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A Design Thinking Framework for Circular Business Model Innovation

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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 CBMI. This article aims to contribute to closing this gap by developing a framework for CBMI based on a design thinking approach, which can support the CBMI process.

Design: The CBMI framework was derived from a multiple case study in which six case companies created circular business models in collaboration with the researchers. The CBMI processes were studied from the time when circular economy and circular business models were first introduced to the companies and the following six months to two years.

Findings: A design thinking process typically consists of three innovation spaces, an exploratory, an ideation, and a prototyping and testing space. Yet, based on the empirical data, this paper identifies two additional spaces, an introductory and an alignment space, for CBMI. The results derived from the six case companies indicate that the developed framework including its tools and techniques are useful for CBMI.

Practical Implications: This study contributes with a framework to help practitioners facilitate and manoeuvre the challenging CBMI process. The framework provides guidelines for the CBMI process and inspiration for tools that could be applied flexibly depending on the organisational setting.

Value: The main contributions of the paper are: an empirically grounded framework to assist CBMI; deeper insight into the use of design thinking for CBMI; a number of tools to support CBMI more generally; and a better understanding of the stages and activities of a CBMI process.

Keywords: Circular economy; Circular business models; Sustainable business models; Circular business model innovation; Design thinking

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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; 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 (Royal Society, 2012; IPCC, 2018). A key element in reversing this development is to make a transition in how we consume and produce goods (WBCSD, 2010; Bocken *et al.*, 2014; Adams *et al.*, 2016; Zou *et al.*, 2017). Companies have integrated concepts such as cleaner production, efficiency improvements, eco-design, life cycle management, and corporate social responsibility in the pursuit of sustainable development (Kørnøv *et al.*, 2007; Short *et al.*, 2014). Nevertheless, literature suggests that incremental product, process and technological innovations are insufficient to transform organisations, industries and societies towards sustainable development (Bocken *et al.*, 2014; Abdelkafi and Täuscher, 2016; Adams *et al.*, 2016; 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 (Short *et al.*, 2014; Adams *et al.*, 2016). Instead, we need a more systemic approach that aligns business operations with long-term sustainability (Stubbs and Cocklin, 2008; Boons and Lüdeke-Freund, 2013).

Sustainable business model innovation offers a possible avenue to integrate sustainability considerations more fully and systematically into the firm (Stubbs and Cocklin, 2008; Short *et al.*, 2014; Abdelkafi and Täuscher, 2016; Evans *et al.*, 2017; Geissdoerfer *et al.*, 2018b) and is considered a force for industry transformation and socio-technical transitions by many authors (Bocken *et al.*, 2013; 2014; Boons and Lüdeke-Freund, 2013; Dentchev, 2018; Geissdoerfer *et al.*, 2016; 2017a; b). While the area of business model innovation more generally continues to be on the rise in academia (Wirtz *et al.*, 2016; DaSilva, 2018; Wirtz and Daiser, 2018), the field of sustainable and circular business model innovation has emerged to address increasing sustainability challenges (Bocken *et al.*, 2014; Schaltegger *et al.*, 2016; Massa *et al.*, 2017; Breuer *et al.*, 2018; Dentchev *et al.*, 2018; Hopkinson *et al.*, 2018; Lüdeke-Freund *et al.*, 2018a). Sustainable business models that are integrated within the circular economy (CE) paradigm are referred to as circular business models (CBMs) (Bocken *et al.*, 2016; Nußholz, 2017; Geissdoerfer *et al.*, 2018a). A shift to CBMs is considered a key enabler of a CE (Bakker *et al.*, 2014b; Tukker, 2015; Lieder and Rashid, 2016; Lüdeke-Freund *et al.*, 2018b), and, potentially of companies that have a net positive impact (Adams *et al.*, 2016). The CE is a regenerative economy in which companies strive to maximise the value and utilisation of products, components and materials at all times (Ellen MacArthur Foundation, 2012; 2013a; Webster, 2015; Blomsma and Brennan, 2017; Geissdoerfer *et al.*, 2017a). A key element of CBMs is the bundling of products that are fit for sharing, repair, upgrades, reuse, refurbishment and/or recycling with supporting services that enable the utilisation of these product features (Ellen MacArthur Foundation, 2013a; Bocken *et al.*, 2016; Ranta *et al.*, 2018) to move from a linear 'take-make-dispose' paradigm towards a circular economy (Esposito *et al.*, 2018).

However, operational guidelines for the realisation of a CE are lacking (Ghisellini *et al.*, 2016; Blomsma and Brennan, 2017; Kirchherr *et al.*, 2017;) not the least in relation to the development and implementation of CBMs (Tukker, 2015; Antikainen and Valkokari, 2016; Linder and Williander, 2017) with a few exceptions, many of those being covered within the grey literature (e.g., Achterberg *et al.*, 2016; Ellen MacArthur Foundation and IDEO, 2016; Kraaijenhagen *et al.*, 2016), but also within the emerging academic literature in this field (e.g. Antikainen and Valkokari, 2016; Heyes *et al.*, 2018).

A number of companies have already adopted CBMs and provide some best-case examples (see e.g. Ellen MacArthur Foundation, 2012; 2013b; b; Guldmann, 2016; Kraaijenhagen *et al.*, 2016). The cases nevertheless provide merely the first insights into how companies started to make the transition towards a circular business. As inspiring as the exemplars and other guidelines are, deeper knowledge is needed about how the innovation process is carried through to facilitate genuine change. This includes knowledge about how to design an appropriate CBM for the company (Lüdeke-Freund *et al.*, 2018b) and about how to facilitate the associated changes in the organisation (Roome and Louche, 2016) and the value chain (Geissdoerfer *et al.*, 2018b).

A transition to CBMs requires that companies deal with challenges at multiple socio-technical levels spanning from the employee level, over the organisational and value chain levels and on to the institutional level (Evans *et al.*, 2017; Guldmann, 2018), including cognitive and structural lock-in to the linear business paradigm (Evans *et al.*, 2017; Guldmann, 2018). The complexity of designing new CBMs infer that CBMI can be considered a 'wicked' design problem, i.e. a design problem that is multi-causal, multi-scalar and interconnected, spans organisational and disciplinary boundaries, lacks definite formulations and solutions, and is characterised by conditions of high uncertainty (Rittel, 1972 cited in Liedtka, 2015).

According to Buchanan (1992) there is a fundamental indeterminacy (i.e. wickedness) in all but the most trivial design problems. Solving wicked issues takes time and effort and perhaps they are never *completely* solved. Instead, the suggested solutions are better or worse as opposed to right or wrong and it can take a long time to evaluate solutions, which ramify throughout the system (Buchanan, 1992). Design thinking (DT) is a design philosophy that offers a possible approach 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 facilitate the development of possible solutions to wicked problems, by fostering learning and managing uncertainty (Beckman and Barry, 2007), thus seems highly relevant in a CBMI context.

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 question: *What could a DT framework tailored to CBMI look like?* We endeavour to answer this question 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, and the paper is rounded off by conclusions, implications of the study and suggestions for further research in section 5.

Theoretical background

Circular economy

Our current economic system is based on extracting raw materials for products that are ultimately turned into waste. Such a linear production system will eventually face difficulty as raw materials grow scarcer and waste problems larger, and the CE has been proposed as an alternative to this production paradigm (Webster, 2015; Ghisellini *et al.*, 2016; Geissdoerfer *et al.*, 2017; Esposito

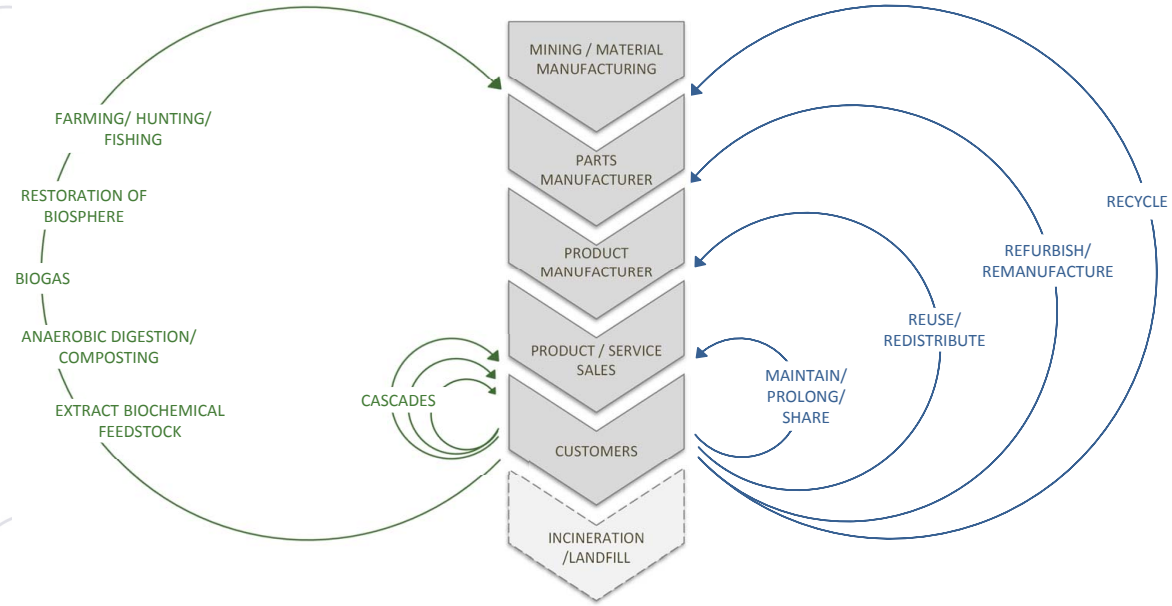

Figure 1: System diagram depicting biological (green) and technical (blue) resource loops in a CE. Adapted from Ellen MacArthur Foundation (2015)

et al., 2018). The CE is outlined as a regenerative industrial system (Ellen MacArthur Foundation, 2012) and can be perceived as "a way to design an economic pattern aimed at increased efficiency of production (and consumption) by means of appropriate use, reuse and exchange of resources, and do more with less" (Ghisellini *et al.*, 2016, p. 8).

The notion of a CE builds on pre-existing concepts such as the principles of reduce, reuse and recycle (Ghisellini *et al.*, 2016; Geissdoerfer *et al.*, 2017), but nevertheless articulates a distinct cognitive unit compared to other sustainability paradigms due to the clearer pronunciation of resource life-extension as a means to create value and to reduce value destruction (Bakker *et al.*, 2014b; Achterberg *et al.*, 2016; Blomsma and Brennan, 2017).

The distinction between technical and biological nutrients is another central aspect of a CE (McDonough and Braungart, 2002; Ellen MacArthur Foundation, 2012; 2013a; Ghisellini *et al.*, 2016; Blomsma and Brennan, 2017; Lüdeke-Freund *et al.*, 2018b) as illustrated in Figure 1, where the left-hand side of the figure corresponds to the biological sphere and the right-hand side to the technical sphere. Manufacturing companies, which are the focal point of the present paper, will typically operate in the technical sphere, where resources are ideally circulated repeatedly in the economy to prolong the useful life of products, components and materials (Stahel, 2010; Ellen MacArthur Foundation and University of Bradford, 2012; Achterberg *et al.*, 2016;). The aim is to increase resource efficiency of the production system and reduce the need for new products, components and virgin raw material and minimise waste generated, through the systematic use of sharing, repair, reuse, remanufacturing and recycling strategies (Ellen MacArthur Foundation, 2013a; 2015; Ghisellini *et al.*, 2016; Lüdeke-Freund *et al.*, 2018b).

Circular business models

The transition to a CE requires changes at the micro, meso and macro levels of society (Ghisellini *et al.*, 2016) and at the micro level an adoption of CBMs is central (Ghisellini *et al.*, 2016; Geissdoerfer *et al.*, 2018a; Lüdeke-Freund *et al.*, 2018b). In general, a business model is "(…) a description of how a company does business" (Richardson, 2008, p.136). Although there are many different views on business models, a commonly accepted understanding is that a business model is a story about, or a blueprint of, how the company operates (Magretta, 2002; Osterwalder and Pigneur, 2010) and it can be perceived as consisting of a number of elements or 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. grey elements of Figure 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 2).

A CBM is a type of sustainable business model (Bocken *et al.*, 2014; 2016; Geissdoerfer *et al.*, 2018a; Lüdeke-Freund *et al.*, 2018b). Several definitions of what constitutes a CBM have been proposed recently, within the emerging field of CBM research, but no uniform and complete definition has been established yet (Lewandowski, 2016; Nußholz, 2017). It has been suggested that CBMs integrate environmental and economic value creation (Bocken *et al.*, 2016; Lieder and Rashid, 2016) by generating profits from a continual flow of reused materials and products over time (Bakker *et al.*, 2014a) and by capitalising on the value embedded in used products (Achterberg *et al.*, 2016; Linder and Williander, 2017). CBMs thus aim to preserve the value of products at the highest possible level of utility (Webster, 2015; Achterberg *et al.*, 2016; Velte and Steinhilper, 2016).

Companies can take different approaches to the development of CBMs (Tukker, 2015). Bocken *et al.* (2016) suggest these are categorised into strategies to slow, close and narrow resource loops. Slowing resource loops is aimed at prolonging product, component and material life through, for instance, maintenance, reuse and remanufacturing (Stahel, 1981; 2010; Bocken *et al.*, 2016; Lüdeke-Freund *et al.*, 2018b), corresponding to the three inner resource loops of Figure 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 (Stahel,

1981; 2010; Bocken *et al.*, 2016; Lüdeke-Freund *et al.*, 2018b), corresponding to the outermost resource loop of Figure 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). A further detailing of these strategies is suggested by Geissdoerfer *et al.* (2018a) to also include intensifying, i.e. supporting a more intense use phase for instance through sharing, and dematerialising, i.e. the substitution of product utility by service and software solutions.

While slowing, intensifying, dematerialising, closing and narrowing resource loops can be attained using both product design or business model design as a starting point (Bocken *et al.*, 2016), this article focuses on the latter. Building on Osterwalder and Pigneur (2010), Bocken *et al.* (2016), Evans *et al.* (2017) and Geissdoerfer *et al.* (2018a), 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 value network, and minimise environmental impacts by means of slowing, intensifying, dematerialising, 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 value networks among companies and other stakeholders will have to be developed to create and deliver novel products and services that demands new forms of company collaboration, customer interaction, logistical systems etc. (Kortmann and Piller, 2016; Evans *et al.*, 2017; Romero and Rossi, 2017; Geissdoerfer *et al.*, 2018a; Brown *et al.*, 2019).

The configuration of the CBM, including the value proposition, key activities, customer relationships etc., will be unique in each case depending on the company context. The context is made up of such factors as the existing business models and value chain partnerships, extant business and environmental strategies and whether the company aims to slow, intensify, dematerialise, close and/or narrow resource loops (cf. green box of Figure 2). Other factors of relevance are the level of management support, the amount of resources available to the CBMI process and the interest of suppliers and customers in engaging in a co-development of new business models. The blue boxes of Figure 2 constitute one way of illustrating the building blocks of a business model in general. All of these building blocks will have to be considered in CBMI before arriving at the final business model configuration, but in addition, the developed CBMs have to tally with specific principles that relate to a CE as well.

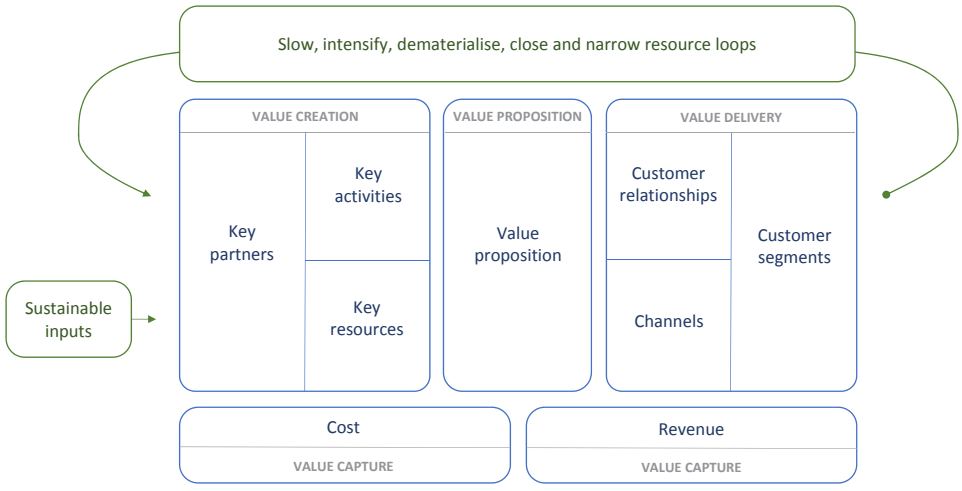

Figure 2: Circular canvas, i.e. a visual representation of a CBM that was one of the intervention tools in the study toolbox. Developed from Osterwalder and Pigneur (2010), Richardson (2008), Bocken *et al.* (2016) and Ellen MacArthur Foundation (2013a)

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 economic and environmental benefits of circulation in the inner circles as opposed to the outer circles of Figure 1 (Ellen MacArthur Foundation, 2012; 2013a; Linder and Williander, 2017) 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, whereas 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.

Second, the principle of 'circling longer' concerns keeping products, components and materials in circulation for as long as possible (Ellen MacArthur Foundation, 2012; 2013a). 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; 2013a). 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 (Bakker *et al.*, 2014a; b; 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 (Ellen MacArthur Foundation, 2012; 2013a; Bakker *et al.*, 2014a; Bocken *et al.*, 2016).

These first four principles interlink with the transformation of resource loops through slowing, intensifying, dematerialising, closing and narrowing strategies and are illustrated in the top green box in Figure 2. The fifth principle, 'sustainable inputs', is about utilising sustainable raw material inputs (e.g. recycled and/or recyclable materials) and renewable energy throughout the value chain to support reduction of the environmental impact of products and/or services (Ellen MacArthur Foundation, 2012; 2013a), and this principle is illustrated via a separate green box in Figure 2.

Business model innovation

Business model innovation (BMI) is a form of organisational innovation (Foss and Saebi, 2017) that is concerned with developing novel 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. Mitchell and Coles, 2003; Osterwalder and Pigneur, 2010). It is considered an important area of innovation by many authors (e.g. Richardson, 2008; Teece, 2010), not least as a means of transforming business towards sustainable development (Romero and Molina, 2011; Evans *et al.*, 2017; Geissdoerfer *et al.*, 2017b).

Four streams of research can be distinguished within the BMI literature (Foss and Saebi, 2017): Conceptualisations and classifications of business model innovation; descriptions of the new business models that are the outcome of the innovation process; assessments of the consequences of BMI on organisational performance; and examinations of BMI as an organisational process. Although also drawing on and contributing to the literature from other streams, this paper primarily falls under the latter, as it focuses on CBMI as a dynamic organisational process. From this process perspective, it is important to note that in addition to making deliberate changes to the core elements of the company, BMI will often involve changes to the underlying business logic (Bucherer *et al.*, 2012; Schaltegger *et al.*, 2012), and this is certainly the case in CBMI (Evans *et al.*, 2017; Lüdeke-Freund *et al.*, 2018b) as the traditional linear business, where profit is generated from one-time sale of goods, is substituted with a circular value creation logic, where profit is instead generated from a continual flow of reused materials and products over time (Bakker *et al.*, 2014a; Linder and Williander, 2017).

Contextual factors are also a key concern, since CBMI, as any innovation, takes place within a given social, organisational and individual setting, which shapes the process (Hargadon, 2014; Foss and Saebi, 2017; Stål and Corvellec, 2018) by influencing among other things what types of CBMs are possible, what stakeholders are involved in the innovation process and what level of novelty can be expected in the outcome of the innovation process (Guldmann and Huulgaard, 2019, Icibaci, 2019). Building on institutional theory, Stål and Corvellec (2018), highlight the relevance of the context of the CBMI by examining the phenomenon of decoupling, i.e. a discrepancy between stated objectives of circular business operations and actual practices, which remain

largely linear. 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).

CBMs demand a deliberate configuration and coordination of organisational functions such as marketing, sales, R&D, production, logistics, IT, finance and customer service within and across organisations (Geissdoerfer *et al.*, 2018a). Facilitating the needed redesign of organisational functions and their interaction as well as of the company-network, which accompanies the development and implementation of new CBMs, requires a collaborative and co-creation-oriented approach across functions and organisations. Particularly, as suggested by Icibaci (2019) in her case study on the reuse of building products in the Netherlands, co-creative governance is needed to avoid that sub-system-based legislation and other governmental rules hinder or even completely block CE implementation in daily practice.

Cognitive and structural lock-in at the organisational, technological, industrial and institutional level is, nevertheless, likely to impede the CBMI process (Unruh, 2002; Doganova and Karnøe, 2012; Evans *et al.*, 2017; Foss and Saebi, 2017) as the development of CBMs will require a break with both existing business logic (Evans *et al.*, 2017; Foss and Saebi, 2017) and existing organisational and value network structures, as outlined above, to create new, systemic solutions (Geissdoerfer *et al.*, 2018a) that furthermore involve more stakeholders (Roome and Louche, 2016) and entail an increased operational risk compared to the existing, linear business models (Linder and Williander, 2017).

The literature emphasises the importance of experimentation as a key means of dealing with the outlined challenges (Antikainen and Valkokari, 2016; Kraaijenhagen *et al.*, 2016; Evans *et al.*, 2017; Weissbrod and Bocken, 2017). Experimentation helps companies test hypotheses underlying the business model ideas and supports organisational learning (Thomke, 2003; Sarasvathy, 2005; Chesbrough, 2010; Osterwalder and Pigneur, 2010). Eventually, every part of the business model (as illustrated by the blue boxes of Figure 2) should by verified through such experimentation, which 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, e.g. in a circular canvas, is an example of an internally oriented tool or approach for experimentation (Chesbrough, 2010), and 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 (Thomke, 2003; Chesbrough, 2010). The choice of experimentation tool will depend on the organisational and field-level landscapes, i.e. on the organisational, value network and institutional setting (Hargadon, 2014) and the CBM under consideration, which means that the experimentation that was conducted in the present study, i.e. the exact configuration, order and scope of experiments, was unique in each case company.

Design thinking

The complexity and uncertainty inherent in CBMI (Evans *et al.*, 2017; Linder and Williander, 2017) 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 definitive choices for as long as possible to maximise 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 (Antikainen and Valkokari, 2016; Geissdoerfer *et al.*, 2018a), 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 (d.school, n.d.; Brown, 2008; Seidel and Fixson, 2013; Carlgren *et al.*, 2016b; Fleury *et al.*, 2016). Liedtka (2015) nevertheless concludes that there are some typical characteristics of this type of innovation process: *"All descriptions of the process emphasise 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."* (p.927). 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 utilised at this stage are observation, interviewing and other kinds of ethnographic research approaches (Liedtka, 2011; 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, 2011; 2015). Surfacing and testing assumptions is also among the techniques featured in this phase. Visual and narrative visualisation instruments such as charts for visual representation along with analogies and storytelling for narrative visualisation 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 1 summarises the main characteristics of the DT process and some typical techniques used. The selection of tools offered in Table 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 is not so much about the specific tools utilised 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.*, 2011). Thus, there are 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.

Research gap: circular business model innovation and design thinking

The pressing need to move towards sustainable development renders a wider adoption of CBMs desirable (Linder and Williander, 2017). However, based on a recent review, Geissdoerfer *et al.* (2018b) point out that it remains unclear how organisations can transition to

Design thinking aspects	Key points		
Guiding principles	• User-centred • Collaboration across functions, perspectives and experience bases • Iterative cycles of moving through innovation spaces • Emphasise 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	Co-creation approaches: • Engage users in generation, development and testing of ideas Visualisation techniques, visual or narrative: • Charts • Organising Post-it notes • Storytelling • Metaphors		

Table 1: General design thinking model. Adapted from Brown (2008), Seidel and Fixson (2013) and Liedtka (2011; 2015)

more sustainable business models in practice; what phases a company undergoes in the process; what the key activities of each phase are; and what tools can support the process.

It is nevertheless clear that CBMI involves challenges at the employee, organisational, value chain and institutional levels (e.g. Rizos *et al.*, 2016; Linder and Willianander, 2017; Evans *et al.*, 2018; Guldmann, 2018). These challenges relate to lock-ins in terms of value creation logic and structures and result in organisational inertia (Chesbrough, 2010; Evans *et al.*, 2017), and consequently there is a need for tools to support companies in the development of sustainable business models (Upward and Jones, 2016; Geissdoerfer *et al.*, 2018b), not least circular ones.

DT appears to be a promising approach to address 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).

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 towards CE in product design, packaging, the use of raw materials etc. One of the tools suggested by the Ellen MacArthur Foundation and IDEO (2016), 'Circular Business Model' (as well as elements of some of the other tools), relate to the specific development of CBMs, and it builds on the original business model canvas (corresponding to blue parts of Figure 2), 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 are 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.

Methods

The study was designed as an exploratory study of six case companies (O'Connor *et al.*, 2003; Yin, 2014). 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), since it allows the researcher to grasp a complex situation and describe actors and processes in an accessible format (Eriksson and Kovalainen, 2008). A multiple-case study can be used to identify common patterns and characteristics between cases (Eriksson and Kovalainen, 2008) and is instrumental in allowing analytical generalisation beyond the specific research context (Healy and Perry, 2000).

The study applied action research, which is a research method where the researcher is directly involved in activities that are intended to foster change on the group, organisational and societal levels (Dickens and Watkins, 1999). The researcher thus immerses in a situation to learn from the insights and perspectives of practitioners and to obtain greater understanding of a problem domain (Evered and Louis, 1981) and a shared interest between researchers and practitioners in learning is a prerequisite for this kind of collaborative research (Shani et al., 2012). The researchers are proactive and visible change agents, who use experimental interventions as a mode of inquiry (Van de Ven and Johnson, 2006; Van de Ven, 2007). In the present study, these interventions were in the form of taking a DT approach to the CBMI process, including suggesting the use of certain tools, proposing involvement of stakeholders from other parts of the organisation or from the value chain etc.

In action research, the research process is centred around cycles of planning, acting and observing, and reflecting (Kemmis and McTaggart, 1988), which means that, while some initial planning and overall organisation of the research process is possible, the details of the unfolding process of research interest will not be known beforehand. Instead, reflection amongst researchers and practitioners on the data generated from the interventions will guide the next step of the process (cf. Figure 3).

Action research is useful to accelerate research in areas where there is a pressing need for progress (McManners, 2016), as it allows for experimentation with different interventions to induce change as opposed to detached observation, and it works well in combination with case studies (Prendeville *et al.*, 2017). The researchers' immersion into the problem field and the multiple data

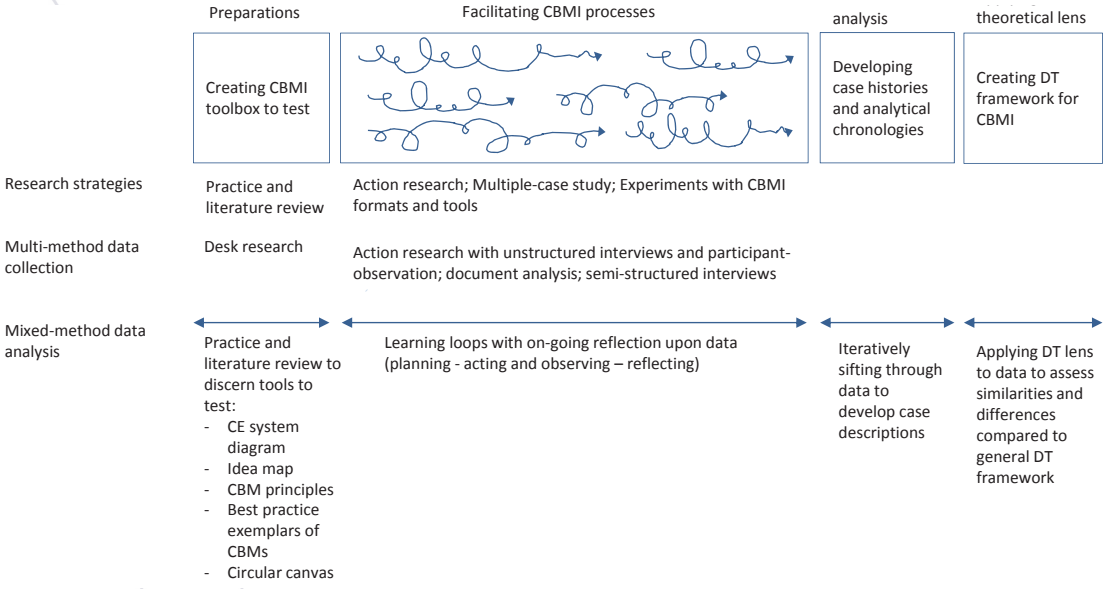

Figure 3: Overview of the research process

collection points (see Table 3) result in access to rich data on the studied processes. The quality of the gathered data is ensured via data triangulation between multiple data sources (e.g. participant-observation and unstructured interviews), researcher triangulation as well as practitioner reviews of the data. These methods to ensure robust data without bias were all applied in the present research (see section 3.3. for details).

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 rationalisation, to understand the impact of short-lived factors and changes, and discern patterns over long periods of time (O'Connor *et al.*, 2003). Ideally, the processes 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 about the initiation of CBMI and the early stages of the process (since we had the chance to introduce the companies to CE and CBMs) as well as some insight into later stages, including testing elements of 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).

Preparation of study

Case selection

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). In this study, all six case companies designed and sold physical products, but were of varying sizes, belonged to two different industries and served both business customers and consumers. The diverse characteristics of the companies allowed us to study differences and similarities between them 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 that the collaboration process had to be adjusted to fit the individual company setting, not least because the CBMI project was also anchored at different organisational levels and because the intensity of the collaboration varied (cf. Table 2).

Preparation of a CBMI toolbox

As part of the case study protocol (Yin, 2014), a few basic tools were developed that would work as interventions to experiment within the companies. 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 (Ghisellini *et al.*, 2016; Blomsma and Brennan, 2017). Consequently, the toolbox was based on early reports published by the Ellen MacArthur Foundation (2012; 2013a), the business model canvas developed by Osterwalder and Pigneur (2010) 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 and CBMs in a comprehensive way, which would enable idea generation and concrete discussions. We experimented with the application of these tools throughout the six CBMI-processes to examine their usefulness. The tools are presented and discussed in section 4.2 of the paper.

Circular business model strategies pursued

In the CBMI process, the researchers encouraged development of CBMs based on a strategy to slow resource loops via the introduction of maintenance, repair, reuse, refurbishment and/or remanufacturing activities, because this kind of CBM was expected to provide radically new and environmentally beneficial solutions and entail a complex and thus revelatory innovation process. CBM strategies to intensify or dematerialise resource loops were either less relevant or seemed too much of a stretch for the companies to relate to, and strategies to narrow or close resource loops seemed too incremental. It was, however, possible for the companies to move in another direction if they preferred that and case company A, for instance, decided to work on a (novel) recycling solution (a CBM for closing resource loops), while most other companies in our sample developed CBMs for slowing resource loops.

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 stakeholders. 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 2: Case company overview. *Micro companies have less than 10 employees; small companies less than 50; medium companies less than 250; and large companies 250 or more (Eurostat, 2016)

Data collection

The initial data collection in the companies focused on 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 CBMs etc., which provided the historical setting (Pettigrew, 1997) for the CBMI process. The primary unit of analysis, nevertheless, was the concrete CBMI process. At the beginning of the study it was not possible to discern what data would be relevant to appropriately document and understand the CBMI process and, consequently, the data collection aimed to document as many details about the processes as possible. Only gradually did meetings and workshops of the CBMI process, stakeholders involved, tools applied, outcomes and encountered issues become the focal points of the data collection.

Due to the action research nature of the study, participant-observation and unstructured interviews (Yin, 2014) relating to our on-site meetings and workshops with the companies were particularly important sources of data. This data was supplemented by semi-structured interviews and document analysis as outlined in Table 3.

The companies participating in the research, had agreed to get introduced to CE and CBMs, but it was up to the companies if they wanted to engage in CBMI after this introduction and for how long within the two-year research period. The researchers suggested approaches and next steps during this collaboration, but ultimately, the companies decided on the next steps, whom to involve and when. In this way, the researchers collaborated closely with company participants to facilitate the CBMI process.

Data analysis including cross-case 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 (Eisenhardt, 1989; Yin, 2014) and to consider what might

Company	Number of sessions involving participant-observation and unstructured interviews	Number of phone meetings involving unstructured interviews	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	- Sales agent in Sweden - Sales agent in Germany	- Folder on company's approach to sustainability - Marketing material - Company website
D	8	3	- Key account manager in United Kingdom - Key account manager in Southern Europe - Customer and project manager from one business unit - Customer from another business unit interviewed two times	- Sustainability reports - Annual reports - Company website
E	8	2	- Sustainability project manager - Sustainability consultant	- Presentation slides from the sustainability director - Sustainability reports - Annual reports - Company website
F	4	6	- Sustainability director - Hardware director - EHS manager - Hardware specialist	- Internal design guideline - Sustainability reports - Annual reports - Company website

Table 3: Data collection in the case companies

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 characterised by temporal presentation (Pettigrew, 1990; 1997), was drafted on each company compiled from field notes, minutes of meetings, corporate documents and interviews applying data triangulation where possible (Yin, 2014).

Over the course of approximately six months, the case histories were developed through repeated iterations to arrive at analytical chronologies of each company, i.e. 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 (Eisenhardt, 1989; Pettigrew 1997; 1990; O'Connor *et al.*, 2003).

The case histories and analytical chronologies were reviewed by a professor who had been involved in some

of the sessions and who had worked with the companies before, 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 the main contact at all case companies to ensure facts were correct and our interpretations of events were in line with the company participants' perceptions, which is a tactic with particular confirmatory power (Miles and Huberman, 1984). The authors 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 processes that had emerged led us to examine the DT literature closer and formulate the research question addressed in this article. The question was examined by comparing data from the multiple-case study with a general DT framework (cf. Table 1), i.e. pattern matching (Yin, 2014).

The pattern matching followed a systematic procedure, where we first analysed each CBMI process individually to examine: (1) What spaces of the general DT framework had the CBMI process moved through, based on the aim and techniques of each DT space? (2) Were there any significant CBMI-activities in the case company that could not be related to the spaces of the general DT framework? (3) What tools were applied in the companies? And finally, (4) were there similarities and differences between the processes in terms of spaces covered, tools applied, stakeholders involved, speed of progress and outcome? The results of these analyses are presented in section 4.

Results and discussion

In the following, we show what CBMI-specific and general tools were utilised during the innovation processes. We also illustrate where the innovation processes that we facilitated align with the innovation spaces of the general DT framework and where additional spaces were needed to capture the characteristics of the processes. Subsequently, we discuss what the principles that guided the CBMI process in the case companies were, and how they relate to a general DT framework.

The innovation process in the case companies

The first step of the innovation process was to clarify the company context, and the researchers examined if the companies had previous experience with CBM principles (cf. section 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 employees 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 a small core team of employees and a cross-organisational workshop in company F.

The introduction to the notion of CE, the principles behind CBMs, and concrete best practice exemplars 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 workshops, 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.

At company A, the innovation process revolved around an examination of ways to close the loop at end-of-life of a work wear collection that was under development. Our examinations focused on existing and upcoming technologies to support such recycling and involved discussions with external partners representing these technologies. At company B, a number of new product concepts were developed that integrated sustainability considerations to narrow loops into the product design. In addition, a small-scale take-back and refurbishment scheme to extend the life of the used electrical products to slow resource loops, was established. Company

C developed several CBM ideas, one of which involved repair, redesign and sales of used apparel, to slow loops, as well as apparel recycling, to close resource loops. The collaboration resulted in development of a business case for this CBM quantifying the economic, social and environmental potential and the company involved applied for a grant to support a full-scale experiment with the implementation of this business model.

Company D developed several CBM ideas and tested the attitude of relevant internal stakeholders and customers towards two of these. The ideas concerned slowing resource loops through maintenance and repair services for furniture in two different business units. Company E focused on an internal clarification on the relevance of CE and CBMs to the company, although some initial CBM ideas were also generated. Finally, at company F internal stakeholders were engaged in discussions on the relevance of CE and CBMs to the company and generated initial ideas for CBMs. The innovation process also led to the integration of CBM principles in a revised product development guide and specific CBMs were explored further through collaboration projects with external stakeholders. A business model to extend the life of electronic products to slow resource loops, was, for example, explored by the company together with an industry association.

Findings regarding the use of different tools

In the CBMI processes in the case companies, tools from the prepared CBMI toolbox (cf. section 3.1.2) were applied along with general innovation tools. The toolbox consisted of the following tools:

- CE system diagram: The system diagram is illustrated in Figure 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 visualising 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, 2013a). They were included in the toolbox to demonstrate what dimensions could and should be considered in relation to new CBMs.
- Best practice exemplars of CBMs: A case collection of CBMs in operation (see Guldmann, 2016). The idea was to provide relevant and inspiring examples to engage companies in the CBMI process, a method utilised in earlier research to facilitate sustainable business thinking (e.g. Bocken *et al.*, 2013; 2015).
- Circular canvas. A business model template like the business model canvas in Figure 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.

The six innovation processes were unique, depending on the company setting, but shared some common features: All processes were facilitated by external actors (i.e. the researchers) and all case companies were new to CBMI. This meant it was necessary to 1) introduce the company to the researchers including its experience with sustainable business development so far, which was attained through formal company presentations and a close dialogue and 2) introduce CE and CBMs to the case companies. The CE and CBM concepts were typically introduced to the case companies by utilising the system diagram, the CBM principles and best practice exemplars described above.

At later stages, the researchers would come back to some of these tools, and the system diagram, for instance, became a tool for idea generation, clustering of ideas (in the form of an idea map), or inspiration for new CE narratives. Similarly, best practice exemplars were now introduced by the researchers, not to kick-start the innovation process, but rather to provide support for a given idea or to challenge the case company to, for instance, consider developing a more ambitious CBM or contemplate particular dimensions of the CBM idea.

Through iterative examinations of 1-2 business model ideas the general configuration of the business model along with the specifics of individual business model elements were gradually clarified. We expected that a visual representation of the business model (like Figure 2) would be needed to support and organise

this work. Nevertheless, the company participants that were involved in the CBMI were experienced business people. They were closely acquainted with the need to consider key elements of a business model idea to ensure its success, for example, 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 quite naturally whether a given CBM idea fitted company values, image, and aspirations. Consideration of business model elements hence effortlessly permeated the discussions during the CBMI process, which meant a visual representation of the business model was not needed at the early stages of CBMI that were studied. A circular canvas or a similar visual business model template may, however, be relevant at later stages of the innovation process, as a checklist to ensure relevant elements of the CBM have been considered; or in cases where company participants are less familiar with the business model concept.

The CBMI toolbox proved flexible in use and, as Table 4 shows, the CE system diagram, the idea map, the CBM principles and best practice exemplars were applied successfully in most of the case companies. An 'x' in the table 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. Only the circular canvas proved redundant as outlined earlier, but was instead replaced with effortless discussions of the associated business model elements, which is reflected in the table by the addition of a 'Business model elements' column.

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. This type of techniques to support an innovation process, are part of the general DT framework (cf. Table 1) and can be found under the headlines of ethnographic research techniques; sense-making and ideation tools; prototyping and testing approaches; visualisation techniques; and co-creation approaches. These techniques were also found to be relevant in a CBMI context and were applied ad hoc, as appropriate.

Findings regarding spaces of the innovation processes

Exploratory, ideation and prototyping and testing spaces

The data analysis of the innovation process in each of the case companies revealed that, although each process was unique, the three original innovation spaces - the exploratory, the ideation, and the prototyping and testing spaces - were observed in all the CBMI processes, although the aim and activities of these spaces changed a little in the CBMI context.

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, not only a phase where more than 100 ideas and concepts for CBMs were generated across the companies, but a phase of also 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

Case company	CE system diagram	Idea map	CBM principles	Best practice exemplars	Circular 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 4: Application of CBMI-specific tools in the case companies

testing ideas in relation to the entire stakeholder group (i.e. the involved network of organisations) of a given CBM, as opposed to the narrower focus on the users in the general DT framework. The data analysis also revealed that the general framework did not fully capture the way in which the CBMI processes unfolded.

Introductory space

As indicated in section 4.1 an introduction of the company participants to CE and CBMs, together with an introduction of the companies to the researchers, was needed to kick-off the CBMI process in the companies. The introduction to CE and CBMs was oriented at making clear the fundamental principles behind these concepts and at creating a common vocabulary for the participants in the innovation team. A similar introduction is argued for by Bocken *et al.* (2013) in the context of a value mapping tool for sustainable BMI, where the authors note an introduction on sustainability may precede the BMI activities depending on background knowledge of participants. Such a starting point may be more broadly formulated as a joint vision for future collaborative CE work (Brown *et al.,* 2019).

However, the general DT model does not include such an innovation stage; consequently, an *introductory space* was added to the CBMI framework to more appropriately mirror the CBMI processes. The innovation process started from this space and iterated back through it, when new internal or external stakeholders got involved in the CBMI process, since these new stakeholders also needed to understand key concepts and principles associated with CBMs and had to be introduced to the vocabulary used by the other participants in the innovation team. The introductory space was also revisited when a recapitulation of key CE and CBM principles was needed for the innovation team to stay on track. For instance, if idea generation regressed into a discussion of sustainable inputs or resource efficiency (i.e. a narrowing of resource loops), disregarding the need for more advanced solutions such as slowing resource loops, participants were challenged to also consider more advanced forms of CBMI to slow resource loops, for example by focusing on reuse, repair and remanufacturing (Bocken *et al.,* 2016).

In cases where 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 stakeholders in the organisation get acquainted with CE and CBMs and their 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 by external stakeholders.

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 to clarify the company's position on CE in the larger companies (i.e. D, E, F) alongside the CBMI activities. These clarification activities are conceptualised as a separate innovation space, an *alignment space.*

In this alignment space, the company participants 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 contact 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 contact 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 company contact 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 to approach CE proactively or not. None of the companies

found that their customers asked specifically for CBMs, which was interpreted by employees in some of the larger companies as a signal that it was not necessary to integrate CBMs in the business yet. Communiqués on the CE by the European Commission nevertheless caught the attention of several of the larger companies. A company participant 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 have 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 strategic agendas in the companies, which we return to below, the progress in the alignment space was slow in the larger companies and this phase took up considerable time and energy in these companies (i.e. D, E and F). One possible explanation for the slow progress in this space is the fundamentally new business logic of CBMs compared to the dominant linear value creation logic (Chesbrough, 2010; Evans *et al.*, 2017) and the way the CBM challenges the existing organisational, technological and industrial structures that companies are locked into (Unruh, 2002; Doganova and Karnøe, 2012).

The alignment space was different in the smaller companies (i.e. A, B and 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 on-going 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 with lower prices for sustainable apparel, and that CBMs could potentially help the company to stay ahead. CBMs were thus perceived as a chance to leverage on-going projects or company aspirations in the small companies and they did not need further validation of the relevance of CBMs 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. on-going projects and pre-existing strategic

	Spaces covered and objectives fulfilled					Other outcome	
	Introductory	Exploratory	Alignment	Ideation	Prototyping and testing		
Case company	Introduction to CE and CBMs	Exploring CBM opportunities in the specific setting	Investigating alignment btw. CBMI and extant aspirations	Generation of multiple CBM ideas	Examination and development of CBM ideas	CBM implementation	Continuation of CBM work
A	x	x	(x)	x	x	-	-
B	x	x	(x)	x	x	x	x
C	x	x	(x)	x	x	(x)	x
D	x	x	x	x	x	-	(x)
E	x	(x)	x	(x)	-	-	x
F	x	x	x	x	(x)	-	x

Table 5: Cross-case comparison of the innovation process

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 on the pre-existing strategic agenda emerged as relevant to integrate with the CBMI: An aspiration for more modularisation in the product design and predictive maintenance to cater to unmet customer needs, for example.

The innovation process varied between the companies, as explained earlier. However, the companies moved through all or most of the innovation spaces, 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. This is summarised in Table 5, where 'x' indicates that yes, the space was covered/the goal attained; '(x)' indicates this was partly the case; and '-' indicates this was not the case.

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 emphasised as important guidelines (Liedtka, 2015). However, a wider system perspective is called for in the CBMI context (Ellen MacArthur Foundation and IDEO, 2016; Evans *et al*., 2017; Geissdoerfer *et al*., 2018a). A perspective that considers the needs of value chain stakeholders and the environment (in the form of slowing, intensifying, dematerialising, closing and narrowing resource loops) in addition to users' needs. This requires companies to be open to collaborations with external in addition to internal stakeholders.

Indeed, multiple stakeholders from within and across all the companies that will be involved in operating a new CBM must be included in the innovation process at some stage (Geissdoerfer *et al*., 2018a), because no single function and no single company holds all the knowledge and competences necessary to do systemic innovation. In our study, it proved difficult to include external stakeholders, 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] prefers not to talk to their customers, salesmen or fashion experts. The company believes it could potentially backfire if the concept is not implemented. In that case, the network will get disappointed and demotivated."

It seemed an internal orientation was needed, initially, in some of the case companies to allow for organisational alignment and a relatively safe learning space to understand how to manoeuvre the CBM innovation journey (Van de Ven *et al.*, 1999; Van de Ven, 2017). Companies B and D opened up to collaboration with existing value chain partners early in the process, whereas companies 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 stakeholders such as industry associations and other universities (company F) or engaging in dialogue with companies from other industries with experience in CBMI (company E).

The two last guidelines of the general DT framework, 'iterative cycles of moving through innovation spaces' and 'emphasise learning', remained relevant in their original form.

Towards a comprehensive framework

The general and the CBMI-specific tools that were applied in the study have been organised according to the spaces in which they were utilised (at one or more case companies) in the overview in Table 6. The table also illustrates the two new innovation spaces that were derived from the data and summarises the adapted guiding principles and aims of the spaces. The framework has been developed into a visually engaging tool for CBMI that can be found in the appendix.

Design thinking aspects	Key points				
Guiding principles	• Systemic perspective • Collaboration across functions, perspectives and experience bases inside and outside the organisation • Iterative cycles of moving through innovation spaces • Emphasise learning				
Innovation spaces	Introductory space	Exploratory space	Alignment space	Ideation space	Prototyping and testing space
Aim of spaces	Determine company setting including basis for CBMI. Present CE and CBM principles. Inspire action	Explore CBM opportunities in the specific company setting	Investigate alignment between CBMI and extant strategies and aspirations	Generate multiple CBM ideas. Seek higher-order thinking and systemic solutions	Examine CBM ideas and develop best ideas further
Tools and techniques for individual spaces	Communication tools: • Company presentation • Presentation of CE and CBMs using system diagram, CBM principles and best practice exemplars	Communication tools: • Presentation of CE and CBMs using system diagram, CBM principles and best practice exemplars Ethnographic research techniques: • Dialogue/interview with internal and external stakeholders e.g. existing/new customers or suppliers • As-is mapping e.g. using an idea map or circular canvas	Communication tools: • Company presentation including strategic agenda and aspirations • 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 stakeholders to investigate alignment between CBMI and extant strategies and aspirations	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 circular canvas	Prototyping and testing approaches: • To-be mapping e.g. using an idea map or circular canvas • Prototyping techniques such as scenario building • Assumption surfacing and testing e.g. by asking challenging questions • Testing ideas with internal and external stakeholders through e.g. interviews • Evaluating ideas e.g. against CBM principles and best practice exemplars • Assessing what resource loops are targeted by a CBM e.g. using an idea map • Field experiments e.g. small-scale market tests
Tools and techniques that span spaces	Co-creation approaches: • On-going dialogue between knowledge experts (e.g. researchers) and company participants • Engaging internal and external stakeholders (e.g. customers and existing/new value chain partners) in generation, development and testing of ideas Data collection and analysis techniques: • Dialogue, interviews, observation, desk research etc. • Competitor analysis, economic calculations, trend analysis etc. • Considering design and viability of business model elements (as illustrated in the circular canvas) • Considering overall fit between CBM ideas and image, resources, values, aspirations etc. of the company Visualisation techniques, visual or narrative: • CE system diagram • Idea map (e.g. with Post-it notes) to cluster and visualise ideas • Storytelling about new kinds of customer experiences, new company roles • Storytelling inspired by best practice exemplars				

Table 6: Design thinking framework for CBMI

It should be emphasised that neither all the CBMI-specific tools (e.g. the system diagram) nor the generic tools for supporting innovation (e.g. customer interviews) were equally relevant in each case. The tools were adjusted in a flexible manner to fit the individual case company setting (similar to the actors involved, the tempo, the order of innovation spaces, the meeting and workshop formats etc.).

BMI is a complex and lengthy process, and Chesbrough (2007) advocates that two to three years is too little time to "develop business-model experiments, obtain clear results, interpret and understand the results, and then carry out a broad deployment of those results" (Chesbrough, 2007, p.17). Arguably, this is particularly the case in CBMI in which a fundamentally new, circular, business logic is *also* introduced and has to be integrated in the business models that are crafted.

In these circumstances, the results attained during the typically two years that we collaborated with the companies are deemed satisfactory: All case companies started to discuss the relevance of CBMs and generated CBM ideas, and all except case company E created CBM experiments, acquired results from the experiments, and interpreted those results to decide on follow-up experiments. Notably, most companies have continued the CBMI work in some form after the research collaboration ended, and a few companies have moved on to CBM implementation or preparations hereof. Overall, these results indicate the framework was a relevant means of introducing the companies to CBMI, inspiring action and supporting the innovation process towards CBM development and implementation.

Conclusion

This exploratory study examined how DT can support the CBMI process. To this end, we experimented with the application of different tools within a DT framework using action research. Based on this, four main contributions are made to the literature: the development of a DT framework for CBMI (cf. Figure 4); deeper insight into the use(fulness) of DT for CBMI and identification of gaps and opportunities within this field; further insight in tool development and use for CBMI more generally; as well as exploring the process stages and activities involved in CBMI.

With respect to the first contribution, which involved the development of a DT framework for CBMI, two new innovation spaces, the introductory and the alignment space, are suggested to complement the common exploratory, ideation, and prototyping and testing spaces of DT to appropriately accommodate the CBMI context. The framework proposes guiding principles for the CBMI process that expand the focal point from users and cross-organisational collaboration to systems and value chain collaboration. It furthermore outlines the aims of the innovation spaces and the associated core activities. Finally, the framework comprises a CBMI toolbox (in the form of a system diagram, an idea map, CBM principles, best practice exemplars and business model elements) that is complemented with innovation techniques of a general character to apply throughout the innovation process.

As for the second contribution related to the use of DT for CBMI, we studied the CBMI process from CE was first introduced in the companies and the subsequent six months to two years, which is little time for the complex innovation task of developing new business models (Chesbrough, 2007), particularly circular ones. Against this backdrop, the results in the case companies are encouraging and indicate that a DT approach to CBMI is indeed relevant, which confirms similar results from the broader field of sustainable BMI, where DT was also found to be useful (Geissdoerfer *et al.*, 2016; Baldassarre *et al.*, 2017).

The third contribution relates to the developed design thinking framework for CBMI, and its suggestions for guidelines, tools and techniques to apply (in individual innovation spaces as well as across spaces). This responds to calls for more instruments to support the CBMI process (Antikainen and Valkokari, 2016; Blomsma and Brennan, 2017). The presented tools and techniques were applied during the CBMI process in six case companies and derived results towards the creation of new CBMs, which means their utility has been illustrated in practice for a small group of case companies. However, more research is needed to determine if the framework and its instruments are relevant in a wide range of organisational settings as the results so far indicate.

The final contribution to the literature is the exploration of a process perspective on CBMI delineated by the

innovation spaces of the framework and the core activities involved in these (cf. aims of spaces). Such deeper understanding of the innovation process is needed in relation to BMI more generally (Chesbrough, 2007; Foss and Saebi, 2017), as well as in relation to sustainable and circular BMI (Antikainen and Valkokari, 2016; Geissdoerfer *et al.*, 2018b).

The relevance for practice from this research is related to an improved understanding of the CBMI process that can assist innovation managers and business developers in manoeuvring this challenging type of innovation process, by providing an overview of the innovation spaces and the associated activities. The developed framework describes a number of concrete tools (e.g. an idea map and CBM principles) that can be applied by practitioners to facilitate innovation at different stages of the CBMI process and offers some overall principles (e.g. strive for internal and external collaboration across functions and emphasise learning).

In terms of limitations, since CBMI is a rather new research field it remains under-explored and therefore this study is mainly explorative and descriptive of nature (de Groot, 1969), with an attempt to formulate the beginning of an explanation for some of the observed phenomena. It is expected that some of the findings can serve as relevant propositions for further research in follow-up studies.

This research focused predominantly on front-end CBMI and the framework has consequently not been sufficiently tested in relation to later stages of the CBMI process such as market testing and full-scale implementation of CBMs and may need to be modified to encompass these stages appropriately. Furthermore, a reinforced involvement of external stakeholders, as well as of internal stakeholders in the large companies, would seem beneficial, which may require the development of sub-processes and workshop formats specifically targeted at supporting such inter- and intra-organisational collaboration. Insights from the open innovation literature on networked production organisations and consumer communities would seem relevant to study further in this respect (e.g. Chesbrough and Crowther, 2006; Laursen and Salter, 2006; Romero and Molina, 2011). Moreover, the type of CBMI pursued (e.g. CBMs for slowing or closing resource loops) as well as the tools used were influenced by the engaged research approach, deemed necessary at the time of the research when the CE concept was still highly new to most organisations, but will have had an impact on the development and focus of the CBMI framework and tools.

In this paper, we have pointed towards the need to align CBMI activities with extant organisational strategies and aspirations (in the alignment space) and touched upon differences between the innovation process in the small and the large case companies. More research is, nevertheless, needed to examine interrelations between the specifics of the organisational as well as industrial, societal, and institutional setting and a suitable configuration of the CBMI process. Such examinations constitute an area currently under-researched within the wider BMI literature (Foss and Saebi, 2017) and only few steps (e.g. Guldmann, 2018; Stål and Corvellec, 2018; Guldmann and Huulgaard, 2019) have been taken to examine this in relation to CBMI (Geissdoerfer *et al.*, 2018a).

Appendix

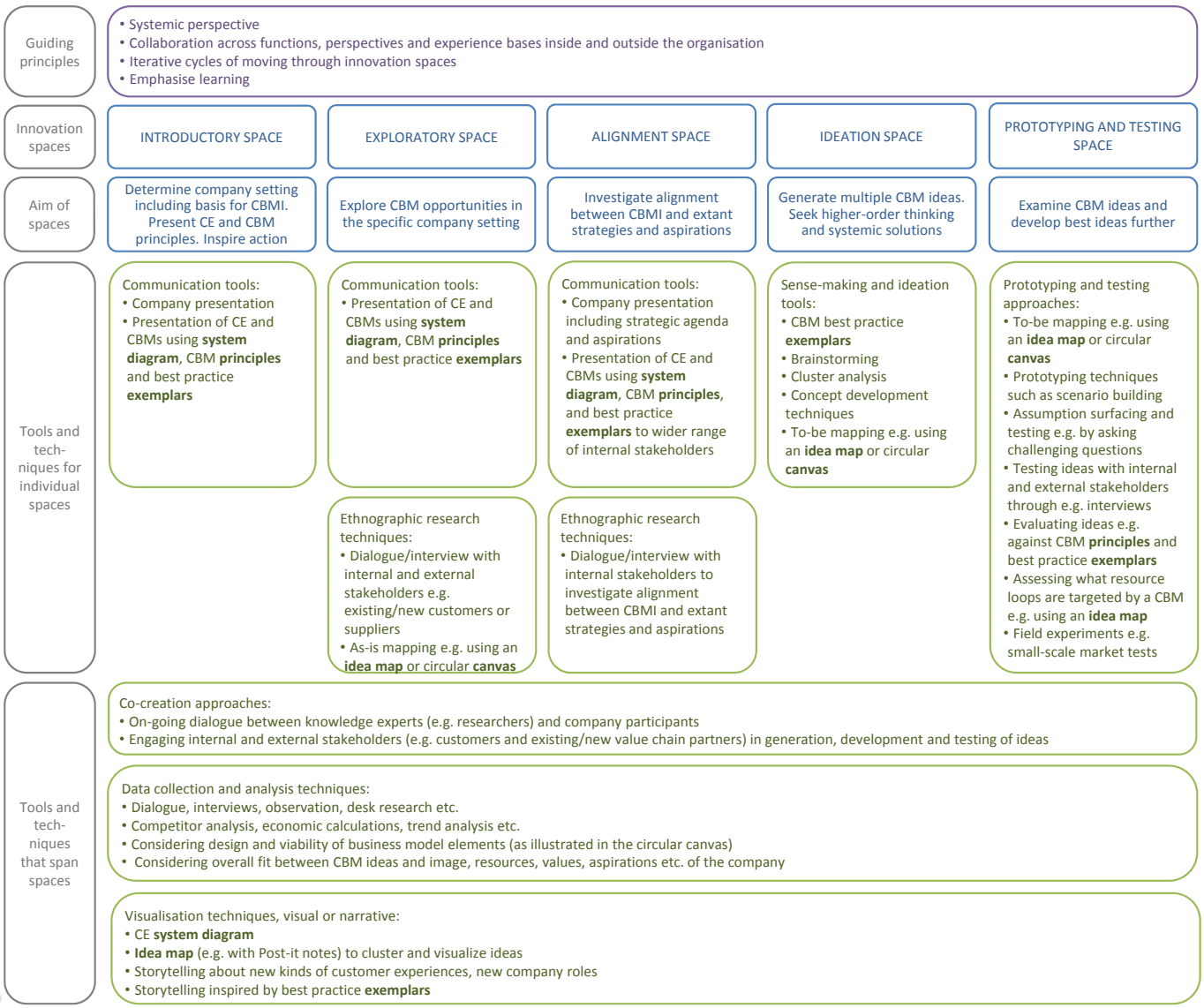

Figure 4: Framework and tools for CBMI developed in this research

In the figure, tools from the developed toolbox (cf. section 4.2) are marked with a bold font, whereas general innovation techniques that were found useful for supporting the CBMI processes are not bolded.

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