; Mont et al., 2006; Riisgaard et al., 2016) or specific sectors (e.g. Stål and Corvellec, 2018), whereas empirical studies of barriers to CBMI based on a study of multiple CBMI processes are lacking. This paper contributes to the literature by providing empirically founded insights into CBMI-specific barriers that are based on an in-depth study of 12 case companies from different sectors. The field research entailed longitudinal action research concerned with the development and study of CBMs in which the researchers typically collaborated with the companies from the time they were introduced to the concept of CE to the time they started to develop CBMs and onwards. In many cases, the study of the CBMI process spanned several years, in some cases resulting in the implementation of CBMs.

Moreover, the paper adds to the literature by suggesting that CBMI could be advanced by linking it to research into radical innovation (RI). There is considerable consensus about the challenging nature of CBMI among scholars (e.g. Linder and Williander, 2017; Mont, 2002; Mont et al., 2006; Stål and Corvellec, 2018), yet, the

CBMI literature has not discussed whether it is possible to connect CBMI to RI conceptually and integrate findings from that field. In this paper, we take steps towards an initial assessment of whether CBMI and RI could be linked conceptually by reflecting on the nature of the two innovation types and by comparing CBMI barriers to RI barriers. Linking the two streams of literature is potentially beneficial because there is a substantial body of literature on RI that may inspire the way in which CBMI processes are framed, organised and facilitated overall—specifically, the way in which CBMI barriers are dealt with.

Consequently, the research question that guides this paper is: *What barriers do companies encounter in circular business model innovation?*

The remainder of the paper is organised as follows: Section 2 offers an overview of key theoretical concepts and of barriers reported in the literature; Section 3 describes methodological approaches applied in the 12 longitudinal action research studies and in the present paper; Section 4 outlines barriers derived from the empirical data and compares these to CBMI barriers and RI barriers from the literature and discuss the results; and Section 5 concludes on the study.

4.2. A CONCEPTUAL FRAMEWORK FOR CIRCULAR BUSINESS MODEL INNOVATION

4.2.1. CIRCULAR BUSINESS MODELS

A business model explains how a company does business (Richardson, 2008) and can be perceived as a blueprint of the underlying business logic of a company (Magretta, 2002; Osterwalder and Pigneur, 2010; Teece, 2010). A minimum of three basic elements outline a business model: (1) The value proposition (i.e. the product and service offering); (2) the value creation and delivery system that enables the company to generate products and service offerings and deliver them to customers via the company's internal resources and capabilities, its value chain, activity system, business processes, suppliers, partners, and customers; and (3) the value capture system, which has to do with how the firm generates turnover and profit, its revenue sources, and the economics of the business (Richardson, 2008) (cf. Figure 4-1).

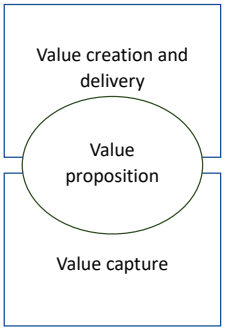

Figure 4-1. Key elements of a linear business model (Richardson, 2008).

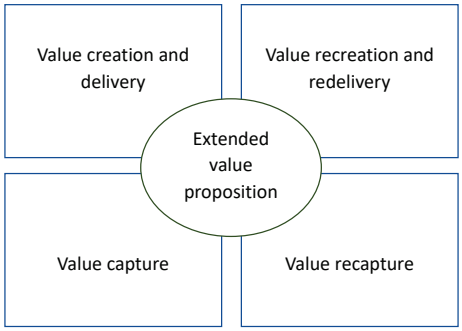

Figure 4-2. Key elements of a circular business model. Developed from Richardson (2008) and Bocken et al. (2016).

A traditional linear business model creates economic value for the actors in the value chain (i.e. the focal firm and its partners, suppliers and customers) (Amit and Zott, 2010). By contrast, a sustainable business model entails a broader understanding of value and stakeholders, since it *'captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries.*' (Schaltegger et al., 2016, p. 6).

A CBM is a type of sustainable business model (Adams et al., 2016; Bocken et al., 2014) that integrates environmental and economic value creation by shifting the business logic from generating profits from one-time sales of goods, to generating profits from a continual flow of reused materials and products over time (Bakker et al., 2014a) by capitalising on the value embedded in used products (Bocken et al., 2016a; Linder and Williander, 2017). Social value creation is typically incorporated less prominently than environmental and economic value creation (Geissdoerfer et al., 2017).

CBMs aim to preserve the embedded value of products at the highest possible level of utility (Velte and Steinhilper, 2016; Webster, 2015) via business model strategies that slow and close resource loops (Bocken et al., 2016a; Stahel, 1981): The flow of resources through the economy is slowed by an extended and/or intensified product utilisation period, and it is closed by recycling post-use materials and re-injecting them into the production system (Bocken et al., 2016a; Stahel, 2010).

The exploitation of the residual value of products after use necessitates a return flow from users to manufacturers, which is enabled by, for example, take-back and leasing schemes (Linder and Williander, 2017; Stål and Corvellec, 2018), and product design

features that allow for repairs, reuse, etc. (Bakker et al., 2014a). Activities related to a CBM do not have to be operated by the focal company itself; instead, CBMs often encompass a network of partner companies in the same fashion as does a linear value chain. The international apparel company H&M, for instance, collaborates with clothing recycling company I:CO to reuse and recycle clothes collected via H&M stores (Guldmann, 2016), and international pump manufacturer Grundfos has established a take-back system in its Danish home market that utilises its pre-existing distribution setup for the return of products to the company (Guldmann and Remmen, 2018).

The environmental and economic profitability of CBMs to close and slow resource loops can be enhanced by adopting well-known strategies to improve resource efficiency in the design of the product and the manufacturing process, use renewable or recyclable materials and renewable energy (Brezet and Hemel, 1997; Ellen MacArthur Foundation, 2013). Yet, these strategies, referred to as strategies to narrow resource loops, are insufficient to constitute CBMs in themselves (Bocken et al., 2016a).

Building on the work of Bocken et al. (2016a), the outlined characteristics of a CBM can be organised into value recreation and redelivery activities, value recapture activities and a resulting extended value proposition, as detailed in Table 4-1.

CBMs often co-exist with linear business models (Bocken et al., 2016b; Hopkinson et al., 2018; Stål and Corvellec, 2018) in both incumbent companies and start-ups: photocopier and printer company Ricoh, for instance, has operated CBMs for more than 30 years but continues to derive much of its profit from sales of new equipment (Hopkinson et al., 2018), and Danish circular start-up Better World Fashion that manufactures jackets from recycled leather, offers one-time sales in addition to leasing and take-back schemes, although the company was founded on circular economy principles (Huulgaard and Vingwe, 2017).

This coexistence is illustrated in Figure 4-2, where the left side of the figure represents value creation, delivery and capture activities known from linear business models. This is value creation from converting virgin raw materials into new products; value delivery in the form of selling the new products; and value capture from the associated sales revenue.

Value recreation mechanisms	Value redelivery and recapture enablers	Possible elements of an extended value proposition for customers	Type of innovation
	CBM strategy: Slow resource loops		
Extend product/ component life or intensify use	- Product design that supports emotional and technical durability, the former via designs that facilitate, for instance, attachment, and the latter via designs that enable repairs, upgrades, remanufacturing, etc., for instance, via a product that can be disassembled and reassembled. - Product-life extending services (e.g. repairs, upgrades, remanufacturing), services aimed at intensifying the product use (e.g. peer-to-peer sharing platform) or servitization (e.g. pay-per-use model). - A flow of goods back to the company or between users through, for instance, leasing, take-back and sharing models.	- Convenience of longer product life and higher level of technical function (and possibly aesthetic qualities). - Appeal of a more sustainable product. - Lower price of reused or repaired products, lower up-front investment in leasing or pay-per-use models. - Economic bonus upon product return or when handing over the product to the next user.	More radical innovation
	CBM strategy: Close resource loops		
Extend material life	- Product design that enables recycling (e.g. products can be separated into material fractions that are uncontaminated and recyclable). - Recycling services (e.g. recycling of materials from the company's own returned goods), of materials from public waste streams or of manufacturing by-products. - Take-back schemes, procurement processes oriented at recycled materials and at recycling by-products.	- Convenient and cost efficient (or profitable) disposal of used products. - Appeal of a sustainable handling of waste. - Lower price of products that integrate recycled materials.	More incremental innovation

Table 4-1. Circular business model strategies. Extended from Bocken et al. (2016a).

The right side of Figure 1B represents the value recreation, redelivery and recapture activities that are added to the business model, when slowing and closing strategies are integrated into the company through the introduction of circular products and services. Value is recreated, for instance, when products are reused, repaired or remanufactured or when recycled materials are used for new circular products. In other words, value is recreated via the implementation of circular services. Value redelivery happens when the reused, upgraded, remanufactured products are offered via ordinary sales, leasing or sharing schemes. Finally, value is recaptured, when

profit is generated from sales, leasing and sharing of the circular products and from the circular services such as repairs, upgrades and remanufacturing.

The extended value proposition resulting from the addition of value recreation, redelivery and recapture activities to the business model could be in the form of the convenience of a longer product life with a higher level of technical functionality; the appeal of a more sustainable product; a lower price of reused or repaired products etc. (Bocken et al., 2016a) as outlined in Table 4-1.

4.2.2. CIRCULAR BUSINESS MODEL INNOVATION AS RADICAL INNOVATION

Business model innovation is the process of making changes to existing business models to create new business model configurations (in a mature company) or crafting entirely new business models (in a start-up or within a new business area of a mature company) (e.g. Osterwalder and Pigneur, 2010; Mitchell and Coles, 2003). Business model innovation is a distinct innovation discipline separate from product and process innovation (Amit and Zott, 2010)

The degree of novelty of an innovation is used to classify it along a continuum from incremental to radical (Tushman and Nadler, 1986), where incremental innovation is concerned with 'doing what we do but better' and RI is concerned with 'doing different' (Bessant et al., 2014). RI is defined differently among scholars as innovation that is new either to the company, to the market or to both (Sandberg and Aarikka-Stenroos, 2014), a categorisation that can also be applied to business model innovation (Foss and Saebi, 2017).

In the present paper, inspired by Foss and Saebi (2017), Mitchell and Coles (2003), and Schaltegger et al. (2012), CBMI is considered radical if multiple business model changes are required in the business model configuration and making those changes to the configuration is new to the company. If only few changes are required to the business model and these are in line with business model changes made earlier in the company, the CBMI is considered incremental. Radical CBMI corresponds mostly to the adoption of CBMs aimed at extending product life (i.e. slowing resource loops), whereas incremental CBMI corresponds better to the adoption of CBMs aimed at extending material life (i.e. closing material loops).

Grundfos' take-back system is useful for illustrating the difference: Grundfos' current system utilises its existing distribution network for reverse logistics and the surplus capacity in a department that was already dealing with disassembly of old machinery, when the take-back system was implemented. Implementing the take-back system has thus meant few changes to Grundfos' pre-existing business model and represents an incremental CBMI. If, for instance, the company had also modified its product design to facilitate better product disassembly and material reuse, it would have moved towards a more radical CBMI, because more elements of its business model

would be modified and would require changes such as designing products for recycling that are new to the company. Finally, had Grundfos introduced remanufacturing services for the returned products, this would have required the establishment of new activities to carry out the remanufacturing itself and to distribute the remanufactured products, possibly in new markets. Most likely, a viable remanufacturing business would also demand a major redesign of the pumps and, in sum, these changes to the business model configuration would represent an example of radical CBMI.

Furthermore, a key difference between CBMs for slowing and for closing resource loops, is the degree of change required in the interaction with customers. Repairing, upgrading and remanufacturing products are examples of services that require a different customer behaviour and attitude towards products, which also increases the risk of non-acceptance. In contrast, recycling activities can be dealt with largely within the existing value chain, not affecting customers.

4.2.3. BARRIERS TO CIRCULAR BUSINESS MODEL INNOVATION AND RADICAL INNOVATION

Innovation barriers can be defined as challenges that can be overcome with some level of effort (Hölzl and Janger, 2012) and a literature review was conducted to identify CBMI barriers in the literature. As a first step, the Web of Science database was searched, combining the subject keywords 'circular economy' and 'barrier*' or 'challenge*'. These broad terms were used in recognition of the lack of convergence on terminology within the CBM and CBMI fields to capture as much relevant literature as possible. The search included all peer-reviewed articles in English that were published before 2018 and resulted in 173 articles that were examined based on title and abstract to single out those that dealt specifically with barriers in relation to the adoption of CBMs in companies in a European context. The 14 papers that remained after this process were studied in full, and seven of these proved relevant to the CBMI context. Two of which contained a relevant review of the literature on barriers to CBM adoption, namely Linder and Williander (2017) and Rizos et al. (2016). The former draws on the product-service system and remanufacturing literature, whereas the latter draws on literature concerning product-service systems, CE, resource efficiency improvements and green supply chain management, among others. Applying a snowballing approach (Bryman, 2012), references from these reviews were examined in the same fashion as the literature from Web of Science and 18 peer-reviewed references were enfolded in the review in addition to ten peer-reviewed references cited in a recent Mistra REES report on CBMI (Mont et al., 2017).

CBMI barriers			RI barriers	
	Description	**Selected references**		**External barriers**
1	Lack of concrete, coherent, strict legislation	Rizos et al. (2016)	a	Unsupportive government and regulatory barriers
2	No government support in the form of training, funding, legislation. No clear place to go for help and long procedures to obtain certifications etc.	Kuo et al. (2010); Rizos et al. (2016)	a	
3	Lack of supportive public procurement policies	Rizos et al. (2016)	a	
4	Taxation of labour rather than raw materials renders labour intensive reuse and recycling activities expensive	Stahel (2010); Kissling et al. (2013)	a	
5	Legislation hinder CBMs, e.g. legislation on sales of waste materials and on cross-border movement of products for reuse	Singh and Ordoñes (2016); Milovantseva and Fitzpatrick (2015); Mont (2002); King et al. (2006)	a	
6	Warranty legislation hinders the use of reused spare parts	Riisgaard et al. (2016)	a	
7	Lack of external funding opportunities	Rizos et al. (2016)	b	Paucity of external finance
8	Financial, legal and operational risk increase in CBMs compared to linear business models, and tools to assess and manage risks are lacking	Kuo et al. (2010); Linder and Williander (2017); Prendeville and Bocken (2017); Sauvé et al. (2016); Mont (2002); Rizos et al. (2016); Besch (2005)	c	Competitive rivalry
9	Lack of interest and understanding from value chain and a need for training and education	Rizos et al. (2016); Adams et al. (2017); Ravi and Shankar (2005); Kuo et al. (2010); Mont et al. (2006)	d	Undeveloped networks and ecosystems
10	Network collaboration challenges, e.g. difficulty of creating the needed networks for circularity and supply chain dependencies that prevent circularity	Pearce (2009); Seitz (2007); Besch (2005); Mont et al. (2006); Wise and Baumgartner (1999); Rizos et al. (2016); Kissling et al. (2013); Boons and Lüdeke-Freund (2013); Prendeville and Bocken (2017); Mont (2002); Kuo et al. (2010)	d	
11	Original spare parts are difficult or impossible to attain or have to be transported over long distances	Riisgaard et al. (2016); Sabbaghi et al. (2017); Mont et al. (2006); Seitz (2007)	d	
12	Rate of technological change may demand frequent design changes that	Besch (2005); King et al. (2006)	e	Technological turbulence

	hinders product reuse and remanufacturing			
13	Fragmented supply chains, lack of green suppliers and long distances to customers	Adams et al. (2017); Rizos et al. (2016); Besch (2005)	f	Inappropriate infrastructure
14	Unpredictable or decreased quality of returned or recycled products and materials	Bocken et al. (2015); Singh and Ordoñes (2016); Kissling et al. (2013); Kuo et al. (2010); Ravi and Shankar (2005)	f	
15	Unpredictable flow of reused goods or recycled materials resulting in e.g. conflict with demand and planning difficulty. Lack of information systems to mediate this	Singh and Ordoñes (2016); Linder and Williander (2017); Östlin (2008, 2009); Ravi and Shankar (2005); Besch (2005)	f	
16	No official training available to repair staff, no access to repair tools and repair guidelines for third party repair companies. General lack of knowledge experts on CE	Riisgaard et al. (2016); Sabbaghi et al. (2017); Rizos et al. (2016)	f	
17	CBMs only relevant to some customers and product types and customer benefits from, and acceptance of, new CBMs uncertain	Pearce (2009); Sundin et al. (2009); Mont (2002); Rizos et al. (2016); Edbring et al. (2016); Besch (2005); Kuo et al. (2010)	g	Market de-mand unclear
18	Low status of products from recycled materials and repaired, reused, refurbished or remanufactured products. Uncertainty about residual value of the latter category. Low status may damage company image if it engages in CBMs	Singh and Ordoñes (2016); Ylä-Mella et al. (2015); van Weelden et al. (2016); Rizos et al. (2016); Edbring et al. (2016); Mont et al. (2006); Besch (2005)	g	
19	Changing fashion trends can be a challenge for long-life products	Mont et al. (2006); Besch (2005)	h	Cultural restrictions
				Internal barriers
20	Unclear business case. Integrating environmental considerations in product and business model design is also perceived as lengthening time to market	Adams et al. (2017); Mont (2002); King et al. (2006)	i	Restrictive organisational mind-set
21	Concerns over risk of decreasing sales due to increased sales of repaired, reconditioned and remanufactured products	Guiltinan (2009); Michaud and Llerena (2011); Besch (2005)	i	
22	Product design should follow certain guidelines to enable circularity. Redesign of old products may thus be needed	Berchicci and Bodewes (2005); Sundin et al. (2009); Östlin (2008)	i	
23	Lack of top management commitment	Ravi and Shankar (2005); Kuo et al. (2010)	i	

24	Lack of knowledge about CE including remanufacturing, recycling etc. and its benefits	Rizos et al. (2016); Ravi and Shankar (2005)	j	Lack of innovation competences
25	Not possessing the necessary technical and technological know-how to engage in new business models. Difficulty of designing new business models including a lack of tools for this	Rizos et al. (2016); Kindström and Kowalkowski (2014); Mont (2002); Bakker et al. (2014b); Urbinati et al. (2017); Ravi and Shankar (2005); Kuo et al. (2010)	j	
26	Companies' supply chain position may limit opportunities to adopt CBMs. Required expertise and knowledge about the products, makes CBMs most suitable for OEMs.	Mont et al. (2006); Pearce (2009); Rizos et al. (2016)	j	
27	Lack of internal resources, i.e. capital, time and staff to investigate opportunities	Rizos et al. (2016); Kindström and Kowalkowski (2014)	k	Insufficient resources
28	Fundamental shift in corporate culture, policies and market engagement is needed that also demand internal reorganisation. Resistance to change.	Mont (2002; 2006); Rizos et al. (2016); Kuo et al. (2010); Besch (2005); Ravi and Shankar (2005)	l	Unsupportive organisational structure
29	Traditional incentive structures and performance metrics are inappropriate to support new business models	Mont (2002); Ravi and Shankar (2005)	l	
30	Repairs impaired by proprietary product designs, parts glued together and other physical product attributes	Riisgaard et al. (2016); Krystofik et al. (2015)	-	-
31	Products and buildings are complex and not designed with EoL reuse or recycling in mind resulting in a low value at EoL	Singh and Ordoñes (2016); Adams et al. (2017)	-	-

Table 4-2. Barriers to circular business model innovation.

The right side of Table 4-2 comprises barriers to RI. These barriers were identified in a recent comprehensive review of the literature on RI barriers by Sandberg and Aarikka-Stenroos (2014). Interestingly, the authors find no significant differences between barriers encountered in different fields of innovation such as product, technology and business model innovation. Service innovation stands out as the only category, since a restrictive local culture is a barrier found only within this field (Sandberg and Aarikka-Stenroos, 2014). Including this particular barrier in the total list of barriers identified in the RI literature, Table 4-3 provides an overview of these and a short explanation of each. Results from the comparison in Table 4-2 are evaluated in Section 4.4.1.

	External barriers	Explanation
a	Unsupportive government and regulatory barriers	Regulations, laws, and standards that hinder/fail to support RI
b	Paucity of external finance	Lack of finance available, and/or resistant investors
c	Competitive rivalry	Competitor behaviour
d	Undeveloped networks and ecosystems	Lack/inertia/resistance of network actors, stakeholders, and the ecosystem
e	Technological turbulence	Changing technologies make prediction difficult, and thus discourage commitment to any particular technology
f	Inappropriate infrastructure	Lacking/incomplete facilities and services
g	Market demand unclear	Behaviour of individual customers. Changing needs/lack of experience resulting in a lack of interest in innovations
h	Cultural restrictions	Shared values and beliefs that characterise groups of people in a particular place and orient their resistance to innovations
	Internal barriers	**Explanation**
i	Restrictive mindset	Fear/resistance of innovations within the firm; seen, for example, in the fear of change, fear of failure, conservative decision-making, and restrictive organisational culture
j	Lack of innovation competencies	Lack of abilities to create RI opportunities, turn these into business proposals, ramp up the new business and diffuse the innovation
k	Insufficient resources	Lack/misallocation of finance, skills, experience, information, or tools within the company
l	Unsupportive organisational structure	Hierarchical arrangement of lines of authority, communications, rights and responsibilities in the company

Table 4-3. Barriers to radical innovation. Adapted from Sandberg and Aarikka-Stenroos (2014).

4.3. METHODOLOGY

4.3.1. RESEARCH DESIGN

The study was designed as exploratory action research where researchers and companies co-created and developed ideas for CBMs. The main emphasis of the CBMI process in the case companies was placed on creating CBMs for slowing loops (i.e. radical business model innovation), although considerations relating to closing business models were also present. The research was organised as a longitudinal,

multiple-case study, since this kind of study allowed the researchers to examine the CBMI process deeply and extensively as it unfolded and to collect rich information about the barriers that were encountered in this process (Orum, 2015; Yin, 2014).

In action research, the researcher is directly involved in activities that are intended to foster change on the group, organisational, and societal levels (Dickens and Watkins, 1999), while observing and reflecting upon the unfolding processes. The CBMI was carried out in collaboration between the case companies and the researchers, taking an engaged scholarship approach (Van de Ven, 2007; Van de Ven and Johnson, 2006). Engaged scholarship is a type of action research in which the researcher immerses herself in a situation to learn from the insights and perspectives of practitioners and obtains greater understanding of a problem domain (Evered and Louis, 1981).

The collaboration was organised in a flexible manner, allowing the companies to decide the pace of the CBMI process as well as what areas to focus on. The CBMI was guided by a Design Thinking framework. Design Thinking is an innovation process tool, which focuses on generating new ideas, and on continually surfacing and testing assumptions associated with these ideas (Brown, 2008; Liedtka, 2011). The literature describes three associated innovation stages in the form of an exploratory, an ideation and a prototyping and testing stage (Brown, 2008; Liedtka, 2015; Seidel and Fixson, 2013), which aim to define an opportunity, generate multiple ideas, and experiment to develop the ideas and select between them, respectively.

Those three stages were preceded by an introductory stage in which the researchers introduced the companies to CE and CBMs and (in the largest companies) an additional stage of organisational alignment was observed, in which the companies worked to clarify their position on CE and CBMs through internal discussions. The stages are presented in a structured order in Table 4-4, however, the actual innovation process involved iterating back and forth between stages.

The two start-ups (A and B) were already developing CBMs (although not articulated as such), when the research collaboration began, which meant the starting point was different in these two companies compared to the rest of the companies. CE and CBM principles were nevertheless discussed recurrently (corresponding to the introductory stage) and the companies actively engaged in a collaboration process in which the pre-existing CBM ideas were examined closer and further developed (corresponding to the other innovation stages) and as such the collaboration with these companies also represented a CBMI process, albeit a process starting from a more advanced state.

Innovation stages	Activities at this stage	Case companies that moved through this stage
Introduction	Outlining CE and CBM principles	All
Alignment	Seek organisational alignment on company's position on CE and CBMs	I, J, K, L
Exploration	Map out company context and attractiveness of CBMs to company	All
Ideation	CBM idea generation	All
Testing	Test of associated hypotheses via customer interviews, technical examinations, economic analyses, etc. to develop and select between ideas	All except L
Implementation	Experimentation with CBMs through small- or large-scale implementation	A, B, D

Table 4-4. Stages of the CBMI process.

4.3.2. CASE SELECTION

Several companies were invited the participate in the research projects, and 26 companies accepted this invitation. They were, in other words, open to being introduced to CE and starting to experiment with CBMI. Out of the 26 companies, 12 companies were selected for this study based on: (1) the company was a manufacturing or wholesale company with either in-house or outsourced production (i.e. companies that sell physical products that fit within the technical cycles of a CE) and (2) the authors had either worked with the company directly or had access to detailed information about the CBMI process via co-researchers from the same research group as the authors.

The 12 companies comprised companies of different sizes, within different sectors and serving different customer segments. This maximum variation sampling allowed the authors *'[t]o obtain information about the significance of various circumstances for case process and outcome'* (Flyvbjerg, 2006, p. 230) and hence enabled an exploratory study through literal and theoretical replication (Yin, 2014) of whether company size and customer segments influence which innovation barriers are encountered.

The case companies were organised into four groups for theoretical replication, that is, four groups expected to produce contrasting results for anticipatable reasons (Yin, 2014), with each group comprised of companies predominantly of the same size and within the same customer segment for literal replication, that is, companies within groups are expected to produce similar results (Yin, 2014. The first group consisted

of B2C start-ups less than three years of age (companies A and B). The second group comprised B2B micro-companies, that is, companies with fewer than 10 employees (Eurostat, 2016) (companies C, D and E). The third group consisted of small companies, i.e. companies with fewer than 50 employees, with a mix of customer segments (companies F, G and H). The final group comprised mid-sized and large companies, that is, companies of more than 50 and 250 employees, respectively, in the B2B segment (companies I, J, K and L). Table 4-5 provides an overview of the 12 case companies.

Case com-pany	Company type	Customer segment	Industry	Duration of CBMI collaboration	Approx. no. of meetings and work-shops	Embed-ded student projects
A	Start-up	Consumer	Apparel	1.5 y	10	x
B	Start-up	Consumer	Apparel	2 y	20	x
C	Micro	Business	Textile goods	0.5 y	5	
D	Micro	Business	Coolers	3 y	10	x
E	Micro	Business	Bedding	0.5 y	10	
F	Small	Consumer	Apparel	3 y	10	x
G	Small	Business	Furniture	2 y	15	x
H	Small	Consumer	Furniture	1 y	10	x
I	Medium	Business	Textiles	3 y	10	
J	Large	Business	Machinery and equipment	2 y	5	x
K	Large	Business	Machinery and equipment	2 y	10	
L	Large	Business	Mechatronic goods	3 y	10	

Table 4-5. Overview of case companies.

4.3.3. DATA COLLECTION AND MANAGEMENT

The collaboration with the case companies lasted between six months and three years, depending on the motivation of the individual company. The researchers' interaction with the companies featured seminars, workshops and meetings involving multiple stakeholders in the companies as well as meetings, phone calls, and email correspondence with the company contacts. The interaction with the researchers was supplemented by master student projects in some of the companies, which were oriented at clarifying specific questions (i.e. testing hypotheses) in relation to the

CBM under development. Case study data was captured in meeting minutes that were shared with the companies and in a case study database (Yin, 2014) containing the researchers' field notes, documents and memos. A detailed description of the collaboration process in seven of the case companies is available in a case report collection by Guldmann and Remmen (2018).

4.3.4. DATA ANALYSIS

Based on the rich information gathered in connection with the action research, a case report was first written on each of the cases. Taking an inductive approach to data in the case study database and the case reports a preliminary list of barriers was then created for each company using data triangulation (Yin, 2014). The individual company lists were then compared, and barriers of a similar character were grouped into one headline. This list of barriers was subsequently expanded upon through discussions between the six researchers that had been involved in the collaboration with the 12 case companies, thus applying an investigator triangulation method (Yin, 2014).

4.3.5. RESEARCH LIMITATIONS

The special context of the research, in which CBMI was initiated in most of the case companies, as a result of the interaction with the researchers, may result in the observation of barriers different from those experienced by companies that initiate CBMI of their own accord. The study primarily pertains the early stages of the CBMI process and therefore other barriers may be encountered at later implementation-oriented stages.

However, it seems the concrete setting of the present study does not constitute an issue, because comparing the observed CBMI barriers to CBMI barriers identified in the literature should highlight any differences between the identified sets of barriers that may derive from the setting, and these data sets display overall comparability (cf. Table 4-7). Moreover, comparing data from the companies that implemented CBMs to data from the companies that did not, do not reveal any systematic differences between the two groups with respect to the mix or number of barriers that were encountered (cf. Cross case analysis in section 4.4.5).

The limited number of companies with similar characteristics means findings from the cross-case analysis (cf. Table 4-8) are indicative and should be verified by further research.

4.4. RESULTS AND DISCUSSION

4.4.1. COMPARING BARRIERS FROM THE LITERATURE

Table 4-2 provides an overview of CBMI barriers and RI barriers reported in the literature and the table shows that the two lists of barriers are generally comparable. The two CBMI barriers, repairs impaired by proprietary product designs, parts glued together and other physical product attributes and products and buildings are complex and not designed with EoL reuse or recycling in mind resulting in a low value at EoL (i.e. barriers 30 and 31) are, nevertheless, found to be specific to the CBMI field. These barriers relate to the concrete product design requirements for circular products, i.e. designs that enable repairs, upgrades, remanufacturing etc. and it is not surprising that no equivalents are found in the RI literature that focuses on traditional product and business model innovation (as well as other fields of innovation) with no such design requirements.

Both the conceptual deliberations in section 2 and the similarities between the identified barriers point to good accordance between CBMI and RI, which suggests it could be useful to enfold the substantial body of literature on RI in the CBMI field, for instance to provide inspiration on how to facilitate CBMI at different stages of the innovation process.

4.4.2. OUTCOME IN THE CASE COMPANIES

The CBMI process encompassed a varying degree of exploration, ideation and testing in the 12 companies that resulted in the generation of multiple CBM ideas and the refinement of some of these. Moreover, in start-ups A and B, as well as in micro-company D, CBMs were implemented during the research project. Table 4-6 summarises main outcomes of the CBMI process.

Case com-pany	Outcome of CBMI process	RI
A	Exploration, ideation and testing of ideas for an internally operated return scheme for apparel. The scheme would support a CBM based on peer-to-peer resale of apparel that would **intensify product use** and **extend product life**, which wat at the testing stage when the collaboration began	x
B	Exploration, ideation, testing and implementation of ideas for improvement of a CBM under implementation when the collaboration began. The pre-existing CBM cantered around goods made from second hand materials coupled with a take-back and leasing scheme for apparel that would **intensify product use** and **extend product life**. The CBMI process facilitated by the research project was focused, among other things, on improving the customers interaction	x
C	Exploration, ideation and testing of ideas for cascaded use of textile goods at their usual end-of-life that would **extend material life**	
D	Exploration, ideation and testing of ideas for new product designs as well as a small-scale implementation of a take-back scheme coupled with remanufacturing and resale that **extend product life**	x
E	Exploration, ideation and testing of ideas for cascaded use of redesigned bedding products in new markets to **extend product life**	x
F	Exploration, ideation and testing of ideas for two different CBMs: A store concept based on a combination of repair, reuse, redesign and recycling services for apparel, and another repair service. Both aimed at **extending product life** and the former also at **extending material life**	x
G	Exploration, ideation and testing of ideas for a combined leasing and refurbishment service for the furniture that would **extend product life**	x
H	Exploration, ideation and testing of ideas for a redesigned piece of furniture and an associated take-back and remanufacturing service to **extend product life**	x
I	Exploration, ideation and testing of ideas for CBMs in two different business units that would extend the life of fabrics through maintenance services and recycle fabrics, respectively. These CBMs thus aimed at **extending material** as well as **product life.** Internal dialogue on relevance of CBMs to clarify the organisation's position on CE	x
J	Exploration, ideation and testing of technical solutions primarily to enable recycling, i.e. solutions oriented at **material life extension**. Internal dialogue on relevance of CBMs to clarify the organisation's position on CE	
K	Exploration and some initial ideation that did not result in concrete work to develop ideas further. Internal dialogue on relevance of CBMs to clarify the organisation's position	
L	Exploration, ideation and testing of ideas e.g. regarding circular packaging and a CBM based on take-back and resale (i.e. CBMs aimed at both **material** and **product life extension**). Internal dialogue on relevance of CBMs to clarify the organisation's position on CE	x

Table 4-6. Outcome of the CBMI process.

4.4.3. EMPIRICALLY DERIVED BARRIERS

The external barriers that were identified during the course of the 12 CBMI processes were organised into barriers at the institutional and value chain levels, while internal barriers were organised into barriers at the organisational and employee levels.

	CBMI	**RI**
Institutional level		
Regulatory barriers	4, 5, 6	a
Low price of virgin raw materials compared to recycled materials	1	a
Difficulty securing funding for circular business models	7, 8	b, c
Market demand unclear	17, 18	g, h
Public procurement policies not sustainability oriented	2, 3	a
Value chain level		
Investments in existing manufacturing facilities and value chain	-	f
Concerns about quality control of returned goods	14	i, f
Concerns about consistency of flow of returned goods	15	i
Dispersed, complex value chains	13, 26	f
Reluctance to involve external stakeholders in CBMI activities	-	h, j
Takes time to build new partnerships and mutual trust	11	d
Lack of knowledge or competencies in value chain	10, 24	d
Organisational level		
Narrow focus of existing sustainability strategies	28	l
Difficulty attaining management buy-in	23	l
ROI and similar requirements for new business ventures	9, 19, 20	i
Cannibalisation concerns	21	i
Little evidence of financial and/or environmental benefits	20	i
Lack of resources, knowledge or competencies in-house	8, 24, 25, 27	j, k
Uncertainty about legislation in this field	27	j
Difficulty establishing cross-organisational collaboration	-	l
Special product design requirements	12, 22, 30, 31	i, e
Employee level		
Lack of knowledge about CE and CBMs	24	j
Lack of commitment to promoting the CE agenda	-	l
Prevailing linear business model structures and thinking	28, 29	j
Incentive structure supporting linear business models	29	l

Table 4-7. Observed CBMI barriers and their link with barriers from the literature.

These barriers were furthermore compared to the CBMI and RI literature. The resulting list of empirically derived barriers is presented in Table 4-7 together with barriers identified in the literature.

BARRIERS AT THE INSTITUTIONAL LEVEL

Barriers observed at the institutional level concern regulatory barriers, such as the taxation of labour rather than raw materials, which meant that labour-intensive reuse, repair, upgrade, remanufacturing and recycling activities were expensive compared to manufacture of new products. Classification of recaptured goods as waste is another example, which induced restrictions on handling and transportation of the goods. Taxation and market structures meant companies found little incentive to use recycled materials, as virgin raw materials were almost as cheap and were considered easier to handle.

Funding difficulties were another barrier, as banks, for instance, were reluctant to support the development and implementation of a CBM in micro-company A, and the small apparel company F failed to attain financial support for market testing of a CBM from public innovation funds, because the funds to support new environmental solutions were earmarked for technology development, whereas the CBM would test new ways of interacting with customers and offer services to slow resource loops. The lack of funding opportunities no doubt related to the unclear market demand for CBMs, which was a major concern for the case companies. While CE-oriented public procurement policies could potentially alleviate this for companies with business-to-government sales, the policies were generally found to be more oriented at cost than sustainability.

BARRIERS AT THE VALUE CHAIN LEVEL

At the value chain level investments made in existing manufacturing facilities and value chain setups were an issue for some of the incumbents. Much time, money and effort went into building these infrastructures, and starting to building new ones that would potentially divert business away from the profitable, established setups looked unattractive to the companies. The companies also worried about how to ensure a high, uniform quality output from the product-life extension activities and about consistence of the return-flow of goods or recycled materials. Globally and culturally dispersed and highly complex value chains rendered it a complicated task to establish new circular systems.

The companies were reluctant to involve value chain partners, including customers in the development of CBMs in many cases. However, building CBMs that serve all the involved partners and start building mutual trust in the expanded value networks required for the operation of new CBMs is often highly recommended. It seemed there was little precedent for this kind of collaboration, especially in the mid-sized

and large companies. In existing value chain setups, the collaboration between partners is typically based on formal agreements following industry standards; however, to develop most CBMs, a collaborative approach is needed, which will initially build more on trust than on standards. Finding new partners and building trust is a demanding and time-consuming task that was a barrier for some companies.

BARRIERS AT THE ORGANISATIONAL LEVEL

At an organisational level, extant sustainability strategies with a narrow focus on, for instance, energy efficiency of products, was a barrier to the adoption of the CE concept and the development of CBMs. The larger companies in particular seemed stuck in the old paradigms on some occasions. A change of strategy and an allocation of resources to CBM development would require a management decision in several of the companies, but many struggled with how to ensure the needed management buy-in to CBMs. This was typically not a barrier in the smaller case companies, where top management was typically involved in the CBMI process from the beginning.

The economic side of CBMs was a concern. First, company investments are traditionally based on key figures such as payback time, return on investment (ROI), or similar. Yet, CBMs operate at different timelines, risks and financial structures than linear business models, and will often not meet the ROI requirements that linear business models do, at least not within the same time span. CBMs thus need to be evaluated on different terms, and according to parameters that are yet to be developed. Second, case companies worried about cannibalisation from new circular offerings that would prolong product life and thus decrease direct sales. Third, little evidence is available that clearly demonstrates the environmental and financial benefits of CBMs.

Most of the case companies were new to CBMs and, consequently, needed to build knowledge and skills within this field and allocate resources to it. One area that posed challenges was lack of knowledge about regulation of relevance to CBMs. In the larger companies, it was important, but difficult, to establish cross-organisational collaboration that would assist internal alignment and development of CE competencies across the company.

The special design of products required to support CBMs, for instance, by avoiding gluing, welding and casting parts together, also constituted a barrier. The redesign process requires new skills, and, while redesign is costly in itself, building new manufacturing lines and supplier networks to implement a new design is particularly so. Furthermore, frequent technological product improvements were highlighted as an issue in some of the technology-oriented companies that meant it would be difficult to ensure a stable product design over time to facilitate remanufacturing.

BARRIERS AT THE EMPLOYEE LEVEL

Most of the case companies were unfamiliar with the notions of CE and CBM when the research collaboration began. This lack of basic knowledge about CE and CBMs was an initial barrier. Some case companies had previous experience with CE principles, for example, from experience with products made of recyclable materials or from a return system, although they were typically not articulated as CBMs. These experiences formed a good starting point for the introduction of CE and CBMs in the companies.

Maybe because of difficulty of attaining management support for the CBMI process particularly in the larger companies, we observed that the company contacts were hesitant about promoting CE internally. The need for a CE agenda to fit with other strategic agendas in the company, the perception that the organisation was already stretched for resources, uncertainty regarding the market demand and regarding the solidity of the business case, also appeared to be important reasons for the cautious approach.

In some of the larger case companies, employees struggled with how to manoeuvre around the extant organisational structures and values, which were strongly influenced by linear business model thinking. In general, it seemed employees found it most appealing to work from the familiar linear business setup and approach CE in small and safe incremental steps. An incentive structure based on linear business model values and business-as-usual operations, for example, rewarding sales volume rather than service contract agreements, was also found to be problematic at the employee level.

4.4.4. COMPARISON WITH THE LITERATURE

CBMI barriers observed in the case companies generally correspond to CBMI and RI barriers in the literature (cf. Table 4-7). However, the observed barriers reluctance to involve external stakeholders in CBMI activities; difficulty establishing cross-organisational collaboration and lack of commitment to promoting the CE agenda do not have a clear equivalent in the reviewed CBMI literature. Although they all relate, more generally, to the fundamental shift in corporate culture and market engagement that is needed and a resistance to this change (i.e. barrier 28 from the CBMI literature).

A possible explanation for why these, more specific, barriers were detected is the present study is that the researchers actively kickstarted the CBMI process in most of the participating companies. It was thus up to the company contacts to integrate the CBMI process in the company, as opposed to the more typical (and more studied) situation where CBMI is introduced by management. The lack of management support combined with the long list of other barriers meant that CBMI was percieved as risky

and promoting CBMs thus transferred into a career-wise risk for the company contacts as well as the other employees involved. This setting meant it was difficult to establish the internal and external collaboration needed to advance the CBMI process.

In the smaller companies, in which management was directly involved, personal risk and cross-organisational collaboration was not an issue, but the companies still exhibited reluctance involving external partners. Possibly because (most of) the companies were just beginning to understand CBMs and how they might progress in that direction, involving external partners seemed premature.

The observed barrier, investments in existing manufacturing facilities and value chain did not have a clear equivalent in the CBMI literature either (although it arguably relates to barriers from the literature such as concerns over risk of decreasing sales and fundamental shift in corporate culture, policies and market engagement). This barrier highlights that incumbent companies are often locked-in to linear business models due to investments in the existing infrastructure and, like the three barriers described above, the barrier is a relevant addition to the list of previously identified barriers.

4.4.5. CROSS-CASE ANALYSIS

The barriers experienced by the individual case companies are mapped out in Table 4-8. Overall, most barriers were encountered by the companies at the organisational level (52), followed by the value chain level (36) and the employee level (23). The fewest barriers were encountered at the institutional level (19). One could speculate if this distribution has to do with the fact that most case companies worked primarily at the early stages of CBMI, as institutional barriers may not be encountered until later stages of the innovation process, closer to implementation. Comparing companies A, B and D — the only companies to implement small- or large-scale CBMs during the research project— to the rest of the companies, nevertheless showed that the companies that implemented CBMs did not experience more institutional barriers than other companies.

All the companies experienced a substantial number of barriers (ranging from 7 to 20). Although the average number of encountered barriers increased with company size (from an average of 9 barriers for the start-ups to an average of more than 11 for the medium-large companies), there are considerable variations between companies of the same size. Hence, medium-sized firm I and large firm K encountered the most barriers (18 and 20, respectively), but the other two large companies, J and L, encountered considerably fewer (9 and 8, respectively), which is less than some of the start-ups, micro-companies and small firms encountered.

	A	B	C	D	E	F	G	H	I	J	K	L	
Institutional level													19
Regulatory barriers		x											1
Difficulty securing funding for circular business models	x	x			x		x	x					5
Market demand unclear	x	x			x	x		x	(x)		x		7
Public procurement policies not sustainability oriented			x	x			x						3
Low price of virgin raw materials compared to recycled materials				(x)	x				(x)				3
Value chain level													36
Investments in existing manufacturing facilities and value chain					x			x	x	(x)	x		5
Concerns about quality control of returned goods					x		x		x		(x)		4
Concerns about consistency of flow of return goods		x					x		x		x		4
Dispersed, complex value chains	x								x	x	x		4
Reluctance to involve external stakeholders in CBMI activities			(x)			x	(x)		x		x		5
Takes time to build new partnerships and mutual trust	x	x	x		x	x	(x)	x	x		x		9
Lack of knowledge or competencies in value chain	x	x			x		x	x					5
Organisational level													52
Narrow focus of existing sustainability strategies				x		x			x	x	x	x	6
Difficulty attaining management buy-in		x			x			x	x		x	x	6
ROI and similar requirements for new business ventures	x	x	x		x			x			(x)		6
Cannibalisation concerns				x		x					x		3
Little evidence of financial and environmental benefits		x		x	x			x	x		x	x	7
Lack of resources, knowledge, or competencies in-house	x	x	x	x	x	x	x	x	x	x	x	x	12
Uncertainty about legislation in this field		x									x		2
Difficulty establishing cross-organisational collaboration									x	x	x	x	4
Special product design required for maximum profitability			x		x			x	x	x	x		6
Employee level													23
Lack of knowledge about CE and CBMs			x	x		x			x	x	x	x	7
Hesitant approach to promoting the CE agenda							x		x		x	x	4
Prevailing linear business model structures and thinking				x	x	x	x	x	x	x	x	x	9
Incentive structure supporting linear business models									x	x	x		3
	7	11	7	8	13	8	10	11	18	9	20	8	130
Company type	start up	start up	micro	micro	micro	small	small	small	medium	large	large	large	
Customer segment	C	C	B	B	B	C	B	C	B	B	B	B	

Table 4-8. Cross-case overview of observed barriers.

The number of barriers experienced varied to a lesser extent within all other groups of companies as well. Therefore, company size did not determine the number of encountered barriers in itself in this study, although there seems to be some correlation between number of barriers experienced and company size.

In the start-up group, as many as 6 barriers (out of 7 and 11 barriers encountered by companies A and B, respectively) were encountered by both companies. In the mid-sized and large company group, 5 barriers were experienced by all four companies. However, despite the similarities in these two groups, the exact mix of barriers encountered seemed to vary greatly, and only the somewhat broadly defined barrier lack of resources, knowledge or competencies in-house was encountered by all case companies.

Most companies experienced barriers at all four socio-technical levels. However, the start-ups did not experience barriers at the employee level, whereas all the incumbents did, not least the mid-sized and large companies. This is not surprising as barriers at the employee level refer to issues such as a lack of knowledge about CBMs, prevailing linear business model thinking, etc. that do not relate to circular start-ups, which means start-ups have an advantage over incumbent companies in this respect.

Whether the customer segment impacts the encountered barriers was examined by focusing on the three small companies of which two (F and H) are B2C companies and one (G) is a B2B company. In this group, the B2B company tended to face more barriers at the value chain level than the B2C companies, whereas the B2C companies faced more organisational barriers. Expanding the analysis to compare start-ups and micro-companies (two groups of very small companies oriented at different customer segments), however, this pattern was not replicated. Therefore, we cannot establish that there is a difference between barriers experienced by B2B and B2C firms.

4.4.6. OTHER DIMENSIONS OF RELEVANCE AND FURTHER RESEARCH

Tables 4-7 and 4-8 provide an overview of the barriers that were observed in the CBMI processes. The long list of barriers indicates that CBMI is a challenging field of innovation, a notion that is supported by the comparability with RI barriers (cf. Tables 4-2 and 4-7) and the conceptual deliberations outlined in Section 4-2. The exact mix of barriers that a company will encounter and which of these will be most challenging to surmount will depend upon its specific internal and external setting. For example, large companies are expected to face more internal barriers to innovation that relate to organisational inertia from path dependency and lock-in than small companies (Bessant et al., 2014; D'Estea et al., 2012; Sandberg and Aarikka-Stenroos, 2014), a pattern that is detected in the cross-case analysis. Small companies, on the other hand, are generally expected to face more external barriers relating to a lack of resources and market structures (D'Estea et al., 2012; Sandberg and Aarikka-

Stenroos, 2014), however, this pattern was not replicated in our study. This may have to do with the fact that we primarily studied the early stages of the CBMI process, whereas later implementation-oriented stages may reveal more of those barriers.

The mix of barriers that companies encounter is also expected to link to more elusive dimensions of the CBMI process. Nevertheless, except for a few notable exceptions (e.g. Bocken et al., 2016a; Urbinati et al., 2017), little research has been done to precisely describe the dimensions that separate different types of CBMs. A further clarification of the CBM concept is thus called for to clearly distinguish and categorise CBMs and clarify whether and how the CBM type influences what barriers are encountered.

This paper contributes to such conceptualisation by suggesting a categorisation of the CBMI process along a continuum from incremental to radical depending on whether few or many elements of the pre-existing business model must be changed and whether these changes are new to the company.

However, more research is needed, for instance, on how the complexity of the CBM under development (in the form of the size and complexity of the new value network, the novelty in the customer interaction, the maturity of enabling technologies etc.) influence what barriers are encountered.

Links between the CBM and the pre-existing linear business model, that is, whether small or large adjustments are needed to the existing business model and what sort of adjustments are needed (Foss and Saebi, 2017; Mitchell and Coles, 2003; Schaltegger et al., 2012) as well as how barriers (and enablers) are influenced by the strategic aspirations of the company and the emerging CE institution of its particular sector (Stål and Corvellec, 2018) would also seem a fruitful avenue for future research.

4.5. CONCLUSION

This paper examined what barriers are associated with CBMI. A comprehensive list of barriers was derived from empirical data from 12 companies engaged in CBMI, resulting in a framework of institutional, value chain-level, organisational-level and employee-level barriers, which highlighted that barriers to CBMI exist on all socio-technical levels.

The study identified barriers not previously reported in the literature, namely *reluctance to involve external stakeholders in CBMI activities; difficulty establishing cross-organisational collaboration; lack of commitment to promoting the CE agenda*

and investments in existing manufacturing facilities and value chain which provide valuable additions to the list of previously identified barriers.

The paper suggested that CBMI can, in many cases, be considered RI through conceptual deliberations and by showing good alignment between CBMI barriers and RI barriers. This calls attention to the opportunity for cross-pollination between the CBMI and the RI literature, for instance, by drawing on the well-established RI literature for ways to manage and facilitate CBMI.

For now, the compiled list of CBMI barriers can inform managers and scholars about a set of possible barriers to the innovation process, which can support a proactive and efficient way of avoiding or overcoming these barriers.

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REFERENCES

Adams, K.T., Osmani, M., Thorpe, T., Thornback, J., 2017. Circular economy in construction: current awareness, challenges and enablers. Proceedings of the Institution of Civil Engineers: Waste and Resource Management 170, 15-24. http://dx.doi.org/10.1680/jwarm.16.00011

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., Overy, P., 2016. Sustainability-oriented Innovation: A Systematic Review. Int. J. Manag. Rev. 18, 180–205. https://doi.org/10.1111/ijmr.12068

Amit, R., Zott, C., 2010. Business model innovation: creating value in times of change. IDEAS Work. Pap. Ser. from RePEc.

Bakker, C.A., den Hollander, M.C., van Hinte, E., Zijlstra, Y., 2014a. Products That Last - product design for circular business models, first ed. TU Delft, Delft, Netherlands.

Bakker, C., Wang, F., Huisman, J., den Hollander, M., 2014b. Products that go round: exploring product life extension through design. J. Clean. Prod. 69, 10–16. https://doi.org/http://dx.doi.org/10.1016/j.jclepro.2014.01.028

Berchicci, L., Bodewes, W., 2005. Bridging environmental issues with new product development. Bus. Strateg. Environ. 14, 272–285.

Besch, K., 2005. Product-service systems for office furniture: barriers and opportunities on the European market. J. Clean. Prod. 13, 1083–1094.

Bessant, J., Öberg, C., Trifilova, A., 2014. Framing problems in radical innovation. Ind. Mark. Manag. 43, 1284–1292. https://doi.org/10.1016/j.indmarman.2014.09.003

Blomsma, F., Brennan, G., 2017. The emergence of circular economy: a new framing around prolonging resource productivity. J. Ind. Ecol. 21, 603–614. https://doi.org/10.1111/jiec.12603

Bocken, N.M.P., Bakker, C., de Pauw, I., van der Grinten, B., 2016a. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 33, 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bocken, N.M.P., Rana, P., Short, S.W., 2015. Value mapping for sustainable business thinking. J. Ind. Prod. Eng. 32, 67–81. https://doi.org/10.1080/21681015.2014.1000399

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. J. Clean. Prod. 65, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Bocken, N.M.P., Weissbrod, I., Tennant, M., 2016. Business Model Experimentation for Sustainability, in: Setchi R., Howlett R., Liu Y., Theobald P. (Eds.) Sustainable Design and Manufacturing 2016. SDM 2016. Smart Innovation, Systems and Technologies, vol. 52. Springer, Cham, pp. 297–306. https://doi.org/10.1007/978-3-319-32098-4_26

Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. J. Clean. Prod. 45, 9–19. https://doi.org/10.1016/j.jclepro.2012.07.007

Boons, F., Montalvo, C., Quist, J., Wagner, M., 2013. Sustainable innovation, business models and economic performance: an overview. J. Clean. Prod. 45, 1–8.

Brezet, H., van Hemel, C., 1997. Ecodesign: a promising approach, United Nations Publications, Paris.

Brown, T., 2008. Design Thinking. Harv. Bus. Rev. 86, 84–92.

Bryman, A., 2012. Social research methods, fourth ed. Oxford University Press, Oxford.

D'Estea, P., Iammarino, S., Savona, M., von Tunzelmann, N., 2012. What hampers innovation? revealed barriers versus deterring barriers. Res. Policy, Manag. Econ. Stud. Sci. Technol. Innov. 41, 482–488.

de Jesus, A., Mendonça, S., 2018. Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy. Ecol. Econ. 145, 75–89.

Dickens, L., Watkins, K., 1999. Action research: rethinking Lewin. Manag. Learn. 30, 127–140. https://doi.org/10.1177/1350507699302002.

Edbring, E.G., Lehner, M., Mont, O., 2016. Exploring Consumer Attitudes to Alternative Models of Consumption: Motivations and Barriers. J. Clean. Prod. 123, 5–15.

Ellen MacArthur Foundation, 2013. Towards the circular economy vol. 2: opportunities for the consumer goods sector. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE_Report-2013.pdf [Accessed July 19, 2018].

Ellen MacArthur Foundation, 2012. Towards the circular economy vol. 1: an economic and business rationale for an accelerated transition. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf [Accessed July 19, 2018].

Eurostat, 2016. Glossary: Enterprise size. http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Enterprise_size%0D%0A [Accessed May 5, 2018].

Evered, R., Louis, M.R., 1981. Alternative perspectives in the organizational sciences: "inquiry from the inside" and "inquiry from the outside". Acad. Manag. Rev. 6, 385–395. https://doi.org/10.2307/257374

Flyvbjerg, B., 2006. Five misunderstandings about case-study research. Qual. Inq. 12, 219–245. https://doi.org/10.1177/1077800405284363

Foss, N.J., Saebi, T., 2017. Fifteen years of research on business model innovation. J. Manage. 43, 200–227. https://doi.org/10.1177/0149206316675927

Franco, M.A., 2017. Circular economy at the micro level: A dynamic view of incumbents' struggles and challenges in the textile industry. J. Clean. Prod. 168, 833–845. https://doi.org/10.1016/j.jclepro.2017.09.056

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E., 2017. The circular economy – a new sustainability paradigm? J. Clean. Prod. 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Guiltinan, J., 2009. Creative destruction and destructive creations: environmental ethics and planned obsolescence. J. Bus. Ethics 89, 19–28. https://doi.org/10.1007/s10551-008-9907-9

Guldmann, E., 2016. Best Practice Examples of Circular Business Models. Danish Environmental Protection Agency, Copenhagen, Denmark. [pdf] Available at: https://www2.mst.dk/Udgiv/publications/2016/06/978-87-93435-86-5.pdf [Accessed September 6, 2018].

Guldmann, E., Remmen, A., 2018. Towards Circular Business Models: Experiences in Eight Danish Companies. Danish Environmental Protection Agency, Copenhagen, Denmark. [pdf] Available at: https://www2.mst.dk/Udgiv/publications/2018/04/978-87-93614-97-0.pdf [Accessed September 6, 2018].

Hopkinson, P., Zils, M., Hawkins, P., Roper, S., 2018. Managing a complex global circular economy business model: opportunities and challenges. Calif. Manag. Rev. 60, 71–94.

Huulgaard, R.D., Vingwe, E., 2017. Nordjyllands mest cirkulære virksomhed 2017. Aalborg, Denmark. [pdf] Available at: https://nben.dk/wp-content/uploads/2017/05/Nordjyllands-mest-cirkulære-virksomhed-2017.pdf [Accessed September 16, 2018].

Hölzl, W., Janger, J., 2012. Innovation barriers across firms and countries. WIFO Work. Pap. 426–458.

Kindström, D., Kowalkowski, C., 2014. Service innovation in product-centric firms: a multidimensional business model perspective. J. Bus. Ind. Mark. 29, 96–111.

King, A., Miemczyk, J., Bufton, D., 2006. Photocopier remanufacturing at Xerox UK - A description of the process and consideration of future policy issues. In: Brissaud, D., Tichkiewitch, S., Zwolinski, P. (Eds), Innovation in Life Cycle Engineering and Sustainable Development. Springer, Dordrecht, 173-186.

Kissling, R., Coughlan, D., Fitzpatrick, C., Boeni, H., Luepschen, C., Andrew, S., Dickenson, J., 2013. Success factors and barriers in re-use of electrical and electronic equipment. Resour. Conserv. Recycl. 80, 21–31.

Krystofik, M., Wagner, J., Gaustad, G., 2015. Leveraging intellectual property rights to encourage green product design and remanufacturing for sustainable waste management. Resour. Conserv. Recycl. 97.

Kuo, T.C., Ma, H.-Y., Huang, S.H., Hu, A.H., Huang, C.S., 2010. Barrier analysis for product service system using interpretive structural model. Int. J. Adv. Manuf. Technol. 49, 407–417. https://doi.org/10.1007/s00170-009-2399-7

Lieder, M., Rashid, A., 2016. Towards circular economy implementation: a comprehensive review in context of manufacturing industry. J. Clean. Prod. 115, 36–51. https://doi.org/10.1016/j.jclepro.2015.12.042

Liedtka, J., 2011. Learning to use design thinking tools for successful innovation. Strateg. Leadersh. 39, 13–19.

Liedtka, J., 2015. Perspective: Linking Design Thinking with Innovation Outcomes through Cognitive Bias Reduction. J. Prod. Innov. Manage. 32, 925–38.

Linder, M., Williander, M., 2017. Circular Business Model Innovation: Inherent Uncertainties. Bus. Strateg. Environ. 26, 182–196. https://doi.org/10.1002/bse.1906

Magretta, J., 2002. Why business models matter. Harv. Bus. Rev. 80, 86–92.

Michaud, C., Llerena, D., 2011. Green consumer behaviour: an experimental analysis of willingness to pay for remanufactured products. Bus. Strateg. Environ. 20, 408–420.

Milovantseva, N., Fitzpatrick, C., 2015. Barriers to electronics reuse of transboundary e-waste shipment regulations: An evaluation based on industry experiences. Resour. Conserv. Recycl. 102.

Mitchell, D., Coles, C., 2003. The ultimate competitive advantage of continuing business model innovation. J. Bus. Strategy 24, 15–21.

Mont, O.; Plepys, A.; Whalen, K.; Nußholz, J.L.K., 2017. Business model innovation for a circular economy: drivers and barriers for the Swedish industry – the voice of REES companies. http://lup.lub.lu.se/record/833402ef-b4d4-4541-a10e-34d1e89d2146 [Accessed May 23, 2018].

Mont, O., Dalhammar, C., Jacobsson, N., 2006. A new business model for baby prams based on leasing and product remanufacturing. J. Clean. Prod. 14, 1509–1518.

Mont, O.K., 2002. Clarifying the concept of product–service system. J. Clean. Prod. 10, 237–245. https://doi.org/10.1016/S0959-6526(01)00039-7

Murray, A., Skene, K., Haynes, K., 2017. The circular economy: an interdisciplinary exploration of the concept and application in a global context. J. Bus. ethics 140, 369–380. https://doi.org/10.1007/s10551-015-2693-2

Nußholz, J.L.K., 2017. Circular business models: defining a concept and framing an emerging research field. Sustainability 9, 1810. https://doi.org/doi:10.3390/su9101810

Oghazi, P., Mostaghel, R., 2018. Circular business model challenges and lessons learned: an industrial perspective. Sustainability 10, 1–19.

Orum, A.M., 2015. Case Study: Logic, in: Wright, J.D. (Ed.), International Encyclopedia of the Social & Behavioral Sciences. Elsevier, 202–207. https://doi.org/10.1016/B978-0-08-097086-8.44002-X

Osterwalder, A., Pigneur, Y., 2010. Business model generation: a handbook for visionaries, game changers, and challengers, first ed. John Wiley & Sons, New Jersey, US.

Östlin, J., Sundin, E., Björkman, M., 2008. Importance of Closed-Loop Supply Chain Relationships for Product Remanufacturing. Int. J. Production Economics 115, 336–48.

Östlin, J., Sundin, E., Björkman, M., 2009. Product Life-Cycle Implications for Remanufacturing Strategies. J. Clean. Prod. 17, 999–1009.

Pearce, J.A., 2009. The profit-making allure of product reconstruction. MIT Sloan Manag. Rev. 50, 59–65.

Ravi, V., Shankar, R., 2005. Analysis of Interactions among the Barriers of Reverse Logistics. Technol. Forecast. & Soc. Chang. 72, 1011–29.

Prendeville, S., Bocken, N., 2017. Design for remanufacturing and circular business models, in: Sustainability Through Innovation in Product Life Cycle Design, EcoProduction. Springer Singapore, pp. 269–283.

Richardson, J., 2008. The business model: an integrative framework for strategy execution. Strateg. Chang. 17, 133–144. https://doi.org/10.1002/jsc.821

Riisgaard, H., Mosgaard, M., Zacho, K.A., 2016. Local circles in a circular economy – the case of smartphone repair in Denmark. Eur. J. Sustain. Dev. 5, 109–124. https://doi.org/10.14207/ejsd.2016.v5n1p109

Rizos, V., Behrens, A., van der Gaast, W., Hofman, E., Ioannou, A., Kafyeke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., Topi, C., 2016. Implementation of circular economy business models by small and medium-sized enterprises (SMEs): barriers and enablers. Sustainability 8, 1212. https://doi.org/10.3390/su8111212

Roome, N., Louche, C., 2016. Journeying Toward Business Models for Sustainability: A Conceptual Model Found Inside the Black Box of Organisational Transformation. Organ. Environ. 29, 11-35. https://doi.org/10.1177/1086026615595084

Sabbaghi, M., Cade, W., Behdad, S., Bisantz, A.M., 2017. The current status of the consumer electronics repair industry in the U.S.: a survey-based study. Resour. Conserv. Recycl. 116, 137–151.

Sandberg, B., Aarikka-Stenroos, L., 2014. What makes it so difficult? A systematic review on barriers to radical innovation. Ind. Mark. Manag. 43, 1293–1305. https://doi.org/10.1016/j.indmarman.2014.08.003

Sauvé, S., Bernard, S., Sloan, P., 2016. Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. Environ. Dev. 17, 48–56.

Schaltegger, S., Hansen, E.G., Lüdeke-Freund, F., 2016. Business Models for Sustainability: Origins, Present Research, and Future Avenues (Editorial Article). Organ. Environ. 29, 3–10. https://doi.org/10.1177/1086026615599806

Schaltegger, S., Lüdeke-Freund, F., Hansen, E.G., 2012. Business cases for sustainability and the role of business model innovation: developing a conceptual framework. Int. J. Innov. Sustain. Dev. 6, 95–119.

Seidel, V.P., Fixson, S.K., 2013. Adopting Design Thinking in Novice Multidisciplinary Teams: The Application and Limits of Design Methods and Reflexive Practices. J. Prod. Innov. Manage. 30, 19-33.

Seitz, M.A., 2007. A critical assessment of motives for product recovery: the case of engine remanufacturing. J. Clean. Prod. 15, 1147–1157.

Singh, J., Ordoñez, I., 2016. Resource recovery from post-consumer waste: important lessons for the upcoming circular economy. J. Clean. Prod. 134, 342–353. https://doi.org/10.1016/j.jclepro.2015.12.020

Stahel, W., 1981. The product-life factor, in: Orr, S.G. (ed.), An Inquiry into the Nature of Sustainable Societies: The Role of the Private Sector. HARC, Houston, TX, pp. 72–96.

Stahel, W.R., 2010. The performance economy. Palgrave Macmillan, Hampshire, UK.

Stål, H.I., Corvellec, H., 2018. A decoupling perspective on circular business model implementation: illustrations from Swedish apparel. J. Clean. Prod. 171, 630–643. https://doi.org/10.1016/j.jclepro.2017.09.249

Sundin, E., Lindahl, M., Ijomah, W., 2009. Product design for product service systems. J. Manuf. Technol. Manag. 20, 723–753.

Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Plan. 43, 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Tushman, M., Nadler, D., 1986. Organizing for innovation. Calif. Manag. Rev. 28, 74–92. https://doi.org/10.2307/41165203

Urbinati, A., Chiaroni, D., Chiesa, V., 2017. Towards a new taxonomy of circular economy business models. J. Clean. Prod. 168, 487–498. https://doi.org/10.1016/j.jclepro.2017.09.047

Van de Ven, A.H., 2007. Engaged scholarship: a guide for organizational and social research. Oxford University Press, New York, US.

Van de Ven, A.H., Johnson, P.E., 2006. Knowledge for theory and practice. Acad. Manag. Rev. 31, 802–21.

van Weelden, E., Mugge, R., Bakker, C., 2016. Paving the way towards circular consumption: exploring consumer acceptance of refurbished mobile phones in the Dutch market. J. Clean. Prod. 113, 743–754.

Velte, C.J., Steinhilper, R., 2016. Complexity in a circular economy: a need for rethinking complexity management strategies, in: World Congress on Engineering, London, UK, 29 June–1 July.

Webster, K., 2017. The Circular Economy: A Wealth of Flows, second ed. Ellen MacArthur Foundation Publishing, Cowes, UK.

Wise, R., Baumgartner, P., 1999. Go downstream. Harv. Bus. Rev. 77, 133–141.

World Economic Forum, 2014. Towards the Circular Economy: Accelerating the Scale-up Across Global Supply Chains. [pdf] Available at: http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf [Accessed September 6, 2018].

Yin, R.K., 2014. Case Study Research: Design and Methods, Fifth ed. SAGE Publications, Thousand Oaks, US.

Ylä-Mella, J., Keiski, R.L., Pongrácz, E., 2015. Electronic waste recovery in Finland: consumers' perceptions towards recycling and re-use of mobile phones. Waste Manag. 45, 374–384.

CHAPTER 5. FACILITATING CIRCULAR BUSINESS MODEL INNOVATION

This chapter examines the second sub-question: *What could a design thinking framework tailored to CBMI look like and what is the potential impact of such a framework?* It consists of article D:

CIRCULAR BUSINESS MODEL INNOVATION AND ORGANISATIONAL TRANSFORMATION

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ABSTRACT

Purpose: Circular business model innovation (CBMI) can support sustainable business transitions, but the process is poorly understood and there is a lack of tools to assist companies in the CBMI process. This article works towards closing these gaps by developing a framework for CBMI based on a design thinking approach, which can support the CBMI process in companies and induce organisational transformation towards more sustainable business.

Design: The CBMI framework was derived from a multiple-case study in which six companies created circular business models in collaboration with the researchers.

Findings: A design thinking process typically consists of three innovation spaces: an exploratory, an ideation, and a prototyping and testing space. Yet, the developed framework advocates two additional spaces, namely an introductory and an alignment space. The results attained in the six case companies indicate that the developed framework is useful for CBMI in diverse organisational settings.

Practical implications: This study contributes with a framework to help practitioners facilitate and manoeuvre the challenging CBMI process. The framework provides guidelines to follow and inspiration for CBMI-specific and general tools that could be adapted to a given organisational setting.

Value: The contribution of the paper is an empirically grounded framework to assist CBMI. The paper also offers a conceptual overview of the CBMI process, and links CBMI to an organisational transformation towards the circular economy.

KEYWORDS: *Circular economy; Circular business models; Sustainable business models; Circular business model innovation; Design thinking*

5.1. INTRODUCTION

Human activities and resource use diminish natural capital at a rate faster than it can be replenished, resulting in a deterioration of the ecological systems our societies depend upon (WWF, 2016). The pace of resource consumption is increasing. Earth Overshoot Day, which demarcates the date where we have used all the resources available for a whole year if we were to stay within the ecological boundaries of the planet, occurs earlier each year (Earth Overshoot Day, 2017). With a rising global population and a larger part of the population moving into the middle class, these problems will continue to grow unless we take swift action (WBCSD, 2010). A key

element in reversing this development is to make a transition in how we consume and produce goods (WWF, 2016; Bocken et al., 2014; WBCSD, 2010), a point made clear by the Brundtland Commission (World Commission on Environment and Development, 1987), followed up at the United Nations Conference on Environment and Development in Rio in 1992 (UN-DESA, 2017) and strongly supported by academia (Zou et al., 2017).

Companies have integrated concepts such as cleaner production, efficiency improvements, eco-design, life cycle management, and corporate social responsibility (Kørnøv et al., 2007; Short et al., 2014) to counter unsustainable development. Findings in the literature nevertheless suggest that such incremental product, process, and technological innovations are insufficient to transform organisations, industries, and societies towards sustainable development (Abdelkafi and Täuscher, 2016; Short et al., 2014; Ceschin and Gaziulusoy, 2016). Current tactics may lead to a reduction of environmental harm, but do not lead to a broader form of value creation, nor to the next level of sustainable business, in which the company has a net positive impact on society (Adams et al., 2016; Short et al., 2014; Network for Business Sustainability, 2012). Instead, we need a more systemic approach that aligns business operations with long-term sustainability.

Sustainable business model innovation offers a possible avenue to integrate sustainability considerations more fully into the firm (Short et al., 2014; Abdelkafi and Täuscher, 2016) and is considered a force for industry transformation and socio-technical transitions by many authors (Geissdoerfer et al., 2017b; Geissdoerfer et al., 2017a; Geissdoerfer et al., 2016; Bocken et al., 2014; Boons and Lüdeke-Freund, 2013; Bocken et al., 2013; Porter and Kramer, 2011). Sustainable business models that are integrated with the circular economy (CE) paradigm are referred to as circular business models (CBMs) (Bocken et al., 2014; Nußholz, 2017). A shift to CBMs is considered a key enabler of a CE (Bakker et al., 2014b; Lieder and Rashid, 2016) and thus of companies that have a net positive impact (Adams et al., 2016). The CE is a regenerative economy in which companies strive to maximize the value and utilization of products, components and materials at all times (Webster, 2015; Ellen MacArthur Foundation, 2012; 2013b). A key element of CBMs is the bundling of products that are fit for repair, upgrades, reuse, refurbishment, and recycling with services that enable the utilization of these product features (Bocken et al., 2016; Ellen MacArthur Foundation, 2013b; Guldmann, 2016).

However, operational guidelines for the implementation of CE are lacking (Blomsma and Brennan, 2017; Ghisellini et al., 2016; Kirchherr et al., 2017) not least in relation to CBMs (Linder and Williander, 2017) with a few exceptions mostly within the grey literature (Achterberg et al., 2016; Kraaijenhagen et al., 2016; Bocken et al., 2016; Ellen MacArthur Foundation and IDEO, 2016). A number of companies have already adopted CBMs and provide some best-case examples (see e.g. Stål and Corvellec, 2018; Guldmann, 2016; Kraaijenhagen et al., 2016; Ellen MacArthur Foundation,

2012; 2013a; b). The cases nevertheless provide only first insights into how companies were able to make the transition towards a circular business. Building on institutional theory, Stål and Corvellec (2018), highlight the relevance of the context of the CBMI and the phenomenon of decoupling (i.e. a discrepancy between stated objectives of circular business operations and actual practices, which remain largely linear) to explain the slow adoption of CBMs. They find that CBM implementation displays decoupling particularly when external pressures are weak, and transparency is lacking: *'A firm does not choose to adopt a particular sustainability approach in a vacuum but is influenced by cognitive, normative and regulative processes.'* (Stål and Corvellec, 2018, p. 638). As inspiring as the exemplars and other guidelines are, and notwithstanding the value of the decoupling perspective, more knowledge is needed about how the innovation process is carried through to facilitate genuine change. This includes knowledge about both how to design an appropriate CBM for the company (Roome and Louche, 2016) and how to facilitate the associated changes in the organisation and the value chain.

The radical shift in business logic and the complex challenges associated with a transition to CBMs (Guldmann and Huulgaard, 2017) infer that CBMI can be considered a case of dealing with a 'wicked' design problem, i.e. a design problem that lacks definite formulations and solutions and is characterized by conditions of high uncertainty (Rittel, 1972 cited in Liedtka, 2015). Design thinking (DT) is a design philosophy that offers a possible response to design problems of this complicated nature (Liedtka, 2015), and is suitable for radical (and incremental) innovation (Fleury et al., 2016). The ability of DT to deal with problems by fostering learning and managing uncertainty (Beckman and Barry, 2007) would seem highly relevant to CBMI processes. However, the opportunity to leverage CBMI processes by applying DT remains under-examined. The goal of the present article is to address this gap in the literature by examining if DT is a useful approach to CBMI, by addressing the research questions: *What could a DT framework tailored to CBMI look like?* and *What is the potential impact of such a framework?* We endeavour to answer these questions by means of an exploratory multiple-case study.

The remainder of this paper is structured as follows. Section 2 describes key theoretical concepts for this study and section 3 illustrates the research methods. Section 4 introduces results from the research, which comprises an adapted DT framework for CBMI including two innovation phases that supplement the usual DT phases, suggestions for CBMI-specific and general tools and an assessment of the outcomes attained using the framework and tools. The paper concludes in section 5 with conclusions, implications of the study and suggestions for further research.

5.2. THEORETICAL BACKGROUND

5.2.1. CIRCULAR ECONOMY

Our current economic system is based on extracting raw materials for products that are ultimately turned into waste. Such a linear system will eventually face difficulty as raw materials grow scarcer and waste issues grow larger, and indeed we already face serious ecological challenges (Earth Overshoot Day, 2017; European Commission, 2014; Global Footprint Network, 2012). The CE has been proposed as an alternative to the linear production paradigm (Webster, 2015) and it is outlined as *'an industrial system that is restorative or regenerative by intention and design'* and which eliminates waste *'through the superior design of materials, products, systems, and, within this, business models'* (Ellen MacArthur Foundation, 2012, p.7).

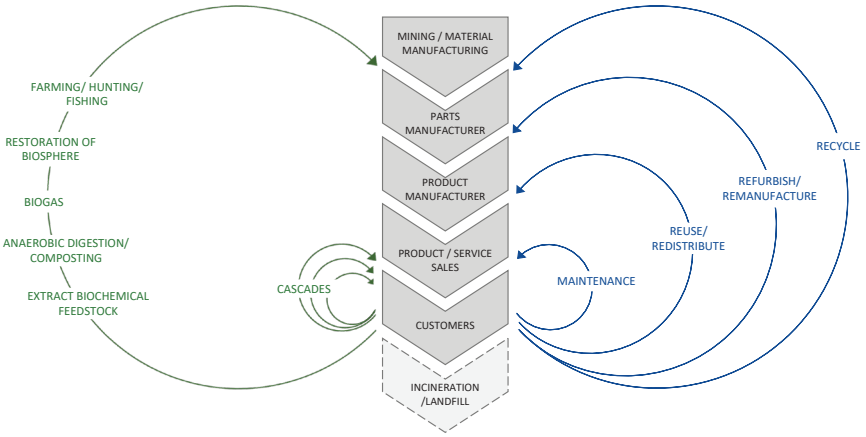

Figure 5-1. System diagram depicting biological (green) and technical (blue) resource loops in a CE. Based on Ellen MacArthur Foundation (2013b, p.24).

In a CE, resources are ideally circulated repeatedly in the resource loops depicted in Figure 5-1 to prolong the useful life of products, components and materials (Achterberg et al., 2016; Ellen MacArthur Foundation and University of Bradford, 2012; Stahel, 2010). The aim is, through the systematic use of repair, reuse, remanufacturing and recycling, to increase resource efficiency of the production system and reduce the need for new products, components and virgin raw material and to reduce waste generated (Guldmann, 2016; World Economic Forum, 2014; Ellen MacArthur Foundation, 2013b).

5.2.2. CIRCULAR BUSINESS MODELS

A company can integrate CE into its business via development and implementation of circular business models. In general, a business model is *'a description of how a company does business'* (Richardson, 2008, p.136). It can be understood as a story about, or a blueprint of, how the company operates (Magretta, 2002; Osterwalder and Pigneur, 2010). The business model is comprised of a number of building blocks. Richardson (2008) for example describes three such building blocks: The value proposition, which is the product of service offering; value creation, which is how value is provided; and value delivery and capture, which is how a firm makes money and captures other forms of value (cf. green elements of Figure 5-2). Osterwalder and Pigneur (2010) detail the description into nine building blocks in their business model canvas, namely value proposition, customers, distribution channels, customer relationships, activities, resources, partners, costs, and revenue, which jointly represent the business model blueprint (cf. blue elements of Figure 5-2).

A circular business model is a type of sustainable business model (Adams et al., 2016; Bocken et al., 2014). No clear definition of what constitutes a CBM is established within this emerging field of research (Nußholz, 2017), however, it has been suggested that CBMs integrate environmental and economic value creation (Lieder and Rashid, 2016) by generating profits from a continual flow of reused materials and products over time (Bakker et al., 2014a) by capitalising on the value embedded in used products (Linder and Williander, 2017). CBMs aim to preserve the embedded value of products at the highest possible level of utility (Velte and Steinhilper, 2016; Webster, 2015) by slowing and closing resource loops (Bocken et al., 2016; Stahel, 2010; 1981).

Slowing resource loops is aimed at prolonging product, component and material life through, for instance, maintenance, reuse and remanufacturing (Bocken et al., 2016; Stahel, 2010; 1981), corresponding to the three inner resource loops of Figure 5-1. Closing resource loops is concerned with recycling resources to put post-use products and materials back into the economy at the end of their functional life (Bocken et al., 2016; Stahel, 2010; 1981), corresponding to the outer resource loop of Figure 5-1. Narrowing resource loops is a third strategy concerned with designing products, services and systems for improved resource efficiency. This tactic is already omnipresent in the linear economy and is relevant as a means to complement slowing and closing strategies from both an environmental and economic viewpoint, although it is not sufficient to constitute a CBM in itself (Bocken et al., 2016).

Slowing resource loops is typically more economically and environmentally profitable than closing them (Linder and Williander, 2017; Ellen MacArthur Foundation, 2013b) as demonstrated e.g. by Jensen (2018) for wind turbines: Retrofitting the turbines to improve energy output and extend the product lifetime (i.e. slowing resource loops), is economically and environmentally viable; material recycling (i.e. closing

resource loops), on the other hand, is viable for certain high-value components such as permanent magnets, whereas blade recycling is not.

While slowing and closing resource loops can be attained using both product design and business model design as a starting point (Bocken et al., 2016), this article focuses on the latter. Building on Osterwalder and Pigneur (2010) and Bocken et al. (2016), we define a CBM as follows: *In a circular business model, the business model elements are joined together to provide a compelling value proposition to customers, generate economic profit to the company, and minimize environmental impacts by means of slowing, closing and narrowing resource loops.* With this definition, for the sake of focus, we purposely define our business model as a rather simplistic producer – consumer type. However, we are aware of more advanced ways of modelling via collaborative networked organisations and customer communities for value co-creation and co-innovation (Romero and Molina, 2011). In a CE, new networks of value creation will need to be developed to close and slow resource loops, including new service and logistical elements (Romero and Rossi, 2017).

As Figure 5-2 depicts, business activities directed at closing and slowing resource loops should be integrated with the configuration of the other building blocks of the business model, including the value proposition, partner network, customer relationships etc.

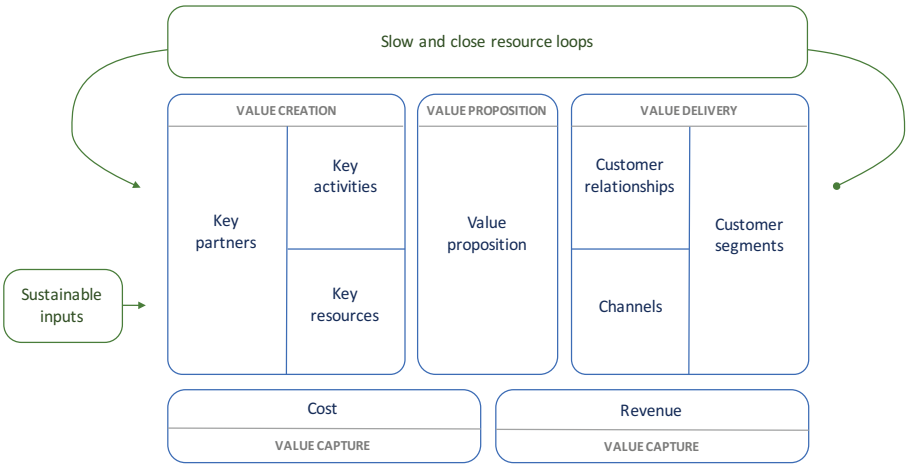

Figure 5-2. Circular business model canvas. Developed from Osterwalder and Pigneur (2010), Richardson (2008), Bocken et al. (2016) and Ellen MacArthur Foundation (2013b).

There are five principles to adhere to in the design of CBMs to create economic and environmental value: The first of these, 'inner circles', stresses the benefits of circulation in the inner circles as opposed to the outer circles of Figure 5-1 (Ellen MacArthur Foundation, 2012; 2013b). Second, 'circling longer' concerns keeping products, components and materials in circulation for as long as possible (Ellen MacArthur Foundation, 2012; 2013b). Third, 'cascading use' is about using products, components and materials for new applications, possibly in new industries, when they no longer work for their original use (Ellen MacArthur Foundation, 2012; 2013b). These three principles focus on value retention of products, components and materials, i.e., keeping products and materials at the highest value for as long as possible (Achterberg et al., 2016). The fourth principle of 'pure flows' concerns ensuring material flows, where materials are uncontaminated and separable to enable recycling, refurbishment and remanufacturing (Bocken et al., 2016; Bakker et al., 2014a; Ellen MacArthur Foundation, 2012; 2013b).

These first four principles interlink with strategies to slow and close resource loops and are thus part of that building block in Figure 5-2. The fifth principle, 'sustainable inputs', is about utilizing sustainable raw material inputs and renewable energy throughout the value chain to support reduction of the environmental impact of products and/or services (Ellen MacArthur Foundation, 2012; 2013b). This principle is illustrated via a separate building block in Figure 5-2.

As the various strategies, principles and business model building blocks outlined in this section suggest, there are several requirements in relation to the CBM design that are unfamiliar to companies and further add to the complexity of a traditional business model innovation (BMI) process. This additional complexity highlights the need for appropriate BMI techniques to support the process and we consequently look more into the literature on BMI in the following section.

5.2.3. BUSINESS MODEL INNOVATION

BMI is about making changes to the building blocks of existing business models to arrive at new configurations of the business model (in a mature company) or creating entirely new business models (in a start-up or within a new business area of a mature company; e.g. Osterwalder and Pigneur, 2010; Mitchell and Coles, 2003). It is considered an important area of innovation by many authors (e.g. Chesbrough, 2010; McGrath, 2010; Teece, 2010; Richardson, 2008; Magretta, 2002), since the commercial success of a given technology or product innovation depends to a large extent on how the product is taken to market, i.e. which business model is applied (Teece, 2010; Chesbrough, 2010; Romero and Molina, 2011).

BMI, as any innovation, takes place within a given social, organisational and individual setting, which shapes the process (Hargadon, 2014; Stål and Corvellec, 2018), and lock-in at the organisational, technological, industrial, societal and

institutional level (Unruh, 2002; Doganova and Karnøe, 2012) may influence the innovation process. Not least in the case of CBMs, which will often break with existing business logic (Chesbrough, 2010; Schaltegger et al., 2012) and market structures to create new, systemic solutions. Uncertainty regarding the best configuration of the business model is another key reason BMI is challenging, as business models often cannot be fully anticipated in advance (McGrath, 2010).

To deal with these challenges, the literature emphasizes *'the centrality of experimentation in the discovery and development of new business models'* (McGrath, 2010, p. 248). Experimentation helps companies test hypotheses underlying the business model ideas and supports organisational learning (Thomke, 2003; Sarasvathy, 2005; Osterwalder and Pigneur, 2010; Chesbrough, 2010; McGrath, 2010). Such experimentation can take place within or across companies (McGrath, 2010) and has been recommended as a sustainability and CE innovation mechanism (Weissbrod and Bocken, 2017).

Mapping out extant and new business models is an example of an internally oriented tool for experimentation (Chesbrough, 2010). A market or focus group study constitutes a market-oriented tool that could be applied at early stages of the BMI process (McGrath, 2010), while a test launch in a specific market could be employed at later stages to attain high fidelity in the experiments (Chesbrough, 2010). The choice of tools applied in the innovation process should consider *'the organisational and field-level landscapes in which they are employed'* (Hargadon, 2014, p.177).

The process of considering where CE would be most relevant to a company, generating ideas within those areas and developing and testing the ideas is referred to as circular business model innovation (CBMI). The break with the dominant logic of the organisation is more pronounced in a transition from linear to circular business models, due to the shift into a new economic paradigm; sustainable business models are more socially complex than their linear counterparts, in that they call for the establishment of new business relationships and the involvement of more actors (Roome and Louche, 2016); and CBMs entail an increased operational risk compared to linear business models (Linder and Williander, 2017). The experimentation required to create organisational learning in traditional BMI would thus seem even more called for in a CBMI context (Weissbrod and Bocken, 2017; Kraaijenhagen et al., 2016; Antikainen and Valkokari, 2016).

5.2.4. DESIGN THINKING

The complexity and uncertainty inherent in CBMI and the experimental approach towards learning that is recommended in the literature (Antikainen and Valkokari, 2016; Kraaijenhagen et al., 2016; Weissbrod and Bocken, 2017) links well with DT. DT is appropriate for dealing with uncertainty and in contrast to traditional management approaches, DT actively avoids making choices for as long as possible

to maximize learning as a deliberate uncertainty reduction strategy (Beckman and Barry, 2007).

DT can be defined as *'the application of design methods by multidisciplinary teams to a broad range of innovation challenges'* (Seidel and Fixson, 2013, p.19) and this approach to innovation has gained increasing academic and practitioner interest in recent years and spread from the field of architecture into many other fields including education, industrial design, industrial engineering, information systems and innovation management (Dolak et al., 2013). DT can be understood as a cognitive style; as an embedded principle in professional practice; and as a method to guide the process of designing, respectively (Dolak et al., 2013). In this paper, we focus on DT as an innovation management tool, used to guide the process of designing new CBMs and a useful definition of DT that applies in this context is: *'a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity.'* (Brown, 2008, p.2). In other words, DT can integrate customer needs with a feasible business model.

Accordingly, DT can be understood as an approach to integrate often conflicting viewpoints on what is desirable in a given (business model) design. The ability of DT to incorporate opposing perspectives applies both at the top level, for conflicts between customer needs, market opportunities, technological and economic constraints, and at the team level, for conflicting viewpoints between innovation team members. In fact, this kind of conflict is perceived as a driving force for creativity in DT termed 'creative friction' (Fleury et al., 2016) and multidisciplinary teams incorporating formally trained designers as well as non-designers is indeed encouraged to exploit such friction (Carlgren et al., 2016a). This ability of DT to integrate multiple viewpoints is relevant in a CBMI context, where multiple actors are oftentimes indispensable to create systems innovation, and DT has been found useful in the related context of sustainable BMI (Geissdoerfer et al., 2016).

Definitions, terminology and the number of process steps described for DT vary somewhat in the literature (Seidel and Fixson, 2013; Fleury et al., 2016; Brown, 2008; d.school, n.d.; Carlgren et al., 2016b). Liedtka (2015, p. 927) nevertheless concludes that there are some typical characteristics of the process: *'All descriptions of the process emphasize iterative cycles of exploration using deep user research to develop insights and design criteria, followed by the generation of multiple ideas and concepts and then prototyping and experimentation to select the best ones - usually performed by functionally diverse groups working closely with users'*. A DT process is an iterative, fluid, or even chaotic journey through three distinct 'innovation spaces' (Brown, 2008). The aim of the exploratory space is to define a problem, an opportunity, or both (Brown, 2008; Seidel and Fixson, 2013). Tools utilized at this stage are observation, interviewing and other kinds of ethnographic research approaches (Liedtka, 2015). The idea generation or ideation space focuses on

generating and developing ideas, meaning that brainstorming techniques are relevant here, along with mind-mapping, and other kinds of sense-making tools (Seidel and Fixson, 2013). Finally, the prototyping and testing stage aims at building prototypes to experiment and generate learning, to make abstract ideas tangible and enhance feedback conversations with decision makers (Liedtka, 2015). Surfacing and testing assumptions is also among the techniques featured in this phase.

Design thinking aspects	**Key points**		
Guiding principles	- User-centred - Collaboration across functions, perspectives and experience bases - Iterative cycles of moving through innovation spaces - Emphasize learning		
Innovation spaces	**Exploratory space**	**Ideation space**	**Prototyping and testing space**
Aim of spaces	Definition of a problem or opportunity	Generation of multiple ideas and concepts. Seeking higher-order thinking and creative solutions	Building models and experimenting to facilitate the development and selection of the best ideas and concepts
Examples of techniques and tools used in individual spaces	Ethnographic research techniques: - Observation - Interviewing - Job to be done - Journey mapping	Sense-making and ideation tools: - Mind-mapping and other forms of cluster analysis - Brainstorming - Concept development techniques to generate hypotheses about potential opportunities	Prototyping and testing approaches: -Assumption surfacing and testing - Field experiments with external stakeholders - Prototyping techniques such as storyboarding and user scenarios
Examples of techniques and tools that span all spaces	Visualization techniques, visual or narrative: - Charts - Organizing Post-it notes - Storytelling - Metaphors Co-creation approaches: - Engage users in generation, development and testing of ideas		

Table 5-1. General DT model, adapted from Liedtka (2015), Seidel and Fixson (2013) and Brown (2008).

Visual and narrative visualization instruments such as charts for visual representation along with analogies and storytelling for narrative visualization can be applied in all innovation stages and so can co-creation techniques that involve users in the generation, development and testing of ideas. Table 5-1 summarises the main characteristics of the DT process and some typical techniques used. The selection of tools offered in Table 5-1 is not exhaustive, but an indication of the sort of tools that could be applied in the process.

Notably, taking a DT approach to innovation work is not so much about the specific tools utilized in the innovation process, but rather about applying techniques that are relevant in the given context and which support an iterative movement between the exploratory, the idea generation, and the prototyping and testing spaces, and which support collaboration, learning and a user-centred focus (Plattner et al., 2010). Thus, there is a large number of techniques that could be applied in the process and ultimately the process should be adapted to fit the specific work at hand (d.school, n.d.). The adjustment of the approach to a particular organisational and external setting is in line with the flexibility called for by scholars (e.g. Hargadon, 2014). Such adjustment of the process to fit the CBMI context is a key theme of the remainder of this article.

5.2.5. RESEARCH GAP

The pressing need to move towards sustainable development renders a wider adoption of CBMs desirable (Adams et al., 2016). However, CBMI involves challenges at the employee, organisational, value chain and institutional levels (e.g. Guldmann and Huulgaard, 2017; Linder and Williander, 2017; Rizos et al., 2016), and there is a need for frameworks to support companies in the development of sustainable business models (Upward and Jones, 2016), not least circular ones. DT appears to be a promising approach to deal with these challenges and a few academic papers have explored DT in relation to sustainable BMI (e.g. Geissdoerfer et al., 2016; Baldassarre et al., 2017), where they have focused on formats to generate sustainable value propositions in one or a few sittings.

Kozlowski et al. (2018) found that DT involved a relevant potential for reducing the negative impact of fashion products, both environmentally and socially, and propose a design tool, the redesign canvas, to support fashion design entrepreneurs in their sustainable decision-making process (Kozlowski et al., 2018). Heyes et al. (2018) have applied the business model canvas in relation to circular business models for one ICT firm. Also, here, a specific tool has been developed and tested, the 'BECE framework', combining back casting and ecodesign activities in a CE context and in the field of energy-efficiency services, progress has been made in the exploration of user-centred sustainable business model design (Tolkamp et al., 2018).

A selection of tools for 'circular innovations' has been suggested by the Ellen MacArthur Foundation and IDEO (2016), who present several tools based on DT principles such as 'learn from nature', 'find circular opportunities', and 'product journey mapping' that are organised into four themes, namely understand, define, make, and release circular innovations (Ellen MacArthur Foundation and IDEO, 2016). These tools are oriented at facilitating a transition of companies towards CE more broadly in product design, packaging, the use of raw materials etc. One of the tools, 'Circular Business Model' (and elements of some of the other tools), relate to the specific development of CBMs, and it builds on the business model canvas, which is supplemented by questions to prompt reflections on a redesign of the current business model.

While aspects of DT and some specific tools have thus been examined in relation to parts of the CBMI process, the application of a DT framework and a selection of tools to the CBMI process in its entirety is less well explored. Based on a case study of multiple cases, this paper suggests a framework and tools that links with DT principles, which can guide the CBMI process in its entirety and start to fill this gap in the literature.

5.3. METHODS

The study was designed as an exploratory, process-based and longitudinal study of multiple cases (Yin, 2014; O'Connor et al., 2003) involving six Danish companies. A case study approach is recommended when the topic of interest is complex and needs to be studied in its context (Flyvbjerg, 2006; Eisenhardt and Graebner, 2007; Yin, 2014). It allows the researcher to grasp a complex situation and describe actors and processes in an accessible format, and for this reason it is a favoured method to study business cases in their micro and macro environment (Eriksson and Kovalainen, 2008). An in-depth study of a single case can be appropriate for theory building; however, a multiple-case approach is particularly recommendable for this purpose as cases can be contrasted using literal and theoretical replication logic (Yin, 2014; Eisenhardt, 1989). Multiple cases can be used to identify common patterns and characteristics between cases (Eriksson and Kovalainen, 2008) and are instrumental in allowing analytical generalisation beyond the specific research context (Healy and Perry, 2000).

Processes such as the CBMI process are most appropriately examined via data collection as the events unfold and before the outcome is known, to prevent post hoc rationalization, to understand the impact of short-lived factors and changes, and discern patterns over long periods of time (O'Connor et al., 2003). Taking an action research approach to the study allowed us to introduce CE to the case companies and study the CBMI process from its initiation, while experimenting with different approaches and tools for the process. In the study, the researchers were proactive

and visible change agents, who used practical interventions (in the form of suggesting the use of certain tools, asking the companies challenging questions, proposing the involvement of actors from the value chain etc.) as a mode of inquiry (Van de Ven, 2007; Van de Ven and Johnson, 2006). An action research approach is useful to accelerate research in areas where there is a pressing need for progress (McManners, 2016) and it works well in combination with case studies (Prendeville et al., 2017).

Ideally, such a process should be studied from beginning to end (Eisenhardt, 1989), however we were only able to follow the process closely within the two-year period of the research project. During this time, we gained detailed insights into the initiation of CBMI and the early stages of the process as well as some insight into later stages, including preparing and implementing CBMs. Via later research projects and follow-up contact with the companies, we tracked whether the CBMI work was continued after the study ended (cf. Table 5-6).

5.3.1. PREPARATION OF STUDY

CASE SELECTION

The multiple-case design utilized a replication logic in which a set of cases are treated as a series of experiments, each with the purpose of confirming or disconfirming the inferences drawn from the other cases (Eisenhardt, 1989; Yin, 2014). The sampling was thus purposive based on theoretical categories (Eisenhardt and Graebner, 2007) and strived for a maximum variation sampling (Flyvbjerg, 2006): While all six case companies designed and sold physical products, they were of different sizes, belonged to different industries and served different customer segments.

In exploratory research into business model learning, companies do not have to be stringently comparable (Tolkamp et al., 2018) as business model learning is not restricted to comparable firms (McGrath, 2010). Instead, the diverse characteristics of the companies allowed us to study differences and similarities between companies of diverse types with the advantage that *'similarities observed across a diverse sample offer firmer grounding for propositions than constant elements observed in a homogenous sample'* (O'Connor et al., 2003, p.356).

The differences between the companies meant the collaboration process had to be adjusted to fit the individual company setting, not least because the project was anchored at different organisational levels and the companies displayed dissimilar levels of engagement in CBMI and consequently, the intensity of the collaboration varied. An overview of the companies can be found in Table 5-2.

Case company	Size	Industry	Customer segment	Project anchoring	Collaboration period	Arrangement of CBMI process
A	micro	Clothing and textiles	Business	Owner-manager and the only employee	6 months	Working meetings with the owner-manager and employee, with potential new value chain partners, and with experts on textile recycling
B	micro	Electrical and mechatronic goods	Business	The owner-manager	2 years	Working meetings with the owner-manager. Collaboration with students to develop new product concepts and student meetings with an existing value chain partner in this connection
C	small	Clothing and textiles	Consumer	Owner-manager responsible for sustainability	2 years	A series of workshops with the management team, interview of sales agents, dialogue with potential new value chain partners
D	medium	Clothing and textiles	Business	Project manager, sustainability department	2 years	Working meetings with the project manager and diverse internal actors. Interviews with key customers
E	large	Electrical and mechatronic goods	Business (and consumer)	Chief technical advisor, R&D	2 years	Working meetings with the technical advisor as well as cross-organisational meetings
F	large	Electrical and mechatronic goods	Business (and consumer)	Corporate sustainability director	2 years	Working meetings with the sustainability director and a cross-organisational workshop

Table 5-2. Case company overview.

PREPARATION OF CBMI TOOLS

When researchers take an inductive approach to data analysis, as we did, it is possible to specify a priori constructs to measure before entering the field (Eisenhardt, 1989). In our action research setting, specifying a priori constructs to measure translated into specifying a priori tools to experiment with. As part of the case study protocol (Yin, 2014), a few basic tools to support the CBMI process in the companies were

thus developed. Because the research was prepared in the beginning of 2014, little literature was available on CE at the time, and the concept had not been translated into operational guidelines, arguably a shortcoming that persists (Blomsma and Brennan, 2017; Ghisellini et al., 2016). Consequently, the toolbox was based on early reports published by the Ellen MacArthur Foundation (2012; 2013b) and a practice review of CBMs in operation that was compiled through desk research (see Guldmann, 2016).

The tools were selected with the purpose of supporting all stages of the innovation process, as well as striking a balance between instruments that were on the one hand sufficiently general to work in all the participating companies, and on the other hand detailed enough to convey the principles and potentials of the CE in a comprehensive way, which would enable idea generation and concrete discussions. The toolbox consisted of the following elements:

- CE system diagram: The system diagram is illustrated in Figure 5-1. The diagram was intended to convey the key principles of a CE, and to illustrate the biological and technical resource loops that can be targeted via CBMs.
- Idea map: The system diagram was also used for clustering and visualizing CBM ideas according to the resource loops of the diagram. When applied in this manner it was termed an Idea map.
- CBM principles: The five principles are described in detail in section 2.2. In short, they concern the value of inner circles, circling longer, cascaded use, pure flows and sustainable inputs (Ellen MacArthur Foundation, 2013b). They were included in the toolbox to demonstrate what dimensions could and should be considered in relation to new CBMs.
- Best practice examples of circular business models: A case collection of circular business models in operation (see Guldmann, 2016). The idea was to provide relevant and inspiring examples to engage companies in the CBMI process. A method utilized in earlier research to facilitate sustainable business thinking (e.g. Bocken et al., 2015).
- Circular business model canvas. A business model template like the canvas in Figure 5-2 was intended to guide the BMI process as suggested by other authors (e.g. Chesbrough, 2010; Bocken et al., 2015). The intention with this tool was to ensure all relevant elements of the new business models were considered in the innovation process.

In addition to the CBMI-specific toolbox, a selection of general techniques was applied, such as brainstorming sessions, customer interviews and surveys, economic calculations, competitor analysis, trend analysis, examining best available technology etc. based on the ad hoc needs that emerged from the innovation processes.

5.3.2. FIELD WORK

UNIT OF ANALYSIS

The primary unit of analysis was the concrete CBMI process with its stream of activities, tools and outcomes. However, we also examined the context that this process unfolded in. First, facts about company age, type of business, customer segments, the CBMI project anchoring in the company etc. as well as information regarding the company history of sustainability work, any previous experience with CBM elements etc. provided the historical setting (Pettigrew, 1997) for the CBMI process. Second, the organisational processes in the larger companies that were set in motion by our interventions at the company and by the company informants emerged as processes that were important to document.

DATA COLLECTION

Due to the action research nature of the study, participant-observation and unstructured interviews (Yin, 2014) relating to our on-site meetings with the companies were particularly important sources of data. This data was supplemented by semi-structured interviews and document analysis.

The first step of the fieldwork was to clarify the company context, and the researchers examined if the companies had previous experience with CBM principles (cf. section 5.2.2); the role of sustainability in company values and strategies; links between CE and extant strategic and tactic aspirations; as well as what economic and human resources were available to the CBMI project. Unstructured interviews with company participants supplemented with document analysis of annual reports, sustainability reports, corporate websites etc. were applied for this purpose. This information was used to decide, in close collaboration with the company participants, on the planning of the CBMI process going forward. In case company C, for example, the process was arranged as a series of workshops with the management team. In company E, various cross-organisational meetings were arranged. While the process featured meetings with the company participants and a cross-organisational workshop, in company F.

The introduction to the notion of CE, the principles behind CBMs, and concrete best practice examples of implemented CBMs followed next. Often, the owner-manager(s) plus a few other employees were involved in the small companies, while specialists, consultants and middle managers were involved in the medium-sized and large companies. As part of this introduction, or at subsequent meetings, the companies were invited to engage in CBMI by generating ideas for CBMs and selecting a few of the most promising ideas for further examination. It was up to the companies if they wanted to engage in CBMI and for how long within the two-year research project. The researchers suggested approaches and next steps during this collaboration, but it was ultimately up to the companies to decide on the next step, whom to involve

and when. This way, the researchers collaborated closely with company i participants to facilitate the CBMI process.

Case company	No. of sessions with participant-observation and unstructured interviews	No. of unstructured phone interviews	No. of semi-structured interviews	Examples of documents
A	6	3		Application for funding for a development project with a partner company Company website
B	6	4		Marketing material Technical product sheet Company website
C	11	5	1 sales agent in Sweden 1 sales agent in Germany	Folder on company's approach to sustainability Marketing material company website
D	8	3	1 key account manager in United Kingdom 1 key account manager in Southern Europe 1 customer and 1 project manager from one business unit 1 customer from another business unit interviewed 2 times	Sustainability reports Annual reports Company website
E	8	2	1 sustainability project manager 1 sustainability consultant	Presentation slides from the sustainability director Sustainability reports Annual reports Company website
F	4	6	1 sustainability director 1 hardware director 1 EHS manager 1 hardware specialist	Internal design guideline Sustainability reports Annual reports Company website

Table 5-3. Data sources.

The unfolding process was documented focusing on internal and external actors involved, key issues, tools applied, timelines and outcome. The data was used for writing up minutes of meetings, which were shared with the companies, and field notes, which were stored in a research log on each case company.

In the CBMI, the researchers encouraged development of services to support inner circles and circling longer in particular, because this strategy was expected to provide the most radically new and environmentally beneficial solutions and entail the most complex and thus revelatory innovation process.

5.3.3. DATA ANALYSIS

The inductive data analysis began in parallel with the unfolding CBMI processes as field notes were used to reflect on emerging patterns in the empirical data (Yin, 2014; Eisenhardt, 1989) and to consider what might be an appropriate next step of the CBMI process in the company. At the end of the research collaboration, a case history (i.e. a description characterized by temporal presentation; Pettigrew, 1990, 1997) was drafted on each company compiled from field notes, minutes of meetings, parts of the documents found relevant etc. applying data triangulation where possible (Yin, 2014). Over the course of approximately six months, the case history was developed through repeated iterations to arrive at analytical chronologies of each company, that is case descriptions that aim *'to get on top of the data, to clarify sequences across levels of analysis, suggest causal linkages between levels of analysis, and establish early analytical themes'* (Pettigrew, 1990, p. 280). The analytical chronologies were between three and nine single-spaced pages in length and comprised a preliminary within- and cross-case analysis that pointed to some conceptual similarities and differences between the CBMI processes in the companies (O'Connor et al., 2003; Eisenhardt, 1989; Pettigrew 1997, 1990).

The case histories and analytical chronologies were reviewed by a researcher who had been involved in some of the sessions in all the companies as well as a researcher who was not part of the study to point out any weak points, inconsistencies or researcher bias, thus incorporating researcher triangulation (Eisenhardt, 1989). The analytical chronologies were further verified by getting feedback from all the case companies to ensure facts were correct and our interpretations of events were in line with participants' perceptions, which is a tactic with particular confirmatory power (Miles and Huberman, 1984). The author naturally retained editorial control and the various researcher and company participant reviews only gave rise to minor discussions about and adjustments to the case descriptions.

At this stage of the data analysis, Eisenhardt (1989) recommends enfolding relevant literature, and the characteristics of the CBMI that had emerged led us to examine the DT literature closer and formulate the research questions that are addressed in this article. The first question (*what could a DT framework tailored to CBMI look like?*)

is examined by comparing data from the multiple-case study with those of the general DT framework (outlined in Table 5-1), relating the innovation spaces and tools utilized, i.e. pattern matching (Yin, 2014).

The pattern matching followed a systematic procedure, where we first analysed each CBMI process individually: (1) Based on the aim and techniques of each DT space, what spaces of the general DT framework had the CBMI process moved through? (2) Were there any significant CBMI-activities in the case company that could not be related to the spaces of the general DT framework? We then did cross-case analysis where we compared the companies to one another in pairs to look for similarities and differences. Overall, the results showed literal replication (i.e. similar results) among the smaller companies and literal replication among the larger companies. The two groups displayed differences between them that could be attributed to the different company size and project anchoring, thus displaying theoretical replication (i.e. different results for anticipatable reasons; Yin, 2014).

The second research question (*what is the potential impact of such a framework?*) was examined by documenting the extent to which the CBMI process of the individual case company was in accordance with the developed DT framework for CBMI and evaluating the outcome of the process.

5.4. RESULTS AND DISCUSSION

In the following, we illustrate how the CBMI processes that unfolded align with the innovation stages of the general DT framework. Subsequently, we illustrate what the guiding principles that characterized the CBMI process in the case companies looked like, and what CBMI-specific and general tools were utilized in each innovation stage. Finally, the outcome of each of the CBMI processes is evaluated to assess the usefulness of the DT framework that emerged from our collaboration with the case companies.

5.4.1. EMERGING INNOVATION SPACES

The innovation processes in the case companies moved through the exploratory, ideation and prototyping and testing spaces in iterative cycles as described in the DT literature (e.g. Plattner et al., 2010; Brown, 2008; Liedtka, 2011). However, the data analysis (cf. section 3.3) showed that the general framework did not fully capture the way the CBMI processes unfolded.

EXPLORATORY, IDEATION AND PROTOTYPING AND TESTING SPACES

The three original innovation spaces, the 'exploratory', the 'ideation', and the 'prototyping and testing' spaces were observed in the CBMI processes, although the aim and contents of these spaces in the CBMI context can be specified some more. The exploratory space hence became a phase where a deeper understanding of the company setting and CBM opportunities was established through interaction with internal and external stakeholders. The ideation space became a place where more than 100 CBM ideas and concepts were generated, seeking higher-order thinking and systems solutions. Finally, in the prototyping and testing space eight of the best ideas were examined and developed further. This stage was oriented towards testing ideas in relation to the entire stakeholder group of a given CBM, as opposed to the narrower focus on the users in the general DT framework.

INTRODUCTORY SPACE

In our study, an introduction to the new CE paradigm and the notion of CBMs kick-started the CBMI process in each case. The innovation process further iterated back through this space, when new internal or external actors got involved in the CBMI process, or when a recapitulation of key CE and CBM principles was needed for the innovation team to stay on track. The general DT model did not include such an innovation stage; consequently, an 'introductory' space was added to the CBMI framework.

In cases were the organisation engages in CBMI on its own accord (in contrast to the present study, where CE and CBMs were introduced to the companies by the researchers), a phase where key actors in the organisation get acquainted with CE, and its key principles must also necessarily precede the concrete CBMI activities. Thus, an introductory space is expected to be typical of CBMI processes, whether initiated by internal or external actors.

ALIGNMENT SPACE

While our research set out to support a concrete CBM development process in the companies, interactions with the companies revealed that there was a need for clarifying the company's position on CE with the wider organisation in the larger companies (i.e. D, E, F) alongside the CBMI activities. These clarification activities are conceptualized as a separate innovation space, an 'alignment' space.

In this alignment space, the company informants sought to engage groups of relevant stakeholders in the CBMI process and to delineate what CBMs might mean to the company through cross-organisational dialogues. In company D, the primary company informant engaged in informal dialogues with the design department manager, to clarify whether she saw some potential in CBMs and would be interested

in actively engaging in the development of these. The informant also sought to involve employees from a business unit that was identified as possibly holding CBM potential. In one of the large companies, the primary informant sought to engage peers as well as management in the alignment activities. For instance, a meeting was set up including directors and vice presidents from the strategy and sustainability departments, two specific business units and R&D. The meeting agenda outlined the need to decide on a company approach to CE:

> *"[...] what is circular economy, and what does it mean to [us]? Who else are active in this area, and what experiences have they gained? Do we have to take a reactive approach to it or do we want to take a proactive approach? Can we gain anything by taking the proactive approach to it? I don't think we will be able to answer any of those questions but we need to discuss whether we want to put resources into this area to clarify what influence it might have for us in the future."*

As the quote indicates, the discussions in the alignment space seemed to revolve around whether the CE should be approached reactively or proactively. None of the companies found that their customers require CBMs, which indicated to the companies that they did not have to act yet. Communiques on the CE by the European Commission nevertheless caught the attention of several of the larger companies. A company informant expressed the motivation for engaging in CBMI in this way:

> *"We could see [circular economy] is starting to accelerate. We saw the material that came from the EU last year before Christmas regarding many of these things. It was perhaps also an attempt to demonstrate due care and diligence. To avoid getting into difficulties, because we experienced that before for example with respect to the RoHS directive."*

Despite the motivation provided by the European Commission and the opportunities to link CBMs with other agendas, which we return to below, the progress in the alignment space was slow and this phase took up considerable time and energy in the collaboration with the larger companies. One possible explanation for this is that the discussions were arguably challenging dominant organisational logic (Chesbrough, 2010) and trying to break with organisational, technological and industrial lock-in (Unruh, 2002).

The format of the alignment space was different in the smaller companies (i.e. A, B, C): First, the smaller companies quickly saw potential in taking a proactive approach to CBMI: Company A, for example, found there was a good fit between CBMs and the company's aspiration to support an ongoing innovation project with a partner company. In company C, the sustainability manager explained that the company was small and had to stay ahead of the sustainability game to have a chance against the big companies that dump prices on sustainable apparel, and that CBMs could

potentially help the company stay ahead. CBMs were thus perceived as a chance to leverage ongoing projects or company aspirations in the small companies and they did not need further validation of the relevance before engaging in CBMI activities.

Second, management was directly involved in the CBMI activities in the small case companies, so management endorsement was built into any decisions made in the CBMI process. This CBMI setting meant that the alignment activities were much more integrated with the activities of the other innovation spaces. For small companies, in which actors other than management initiate the CBMI process, the alignment space is nonetheless likely to take on a format more like that found in larger companies.

As outlined above, the small companies quickly linked the old (e.g. ongoing projects and pre-existing strategic aspirations) with the new (i.e. CBMs; Hargadon, 2014) and this linking process was also detected in the larger companies. For instance, in company D, where one of the ideas was selected for further examination because it involved close customer interaction and potential co-creation of CBMs, and the notion of working closely with customers to develop new business opportunities was an established practice in the company. In company F, several themes emerged as relevant to integrate with the CBMI: An aspiration for more modularization in the product design and predictive maintenance to cater to unmet customer needs, for example.

5.4.2. WIDER SCOPE OF GUIDING PRINCIPLES

Within the general DT framework, having a user-centred perspective and collaborating across functions and experience bases *inside* the organisation are emphasized as important guidelines. However, a wider system perspective in called for in the CBMI context, which Ellen MacArthur Foundation and IDEO (2016) also note in relation to their Circular Design Guide. A perspective that considers the needs of value chain stakeholders and the environment (in the form of slowing and closing resource loops) in addition to users' needs. This requires companies to be open to collaborations with outside actors in addition to inside actors. Collaborating across functions, perspectives and experience bases inside and outside the organisation is a relevant means of ensuring different stakeholder knowledge and perspectives are represented in the innovation process.

Indeed, multiple actors from all the companies that will be involved in operating a new CBM must be included in the process at some stage, because no single function and no single company holds all the knowledge necessary to do systems innovation. Our data nevertheless suggests that it was difficult to include external actors, such as existing or new value chain partners, in some of the companies at the beginning of the CBMI. In company C, for instance, a field note entry three months into the collaboration stated

> *"[Company C] preferred not to talk to their customers or salesmen or fashion experts. The company believed it could potentially backfire if the concept was not implemented. In that case, the network would get disappointed and demotivated"*

It seemed an internal orientation was needed initially to allow for organisational alignment and a relatively safe learning space to understand how to manoeuvre the CBM innovation journey (Van De Ven, 2017; Van de Ven et al., 1999). Company B and D opened up to collaboration with existing value chain partners early in the process, whereas company A and C opened up to external collaboration during the collaboration and focused on collaborating with new potential value chain partners (as opposed to partners from the existing value chain). The large companies were reluctant to bring in external partners and when they did, the companies preferred collaboration with non-value chain actors such as industry associations and other universities (company F) or engaging in dialogue with companies from other industries with experience on CBMI (company E).

The two last guidelines, 'iterative cycles of moving through innovation spaces' and 'emphasize learning', remained relevant in their original form.

5.4.3. USE OF CIRCULAR BUSINESS MODEL INNOVATION-SPECIFIC TOOLS

In the CBMI processes, tools from the CBMI-specific toolbox (cf. section 3.1.2) along with general innovation tools were applied in the case companies. The CE system diagram, the idea map and the CBM principles proved relevant to most companies and most innovation stages. They constituted tools that the innovation team would circle back to in order to recapitulate on key principles and create a visual of how a given CBM idea related to the resource loops. The tools provided an overview and inspired further idea development. Which tools were applied in which company is outlined in Table 5-4, where 'x' indicates that a tool was applied; '(x)' indicates that some CBMI activities were in line with a particular tool, but without concrete application of the tool; '-' indicates that the tool was not applied.

Best practice exemplars of CBMs from well-established companies were used at the beginning of the CBMI process for inspiration and to establish legitimacy of employing CBMs. At later stages the researchers linked the CBM ideas that were developed at the case companies to best practice examples of companies that had implemented similar CBMs to provide support for a given idea and/or to challenge the case company to, for example, consider developing a more ambitious CBM or contemplate particular dimensions of the idea.

Case company	CE system diagram	Idea map	CBM principles	Best practice exemplars	Circular business model canvas	Business model elements
A	(x)	-	x	x	-	x
B	x	(x)	x	x	-	x
C	x	x	x	x	(x)	x
D	x	x	x	x	-	x
E	x	x	-	x	-	x
F	x	x	-	x	-	x

Table 5-4. Application of CBMI-specific tools in the case companies.

The participants that were involved in the CBMI were experienced business people, who were closely acquainted with the need to consider key elements of a CBM to ensure its success, e.g. having a relevant value proposition to a specific customer segment, providing the value proposition in a cost-efficient way and establishing relevant business partnerships that would enable operationalization of the CBM. They also assessed whether a given CBM fitted with company values, image, and aspirations. Consideration of key business model elements hence effortlessly permeated the CBMI process, which meant a visual representation of the business model was not needed (cf. Table 5-4). A visual CBM canvas or a similar business model template may however be relevant at later stages of the innovation process, as a checklist to ensure all relevant elements of the CBM have been considered, or in cases where participants are less familiar with the business model concept.

The CBMI-specific toolbox proved flexible in use and most tools were applied successfully in different company settings and innovation spaces. For instance, at the early stages of the innovation process the CE systems diagram functioned as a communication tool for the introduction of CE in the case companies, while at later stages it was a tool for idea generation, clustering of ideas (in the form of an idea map), or inspiration for new CE narratives.

5.4.4. TOOLS APPLIED AT DIFFERENT STAGES OF THE INNOVATION PROCESS

The general techniques to support an innovation process, which were described in the general DT framework (cf. Table 5-1) namely ethnographic research techniques; sense-making and ideation tools; prototyping and testing approaches; visualization techniques; and co-creation approaches were also found relevant in a CBMI context and were applied ad hoc as appropriate. The general and the CBMI-specific tools have been organised according to the spaces in which they were utilized (at one or more case companies) in the overview in Table 5-5.

Design thinking aspects	**Key points**				
Guiding principles	• CBM principles: Value of inner circles, circling longer, cascaded use, pure flows and sustainable inputs • Collaboration across functions, perspectives and experience bases inside and outside the organisation • Iterative cycles of moving through innovation spaces • Emphasize learning				
Innovation spaces	**Introductory space**	**Exploratory space**	**Alignment space**	**Ideation space**	**Prototyping and testing space**
Aim of spaces	Introduction to CE and CBMs. Inspiring action.	Exploring company setting and CBM opportunities related to this setting.	Alignment between CBMI and extant aspirations. Activation of key internal stakeholders.	Generation of multiple CBM ideas. Seeking higher-order thinking and systems solutions.	Examination of CBM ideas and further development of best ideas.
Techniques and tools used in individual spaces	Communication tools: - Company presentation - Presentation of CE and CBMs using system diagram, CBM principles, and best practice exemplars	Communication tools: - Recap on CE and CBMs using system diagram, CBM principles and best practice exemplars Ethnographic research techniques: - Dialogue/ interview with internal and external stakeholders such as existing/ new customers, suppliers or other partners - As-is mapping	Communication tools: - Presentation of CE and CBMs using system diagram, CBM principles, and best practice exemplars to wider range of internal stakeholders Ethnographic research techniques: - Dialogue/ interview with internal and external stakeholders such as existing/ new customers, suppliers or other partners	Sense-making and ideation tools: - CBM best practice exemplars - Brainstorming - Cluster analysis - Concept development techniques - To-be mapping e.g. using an idea map or a CBM canvas	Prototyping and testing approaches: - Assumption surfacing and testing e.g. by asking challenging questions - Testing ideas with internal and external stakeholders through e.g. interviews - Prototyping techniques such as scenario building - Description of business model e.g. using an idea map or CBM canvas - Evaluate ideas e.g. against CBM principles and best practice exemplars, or using system diagram to illustrate what resource loops are slowed/ closed - Field experiments e.g. small-scale market tests

Techniques and tools that span all spaces	Visualization techniques: - CE system diagram - Idea map (e.g. with Post-it notes) to cluster and visualize ideas - Storytelling about new kind of customer experiences, new company roles - Storytelling inspired by best practice exemplars Co-creation approaches: - On-going dialogue between researchers and company informants - Engaging internal and external stakeholders (e.g. customers) in generation, development and testing of ideas Other data collection and analysis techniques: - Dialogue, interviews, observation, other stakeholder interaction, Competitor analysis, economic calculations, trend analysis etc. - Considering key CBM elements (as illustrated in the CBM canvas) and fit between new CBM and image, resources, values and aspirations of the company

Table 5-5. Framework for CBMI.

The table illustrates the innovation spaces that were derived from the data and summarises the adapted guiding principles and aims of spaces. The framework in Table 5-5 is developed into a visually engaging tool for CBMI that can be found in the appendix.

The table illustrates that the innovation covered several, if not all, innovation spaces in each case company. Corresponding to all companies getting introduced to CE and CBMs; exploring the specific company setting and the CBM opportunities in this setting; ensuring alignment with extant aspirations; and generating CBM ideas. All companies, except company E, furthermore examined specific CBM ideas.

Case company	Introductory: Introduction to CE and CBMs	Exploratory: Exploring company setting and CBM opportunities	Alignment: Alignment between CBMI and extant aspirations	Ideation: Generation of multiple CBM ideas	Prototyping and testing: Examination of CBM ideas	Involvement of multiple internal actors	Involvement of new or existing value chain actors	CBM implementation	Continuation of CBM work
A	x	x	(x)	x	x	n/a	x	-	-
B	x	x	(x)	x	x	n/a	x	x	x
C	x	x	(x)	x	x	x	x	(x)	x
D	x	x	x	x	x	x	x	-	(x)
E	x	(x)	x	(x)	-	x	-	-	x
F	x	x	x	x	(x)	x	-	-	x

Table 5-6. Cross-case comparison of the innovation process.

5.5. CONCLUSION

The first research question that this paper asked was: *What could a DT framework tailored to CBMI look like?* This question was addressed by developing a CBMI framework based on experiences from six case companies, which couples the general exploratory, ideation, and prototyping and testing spaces of DT with two new innovation spaces, the introductory and the alignment space. The framework suggests guidelines for the CBMI process in addition to aims and contents of the individual innovation spaces, which are all adapted to a CBMI context. It also features a CBMI-specific toolbox consisting of five flexible tools and suggestions for complementary general innovation techniques. The flexibility of the framework allows the order of innovation spaces, the amount of time spent on the individual spaces, the internal and external actors involved and the use of general and CBMI-specific tools to be adjusted. The framework was derived from the CBMI process in six different case company settings, which suggests it can support the CBMI process in a range of organisations. The study hence contributes with a flexible framework that can be adapted to a given organisational setting and help practitioners facilitate and manoeuvre the challenging CBMI process.

A central point of the CBMI framework is the need to expand focus of the innovation to the system of internal and external actors required to operate a CBM. This demands a deliberate integration of multiple internal and external actors throughout

the innovation process. As for external actors, the study implies that, in some companies, their involvement is best integrated into the CBMI process at later stages, after a period of company-internal focus, which works as a safe learning space with regards to the CBMI process.

The second research question was: *What is the potential impact of such a framework?* This question was addressed through an assessment of the specific outcomes of the CBMI process at the six case companies. We studied the CBMI process from CE was first introduced in the companies and the next approximately two years. On this background, the case company results are encouraging and indicate that the adapted DT framework and the associated CBMI toolbox are indeed appropriate for the facilitation of CBMI processes, since CBMI is a challenging endeavour that is expected to take some time. Specifically, the framework highlights the necessity of an introduction to CE and CBMs through the addition of an introductory space, and the essential interaction between the specific CBMI process and the wider organisational agenda through the addition of an alignment space.

More specifically, the empirical findings showed that the CBMI takes place within a wider organisational setting, which influences and is influenced by the CBMI process. The tangible CBMI activities set in motion a gradual integration of the CE paradigm within the company, a more elusive change process that could be termed the company's CE journey. The CE journey in return influences the legitimacy of, engagement of actors for, and overall traction of the CBMI process. The CBMI process and the CE journey are hence mutually dependent dimensions of an organisational transformation towards the CE.

This way, the study adds to current knowledge about CBMI processes by offering a conceptual overview of the process and its association with the organisational adoption of the new CE paradigm.

5.5.1. RESEARCH LIMITATIONS AND FURTHER RESEARCH

The adapted CBMI framework is based on inductive data analysis from an action research study that was carried out in six case companies and on the DT literature. The study focused predominantly on early stage CBM innovation. The framework has consequently not been sufficiently tested in relation to later stages of the CBMI process such as small-scale market testing and implementation of CBMs and may have to be modified to encompass these stages. More research is also needed to verify if the framework is indeed useful in a wide range of organisational settings as the results so far indicate.

In the present study, it proved difficult to integrate value chain actors into (early stages of) the CBMI process in some companies, especially the large ones. More extensive involvement of key external actors (at later stages) may require

development of tools or workshop formats specifically targeted at facilitating such inter-organisational collaboration and integrating these into the CBMI framework. Insights from the open innovation literature on networked production organisations and consumer communities would seem relevant to study further in this respect and well as in relation to reinforced involvement of external and internal stakeholders (e.g. Chesbrough and Crowther, 2006; Laursen and Salter, 2006; Romero and Molina, 2011).

Our research has shown that the CBMI work is nested within a wider organisational setting that influences which tools, which guidelines, and which opportunities are most appropriate in a given company and the CBMI process conversely affects the organisation. More research into the interaction between the CBMI and the organisational (and industrial, societal, and institutional) setting would be beneficial, as well as research into how these impacts are best managed.

APPENDIX

In Figure 5-3, CBMI-specific tools are marked with a bold font (cf. section 3.1.2), whereas generic innovation tools that were found useful for supporting the CBMI processes are not bolded.

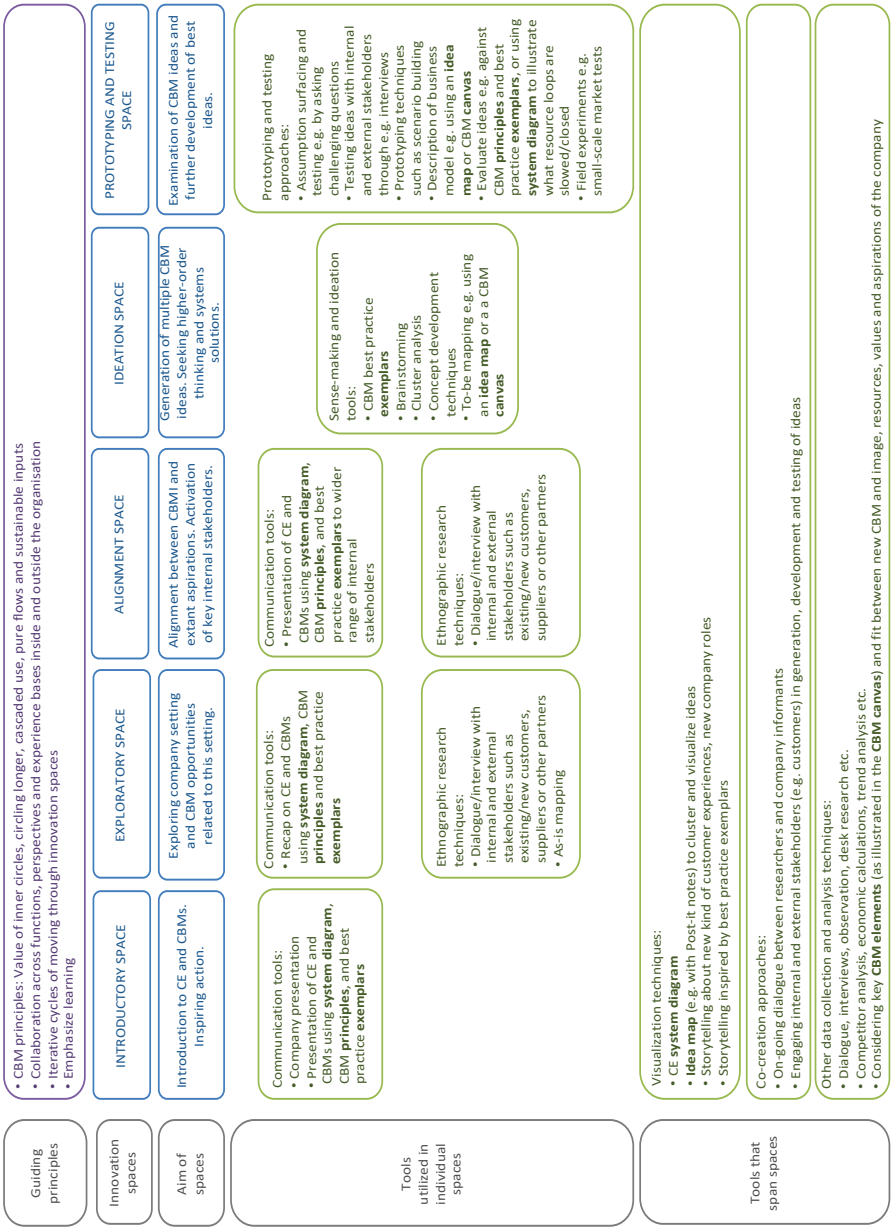

Figure 5-3. Framework and tools for CBMI developed in this research.

REFERENCES

Abdelkafi, N., Täuscher, K., 2016. Business Models for Sustainability from a System Dynamics Perspective. Organ. Environ. 29, 74–96. https://doi.org/10.1177/1086026615592930

Achterberg, E., Hinfelaar, J., Bocken, N.M.P., 2016. Master circular business models with the Value Hill. Circle Economy, The Netherlands.

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., Overy, P., 2016. Sustainability-oriented innovation: A systematic review. Int. J. Manag. Rev. 18, 180–205. https://doi.org/10.1111/ijmr.12068

Antikainen, M., Valkokari, K., 2016. A Framework for Sustainable Circular Business Model Innovation. Technol. Innov. Manag. Rev. 6, 5–12.

Bakker, C.A., den Hollander, M.C., van Hinte, E., Zijlstra, Y., 2014a. Products That Last - product design for circular business models, First. ed. TU Delft Library, Delft, the Netherlands.

Bakker, C., Wang, F., Huisman, J., den Hollander, M., 2014b. Products that go round: Exploring product life extension through design. J. Clean. Prod. 69, 10–16. https://doi.org/http://dx.doi.org/10.1016/j.jclepro.2014.01.028

Baldassarre, B., Calabretta, G., Bocken, N.M.P., Jaskiewicz, T., 2017. Bridging sustainable business model innovation and user-driven innovation: A process for sustainable value proposition design. J. Clean. Prod. 147, 175–186. https://doi.org/10.1016/j.jclepro.2017.01.081

Beckman, S.L., Barry, M., 2007. Innovation as a learning process: Embedding design thinking. Calif. Manage. Rev. 50, 25–56.

Blomsma, F., Brennan, G., 2017. The emergence of circular economy: A new framing around prolonging resource productivity. J. Ind. Ecol. 21, 603–614. https://doi.org/10.1111/jiec.12603

Bocken, N.M.P., Bakker, C., de Pauw, I., van der Grinten, B., 2016. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 33, 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bocken, N.M.P., Rana, P., Short, S.W., 2015. Value mapping for sustainable business thinking. J. Ind. Prod. Eng. 32, 67–81. https://doi.org/10.1080/21681015.2014.1000399

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. J. Clean. Prod. 65, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2013. A value mapping tool for sustainable business modelling. Corp. Gov. 13, 482–497. https://doi.org/10.1108/CG-06-2013-0078

Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: State-of-the-art and steps towards a research agenda. J. Clean. Prod. 45, 9–19. https://doi.org/10.1016/j.jclepro.2012.07.007

Brown, T., 2008. Design Thinking Harv. Bus. Rev. 86, 84–92.

Carlgren, L., Elmquist, M., Rauth, I., 2016a. The challenges of using Design Thinking in industry - Experiences from five large firms. Creat. Innov. Manag. 25, 344–362. https://doi.org/10.1111/caim.12176

Carlgren, L., Elmquist, M., Rauth, I., 2016b. Framing Design Thinking: The concept in idea and enactment. Creat. Innov. Manag. 25, 38–57. https://doi.org/10.1111/caim.12153

Ceschin, F., Gaziulusoy, I., 2016. Evolution of design for sustainability: From product design to design for system innovations and transitions. Des. Stud. 47, 118–163. https://doi.org/10.1016/j.destud.2016.09.002

Chesbrough, H., 2010. Business model innovation: Opportunities and barriers. Long Range Plann. 43, 354–363. https://doi.org/10.1016/j.lrp.2009.07.010

Chesbrough, H., Crowther, A.K., 2006. Beyond high tech: Early adopters of open innovation in other industries. R&D Manag. 36, 229–236. https://doi.org/0.1111/j.1467-9310.2006.00428.x

d.school, n.d. An Introduction to Design Thinking: Process Guide. Hasso Plattner Institute of Design at Stanford, Stanford.

Doganova, L., Karnøe, P., 2012. The innovator's struggle to assemble environmental concerns to economic worth: Report to Grundfos New Business. Grundfos New Bus. 41.

Dolak, F., Uebernickel, F., Brenner, W., 2013. Design Thinking and Design Science Research. Working Paper. University of St. Gallen, St. Gallen.

Earth Overshoot Day, 2017. *Past Earth Overshoot Days*, available at: http://www.overshootday.org/newsroom/past-earth-overshoot-days/ [Accessed November 7, 2017].

Eisenhardt, K.M., 1989. Building theories from case study research. Acad. Manag. Rev. 14, 532–550.

Eisenhardt, K., Graebner, M., 2007. Theory building from cases: Opportunities and challenges. Acad. Manag. J. 50, 25–32.

Ellen MacArthur Foundation, 2013a. The circular economy applied to the automotive industry. [pdf] Available at: http://www.ellenmacarthurfoundation.org/news/the-circular-economy-applied-to-the-automotive-industry-1 [Accessed November 4, 2014].

Ellen MacArthur Foundation, 2013b. Towards the circular economy vol. 2: opportunities for the consumer goods sector. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE_Report-2013.pdf [Accessed September 6, 2018].

Ellen MacArthur Foundation, 2012. Towards the circular economy vol. 1: an economic and business rationale for an accelerated transition. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf [Accessed July 19, 2018].

Ellen MacArthur Foundation and University of Bradford, 2012. Walter Stahel on the Performance Economy [video]. Available at: https://www.youtube.com/watch?v=PhJ-YZwDAVo [Accessed September 26, 2018].

Ellen MacArthur Foundation, IDEO, 2016. Circular Design Guide. Available at: https://www.circulardesignguide.com [Accessed March 17, 2017].

Eriksson, P., Kovalainen, A., 2008. Qualitative Methods in Business Research. SAGE, Los Angeles, Calif.

European Commission, 2014. Towards a Circular Economy: A Zero Waste Programme for Europe. [pdf] Available at: https://www.oecd.org/env/outreach/EC-Circular-econonomy.pdf [Accessed September 6, 2018].

Fleury, A.M., Stabile, H., Carvalho, M.M., 2016. An overview of the literature on Design Thinking: Trends and contributions. Int. J. Eng. Educ. 32, 1704–1718.

Flyvbjerg, B., 2006. Five misunderstandings about case-study research. Qual. Inq. 12, 219–245. https://doi.org/10.1177/1077800405284363

Geissdoerfer, M., Bocken, N.M.P., Hultink, E.J., 2016. Design Thinking to enhance the sustainable business modelling process – A workshop based on a value mapping process. J. Clean. Prod. 135, 1218–1232. https://doi.org/http://dx.doi.org/10.1016/j.jclepro.2016.07.020

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J., 2017a. The Circular Economy – A new sustainability paradigm? J. Clean. Prod. 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Geissdoerfer, M., Savaget, P., Evans, S., 2017b. The Cambridge Business Model Innovation process. Procedia Manuf. 8, 262–269. https://doi.org/10.1016/j.promfg.2017.02.033

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Global Footprint Network, 2012. 2012 Annual Report. [pdf] Available at: https://www.footprintnetwork.org/content/images/article_uploads/2012_Annual_Report.pdf [Accessed September 6, 2018].

Guldmann, E., 2016. Best Practice Examples of Circular Business Models. Danish Environmental Protection Agency, Copenhagen, Denmark. [pdf] Available at: https://www2.mst.dk/Udgiv/publications/2016/06/978-87-93435-86-5.pdf [Accessed September 6, 2018].

Guldmann, E., Huulgaard, R., 2017. Challenges to Circular Business Modeling, in: Aravossis, K. (Ed.), Towards a Greener Challenge & Evolution in the Framework of the Circular Economy, Proceedings of the 18th European Roundtable on Sustainable Consumption and Production. Grafima Publications, Thessaloniki, Greece, pp. 21–29.

Hargadon, A.B., 2014. Brokerage and Innovation, in: Dodgson, M., Gann, D.M., Phillips, N. (Eds.), Oxford Handbook of Innovation Management. New York, pp. 163–180.

Healy, M., Perry, C., 2000. Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm. Qual. Mark. Res. An Int. J. 3, 118–126.

Heyes, G., Sharmina, M., Mendoza, J.M.F., Gallego-Schmid, A., Azapagic, A., 2018. Developing and implementing circular economy business models in service-oriented technology companies. J. Clean. Prod. 177, 621–632.

Jensen, J.P., 2018. Narrowing, Slowing and Closing the Resource Loops - Circular Economy in the Wind Industry [PhD dissertation]. Aalborg Universitetsforlag, Aalborg, Denmark.

Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: An analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Kozlowski, A., Searcy, C. and Bardecki, M., 2018) The reDesign canvas: Fashion design as a tool for sustainability. J. Clean. Prod. 183, 194–207.

Kørnøv, L., Thrane, M., Remmen, A., Lund, H. (Eds.) 2007. Tools for Sustainable Development. Aalborg Universitetsforlag, Aalborg, Denmark.

Kraaijenhagen, C., van Oppen, C., Bocken, B., 2016. Circular Business: Collaborate and Circulate, first ed. Circular Collaboration, The Netherlands.

Laursen, K., Salter, A., 2006. Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. Strateg. Manag. J. 27, 131–150. https://doi.org/10.1002/smj.507

Lieder, M., Rashid, A., 2016. Towards circular economy implementation: A comprehensive review in context of manufacturing industry. J. Clean. Prod. 115, 36–51. https://doi.org/10.1016/j.jclepro.2015.12.042

Liedtka, J., 2015. Perspective: Linking Design Thinking with innovation outcomes through cognitive bias reduction. J. Prod. Innov. Manag. Vol.32, 925–938.

Liedtka, J., 2011. Learning to use Design Thinking tools for successful innovation. Strateg. Leadersh. 39, 13–19.

Linder, M., Williander, M., 2017. Circular Business Model Innovation: Inherent uncertainties. Bus. Strateg. Environ. 26, 182–196. https://doi.org/10.1002/bse.1906

Magretta, J., 2002. Why Business Models Matter. Harv. Bus. Rev. 80, 86–92.

McGrath, R., 2010. Business models: A discovery driven approach. Long Range Plann. 43, 247–261. https://doi.org/10.1016/j.lrp.2009.07.005

McManners, P., 2016. The action research case study approach: A methodology for complex challenges such as sustainability in aviation. Action Res. 14, 201–216.

Miles, M. B., Huberman, A. M., 1984. Drawing valid meaning from qualitative data: Toward a shared craft. Educ. Res. 13, 20–30.

Mitchell, D., Coles, C., 2003. The ultimate competitive advantage of continuing business model innovation. J. Bus. Strategy 24, 15–21.

Network for Business Sustainability, 2012. Innovating for Sustainability: A Systematic Review of the Body of Knowledge. [pdf] Available at: https://nbs.net/p/systematic-review-innovating-for-sustainability-e76ab6db-fdbb-4610-8064-48309adf7e2b [Accessed September 6, 2018].

Nußholz, J.L.K., 2017. Circular Business Models: Defining a concept and framing an emerging research field. Sustainability 9, 1810. https://doi.org/https://doi.org/10.3390/su9101810

O'Connor, G.C., Rice, M.P., Peters, L., Veryzer, R.W., 2003. Managing Interdisciplinary, Longitudinal Research Teams: Extending Grounded Theory-Building Methodologies. Organ. Sci. 14, 353–373.

Osterwalder, A., Pigneur, Y., 2010. Business model generation: a handbook for visionaries, game changers, and challengers, first ed. John Wiley & Sons, New Jersey, US.

Pettigrew, A. M., 1997. What is a processual analysis? Scand. J. Manag. 13, 337–348.

Pettigrew, A. M., 1990. Longitudinal field research on change: Theory and practice. Organ. Sci. 1, 267–292.

Plattner, H., Meinel, C., Leifer, L., 2010. Design Thinking: Understand - Improve - Apply. Springer, Heidelberg.

Porter, M.E., Kramer, M.R., 2011. Creating Shared Value: How to reinvent capitalism - and unleash a wave of innovation and growth Harv. Bus. Rev. 89, 62.

Prendeville, S. M. et al., 2017. Uncovering ecodesign dilemmas: A path to business model innovation. J. Clean. Prod. 143, 1327–1339.

Richardson, J., 2008. The business model: An integrative framework for strategy execution. Strateg. Chang. 17, 133–144. https://doi.org/10.1002/jsc.821

Rizos, V., Behrens, A., van der Gaast, W., Hofman, E., Ioannou, A., Kafyeke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., Topi, C., 2016. Implementation of circular economy business models by small and medium-sized enterprises (SMEs): Barriers and enablers Sustainability 8, 1212. https://doi.org/10.3390/su8111212

Romero, D., Molina, A., 2011. Collaborative networked organisations and customer communities: Value co-creation and co-innovation in the networking era. Prod. Plan. Control 22, 447–472. https://doi.org/10.1080/09537287.2010.536619

Romero, D., Rossi, M., 2017. Towards circular lean product-service systems. Procedia CIRP 64, 13-18.

Roome, N., Louche, C., 2016. Journeying towards business models for sustainability: A conceptual model found inside the black box of organisational transformation. Organ. Environ. 29, 11–35. https://doi.org/10.1177/1086026615595084

Sarasvathy, S.D., 2005. What Makes Entrepreneurs Entrepreneurial? [pdf] Available at: http://www.effectuation.org/sites/default/files/documents/what-makes-entrepreneurs-entrepreneurial-sarasvathy.pdf [Accessed June 8, 2018].

Schaltegger, S., Lüdeke-Freund, F., Hansen, E.G., 2012. Business cases for sustainability and the role of Business Model Innovation: Developing a conceptual framework. Int. J. Innov. Sustain. Dev. 6, 95–119.

Seidel, V.P., Fixson, S.K., 2013. Adopting Design Thinking in novice multidisciplinary teams: The application and limits of design methods and reflexive practices. J. Prod. Innov. Manag. 30, 19–33.

Short, S.W., Bocken, N.M.P., Barlow, C.Y., Chertow, M.R., 2014. From refining sugar to growing tomatoes. J. Ind. Ecol. 18, 603–618. https://doi.org/10.1111/jiec.12171

Stahel, W.R., 2010. The Performance Economy, Palgrave Macmillan, Hampshire, UK.

Stahel, W., 1981. The product-life factor, in: Orr, S.G. (Ed.), An Inquiry into the Nature of Sustainable Societies: The Role of the Private Sector. HARC, Houston, TX, pp. 72– 96.

Stål, H. I. and Corvellec, H., 2018. A decoupling perspective on circular business model implementation: Illustrations from Swedish apparel. J. Clean. Prod. 171, 630–643. https://doi.org/10.1016/j.jclepro.2017.09.249

Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Plann. 43, 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Thomke, S.H., 2003. Experimentation matters: unlocking the potential of new technologies for innovation. Harvard Business Press, Boston, US

Tolkamp, J., Huijben, J.C.C.M., Mourik, R.M., Verbong, G.P.J., Bouwknegt, R., 2018. User-centred sustainable business model design: The case of energy efficiency services in the Netherlands. J. Clean. Prod. 182, 755–764.

UN-DESA, 2017. The 10 Year Framework of Programmes on Sustainable Consumption and Production Patterns. [pdf] Available at: https://sustainabledevelopment.un.org/hlpf/index.php?page=view&type=400&nr=1444&menu=35 [Accessed November 7, 2017].

Unruh, G.C., 2002. Escaping carbon lock-in. Energy Policy 30, 317–325.

Upward, A., Jones, P., 2016. An ontology for strongly sustainable business models: Defining an enterprise framework compatible with natural and social science. Organ. Environ. https://doi.org/10.1177/1086026615592933

Van De Ven, A.H., 2017. The innovation journey: You can't control it, but you can learn to maneuver it. Innovation 19, 39–42. https://doi.org/10.1080/14479338.2016.1256780

Van de Ven, A.H., 2007. Engaged scholarship: a guide for organizational and social research. Oxford University Press, New York, US.

Van de Ven, A.H., Johnson, P.E., 2006. Knowledge for theory and practice. Acad. Manag. Rev. 31, 802–21.

Van de Ven, A.H., Polley, D.E., Garud, R., Venkataraman, S., 1999. The Innovation Journey. Oxford University Press, New York, US.

WBCSD, 2010. Vision 2050: The new agenda for business. World Business Council for Sustainable Development, Conches-Geneva, Switzerland. [pdf] Available at: https://docs.wbcsd.org/2018/02/Vision2050.pdf [Accessed September 6, 2018].

Webster, K., 2017. The Circular Economy: A Wealth of Flows, second ed. Ellen MacArthur Foundation Publishing, Cowes, UK.

Weissbrod, I., Bocken, N.M.P., 2017. Developing sustainable business experimentation capability – A case study. J. Clean. Prod. 142, 2663–76. https://doi.org/10.1016/j.jclepro.2016.11.009

WCED - World Commission on Environment and Development, 1987. Our common future. Oxford University Press, Oxford, UK.

World Economic Forum, 2014. Towards the Circular Economy: Accelerating the Scale-up Across Global Supply Chains. [pdf] Available at: http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf [Accessed September 6, 2018].

WWF, 2016. Living planet report 2016: Summary. [pdf] Available at: http://d2ouvy59p0dg6k.cloudfront.net/downloads/lpr_2016_summary_web.pdf [Accessed September 6, 2018].

Yin, R.K., 2014. Case Study Research: Design and Methods, Fifth ed. SAGE Publications, Thousand Oaks, US.

Zou, H., Du, H., Wang, Y., Zhao, L., Mao, G., Zuo, J., Liu, Y., Liu, X., Huisingh, D., 2017. A review of the first twenty-three years of articles published in the Journal of Cleaner Production: With a focus on trends, themes, collaboration networks, low/no-fossil carbon transformations and the future. J. Clean. Prod. 163, 1–14. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.04.157

CHAPTER 6. THREE TYPES OF CIRCULAR BUSINESS MODEL INNOVATION

Chapter six examines the third sub-question: *How does the company setting affect the circular business model innovation process?* It consists of book chapter E:

CIRCULAR BUSINESS MODEL INNOVATION FOR SUSTAINABLE DEVELOPMENT

By Eva Guldmann and Rikke Dorothea Huulgaard, Aalborg University.

The chapter is accepted for publication in:

'Innovation for Sustainability: Business Transformations Towards a Better World'.

Edited by Nancy M.P. Bocken[a,b], Paavo Ritala[c], Laura Albareda[c,d] and Robert Verburg[b]. [a]Lund University, [b]Delft University of Technology, [c]Lappeenranta University of Technology, [d]Deusto University.

The book is set for publication by Palgrave Macmillan in 2019.

Omitted from the online version of the dissertation

CHAPTER 7. THE CIRCULAR ECONOMY JOURNEY

Chapter seven examines the final sub-question: *How can circular business model innovation activities support the overall organisational journey towards circular economy?* It consists of article F:

THE CIRCULAR ECONOMY JOURNEY - HOW TRANSFORMATION SPACES CAN SUPPORT ORGANISATIONAL CHANGE

By Rikke Dorothea Huulgaard, Eva Guldmann and Søren Kerndrup, Aalborg University.

The article will be submitted to Journal of Cleaner Production.

ABSTRACT

The literature on the integration of circular economy in companies highlights that companies face several challenges when working with circular business model innovation, because the integration of circular principles causes disruptive changes to a company's business model, for instance, in the form of making modifications to the value proposition, appropriating value from new revenue streams and working with new and unfamiliar business partners. Through two field experiments in a Danish mechatronics company, the aim of this paper is to determine how transformation spaces organised around circular business model innovation activities can support companies at the early stages of their journey towards circular economy. The analysis shows that the use of transformation spaces allows for idea generation and small-scale experimentation with circular economy, which facilitates a reframing of old mind-sets and organisational structures that leads to a gradual integration of circular economy principles in the company.

KEYWORDS: *Circular economy; Field experiments; Circular business model innovation; Change processes; Transformation spaces; Case study.*

7.1. INTRODUCTION

Circular economy (CE) has in recent years been promoted as an economic paradigm that can provide the necessary leverage towards sustainable development. A CE is well described on a conceptual level, (see e.g. Ellen MacArthur Foundation, 2012; Geissdoerfer et al., 2017a; Ghisellini et al., 2016; Kirchherr et al., 2017), but less has been published on how CE is implemented in practice (Blomsma and Brennan, 2017; Ghisellini et al., 2016). The transition towards sustainable development and CE demands a move away from our current approaches to establish new production, consumption, transportation and energy systems, which lead to the development and combination of new technologies, user and market practices and political and cultural discourses (Geels et al., 2008) and a break with current lock-ins in terms of mental, technological, economic, organisational and institutional structures (Doganova and Karnøe, 2012). Scholars are therefore beginning to examine the potential of sustainable business model innovation to support an unlocking of old structures (Bocken et al., 2013, 2014, Geissdoerfer et al., 2017a, 2017b, 2016; Porter and Kramer, 2011). Circular business model innovation is a particular kind of sustainable business model innovation which focuses on the closing and slowing of materials loops through product and business model design (Bocken et al., 2016).

When designing new business models, it is not possible to anticipate every aspect of the business model in advance; instead, these must be adjusted over time as gradual learning takes place (McGrath, 2010) and experimentation in the development of the

business models is therefore crucial to supporting organisational learning (Chesbrough, 2010; McGrath, 2010). The organisational learning and transformation process is nevertheless not well-described in the literature (Zollo et al., 2013), and in this article, we examine how circular business model innovation activities may support organisational learning and an overall organisational journey towards CE to answer the research question: how can circular business model innovation activities support the overall organisational journey towards circular economy? We examine this question via an in-depth case study of the early stages of the CE journey in the Danish multinational company, Danfoss. Specifically, we analyse how different 'transformation spaces' can facilitate dialogue on CE and experimentation with circular business models and support the needed organisational change.

7.2. THEORETICAL BACKGROUND

Our theoretical framework is based on the concept of CE as it is defined by the Ellen MacArthur Foundation (2013) and the understanding of challenges related to the transition from the current linear economy to a CE (Guldmann and Huulgaard, 2017). This transition can be regarded a complex innovation journey, where actors explore new and unfamiliar terrain. Therefore, there is a need for agile processes, where it is possible to navigate according to the experience and knowledge that is developed along the way (Blank, 2017; McGrath, 2010; Ries, 2017; Weissbrod and Bocken, 2017). It is this focus in particular on the transformation and learning processes that, among others, Zollo and colleagues (2013) call for, which is our focus in this paper. Changes in a company's purpose, as is required in the transition from linear economy to CE, demands changes in the softer aspects of an organisation, such as values, beliefs, motivations of its actors, taken-for-granted notions and artefacts, which are included in the organisation's culture (Zollo et al., 2013). The transition from a linear economy to a CE also demands a break with the dominant technical, organisational and business related activities and routines through, for instance, new business models (Bocken et al., 2013, 2014, Geissdoerfer et al., 2017b, 2016; Porter and Kramer, 2011). Roome and Louche (2016) have analysed the processes of how companies change their business models to sustainable business models and argue that business models for sustainability are more socially complex than the linear business models they replace, because these lead to new business relationships and involve more actors than the previous business models. Likewise, the process that leads to the revised business model is more complex, time-consuming and dynamic than its linear business model innovation counterpart (Roome and Louche, 2016). This complexity of sustainable business model innovation demands experimentation and testing of new possibilities within and between companies (Bocken et al., 2018; Bocken et al., 2016; Weissbrod and Bocken, 2017). We argue that this experimentation and testing can be advanced and facilitated through transformation spaces that make it possible to collaborate across individual and collective specialisations and knowledge domains (Gish and Clausen, 2013).

7.2.1. TRANSITIONING TOWARDS A CIRCULAR ECONOMY

CE is an emerging field, and there are many different definitions of the term, the most cited of which is that of the Ellen MacArthur Foundation (Kirchherr et al., 2017), which defines a CE as (2013, p. 22): *'an industrial economy that is restorative by intention; aims to rely on renewable energy; minimises, tracks, and eliminates the use of toxic chemicals; and eradicates waste through careful design'*. According to Bocken and colleagues (2016), the CE is about slowing and closing resource loops, which happens through the implementation of specific product design strategies and business model strategies. In other words, product design and business model design constitute two main pillars of operationalising the CE. Both are involved when ensuring that it is possible to maintain, reuse, redistribute, refurbish, remanufacture and recycle the product and its components, as well as ensuring the necessary transformation of the company practices and organisation (Ellen MacArthur Foundation, 2013; Weissbrod and Bocken, 2017).

7.2.2. INNOVATION JOURNEYS AND TRANSFORMATION SPACES

As mentioned, the process of developing and implementing circular business models is more complex than linear business model innovation. We apply the notion of innovation journeys (Van De Ven, 2017; Van de Ven et al., 1999) to describe the process companies are going through. The innovation journey concept captures the notion that innovation processes are open, uncertain, characterised by exploration and unexpected outcomes and that the end destination is not known beforehand (Geels et al., 2008).

Before any formal innovation plans are made, a gestation period of several years is typical, in which events that are more or less random take place without deliberately pointing towards a specific innovation (Van de Ven et al., 1999). It is this early phase of the innovation process with which we are concerned in the present article. The events of the gestation phase might eventually lead to the initiation of a formal innovation process, but oftentimes an internal or external shock is needed to get this process started. This could be, for instance, sudden decreasing sales rates or changes in environmental conditions. In particular, in the early phases of the innovation process, influences from external partners are important for the unfolding of the innovation journey, and it is therefore important to support internal-external collaborations (Geels et al., 2008).

Van de Ven (2017) compares the innovation process to a river, in that it is impossible to control, however, it is possible to increase the odds of success by learning to manoeuvre it. An innovation process is a continuous shift between divergent cycles, where the process is opened up, new ideas explored and new relationships are built, and convergent cycles, where the actors integrate and narrow the process, testing and implementing ideas and collaborating in established networks. Van de Ven

(2017) highlights the importance of supporting learning and that managers are given the possibility to practice their manoeuvring skills in relatively safe environments before commencing innovation journeys.

In practice, most companies and networks are locked into existing technological, organisational, industrial, societal and institutional structures (Doganova and Karnøe, 2012; Unruh, 2002), which makes it difficult to rethink products and business models, as is needed on the journey towards CE (Bocken et al., 2016), and to achieve the knowledge exchange that is needed across existing structures, routines and institutions (Clausen and Yoshinaka, 2007). Gish and Clausen (2013) suggest the notion of technological frames, which describes how different collectives attribute and negotiate meaning in connection with problems, solutions, ideas, technologies and events, as well as how they act and interact with each other in the process.

In this article, we combine elements of the lock-in structures outlined by Doganova and Karnøe (2012) with the cognitive elements of mind-set and negotiation of meaning that are discussed by Gish and Clausen (2013) to derive a construct that we term a dominant frame. A dominant frame hence consists of the mind-sets, organisational or institutional structures that a company, or a part of the company, operates under. A dominant frame influences the ways actors behave, and different frames are found in different parts of an organisation. How an idea or a concept, such as CE, is approached depends on the dominant frames of those discussing the concept (Gish and Clausen, 2013). A dominant frame at the mind-set level could be familiarity with linear business models and an associated scepticism about circular business models. Examples of dominant frames at the organisational level include a focus on cost reduction, on energy efficiency or on operational, rather than tactical and strategic, activities. Finally, a dominant frame at the institutional level could be the environmental legislation influencing the company overall or a particular CE idea.

Orlikowski and Gash (1994) note that when different technological frames are incongruent, actors experience difficulties and conflicts in their collaboration, and, in such cases, it is necessary for the organisational actors involved to reframe the technological frames (Gish and Clausen, 2013). We argue that similar reframing is needed in the case of incongruent mind-sets and organisational and institutional frames. To promote reframing, a number of different approaches and methods have been developed within design as well as learning theory, which aim to promote and facilitate the development of knowledge through communication between actors, thus achieving a mutual understanding across the different dominant frames (Brandt et al., 2013).

Clausen and Gunn (2015) and Clausen and Yoshinaka (2007) develop the concept of temporary spaces and socio-technical spaces, where actors can exchange ideas, activities and solutions in new ways, and note that these socio-technical spaces must be constructed in a way that allows the actors to engage and involve themselves

across the existing knowledge domains, work practices and institutions. On a similar note, Jørgensen and Sørensen (1999) develop the concept of the development arena. The development of such development arenas provides actors the opportunity to meet up and exchange information and knowledge and to interact and co-create new solutions. These interactive processes are facilitated in part through facilitators and in part through objects or artefacts, which tie activities and actors together in a co-creation process (Jørgensen and Sørensen, 1999).

In our analysis of Danfoss' CE journey, we take our point of departure in the space and arena concepts presented above, and we apply the notion of transformation spaces. In a transformation space, interaction between different actors from the organisation are facilitated, which opens up a process of idea generation and experimentation. We argue that through such transformation spaces, the reframing of the dominant frames become possible, as is necessary to the transformation from a linear to a circular business model.

7.3. METHODOLOGY

The role of transformation spaces in the CE journey was examined using field experiments as part of a longitudinal case study. The point of departure of this paper is an ongoing collaboration with the Danish company Danfoss, which began in 2011. The case study approach was chosen because this method is rich with empirical information and allows the researcher to study the nature of the phenomenon and experiments deeply and extensively over time (George and Bennet, 2005). Furthermore, a longitudinal study allows the researchers and the employees at the company to build of a relationship of trust, and it allows the researchers to follow company routines and processes, decisions, priorities and strategic foci, as well as the developments within these areas and how field experiments influence these over time.

7.3.1. RESEARCH DESIGN AND DATA SOURCES

Our research design consisted of two main parts: 1) interactive action research, where we created and facilitated a field experiment in the form of a cross-organisational workshop, and observation of another field experiment in the form of a hackathon, facilitated by other external actors; and 2) an interview component, where we sought to understand the background for Danfoss' approach to CE and to uncover any changes to the dominant frames over time, i.e. changes in mind-set and in organisational and institutional structures.

ACTION RESEARCH

In the action research, we facilitated a cross-organisational workshop, where our role as action researchers was to be proactive and visible change agents using practical interventions as means for change (Van de Ven and Johnson, 2006). The aim of the workshop was to create a transformation space that would start unlocking dominant frames working in opposition to the adoption of CE by: creating an awareness and understanding of the concept of CE across the organisation; creating a space where the potentials of CE internally in the different departments and across different departments could be discussed and ideas for circular business models could be initially tested; and facilitating and creating new collaborations between departments.

During our collaboration with Danfoss, we were given the opportunity to observe a CE hackathon facilitated by the Danish Design Council with the aim of redesigning product packaging. We were interested in investigating how this type of activity would facilitate the gestation phase of circular business model innovation. Following the two field experiments, we conducted follow-up interviews with key actors to determine the outcome of the field experiments in terms of changes to mind-sets and to organisational and institutional frames.

ESTABLISHING A CONTEXTUAL OVERVIEW

To understand the CE journey that Danfoss was going through, the company context and the dominant frames, we also applied an exploratory research approach. This implied close interaction with employees from different departments, and the employees included managers, directors and specialists. As a means to establish this contextual overview and a foundation for analysing the transformation process, we mapped all events and activities related to CE on a timeline. During the data gathering process, our focus was to track any activities in the company, which related to CE, to identify how these initiatives were started, how the activities were developed and who the involved actors were. Furthermore, we followed the activities until they either were successfully implemented or terminated.

A summary of the action research and exploratory research activities, including the data sources is illustrated in Table 7-1. All interviews were recorded and transcribed. Furthermore, memos and logbook notes were significant methods applied. Memos serve, according to Bryman (2012), as reminders about what is meant by the terms used and provide the building blocks for certain amount of reflection.

Research activity	Description	Purpose	Data sources
Field experiment 1	Cross-organisational workshop. Timing: Fall 2015	To analyse whether the workshop functioned as a transformation space and in what ways it facilitated dialogue and CE experimentation.	Direct observation of participants. Follow-up interviews with four key informants to identify changes in framing before and after the workshop.
Field experiment 2	CE hackathon primarily involving external actors. Timing: Fall 2016	To analyse whether the hackathon functioned as a transformation space and in what ways it facilitated dialogue and CE experimentation.	Direct observation of participants. Follow-up interviews with four key informants to identify changes in framing before and after the hackathon.
Contextualisation	Mapping major CE events and activities on a 2008-2017-timeline. Examining changes in mind-sets and organisational and institutional structures.	To establish pre-existing and post-experimental frames and thus understand the context of the transformation process.	Document analysis. Semi-structured interviews with four key actors. Meetings and unstructured interviews with company contact. Emails. Observations.

Table 7-1: Summary of research activities, purpose and data sources.

7.3.2. CASE COMPANY DESCRIPTION

Danfoss is a multinational Danish company within the mechatronics sector. Danfoss was founded in 1933, has more than 26,000 employees worldwide, consists of four business segments, i.e. four main business units, and had a group turnover of EUR 5.8 billion in 2017 (Danfoss, 2018). Sustainability-related activities, such as

developing strategies and guidelines, are primarily rooted in the group sustainability department, i.e. a unit separate from the operational parts of the organisation, while the operational parts of the organisation are responsible for implementing the sustainability initiatives. Sustainability is a key concern in Danfoss and has been so for many years.

Danfoss was selected as a case company for this study, because the company is a large incumbent company with complex organisational structures. Its sustainability work is focused on compliance, energy efficient products and corporate social responsibility, which all in all constitute a company profile referred to as 'operational optimisation' by Adams and colleagues (2016). This company profile renders Danfoss appropriate for the study of the influence of dominant frames and lock-ins in early stage circular business model innovation, as well as the study of the role transformation spaces can play in a reframing.

7.3.3. DATA ANALYSIS

The focal point of our data analysis is the two field experiments: the cross-organisational workshop created and facilitated by us in collaboration with Danfoss, and the CE hackathon facilitated by other external partners. Based on the contextualisation, i.e. the mapping of events related to CE and the pre-existing and post-experimental frames, we can analyse the impact of the two field experiments and their effects as transformational spaces.

7.4. THE JOURNEY TOWARDS CIRCULAR ECONOMY AT DANFOSS

This section describes and analyses Danfoss' CE journey and the role of field experiments in facilitating interaction across the different dominant frames in the company. First, we present the organisational context of Danfoss and, based on the mapping of events and activities linked to CE, we describe and analyse the dominant frames influencing Danfoss´ approach to CE experimentation. Then, we analyse how the two field experiments supported organisational transformation in Danfoss and thus their effectiveness as transformation spaces.

7.4.1. DANFOSS' EARLY APPROACH TO CIRCULAR BUSINESS MODEL INNOVATION

To establish the context of the CE journey, we mapped organisational and institutional events related to CE on a timeline. This allowed us to determine dominant frames and to create a foundation for analysing the transformation process.

For the sake of overview, Figure 7-1 illustrates only what we consider major activities and events in the CE journey.

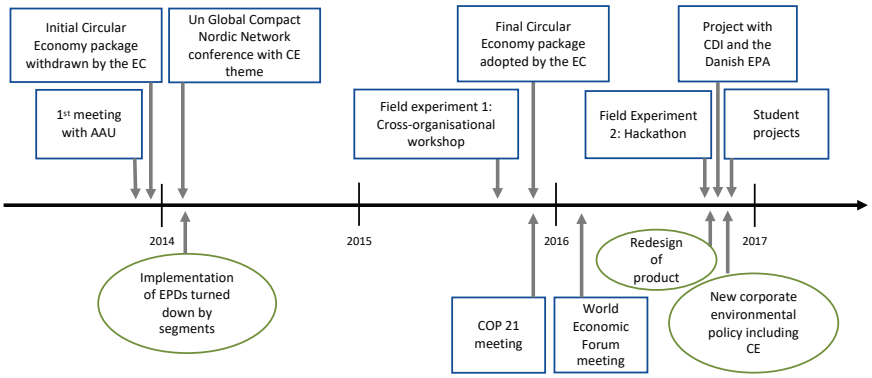

Figure 7-1. Danfoss' journey towards circular economy. Circles depict internal forces and rectangles depict external forces.

In what follows, we describe and analyse the dominant pre-existing organisational, institutional and mind-set frames, as well as the events and activities influencing these and the resulting post-experimental frames.

Our first meeting with Danfoss concerning the research project on circular business model innovation occurred in late 2013. Our contact point at Danfoss was the group sustainability department, who were interested in a collaboration. The dominant mind-set concerning sustainability was a long-standing focus on compliance, energy efficient products and CSR, which was reflected in existing mind-sets and organisational procedures as well as a burgeoning interest in resource efficiency. The decisive argument for Danfoss to take part in the collaboration was therefore the connection between CE and resource efficiency. In other words, it was possible engage Danfoss in the collaboration by bridging the pre-existing dominant frames around company sustainability and a new frame including CE principles via the shared element of resource efficiency.

The company was severely affected by decreasing sales during the financial crisis in 2008-2009, and the principal focus of management in 2008-2012 was thus to get the company back on track after the crisis. It was a period during which it was difficult to get environmental projects prioritised (Group Sustainability Director, interview on November 29, 2002). In this period, Danfoss' dominant frames were locked in by the accumulated routines and practices related to the focus on cost savings, optimisation

and efficiency goals, leaving little room for experimentation with new business or sustainability concepts.

In 2013, the first group sustainability strategy was launched, which marked the beginning of a gradual unlocking and reframing in some parts of the organisation, as the sustainability strategy served as an important artefact in this context. One reason for launching the strategy was that one of the segments asked for milestones and clear statements on the company position towards sustainability (Group Sustainability Director, interview on November 29, 2002).

On the institutional level, the EU launched the first draft of the CE package in June 2014. Although the draft could be considered a statement of intent and was later withdrawn, it drew some attention to CE at Danfoss, especially in the group sustainability department (Group Sustainability Director, interview on December 12, 2016). A dominant frame in this department, and in Danfoss more generally, was a focus on compliance, and with the launch of the CE package, a future area of legislation to comply within was highlighted and a gradual reframing at the group sustainability department to embrace CE was in its infancy.

While the sustainability strategy and an improved economic performance of Danfoss meant it became easier to get environmental projects approved with top management around 2013-2014, it still proved difficult to create the necessary commitment to change in the operational part of the company, i.e. on the segment level. Comparing interviews with the group sustainability director and with the three interviewees from the operational part of the company reveals that the dominant frames at the group sustainability department and at the different segments were not congruent. In the sustainability department, a curiosity towards a broader perception of sustainability (i.e. moving beyond compliance, CSR and energy-efficiency to include elements of life-cycle thinking) was growing, but at the segment level, employees were still locked into mind-sets, routines and structures that supported a focus on energy efficiency as the primary means of ensuring a sustainable business. As an example, according to the sustainability director, top management approved a budget for a test-implementation of Environmental Product Declarations in one of the segments. Despite the assigned budget, however, no segments wanted to participate in the test-implementation, since they felt they were too stretched for resources.

The incongruence between the different segments' dominant frames and the lock-ins into specific mind-sets, routines and practices became obvious in our collaboration with the company, too. Both the group sustainability department and the researchers wanted to involve one of the company segments in some sort of pilot project or other field experiment to make the CE explorations and results as operational and hands-on as possible. However, due to the heavy workload from the day-to-day operations,

i.e. a frame that was incongruent with the new CE frame, the segments initially turned this down.

The research collaboration nevertheless led to a revision of an eco-design guideline for the product development, a project driven by the group sustainability department, whose dominant frame was beginning to include CE aspects. The guideline was updated to include CE elements, such as to consider if new service-oriented business models, take back schemes and recycling of materials would be appropriate. However, to date, this guideline has not been implemented in any segments, possibly due to incongruent frames between the group sustainability department and the segments.

In conclusion, even though the group sustainability department was interested in exploring the potentials of working with CE, the extant themes of the sustainability strategy, e.g. energy efficiency, proved difficult to circumvent. These frames permeated both group guidelines, employee mind-sets and what did and did not constitute legitimate sustainability considerations throughout the operational parts of the company and to some extent also in the group sustainability department.

7.4.2. CROSS-ORGANISATIONAL WORKSHOP ON CIRCULAR ECONOMY

Based on the challenges to initiating an integration of CE principles at Danfoss described previously, we wanted to create a transformation space, which could act as a safe learning space for the exploration of new mind-sets through an exchange of ideas between organisational actors and the development of solutions in new ways. We therefore wanted to conduct a field experiment in the form of a cross-organisational workshop.

Initially, it was difficult to get the segments interested in a workshop, and the dialogues between the company and the researchers on how a collaboration could be set up and which segments could be interested in being involved lasted more than a year. However, while working on the revision of the eco-design guideline, a gradual reframing of mind-sets and dominant frames towards a burgeoning openness to CE principles took place, and interest for the workshop rose in both the segments and the sustainability department. One reason for this shift in mind-set was the group sustainability managers active participation in the UN Global Compact Nordic Network, where CE was on the agenda already in early 2014. Furthermore, memos and notes on CE had been prepared for Danfoss' CEO, as part of the company's participation in COP 21 in Paris and the World Economic Forum meeting in 2015, as well as the launch of EU's initial CE Package. These documents and events acted as artefacts that rendered the reframing of mind-sets and frames possible. Hence, an institutional reframing (at the Global Compact network level, the COP and the societal levels) influenced the mind-set of the actors and the way they responded to the workshop and helped articulate the relevance of CE to Danfoss.

The cross-organisational workshop was held in autumn of 2015 in close collaboration with the group sustainability department and had 14 participants from two different segments, who held positions within R&D, product management, quality, industry affairs, group regulatory, sustainability and public affairs departments. Four researchers, including the authors, also participated in the workshop.

To facilitate interaction between actors across different dominant frames, the workshop was organised in the following way. First, the group sustainability manager presented the status quo of Danfoss' work with CE so far, namely, the integration of CE in the eco-design guideline. The aim of this part of the workshop was to establish a common understanding of how CE already was, though in small scale, part of Danfoss' aims and activities. Next, one of the researchers (one of the authors) explained the concept of CE in more detail and gave examples of how companies similar to Danfoss had already implemented CE. The intention was to establish a common vocabulary for discussing the potentials of CE for Danfoss, inspire ideas for how to integrate CE at Danfoss and to have the examples act as artefacts supporting a reframing from 'CE is a new concept that may not be relevant to Danfoss at all' to 'other companies that we could compare ourselves to have done this – how might we go about an integration of CE in Danfoss?'.

Throughout the workshop, the participants were eager to discuss and pose questions, and ideas for how to work with CE were already being generated at this point. Furthermore, examples of former practices and routines that were in alignment with CE principles were mentioned. In other words, old practices and organisational structures were put into a CE context, thus effectively bridging old ways and potential new ways of approaching sustainability in Danfoss (i.e. an example of the sustainability reframing that took place during the workshop).

The last element of the workshop was a brainstorming session among the participants on ideas for CE pilot projects in the company. For this purpose, large posters with principal resource loops in the CE were applied, i.e. posters illustrating the maintenance, reuse, repair, remanufacturing and recycling loops. The participants were asked to note their CE ideas on Post-it notes individually and place these on the posters. Subsequently, the suggestions were presented in plenum and discussed briefly by the participants.

It had previously proven difficult to engage the segments in CE projects, yet after the workshop, one of the directors that participated in the workshop was asked if his department would be interested in a collaboration with the Danish Design Council and University of Southern Denmark on a CE hackathon (to which we will return in the following section) and quickly accepted this invitation. The workshop, supported by the aforementioned institutional reframing, thus proved to function as a transformation space that resulted in changed mind-sets regarding CE, at least for some of the participants.

The shift in mind-sets and framings took place due to a combination of reasons. One was that the concept of CE and the potential value of the hackathon were now familiar to the director and the specialist he assigned to the task. The cross-organisational workshop had pointed to some potentials of CE for Danfoss, and due to the interactive style of the workshop, ideas for how to integrate CE with extant strategic priorities in the segments had already been discussed. The hardware director (interviewed September 21, 2016) comments on the new opportunity to participate in a CE hackathon this way:

> *"The workshop had planted some seeds and I had already accepted the line of reasoning, so it did not take much consideration and argumentation for me to decide. It was more a matter of finding the right place to do it."*

In this way, the cross-organisational workshop successfully created a transformation space for Danfoss to explore and learn about CE, and reframing was beginning to take form amongst the participants, who now had some common understanding and vocabulary in relation to CE.

Furthermore, during the workshop, we observed how the different employees from the various departments could change their mind-set and set aside the dominant frames, as well as generate new ideas and explore the opportunities for future collaboration across different dominant frames. The result was several ideas for how the segments could benefit from CE activities and for how to combine these with existing knowledge in Danfoss, such as, for instance, modularity in the product design and service contracts. The workshop also highlighted challenges related to the implementation of CBMs, such as institutional lock-ins, e.g. regulation, organisational lock-ins, e.g. difficulties in communicating the benefits of CE in standard business case templates, and that endorsement from management on small-scale pilot projects was needed.

7.4.3. HACKATHON

The second field experiment was a CE hackathon. In contrast to the cross-organisational workshop, the researchers did not play an active role in this transformation space, as it was created and facilitated by other external partners. Rather, our role was to observe and interview the actors involved at the event and to subsequently interview key actors in Danfoss to assess the outcome of the hackathon in terms of reframing.

In the hackathon, the role of the few directly involved Danfoss employees was also different from the role of employees in the cross-organisational workshop. In the workshop, Danfoss employees were active participants in the event, whereas in the hackathon, it was mostly students from University of Southern Denmark that generated and discussed ideas. The role of the employees from Danfoss involved in

the hackathon was to define a task for the students to work with, to evaluate the various suggestions and to decide on a winning design that would be presented to R&D managers and employees.

Danfoss decided that redesign of the packaging for a product, that was itself under redesign at the time, was to be the focus of the hackathon. The students were divided into three groups, each developing their own solution, which they had 24 hours to complete. During these 24 hours, they were given different presentation as inspiration for their work. They also had different materials and tools at their disposal to build a prototype. At the end of the hackathon, the packaging prototypes were presented to the R&D department, and they therefore had the potential to act as artefacts supporting a reframing of the dominant frames. It would seem, then, that the hackathon created a safe learning environment for Danfoss and together with the cross-organisation workshop it helped reframe the dominant sustainability frame to also include CE experimentation. Danfoss was nevertheless not so far along in its CE journey as to convert the experimentation into concrete new products, packages or business models, for instance, the winning packaging solution from the hackathon was not implemented.

7.4.4. IMPACT OF THE TWO TRANSFORMATION SPACES

It seems from what has been discussed above that the workshop and the hackathon functioned as transformation spaces that facilitate an initial reframing of dominant sustainability frames. In line with Geels (2008), it furthermore seems that interaction with external actors and events play a role in the early stages of the CE journey. The CE Package is an example of an external event that influenced the institutional frames and motivated the company, or at least the sustainability department, to pay closer attention to the concept of CE. The workshop is another example of an event, this time influencing mind-sets and organisational structures and opening up a new part of the company to CE experimentation.

Following the workshop and the hackathon, Danfoss continued to experiment with CE. In conjunction with the hackathon, it was decided, for instance, that students from the University of Southern Denmark would work with the redesign of one of Danfoss' products, with the aim of integrating CE considerations in the redesign. Later, Danfoss engaged in a project organised by the Confederation of Danish Industry and a range of other trade organisations within the electric and electronics industry (Danish Environmental Protection Agency, n.d.). The aim of this project was to develop a number of business cases for CBMs in the Danish electronics sector. However, perhaps the aim of this project was too specific to match Danfoss' position in its CE journey at the time, or its execution would have benefitted from a deeper level of employee-involvement, because the developed business case was met with scepticism and did not get the impact one would expect from a positive business case.

It was the same segment that participated in the hackathon and student projects and that agreed to participate in the project with the Confederation of Danish Industry, implying that a new dominant frame on sustainability had been established in this part of the organisation, substituting the old energy-efficiency oriented frame with a frame also including CE considerations. A new frame was furthermore in congruence with the frame of the group sustainability department, which has led to CE becoming more integrated in Danfoss' strategies: CE was included in the environmental policy that was implemented in the beginning of 2017, where it is specifically stated that sustainability and CE principles should be promoted if technically and environmentally feasible (Group Sustainability Director, interview on December 12, 2016). In this way, for the first time CE was communicated as a legitimate, relevant concept for the company as a whole, and the reframing has thus begun to spread beyond the sustainability department and the employees involved in the various experiments to also involve higher level management and set the tone for the entire organisation. We asked the group sustainability director (interview on December 12, 2016) if it had been challenging to integrate CE in the environmental policy, but this was not the case:

> *"No, it is not that [CE] we have spent our time discussing. We have discussed other things, but this was accepted without problems. It [the environmental policy] has been in review in all of the segments and all corners of the organisation, and no one had objections*.".

Furthermore, the group sustainability department and the group regulatory department have begun a process to include CE in the sustainability strategy, the governance structures and daily practice, implying that the two transformation spaces did indeed facilitate a reframing that has allowed the company to move forward in its CE journey.

7.5. CONCLUSION

The aim of this paper was to analyse how early stages of Danfoss' innovation journey from a linear business paradigm towards a circular business paradigm could be supported through transformation spaces that provide the opportunity to create and share ideas, and experiment and develop projects across different dominant sustainability frames in different segments and departments. The research question that guided this research was: how can circular business model innovation activities support the overall organisational journey towards circular economy? We answered the research question through an analysis of two specific field experiments at the early stages of Danfoss' CE journey: a cross-organisational workshop created and facilitated by the researchers in close collaboration with Danfoss, and a CE hackathon in which the researchers had an observatory role.

In line with the theoretical constructs of Gish and Clausen (2013) and Doganova and Karnøe (2012), our analysis shows that through two transformation spaces, it was possible to facilitate CE idea generation and small-scale experimentation with CE, despite dominant sustainability frames in Danfoss that were originally incongruent with CE. Furthermore, the analysis shows that such transformation spaces can constitute the safe learning environments that are necessary for a gradual reframing.

Currently, Danfoss is somewhere between the gestation phase of the circular business model innovation process, and the beginning of the ignition phase. Although Danfoss' focus is primarily directed inwards at processes within existing practices, and the projects commenced can be characterised as low-risk, stand-alone activities involving only one segment, it is an approach that allows Danfoss to experiment and learn in a more or less safe environment. As Van de Ven (2017) points out, innovations processes cannot be controlled, but you can learn to manoeuvre them. The two transformation spaces analysed in this study could be a way to build such manoeuvring skills to further facilitate the CE journey.

The different setups of the two transformation spaces, however, seems to have had a different impact on the early stage circular business model innovation. So far, no circular business model ideas have been implemented, but the transformation spaces have facilitated a reframing of the sustainability frames to also include CE in Danfoss. The cross-organisational workshop in particular appears to have created a new and shared sustainability frame and a common vocabulary among the participants, which made it easier for the Group Sustainability Director to subsequently engage workshop participants in the hackathon, in student projects on a CE redesign of a product and in the project to develop a concrete business case. The different impact of the two transformation spaces is likely due to the different type of involvement of Danfoss employees in the two spaces. In the cross-organisational workshop, a group of employees were active in generating and discussing ideas, i.e. in the CE experimentation. In contrast, only a few employees were involved in the hackathon, and they had a more passive role, i.e. to design a task for others to solve and to evaluate the results at the end of the hackathon. Instead, the participating students were the active participants.

The mapping of the events related to CE illustrates the importance of external actors in the facilitation of circular business model innovation. Prior to our collaboration with Danfoss and the introduction to CE, the concept was not part of the dominant frame in any sector of Danfoss' organisation. By linking the old dominant sustainability frame with a CE frame through the shared element of resource efficiency, it was possible to generate some initial interest in CE. This interest was further stimulated by a gradual reframing of institutional structures, facilitated by such factors as the original CE Package from the European Commission and a focus on CE at UN Global Compact and COP 21 meetings. Although no formal circular business model innovation processes have started yet, progression in the institutional reframing

could potentially provide the shock necessary for a formal circular business model innovation process to begin (Van de Ven et al., 1999), not least if specific demands on the integration of circular principles in companies became regulatory requirements.

7.5.1. LIMITATIONS OF RESEARCH

As described in the method section, this study is based on a large, incumbent company that has worked with sustainability for several years, but focused mainly on compliance, energy efficient products and CSR in its sustainability work. The findings are thus not necessarily relevant to other types of companies. Smaller, more agile companies, for example, are less likely to benefit from transformation spaces in a way similar to Danfoss.

The study specifically examined the early phases of the case company's CE journey. The conclusions on the relevance of transformation spaces for the reframing of dominant mind-sets and organisational and institutional frames hence relate to this stage of the journey, whereas other methods could be relevant at later stages.

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REFERENCES

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., Overy, P., 2016. Sustainability-oriented Innovation: A Systematic Review. Int. J. Manag. Rev. 18, 180–205. https://doi.org/10.1111/ijmr.12068

Blank, S., 2017. Why You Can't Just Tell a Company 'Be More Like a Startup'. Havard Bus. Rev. fall, 1-5. Available at: https://hbr.org/2017/06/why-you-cant-just-tell-a-company-be-more-like-a-startup [Accessed September 26, 2018].

Blomsma, F., Brennan, G., 2017. The Emergence of Circular Economy: A New Framing Around Prolonging Resource Productivity. J. Ind. Ecol. 21, 603–614. https://doi.org/10.1111/jiec.12603

Bocken, N., Short, S., Rana, P., Evans, S., 2013. A value mapping tool for sustainable business modelling. Corp. Gov. Int. J. Bus. Soc. 13, 482–497. https://doi.org/10.1108/CG-06-2013-0078

Bocken, N.M.P., Bakker, C., Pauw, I. De, 2016. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 1015, 20. https://doi.org/10.1080/21681015.2016.1172124

Bocken, N.M.P., Schuit, C.S.C., Kraaijenhagen, C., 2018. Experimenting with a circular business model: Lessons from eight cases. Environ. Innov. Soc. Transitions 28, 79–95. https://doi.org/10.1016/J.EIST.2018.02.001

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. J. Clean. Prod. 65, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Bocken, N.M.P., Weissbrod, I., Tennant, M., 2016. Business Model Experimentation for Sustainability, in: Setchi R., Howlett R., Liu Y., Theobald P. (Eds.) Sustainable Design and Manufacturing 2016. SDM 2016. Smart Innovation, Systems and Technologies, vol. 52. Springer, Cham, pp. 297–306. https://doi.org/10.1007/978-3-319-32098-4_26

Brandt, E., Binder, T., Sanders, E., 2013. Tools and techniques: ways to engage telling, making and enacting, in: Simonsen, J., Robertson, T. (Eds.), Routledge International Handbook of Participatory Design. Routledge, New York, pp. 145–181.

Chesbrough, H., 2010. Business model innovation: Opportunities and barriers. Long Range Plann. 43, 354–363. https://doi.org/10.1016/j.lrp.2009.07.010

Clausen, C., Gunn, W., 2015. From the social shaping of technology to the staging of temporary spaces of innovation -a case of participatory innovation. Spec. Issue of Sci. Technol. Stud. Polit. Innov. Environ. Sustain. 28, 73–94.

Clausen, C., Yoshinaka, Y., 2007. Staging socio-technical spaces: translating across boundaries in design. J. Des. Res. 6, 61. https://doi.org/10.1504/JDR.2007.015563

Danfoss, 2018. 2017 Financial highlights in EURO. [pdf] Available at: http://files.danfoss.com/download/CorporateCommunication/Financial/Financial-highlights-in-EURO-2017.pdf [Accessed September 26, 2018].

Danish Environmental Protection Agency, n.d. Frivillig aftale om miljøvenlig elektronik og genanvendelse af elektronikaffald [www document] Available at: http://mst.dk/service/nyheder/nyhedsarkiv/2013/okt/frivillig-aftale-om-elektronik/ [Accessed September 13, 2017].

Doganova, L., Karnøe, P., 2012. The innovator's struggle to assemble environmental concerns to economic worth: Report to Grundfos New Business. Grundfos New Bus. 41.

Ellen MacArthur Foundation, 2013. Towards the circular economy vol. 2: opportunities for the consumer goods sector. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE_Report-2013.pdf [Accessed September 6, 2018].

Ellen MacArthur Foundation, 2012. Towards the circular economy vol. 1: an economic and business rationale for an accelerated transition. [pdf] Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf [Accessed July 19, 2018].

Geels, F.W., Hekkert, M.P., Jacobsson, S., 2008. The dynamics of sustainable innovation journeys. Technol. Anal. Strateg. Manag. 20, 521–536. https://doi.org/10.1080/09537320802292982

Geissdoerfer, M., Bocken, N.M.P., Hultink, E.J., 2016. Design thinking to enhance the sustainable business modelling process – A workshop based on a value mapping process. J. Clean. Prod. 135, 1218–1232. https://doi.org/10.1016/j.jclepro.2016.07.020

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J., 2017a. The Circular Economy – A new sustainability paradigm? J. Clean. Prod. 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Geissdoerfer, M., Savaget, P., Evans, S., 2017b. The Cambridge Business Model Innovation Process. Procedia Manuf. 8, 262–269. https://doi.org/10.1016/j.promfg.2017.02.033

George, A. l., Bennet, A., 2005. Case Studies and Theory Development in the Social Sciences. MIT Press, Cambridge, US.

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Gish, L., Clausen, C., 2013. The framing of product ideas in the making: a case study of the development of an energy saving pump. Technol. Anal. Strateg. Manag. 25, 1085–1101. https://doi.org/10.1080/09537325.2013.832746

Guldmann, E., Huulgaard, R., 2017. Challenges to Circular Business Modeling, in: Aravossis, K. (Ed.), Towards a Greener Challenge & Evolution in the Framework of the Circular Economy, Proceedings of the 18th European Roundtable on Sustainable Consumption and Production. Grafima Publications, Thessaloniki, Greece, pp. 21–29.

Jørgensen, U., Sørensen, O., 1999. Arenas of Development - A Space Populated by Actor-worlds, Artefacts, and Surprises. Technol. Anal. Strateg. Manag. 11, 409.

Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: An analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

McGrath, R., 2010. Business models: A discovery driven approach. Long Range Plann. 43, 247–261. https://doi.org/10.1016/j.lrp.2009.07.005

Miles, M.B., Huberman, M.A., 1984. Qualitative Data Analysis: A Sourcebook of New Methods. Sage, Beverly Hills, US.

Orlikowski, W.J., Gash, D.C., 1994. Technological frames: making sense of information technology in organizations. ACM Trans. Inf. Syst. 12, 174–207. https://doi.org/10.1145/196734.196745

Porter, M.E., Kramer, M.R., 2011. Creating shared value: how to reinvent capitalism - and unleash a wave of innovation and growth. Harv. Bus. Rev. 89, 62.

Ries, E., 2017. The Startup Way: How Modern Companies Use Entrepreneurial Management to Transform Culture & Drive Long-Term Growth. Currency, New York.

Roome, N., Louche, C., 2016. Journeying Toward Business Models for Sustainability. Organ. Environ. 29, 11–35. https://doi.org/10.1177/1086026615595084

Unruh, G.C., 2002. Escaping carbon lock-in. Energy Policy 30, 317–325.

Van De Ven, A.H., 2017. The innovation journey: you can't control it, but you can learn to maneuver it. Innovation 19, 39–42. https://doi.org/10.1080/14479338.2016.1256780

Van de Ven, A.H., Johnson, P.E., 2006. Knowledge for theory and practice. Acad. Manag. Rev. 31, 802.

Van de Ven, A.H., Polley, D.E., Garud, R., Venkataraman, S., 1999. The Innovation Journey. Oxford University Press, New York, US.

Weissbrod, I., Bocken, N.M.P., 2017. Developing sustainable business experimentation capability - A case study. J. Clean. Prod. 142, 2663–76. https://doi.org/10.1016/j.jclepro.2016.11.009

Zollo, M., Cennamo, C., Neumann, K., 2013. Beyond What and Why. Organ. Environ. 26, 241–259. https://doi.org/10.1177/1086026613496433

CHAPTER 8. CONCLUSION

This chapter sums up and connects the findings from the two background reports, technical reports A and B, as well as articles C, D and F and book chapter E, presented in Chapters 4-7 to answer the four research sub-questions and the main research question. Suggestions for further research to complement the findings of this dissertation round off the chapter.

8.1. AN IMPROVED UNDERSTANDING OF CIRCULAR BUSINESS MODELS

The introduction to this dissertation described the societal relevance of a shift towards a CE as part of a larger sustainable development agenda, and the main theme of the dissertation was how companies can engage in circular business model innovation to make this move towards a CE. To begin answering this question, different ways of categorising CBMs were explored throughout the research process, beginning with the state-of-the-art of current CBM practices in report A, in which three frameworks for organising CBMs were examined based on resource loops, value bases and business model archetypes, respectively. The frameworks were useful for visualising the diversity of CBMs detected in the practice state-of-the-art, but did not provide insight as to what type of CBMs best assist the integration of CE into the core of the company.

More specific conceptualisations have been developed since then, most notably, the distinction between CBMs that narrow, slow and close resource loops (Bocken et al., 2016) that was adopted in later stages of my research. Building on this division, the dissertation has contributed to the conceptualisation of CBMs in the literature by linking CBMs for closing loops to incremental innovation, while linking CBMs for slowing loops to radical innovation and a higher potential for moving companies towards a net positive impact on society (cf. article C).

At the level of CBM configuration, the typical co-existence of linear and circular business model elements was pointed out (cf. article C and book chapter E in Chapters 4 and 6), and a visual model to support this more nuanced conceptualisation of CBMs was suggested (cf. Figure 4-2). The proposed conceptualisation and visual model elucidate the circular value recreation, value redelivery and value recapture elements vis-a-vis the value creation, delivery and capture elements known from virgin manufacturing in linear business models, and the model shows how the circular elements (i.e. new product designs and associated services such as repair and take-back schemes) complement the linear business model to offer an *extended* value

proposition that is more comprehensive and attractive than the value proposition based on the linear business model elements alone.

The co-existence of linear business models and CBMs has only been discussed peripherally in the CBMI literature up until now (by e.g. Stål and Corvellec (2018)), and the exploration of the co-existence on the business model *element* level, which was presented in Chapter 4, is new. These themes seem important to examine closer in further research in order to understand how incumbent companies can best integrate circular services and product designs in their existing linear business model.

8.2. MULTIPLE BARRIERS

The first sub-question – *what are the barriers to circular business model innovation?* – was examined in article C, where multiple barriers to CBMI were identified at the employee, the organisational, the value chain and the institutional levels. Most barriers identified were in accordance with those reported in the literature on CBMs and in the related streams of literature on e.g. product-service systems and closed-loop manufacturing, but barriers not previously reported were also uncovered: reluctance to involve external stakeholders in the CBMI activities; difficulties in establishing cross-organisational collaboration; lack of commitment to promoting the CE agenda; and reluctance to engage in CBMI because of financial resources and other resources invested in the existing manufacturing facilities and value chains.

The similarity between barriers to radical innovation and to CBMI that was demonstrated in article C supports a categorisation of CBMs for slowing resource loops as radical innovation. The radical innovation literature could, hence, be a relevant place to look for more inspiration on how to organise and facilitate CBMI. In this dissertation, the radical innovation literature inspired, for instance, the comparison of CBMI processes in the case companies with a design thinking approach to innovation to derive an adapted design thinking framework appropriate for CBMI.

8.3. A FRAMEWORK AND TOOLS TO SUPPORT THE INNOVATION PROCESS

This comparison was made in article D to answer the second sub-question: *what could a design thinking framework tailored to CBMI look like and what is the potential impact of such a framework?*

The comparison showed that the organisation of the CBMI process in the case companies was in an overall perspective comparable to design thinking, although some adjustments to the framework were needed to fully reflect the CBMI process.

The study demonstrated that most of the a priori specified tools (i.e. a CE system diagram, idea maps, principles for CBMs to adhere to and a collection of best practice examples) were useful in the CBMI process. The best practice exemplars were applied the most frequently, followed by the CE system diagram, idea maps and CBM principles. Only the CBM canvas proved superfluous because the experienced company participants considered and discussed intuitively the modifications that would be required to the existing business model, without the support of a visual tool. Considering the reconfiguration of business model elements to fit a new CBM was, in other words, important, but did not demand a visual tool in the case companies. In addition to these CBMI-specific tools, a number of supplementary tools of a more general character were applied on ad hoc basis to support the CBMI process, such as customer interviews, market analyses, trend analyses, etc.

The need to expand focus of the innovation work to the system of internal and external stakeholders required to operate a CBM is a central point of the developed CBMI framework. The systemic focus demands a deliberate integration of multiple internal and external stakeholders throughout the innovation process. In some companies, external stakeholders are best involved in the CBMI process at later stages, after a period of company-internal focus, which works as a safe learning space with regards to the CBMI process. A similar finding is reported in the work of Bocken and colleagues (2018).

The developed design thinking framework couples the three traditional innovation spaces (i.e. the exploratory; ideation; and prototyping and testing spaces) with two new spaces (i.e. the introductory and alignment spaces) and contributes to describing key stages and activities of the CBMI processes. The case company results were encouraging in terms of the generation of CBM ideas, development of selected CBM ideas, preliminary tests of the new business models and a continued commitment to work with CBMI after the research collaboration ended, which indicates that the adapted framework and the associated CBMI toolbox are indeed appropriate for the facilitation of CBMI processes.

The flexibility of the framework allows the order of innovation spaces, the amount of time spent on the individual spaces, the internal and external stakeholders involved and the use of general and CBMI-specific tools to be adjusted, which is of importance to accommodating the CBMI process in different company settings.

8.4. THE IMPORTANCE OF COMPANY SETTING

The multiple-case studies included manufacturing and wholesale companies of different sizes and serving different customer segments. The intention with this case selection was to begin to answer the third sub-question: *how does the company setting affect the circular business model innovation process?*

Case companies in all industries, of all sizes and both B2B and B2C companies experienced barriers at the organisational, the value chain and at the institutional levels in the CBMI process, and all except start-ups experience barriers at the employee level as well. Cross-case analysis showed there were no clear difference between the number or type of barriers experienced in companies of different sizes and serving different customer segments.

The adapted design thinking framework for CBMI was also found to be suitable for the overriding organising of the CBMI process for the case companies across industries, sizes and customer segments. Although some differences pertaining the phases of the CBMI process were detected between the small and the larger case companies: the large companies typically spent considerable time in a phase of organisational alignment concerned with clarifying the company's position on CE, whereas the alignment in the small companies happened spontaneously. This meant that the progress of the CBMI in terms of generation of CBM ideas and development and testing of these was faster in the small companies (cf. report B and article D).

Moving beyond the distinction between small and larger companies, book chapter E considered three different foundations for CBMI comprised of the existing business model type (linear or circular); the employees driving the CBMI (staff or management); and the company's sustainability strategy (aimed at balancing profitable business and environmental improvements; at being more sustainable than competitors; or at having a net positive impact).

Comparing the CBMI process in case companies with different foundations for CBMI revealed dissimilarities between the CBMI processes in terms of the goal of the innovation process, the internal and external stakeholders involved, the characteristics of the experimentation and the level of business model improvements that was achievable. The three types of CBMI were termed internal, hybrid and systemic CBMI, and are discussed in more detail in section 8.6.

8.5. SUPPORTING THE CIRCULAR ECONOMY JOURNEY

The desire to understand how the CBMI activities influence and are influenced by the companies' attitude towards the CE paradigm more generally and its integration in the company motivated the fourth sub-question: *how can circular business model innovation support the overall organisational journey towards circular economy?*

Analysis of the CBMI process in Danfoss, one of the large case companies, showed that different business units and departments in the company were locked into specific mind-sets and organisational and institutional structures that influenced their approach to CBMI. The CBMI activities in the company nonetheless allowed CE idea generation and internal experimentation with CE across these mind-sets and

organisational and institutional structures, thus supporting a gradual reframing of mind-sets and structures. This effect of CBMI activities was identified even though the activities were initiated by external stakeholders from outside the value chain, were stand-alone activities and were predominantly concerned with incremental improvements of the existing business model, and thus not interfering with the business model of the core business.

The organisational journey towards CE could be understood as a gradual reframing of dominant logic and locked-in structures that could potentially move the company from one category of sustainability strategy to the next category in better alignment with CE principles, and CBMI activities were found to facilitate this reframing.

The dissertation has thus demonstrated that CBMI activities together with complementary external events facilitated a gradual integration of the CE paradigm in the case companies. The CE journey, in return, influenced the legitimacy of the CBMI process, the engagement of stakeholders in the innovation work and the overall traction of the process (cf. articles D and F). The CBMI process and the CE journey are hence mutually dependent dimensions of an organisational transformation towards CE.

8.6. ANSWERING THE MAIN RESEARCH QUESTION

By drawing upon the results from the three articles C, D and F and book chapter E, it is now possible to answer the main research question: *how can companies in different settings engage in circular business model innovation?*

An integration of CE into the core of a company is primarily attained through the adoption of CBMs for slowing resource loops in the company (cf. section 1.4). However, the development and implementation of CBMs for slowing resources loops can be considered a radical form of sustainability-oriented innovation for which not all companies are equally equipped, and so the result of engaging in CBMI will not necessarily be an integration of CE into the core business. Instead, the CBMI process can facilitate a gradual move towards this by supporting the company's CE journey.

The outcome of the CBMI process including the attainable level of business model improvements will depend on the company's specific foundation for CBMI and three types of CBMI that can support companies with different foundations for CBMI are suggested in this dissertation: internal, hybrid and systemic CBMI.

Internal CBMI is typical for companies that have a linear business model; that seek to balance profitable business and environmental improvement through well-established eco-efficiency methods; and where individual staff members drive the innovation process. Even when the CBMI is organised to fit the company setting,

companies in this group find it difficult to integrate CBMs into the core business. Instead, the goal is to get acquainted with the CE and circular business model concepts, generate initial CBM ideas to get a sense of the opportunities and challenges involved in a shift to CBMs and commence internal dialogue oriented at clarifying the company position on CE. The CBMI may result in the conception of an internal circular business model, a term used to describe the integration of procedures for narrowing and closing resource loops within the company or within its existing value chain. The business model of the core business, i.e. the business driving main revenue in the company, is not affected by internal CBMs, and institutional shock of some sort, e.g. in the form of new legislation, may be needed to kick-start the integration of CBMs into the core business.

Hybrid CBMI is possible in companies where the business model is linear; the aim is to be more sustainable than competitors through continuous improvements of the environmental performance; and the CBMI process is driven by management. Companies that initiate CBMI from this foundation are in a better position to develop CBMs for closing and not least for slowing resource loops by creating circular services and/or product designs that can be integrated with the existing linear business model of the core business. The resulting business model is a hybrid CBM that combines linear and CBM elements. The CBMI process can help the company assess the business potential of CBMs via the generation of CBM ideas for slowing and closing resource loops that are tested through internal and external experimentation.

Systemic CBMI is useful in companies whose core business is already based on a circular business model; where the company aspires to have a net positive impact on society and actively pursues this objective via close collaboration with value chain partners; and where management drives the CBMI process. Systemic CBMI is characterised by a high degree of experimentation with external stakeholders in which the company explores opportunities for refining the existing CBM via the development of new or improved circular services and/or products that close, narrow and slow resource loops in a (more) optimal way.

Organising the CBMI process according to the adapted design thinking framework for CBMI developed in article D (i.e. Chapter 5 of the dissertation) is recommendable for all three types of CBMI, because the framework builds on experimentation that is useful in the CBMI process and because it offers the flexibility needed to accommodate different company settings. The toolbox developed to support the innovation process consists of four CBMI-specific tools and can be supplemented with other instruments as needed. Applying this framework and these tools generated more than 100 ideas for CBMs in the case companies in the Closing Material Loops project alone, eight of which were examined closer and one of which was implemented. Furthermore, most of the case companies have continued the CBMI work in some form after the research collaboration was concluded. These are testimonies that organising the CBMI process according to the adapted design

thinking framework and utilising the developed toolbox were indeed appropriate means to support the CBMI process in the case companies.

8.7. FURTHER RESEARCH

This dissertation applied a company-internal perspective to the shift towards a CE, which resulted in insights regarding opportunities for, and barriers to, CBMI in companies and insights into the overall transformation process towards CE in companies, i.e. the CE journey.

It would be beneficial to complement the research conducted with investigations into the role of the wider company setting (cf. Figure 2-1) for the unfolding of the CBMI process and the overall CE journey. External factors to examine closer would be the importance of concrete regulation and of public debate on CE, the influence from industry-specific standards and institutions and the possibilities for value chain collaboration and for ensuring customer acceptance of the new business models.

The research conducted showed that not only expected and concrete legislation, but also the societal discourse and formal events oriented at CE, influence the CE journey (e.g. article F). These are external factors that affect all companies, but particularly companies for which compliance is a key motivator for sustainability-oriented innovation. Further examinations of the influence of these factors would be interesting and links with the second level of external influences, industry standards and institutions, where Stål and Corvellec (2018) have noted how the emerging CE institution within the textile industry influences the type of CBM that is adopted by the companies. An examination of industry-specific dynamics, such as the emerging CE institution, would be a valuable supplement to the company-internal focus of this dissertation.

As for external influences relating to the value chain, a more careful examination of the potentials of co-creation approaches would be relevant. This could include co-creation activities with existing and new value chain partners within and across industries. The effect of involving customers in such activities would be interesting to examine closer and may help address some key research questions that are left unanswered in this dissertation: will customers embrace CBMs? If so, what constitutes environmental or social value to customers, and what level of inconvenience or hindrance are they willing to accept for an economic, environmental or social upside in a CBM compared to a linear business model?

Initiating the CBMI process in most of the case companies, this dissertation focused mainly on early-stage CBMI and CE journeys. Future research would thus benefit from including later stages of the CBMI, such as market testing, full-scale

implementation and ongoing refinement of the CBMs to attain a more complete view of the CBMI process in its entirety.

REFERENCES

Bocken, N.M.P., Bakker, C., de Pauw, I., van der Grinten, B., 2016. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 33, 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bocken, N.M.P., Schuit, C.S.C., Kraaijenhagen, C., 2018. Experimenting with a circular business model: Lessons from eight cases. Environ. Innov. Soc. Transitions 28, 79–95. https://doi.org/10.1016/J.EIST.2018.02.001

Stål, H.I., Corvellec, H., 2018. A decoupling perspective on circular business model implementation: Illustrations from Swedish apparel. J. Clean. Prod. 171, 630–43.

APPENDICES

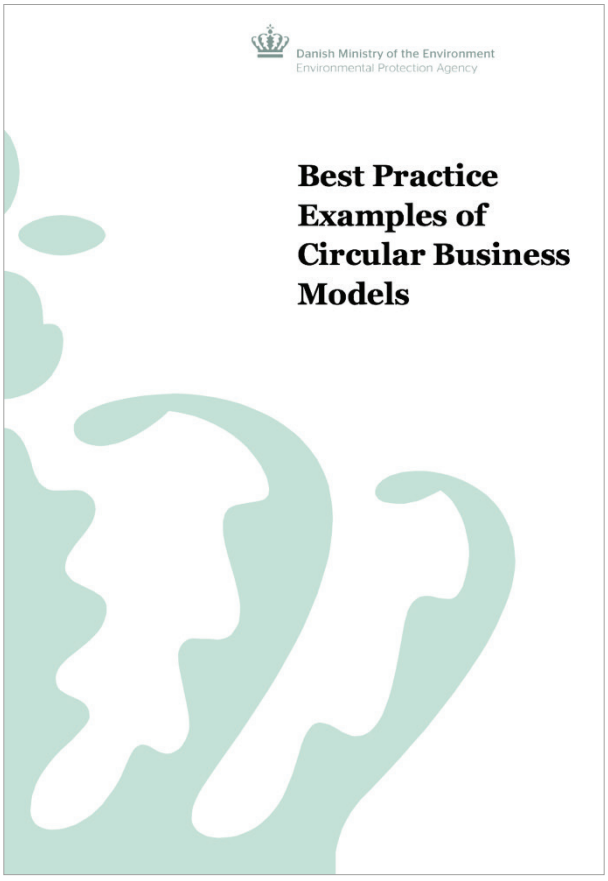
Appendix A. Best Practice Examples of Circular Business Models **164**

Appendix B. Towards Circular Business Models: Experiences in Eight Danish Companies **165**

Appendix A. Best Practice Examples of Circular Business Models

Technical report A is published online via the Danish Environmental Protection Agency. The front cover is reproduced below and the full report is available via the homepage of the agency.

Guldmann, E., 2016. Best Practice Examples of Circular Business Models. Danish Environmental Protection Agency, Copenhagen, Denmark. [pdf] Available at: https://www2.mst.dk/Udgiv/publications/2016/06/978-87-93435-86-5.pdf. [Accessed September 6, 2018].



Appendix B. Towards Circular Business Models: Experiences in Eight Danish Companies

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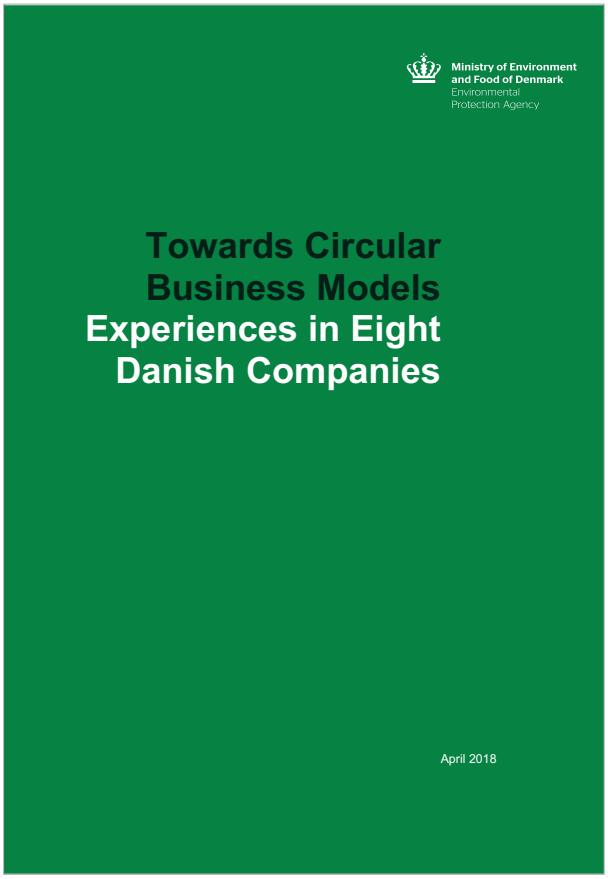
Guldmann, E., Remmen, A., 2018. Towards Circular Business Models: Experiences in Eight Danish Companies. Danish Environmental Protection Agency, Copenhagen, Denmark. [pdf] Available at: https://www2.mst.dk/Udgiv/publications/2018/04/978-87-93614-97-0.pdf [Accessed September 6, 2018].



SUMMARY

The need for more sustainable development demands that sustainability is integrated into the core of companies in new ways, and the development of new sustainable business models is a possible avenue to this. Circular business models are sustainable business models that align with a circular economy, where products, components and materials are kept at their highest function and value at all times to minimise the flow of resources through the economy.

This dissertation examines how companies can develop such circular business models. The research identifies different types of circular business models and outlines ways of initiating the business model innovation process, depending on the company setting. The research pinpoints barriers to the innovation process and suggests innovation strategies and tools that can help circumvent these barriers, and it investigates the link between experimenting with circular business model innovation and integrating the circular economy paradigm more broadly in a company.

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