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Review

A Review and Evaluation of Circular Business Model Innovation Tools

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Abstract: The circular economy has been heralded as a potential driver for sustainable development by business, academia, and policymakers. In a future circular economy, new business models are needed that slow, close and narrow resource loops to address key resource and climate challenges. After a phase of excitement and inspiration, an operationalization phase needs to start to ensure the best possible implementation and transition towards a circular economy. This operationalization phase will involve the development of products, processes and business models that significantly lower the negative impact on the environment, reduce waste and resource pressures and, rather, create a positive impact on society and environment. This paper focuses on the circular business model lens as a comprehensive way of addressing business innovation. Within this evolving circular economy operationalization phase, several tools, approaches and methods are emerging that could support circular business model innovation. This paper seeks to create a comprehensive tools overview through a literature and practice review. It provides structure to the emerging range of tools, methods and approaches, and, based on this, a guideline for future tool development. Finally, it gives an overview of opportunities and gaps as well as a future agenda for research and practice.

Keywords: circular economy; business models; literature review; practice review; business model innovation; innovation tools; circular business model tools; product service systems; PSS; circular business model experimentation

1. Introduction

Sustainability has long been recognized as a core issue, as well as an opportunity, for businesses [1–3]. It has been argued that more radical approaches beyond product and process redesign, such as the move towards new product-service combinations and business models, can lead to higher environmental gains [4–8]. The circular economy (CE) is an alternative paradigm to the current 'take-make-dispose' linear economy to help slow, close and narrow resource loops [9,10]. With nascent roots in the 1960s [11–14], the CE paradigm has been popularized in the past decade, entering policy and business debates [12,15,16]. New circular business models (CBMs) have been heralded as a potential driver for CE transitions [12,17]. CBMs contribute to the slowing of resource loops by encouraging long product life and reuse of products, closing loops through capturing the residual value from by-products or "waste" through business model innovation, and narrowing resource loops through product design and manufacturing efficiencies [9]. However, CBMs are not yet widespread in business practice because of the need to change the key building blocks of the business, as well as the need to go against dominant business paradigms [18,19].

After a period of 'excitement' about the CE paradigm, it is time to start 'operationalizing' the CE concept [11] in a way that it lives up to 'sustainability expectations' [10,20,21] and avoids negative side-effects [22]. This requires change at the citizen, business and policy levels [12]. In this paper, we focus on the *business* level predominantly (recognizing that this level is intertwined with consumers and policy) by identifying CBM tools and approaches as a way to support operationalization of the CE [23].

To support the business model design, it has been recognized in management literature and practice that the innovation process requires "structure and guidance to frame and focus thought" [24]. To provide guidance in the process of circular business model innovation (CBMI) and help business developers overcome the challenges experienced when designing and innovating business models towards circularity [25,26] (e.g., communicating offers, optimally arranging reverse logistics and addressing time delays between product availability and demand), a broad variety of methods and tools have been developed [7,23,27–31].

We argue that the infusion of tools in practice would benefit from an overview of the state of the art of CBMI tools, and an assessment of potential contributions of such tools in the business model innovation process. Research on tool development highlights that many tools are being developed but not used in practice, which may be due to the lack of transparency in the tool development process and limited (reported) testing with potential users of the tools [32,33]. Hence, this paper presents an overview of existing tools and methods for circular business model innovation. The overview seeks to provide structure to the landscape of tools and identifies promising tools to support practitioners in the CBMI process, using criteria developed in this research. These criteria are developed into a final 'tools checklist', which aims to support researchers and practitioners in future sustainability tool development.

The paper proceeds with a review of the relevant background literature (Section 2), a description of the methodology (Section 3), and the findings (Section 4). Section 5 presents the discussion and Section 6 presents the conclusions.

2. Background

2.1. Emergence of Circular Business Model Innovation

A business model broadly describes 'the way business is done' [34] by illustrating how a business proposes, creates and delivers and captures value [35] for the business, customer and wider group of stakeholders [36]. As such, it provides a 'systemic lens' to investigate businesses and the ways they operate [37]. A business model is typically depicted by a value proposition (product/service offering), value creation and delivery (how this value is provided e.g., through activities and sales channels) and value capture mechanisms (how money is made and other forms of value are captured) [34].

Innovating the business model can take two broad forms, i.e., the design of an entirely new business model, or the reconfiguration of the elements of an existing business model [38] and is associated with increased competitiveness of companies [39]. Business model innovation can be thought of as an iterative process that consists of several phases (e.g., ideation, implementation and evaluation) [40] and involves different levels of detail (e.g., changes at a conceptual level to changes in operational practices) [41].

The concept of value is central to business models. In traditional management literature, value refers to the value captured for the firm [42], its customers [34] and stakeholders such as shareholders [38]. In today's economic system, negative externalities of production and consumption practices are insufficiently incorporated in prices and many potential value creation opportunities of businesses are wasted, missed or destroyed [43]. Literature on sustainable business models highlights the need for a broader understanding of value, including the benefits and costs to other stakeholders beyond the firm and its customers, specifically to society and the environment [43,44]. As such, sustainable business models (SBMs) integrate economic, environmental and social aspects of

sustainability into the purpose of an organization, at the firm and at network levels [45,46], and use a triple bottom line (people, profit, planet) approach in measuring performance [47].

A multitude of sustainable business model archetypes has been identified in the literature [9,19,47–50]. One type of a sustainable business model is a circular business model (CBMs) [10,43]. The concept of CBMs builds on the research field of business models [34,41,51,52], and research fields such as those on closed loop value chains [53,54], product service systems (PSS) [5] and industrial ecology [55–57]. These fields have since long recognized the importance of tracing material flows to reduce environmental impact while 'creating value from "waste"' [55–57], and the environmental and economic opportunities associated with optimizing the use intensity and longer use of products [5]. CBMs focus on slowing, closing and narrowing loops to maintain the embedded economic value for as long as possible, reduce environmental impacts and deliver superior customer value [21,27,49]. To embed circular practices in the business model, firms can design products for longevity [58], provide offers aligned with preserving product integrity [59,60] or recover material resources at end of life (i.e., recycling, industrial symbiosis) [30,61]. Yet, firms wanting to capitalize on circular practices must adopt an innovation perspective that goes beyond the direct supply chain needed for the production of products to consider networks for multiple cycles of value creation as well as disposal when the end of life is irreversibly reached [30].

The process of circular business model innovation (CBMI) in this paper is understood as innovating the business model (i.e., updating the elements of an existing business model, or establishing a new organization and associated business model) to embed, implement and capitalize on circular economy practices. Such practices may focus on different aspects of the circular economy, such as product durability and design for product life extension to slow resource loops, and recycling approaches to close the loop [9]. CBMI requires an iterative process of several phases (e.g., ideation, implementation and evaluation) [40] and can result in different degrees of innovation (e.g., a new activity added to a business model vs. a comprehensive change in various business model elements). By rethinking how a company creates, delivers and captures value, business model innovation can be a holistic approach to align the value creation logic of a company with circular principles. Particularly in established firms, CBMI is related to trialing and testing a variety of models to assess their suitability but is also about setting in motion internal changes within the organization, through engaging stakeholders internal and external to the firm [62].

With recent developments in policy, fueled by organizations such as the Ellen MacArthur Foundation, CBMs have become more prominent as a way to achieve greater levels of sustainability [5,12] and tackle ever more pressing climate change impacts [63] while contributing to firm competitiveness and broader socio-economic issues [12]. However, to this date, the uptake of CBMs is slow [11,18] and more research is needed to understand which tools and methods can provide effective support for companies in their transition towards CBMs.

2.2. Towards Tools for Circular Business Model Innovation

Circular business model innovation (CBMI) is a relatively recent field, with most tools and methods to support the business model innovation process only having recently emerged. However, in the fields underlying the CBM concept (Section 2.1), a plethora of tools and methods has been developed. Work on eco-design and innovation tools, for instance, has been popular for a few decades [32], with many contributions focusing on design for X, where X refers to various strategies such as recycling and reuse [64,65]. Later, many tools and approaches to support the design of (sustainable) PSS became prominent [8,66]. Over the past decades, an increasing number of 'sustainability tools' for business model design [67] have been suggested [32].

Generally, tools take the form of guidelines (e.g., little detail but broadly applicable such as sustainability standards by the International Standards Organization, ISO), checklists (in-depth, but narrow, with application at selected stages of the product development) or more analytical tools (e.g., providing detailed and/or systematic analysis at specific stages of the product development process, such as life cycle assessment) [68,69]. They may cover one or multiple aspects of the product

lifecycle [70] and can be qualitative or quantitative in nature [71]. Tools tend to focus on conceptual design, ideation and supply chain involvement as well as integrating stakeholder, customer and managerial concerns [67].

Despite the plethora of tools, research indicates that tools that fit company needs and expectations well are scarce [70]. Many popular generic tools and approaches (e.g., business model canvas by Osterwalder and Pigneur [72] or the lean startup approach by Ries [73]) appear to be used flexibly in practice, but without a specific focus on CBMI. However, without adequate facilitation, the widespread use of these more generic tools may also 'dilute' the focus on sustainability or the circular economy [33,62] and result in more conventional business cases lacking a clear positive environmental or societal impact. On the other hand, many tools specifically developed for sustainability or circularity innovation purposes, unfortunately, remain unused [32]. This may be due to the fact that they have not been tested empirically and did not include users (most importantly business developers in companies) and their needs in the CBMI process [32]. Furthermore, tools may be too complex or demanding in terms of time commitment and number of steps in the process, or too context-specific (see tool requirements in [34]). It is perhaps not surprising that tools such as the business model canvas by Osterwalder and Pigneur [72] or the lean startup approach by Ries [73] are so popular because initially, they look simple and generic, i.e., adaptable to various contexts. Finally, tools seem to be developed within a particular discipline (e.g., engineering, business, design) [32], but fail to learn from beneficial interdisciplinary insight that could support the usability of tools. As an example of work trying to integrate different disciplines, design science has become more prominent in sustainability business-oriented tools, by specifically using a stakeholder and user perspective [74,75], using techniques from design science such as prototyping [76], and, more generally, testing tools with users iteratively in practice [74].

2.3. Tools for Circular Business Model Innovation: Gaps and Opportunities

A number of tools are emerging that focus specifically on business model innovation for circular economy practices. Often tools on CBMI build on approaches from traditional management literature. For instance, a number of business model visualization and mapping tools have been suggested that build on the Business Model Canvas by Osterwalder and Pigneur and emphasize the notion of 'value creation' [23,30,72,77–79]. Popular innovation approaches, such as effectuation (learning from entrepreneurial practice) [80] and lean start-up (focusing on trialing new ideas in practice in a fast and iterative way) [73], have been used as building blocks for recent approaches to CBMI [81,82]. Many other tool types that focus on ideation for CBMs are also emerging, such as serious games [83,84], case databases [85] and typologies [61].

To support the effective adoption and further development of CBMI tools in practice, first, a clear overview of the state of the art of tools and their potential contribution in the business model innovation process is needed. For eco-design tools, several reviews have been conducted (e.g., [32,67,71]). These reviews focus on evaluating tools according to two dimensions: *tool purpose*, which describes the type and purpose of the tool (e.g., checklist, analytical [68]; nature of the tool (e.g., qualitative, quantitative) [71]), and *tool form and characteristics* (e.g., diagrams or computer-based tools [70] and evolution of tool development over time e.g., [86]).

To the best of our knowledge, only one review to date focuses on tools and approaches that have been suggested for CBMI [87]. However, to begin 'operationalizing' the CE [11], there is a need for a further thorough investigation of tools, in particular because many sustainable innovation tools are developed, but they are not used in practice [32] and there is a risk that 'generic tools' (e.g., [72,73]) might not lead to CBMs with a clear environmental impact [88]. Furthermore, clear methodological approaches and assessment of tools often lack, even for those developed within academia [89]. Hence, we seek to identify and investigate promising tools with the potential to support CBMI in practice that have been developed in a rigorous and transparent manner through 'empirical testing' (i.e., iterations and deliberate learning and improvement) with the potential user. In addition, to support practitioners and their various objectives and business settings, we investigate additional tool characteristics, such

as targeted user group, and whether guidance on use and validation of the tool (suggested in design studies [74,76]) is available.

To address this gap, this paper develops an overview of tools for CBMI that provides structure to the landscape of tools and identifies 'good practice' CBMI tools. To do this, we describe the purposes and type of the selected tools, characteristics and form [68,70,71] and use and validation of the tool, extending earlier work in earlier reviews [87] by also emphasizing the use and validation of tools. Through screening and selecting existing tools according to a set of 'quality' criteria, we identify tools with a validated potential to support researchers wanting to develop future CBMI tools and practitioners interested in applying tools for CBMI.

3. Methods

The main objective of this study is to identify CBMI tools and their characteristics. In particular, and in contrast to previous reviews, this study centers on business model innovation and CE, with a focus on tools' rigor and validation, and aiming to address the gap of empirically tested tools [32]. Based on this overall objective, a systematic literature review was performed to identify publications offering CBMI tools. An extensive review protocol of tool selection criteria was applied to create an overview of existing CBMI tools. Figure 1 contains a visualized overview of the process, which is further explained in the following sub-sections.

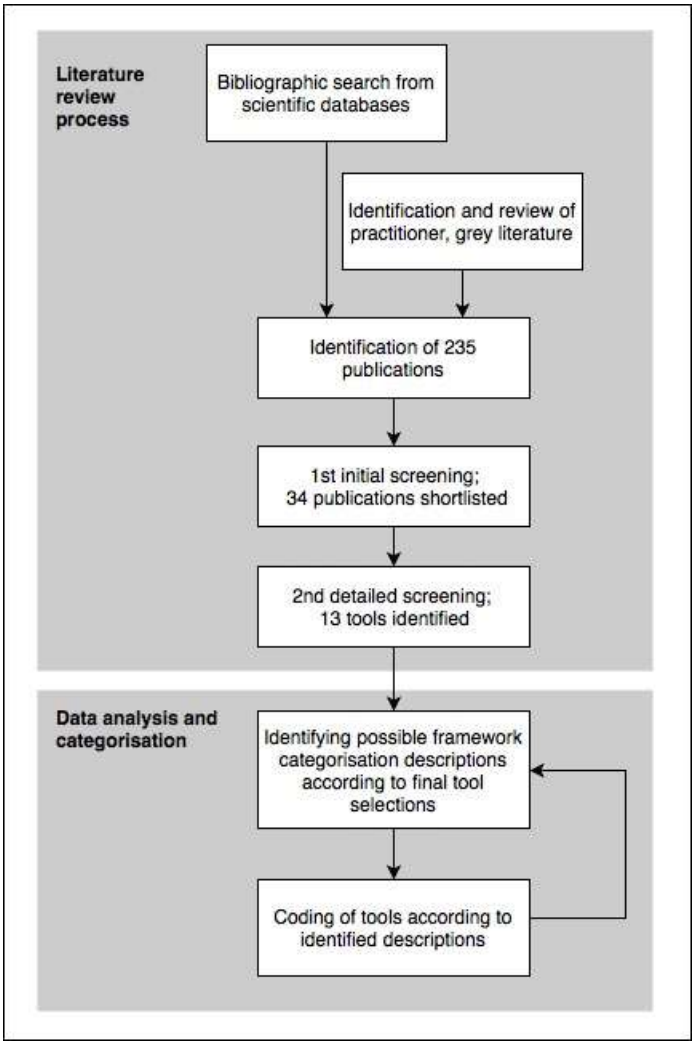

Figure 1. Overview of the literature review and analysis process used in this paper.

3.1. Literature Review Process

3.1.1. Identification of the First Set of Publications

Between November 2018 and January 2019, the authors identified publications related to CBMI tools through a bibliographic search. The review focused on publications in the peer-reviewed literature and was complemented by a review of tools from grey literature. Publications were first identified by searching in the two major academic databases Scopus and Web of Science, using a combination of keywords related to the circular economy (*circular, circular economy, resource efficiency, resource loops*) with keywords related to business model innovation (*business model, business innovation, innovation, product-service system*) and keywords related to tools, processes or methods (*tool, framework, typology, game, operationalise, implement*) (The Boolean combination of search words was ("circular" OR "circular economy" OR "resource efficiency" OR "resource loops") AND ("business model" OR "business innovation" OR "innovation" OR "product-service system") AND ("tool" OR "framework" OR "typology" OR "game" OR "operationalize" OR "implement") AND ("business").).

This broad search strategy was designed in line with the objective of the paper to create an overview of existing tools and methods suited for CBMI. Due to interest in CBM tools by practitioners and the relative immaturity of the field, the authors also conducted a complementary grey-literature review. For this, the authors reviewed practitioner-focused CE-related websites (listed in Appendix A) as well as materials from workshops, conferences, and courses attended by the authors. The grey literature review search was less structured than the academic database search, as information on CBMI tool development in practice is dispersed. However, the search built on the authors' experiences with tool development and knowledge of relevant CE initiatives and projects.

After identification and elimination of duplicates found across the bibliographic databases, in total, 235 (online) publications related to CBMI tools were identified. This total selection comprised 163 academic journal articles, 41 conference papers, 14 books and book chapters, 13 websites and online tools, three reports and one thesis.

3.1.2. Shortlisting of CBMI Tools through Two Phases of Filtering

In the next step, these 235 publications were further screened and shortlisted in two review rounds to identify tools that are in line with the scope and purpose of the paper as previously presented in Section 2.3. Table 1 summarizes the selection criteria for suitability that were applied in the two rounds of screening.

Table 1. Overview of tool selection criteria used while reviewing publications.

No.	Criteria	Explanation/Description	1st Initial Screening	2nd Detailed Screening
1	The publication must be relevant to CE/CE business models	The initial screening focused on a broad relevance to CE/ CE business models, and the second screening filtered out those not specifically developed for this purpose. Recent literature reviews have included various sustainable business (model) tools—however, as our focus is on CBM, we focus here on CE specific ones.	X	X
2	The publication is about a tool, process or method (in a broad sense)	We define a 'tool' to mean a set of prescriptive steps that is replicable and can be independently undertaken by practitioners to achieve a specific, intended outcome. In other words, a procedure or process on how to use the tool exists and this enables others to use it. Within this understanding, different forms of a tool are possible, including processes, frameworks, typologies, and board games.	X	X

Table 1. *Cont.*

No.	Criteria	Explanation/Description	1st Initial Screening	2nd Detailed Screening
3	The tool must be rigorously developed	The tool must be developed rigorously, building on insights from literature and practice.		X
4	The tool has been validated in practice, and this has been documented	To be considered 'validated in practice', the tool must be empirically tested and then documented in the publication. 'Thought experiments', or where the authors apply a tool conceptually to a case study themselves to illustrate how the tool could be used in practice are not considered validated in practice.		X
5	A procedure is ready on how others can use it	A procedure is available for use by others, so the tool can be used independently.		X

The shortlisting process showed that although a relatively large number of tools comply with criteria No 1 and 2 ("CE/CE business models" and "a tool, process or method"), only a small number meet criteria No 3 ("rigorously developed"), criteria No 4 ("validated in practice") and criteria No 5 ("procedure available") in Table 1. After the first initial screening and application of criteria, 34 publications containing tools remained. The second detailed screening identified a total of 13 publications about tools as suitable for further analysis. The longer list of 34 tools resulting from the first screening and reasons why these were excluded is provided in Appendix B. Table 2 presents the final selection of publications with tools that were shortlisted for further analysis.

Table 2. Shortlisted publications with tools for analysis.

No.	Authors	Year	Title	Reference
1	Antikainen M., Aminoff A., Kettunen O., Sundqvist-Andberg H., Paloheimo H	2017	Circular economy business model innovation process—Case study	[90]
2	Bocken N., Miller K., Evans, S.	2016	Assessing the environmental impact of new Circular business models	[91]
3	Evans S. and Bocken N.	2014	A tool for manufacturers to find opportunity in the circular economy	[92]
4	Haines-Gadd M., Chapman J., Lloyd P., Mason, J., Aliakseyeu, D.	2018	Emotional Durability Design Nine—A Tool for Product Longevity	[93]
5	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	[75]
6	Leising E., Quist J., Bocken N.	2018	Circular economy in the building sector: Three cases and a collaboration tool	[28]
7	Manninen K., Koskela S., Antikainen R., Bocken N., Dahlbo H., Aminoff A.	2018	Do circular economy business models capture intended environmental value propositions?	[88]
8	Mendoza J.M.F., Sharmina M., Gallego-Schmid A., Heyes G., Azapagic A.	2017	Integrating Backcasting and Eco-Design for the Circular economy: The BECE Framework	[94]
9	Nußholz J.L.K.	2018	A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops	[30]

Table 2. *Cont.*

No.	Authors	Year	Title	Reference
10	Pigosso D.C.A., Schmiegelow, A., Andersen M.M.	2018	Measuring the Readiness of SMEs for Eco-Innovation and Industrial Symbiosis: Development of a Screening Tool	[95]
11	Sinclair M., Sheldrick L.; Moreno M., Dewberry E.	2018	Consumer Intervention Mapping: A Tool for Designing Future Product Strategies within Circular Product Service Systems	[96]
12	Whalen K., Berlin C., Ekberg J., Barletta I., Hammersberg P.	2018	'All they do is win': Lessons learned from the use of a serious game for Circular economy education	[83]
13	Whalen, K.	2017	Risk and Race: creation of a finance-focused circular economy serious game	[84]

To ensure the accuracy of the screening procedure, all shortlisted publications were independently reviewed by the authors. This process was characterized by frequent meetings among all four authors to discuss the decision-making process and help align the interpretation of selection criteria. In each screening round, the publications were equally distributed between the four authors of this paper and checked against the selection criteria. This was followed by meetings between the authors to compare outcomes and reasoning during the decision-making. During the first and second screening, different authors were allocated to the publications. A 'final check' was done by yet another author, which followed by a meeting to create the final list of tools. At the end of the process, each publication had been evaluated multiple times and at least by three different authors in detail. More detail on the process and criteria adopted is provided in the 'Review Protocol' in Appendix C.

3.2. Data Analysis and Categorization

In order to enable easier comparison against each other and give structure to the emerging landscape of CBMI tools, the identified 13 tools were analyzed according to a framework that was compiled from literature previously identified in Section 2.3. The framework comprises four main categories:

- Tool purposes
- Tool characteristics and form
- Tool user group
- Tool validation

For each category, a number of initial sub-categories and examples were developed based on earlier tool reviews (e.g., [67,70,71,87]) and business model innovation literature (see Table 3). In the purpose category, the CBMI stages have been adopted from the business model innovation phases "initiation, ideation, integration, and implementation" in Frankenberger et al. [40] and the more generic build, measure, learn cycle by Ries [73], which has previously been applied to large businesses experimenting with new business models [82,97]. Following a content analysis of the tools, the framework was iteratively fine-tuned. This process was characterized by frequent discussions and check-ins among the authors. Table 3 displays the final framework to analyze the selected 13 tools.

Table 3. Framework for tool analysis [1].

Main Categories	Sub-Categories	Examples
Purpose	Circular business model innovation stage	Ideate and design; implement and test; evaluate and improve
	Intention/Focus	Training; decision-making; educational
	Scope	Single firm perspective; value chain/ecosystem perspective
Characteristics and form	Complexity	single tool; a portfolio of tools
	Form/type	Typology; maturity model; canvas; workshop; game; database of cases
	Nature of data	Quantitative; qualitative
User group	Target user scope	Single company or organization; multiple companies or organizations
	Target actors	Students; policy/government; large business; SME; academic; other
Validation	Application in practice	Conceptual; tested with multiple users after the initial version
	Test group	Students; practitioners; academics

[1] Developed from business model innovation literature (e.g., References [40,73]), and drawing on earlier tool reviews e.g., References [67,70,71,87]).

4. Results

This section presents the main results of the analysis. The focus is on the purpose and form of tools (Section 4.1), as well as the target user group and validation (Section 4.2).

4.1. Purpose and Form of the Tool

Table 4 classifies the tools according to the three phases in the iterative CBMI process as previously discussed [40,73]. While ideate and design type of tools dominate the shortlist, a few 'multi-purpose tools' address two or even three phases of the CBMI process. The overview in Table 4 shows that there are CBMI tools that help companies implement and test, as well as evaluate and improve CBMI options. Although some tools were generic and designed to help a variety of firms identify new opportunities for capturing value based on circular economy principles [30,92,94], most tools focused on one particular aspect related to CBMI. For example, a few focused on product development and linking customer needs and wants to circular design strategies [93,96]. Others focused on interpreting environmental impact and circular business model propositions [88,91].

All tools were classified as qualitative, as none of the tools required entering numerical data or performing calculations. Furthermore, five tools were identified to take a clear value chain perspective, focusing on the steps from material acquisition to end of life [30,83,84,95,96]. Finally, the findings show the presence of a variety of different forms, such as tools that offer a process and conceptual framework, and others that focus on visually engaging formats, such as cards and games. However, besides the games which must be connected and applied to the real-world after the tool has been used [83,84], the remaining tools present step-by-step processes or (conceptual) frameworks that can be followed and used immediately in the innovation process. In fact, some tools, such as Nußholz [30] and Heyes et al. [75], build on more generic types of business model canvases (evolving from Osterwalder and Pigneur [72]) as part of the tool or process.

Table 4. Tool characteristics with regards to purpose, Circular Business Model Innovation (CBMI) phase [2], and form/type.

No.	Authors	Year	Title	Purpose	Ideate and Design	Implement and Test	Evaluate and Improve	Form/Type
1	Antikainen M., Aminoff A., Kettunen O., Sundqvist-Andberg H., Paloheimo H.	2017	Circular economy business model innovation process—Case study	Process tool to guide the overall business model innovation process	X	X		Process/framework
2	Bocken N., Miller K., Evans, S.	2016	Assessing the environmental impact of new Circular business models	Rapid circularity assessment to assess the potential environmental impact of new business model ideas for clothing retailers.			X	Structured table with questions
3	Evans S. and Bocken N.	2014	A tool for manufacturers to find opportunity in the circular economy	Guidance through a database of value creating opportunity areas for the circular economy and assessment tool	X		X	Online tool
4	Haines-Gadd M., Chapman J., Lloyd P., Mason, J., Aliakseyeu, D.	2018	Emotional Durability Design Nine—A Tool for Product Longevity	Helps to implement an emotionally durable design in the new product development process	X			Cards
5	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	Backcasting and Eco-design for the Circular economy (BECE) framework developed for the service sector (ICT) aiming to be user-centric	X	X	X	Process and framework
6	Leising E., Quist J., Bocken N.	2018	Circular economy in the building sector: Three cases and a collaboration tool	Collaboration tool for the building sector	X	X	X	Conceptual framework with a process
7	Manninen K., Koskela S., Antikainen R., Bocken N., Dahlbo H., Aminoff A.	2018	Do circular economy business models capture intended environmental value propositions?	Rapid environmental assessment tool to help companies refine their environmental value proposition			X	Conceptual tool with steps
8	Mendoza J.M.F., Sharmina M., Gallego-Schmid A., Heyes G., Azapagic A.	2017	Integrating Backcasting and Eco-Design for the Circular economy: The BECE Framework	Comprehensive CE tool with design elements	X	X	X	Process and frameworks
9	Nußholz J.L.K.	2018	A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops	Collaborative CBM mapping tool	X		X	Canvas tool
10	Pigosso D.C.A., Schmiegelow, A., Andersen M.M.	2018	Measuring the Readiness of SMEs for Eco-Innovation and Industrial Symbiosis: Development of a Screening Tool	Screening tool to support companies explore the potential for eco-innovation with a focus on IS and industrial symbiosis.	X			Screening tool

Table 4. *Cont.*

No.	Authors	Year	Title	Purpose	Ideate and Design	Implement and Test	Evaluate and Improve	Form/Type
11	Sinclair M., Sheldrick L.; Moreno M., Dewberry E.	2018	Consumer Intervention Mapping: A Tool for Designing Future Product Strategies within Circular Product Service Systems	Tool for creating future circular product strategies	X			Cards + process
12	Whalen K., Berlin C., Ekberg J., Barletta I., Hammersberg P.	2018	'All they do is win': Lessons learned from the use of a serious game for Circular economy education	Experiential learning game for educating about material criticality and CE	X			Game
13	Whalen, K.	2017	Risk and Race: creation of a finance-focused circular economy serious game	Finance-oriented CBM game	X			Game

[2] CBMI phases based on References [40] and [73].

4.2. Empirical Testing, User Involvement and Generalisability

Table 5 classifies the final 13 tools according to the target user, level of user involvement, and generalizability. All of the developed tools are targeted to businesses practitioners, while a few of them address additional use groups such as students and educators (e.g., [83,84]).

We emphasize that empirical validation is often very limited or completely lacking for the large majority of potential CBMI tools (Appendix B). Findings show that even among our elected shortlist, most tools have been tested with practitioners only with a limited number of workshops, or with students (e.g., [83,84]). Moreover, guidance on how to use the tools in practice is often missing, potentially undermining the more widespread use of tool among business practitioners. Sometimes such guidelines are published in a separate annex, or afterwards (e.g., [98]) these were only considered if easily identifiable in the publication. Furthermore, while nine out of the 13 tools are of a generic nature (i.e., suitable for different sectors), a few tools have specifically been developed for a certain sector (e.g., textiles).

Table 5. Tool characteristics in regard to testing, user involvement, and generalizability.

No.	Authors	Year	Title	Target User	Level of User Involvement Mentioned in the Publication	Generalizability
1	Antikainen M., Aminoff A., Kettunen O., Sundqvist-Andberg H., Paloheimo H.	2017	Circular economy business model innovation process—Case study	Business	Developed with three company cases and consumer involvement, then tested with a more complex pilot	Generic: based on multiple cases
2	Bocken N., Miller K., Evans, S.	2016	Assessing the environmental impact of new Circular business models	Business, clothing sector	Developed with one company case	Specific: Developed for the clothing sector
3	Evans S. and Bocken N.	2014	A tool for manufacturers to find opportunity in the circular economy	Practitioners of manufacturing companies, retailers or purchasers.	Developed from literature and iterative practice—e.g., 50 surveys, three workshops	Generic

Table 5. *Cont.*

No.	Authors	Year	Title	Target User	Level of User Involvement Mentioned in the Publication	Generalizability
4	Haines-Gadd M., Chapman J., Lloyd P., Mason, J., Aliakseyeu, D.	2018	Emotional Durability Design Nine—A Tool for Product Longevity	Business, designers	Multiple iterations including seven workshops to test concept and framework	Generic, focus on product longevity
5	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	Business, services, ICT	Applied in two workshops within one company	Specific: Service and ICT focused
6	Leising E., Quist J., Bocken N.	2018	Circular economy in the building sector: Three cases and a collaboration tool	Business, building sector	Three case companies and students validating tool	Specific: Developed for the building sector
7	Manninen K., Koskela S., Antikainen R., Bocken N., Dahlbo H., Aminoff A.	2018	Do circular economy business models capture intended environmental value propositions?	Business	Applied with three case study companies	Generic: Tested with multiple industries
8	Mendoza J.M.F., Sharmina M., Gallego-Schmid A., Heyes G., Azapagic A.	2017	Integrating Backcasting and Eco-Design for the Circular economy: The BECE Framework	Business, designers	Developed from literature, and tested with one pilot case	Generic, but testing limited
9	Nußholz J.L.K.	2018	A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops	Business	Developed from literature, triangulation on empiric cases, expert interviews, student workshops and tested with two pilot companies	Generic, but testing with business practitioners limited
10	Pigosso D.C.A., Schmiegelow, A., Andersen M.M.	2018	Measuring the Readiness of SMEs for Eco-Innovation and Industrial Symbiosis: Development of a Screening Tool	Business, specifically SMEs	six municipalities, involving 108 SMEs involved in developing and testing the tool	Developed for SMEs
11	Sinclair M., Sheldrick L.; Moreno M., Dewberry E.	2018	Consumer Intervention Mapping: A Tool for Designing Future Product Strategies within Circular Product Service Systems	Business, designers	Validation of the tool in three workshops	Generic
12	Whalen K., Berlin C., Ekberg J., Barletta I., Hammersberg P.	2018	'All they do is win': Lessons learned from the use of a serious game for Circular economy education	Students, business, government	Tested in three student workshops	Generic
13	Whalen, K.	2017	Risk and Race: creation of a finance-focused circular economy serious game	Business, educators, entrepreneurs	Tested with three student workshops	Generic, with PSS focus

5. Discussion

This research aimed to contribute to the popular field of the circular economy by providing an examination of circular business model innovation (CBMI) tools and to support current research and practice and future tool development. The process of CBMI tool collection led to a list of 13 tools. While many sustainability tools have been developed, it was found that only a few at present focus specifically on CBMI, despite the rising popularity of the CE. The variation in tools identified reveals

that scholars have attempted to 'embed circularity' within different phases of the business model development process. The final list of CBMI tools is comprised of processes or (conceptual) frameworks and tools that are predominantly qualitative in nature and processes or (conceptual) frameworks. Most tools have only been tested with a limited number of workshops or users, at least as documented in the papers. Furthermore, many tools lack comprehensive descriptions of how they can be used by others. Hence, the discussion focuses on insights to support future tool use. This is followed by contributions to research and practice and outlining limitations and future research.

5.1. CBMI Tool Development to Increase Uptake in Practice

The broad literature search found that there are many potential tools that could be applied to support CBMI—however, a significant number are quite generic and not specific to CE (e.g., [72,73]) and among the ones specific to CE, many do not fulfil the strict selection criteria applied (e.g., transparent development process and tested with users, see Appendix B). The analysis also revealed that tools could benefit from an interdisciplinary approach adopted recently by some authors (e.g., [74]), such as embedding design approaches in the business modelling processes [74,76]. Iterative (tool) development—including multiple tests with users—is also an important element in design research [98] and could increase the usefulness of CBMI tools and their future uptake. Considering that user validation and iteration is a key aspect emphasized in fields such as design science and practice [74], we highlight the importance of developing tools in collaboration and interaction with practitioners and embedding insight from across disciplines. While design science is one promising field to inspire tool development, it is expected that fields such as business studies and engineering [32] but also other further afield research disciplines such as biology could provide inspiration for tool development [99]. Finally, simplicity, the ability to drive business change, and adaptability to different contexts were identified as criteria for sustainability tools in earlier research [28],but are also echoed in the approaches to tool development examined in this research, where many tools were found to be generic, adaptable and easy to use.

Based on the selection criteria developed and applied in this paper, as well as insight from the literature reviewed in this paper, we developed a checklist for CBMI tool development, found in Box 1.

Box 1. Checklist for CBMI tool development.

Checklist for CBMI tool development

1. The tool is purpose-made for CBMI [62,82].
2. The tool is rigorously developed—from both literature and practice insights [43].
3. The tool is iteratively developed and tested with potential users [32,100].
4. The tool integrates relevant knowledge from different disciplines [75,76].
5. The final tool version has then been used by practitioners, preferably multiple times [32,100], and an evaluation of this process is done to assess tool use and usefulness [76,101].
6. The tool provides a transparent procedure and guidance on how others can use the tool [98].
7. Circular economy or broader sustainability objectives and impact are firmly integrated into the tool and safeguarded when tool application is facilitated by others than the tool developer [33,62].
8. The tool is simple and not too time-consuming [24,28,102].
9. The tool inspires or triggers (business) change [28].
10. The tool is adaptable to different (business) contexts [28].

These 10 criteria are aimed at guiding future research (and practice) contributions in CBMI tool development. Box 1 was developed for CBMI, but we argue that the checklist could be more widely applied to sustainability tool development. To this end, "CBMI" in point 1 in the checklist could be replaced with the broader term "sustainability-oriented innovation" as we see that the further guidance in the checklist is more generally applicable. Thus, although our checklist was developed to support CBMI, it is also potentially of use to a wider audience of sustainability tool developers.

5.2. Contributions to Theory and Practice

Despite the plethora of sustainability-oriented tools [32], few reviews of CBMI tools have been developed to date. We add to existing research by developing a shortlist of CBMI tools based on the tool quality criteria developed in this paper and give insight into the different characteristics of existing CBMI tools. Based on these insights and former 'tool literature' we developed a checklist for future researchers and practitioners in the field CBMI, but also for sustainability tool developers more generally. Thus, we seek to contribute to theory by connecting CBMI and sustainability tool development and responding to earlier research which highlights the deficiencies of sustainability tools [32]. To practice, we aim to provide a useful overview of existing CBMI tools, in particular of their purposes and relevance in the innovation process. For practitioners such as consultants in the broader CE field, we aim to provide a useful guideline on how to develop more rigorous tools that could benefit CBMI implementation.

5.3. Limitations and Future Research

The (C)BMI process is highly iterative, and as mentioned before, researchers have tried to find different 'entry-points' for tools in the process. In this paper, we adopted the generic phases of 'ideation and design', 'implement and test' and 'evaluate and improve' [40,81,82]. A limitation of this approach is that in practice, the (C)BMI process in companies may follow different phases or may take place in a more ad-hoc manner. Within these overarching phases, a variety of tools could fit, and some may be useful across several phases. Hence, future research is encouraged to provide deeper empirical insights into the complexities of actual circular business model innovation processes. Longitudinal ethnographic [82] and action-type [81] of research approaches that follow the actual steps and outcomes of the CBMI process could help increase understanding of the CBMI process, overcome specific organizational barriers and identify the most fitting business models. Indeed, CBMI is related to trialing and testing a variety of models to assess their suitability, as well as setting in motion internal changes through engaging stakeholders internal and external to the firm [62]. Future tool development could consider both these aspects more profoundly, as they are potentially of quite a different nature—on the one hand emphasizing ideating, developing and testing new propositions—and on the other hand highlighting the need for internal 'change management'—as well as novel collaborations towards circular business models and value chains. Due to the various organizational aspects linked to CBMI, different tools might be developed, catering for different organizational sizes and types (see e.g., [95] for SMEs and [84] for entrepreneurs).

Future research may also benefit from a clear interaction between researchers and practitioners who can exchange knowledge on 'best tool practice'. For example, adopting the criteria in the CBMI tool development checklist (Box 1), coupled with further insight from tool use in practice, could feed back into future research in this field.

Finally, the research has benefited but also been limited by the lenses of the involved researchers. As an interdisciplinary team representing research across sustainability, business, design and engineering disciplines, we sought to present a broad view on tools and possible criteria. However, because of the authors' own experience of developing (CBMI) tools, subjectivity is hard to avoid. We sought to address this through the multiple review phases of the tools, involving different authors each time. Another limitation is related to the fact that the identified CBMI tools may have been developed and tested further beyond the publication, but such evidence was not gathered, due to the accessibility of such insight. Hence, openness and transparency on tool procedures and development can further improve uptake of CBMI tools.

6. Conclusions

This research aims to contribute to CBMI tool development in two ways. Firstly, it presents an overview of existing CBMI tools, provides structure to the landscape of existing tools, and identifies gaps. We find that current tools exist for all generic phases of CBMI: ideate and design; implement and test; evaluate and improve. However, the majority are (semi-) qualitative in nature and focus on the ideation and design phase. This suggests an opportunity for more quantitative tools and tools that support all phases of the CBMI process. As various tools build on widely used business model work, such as the business model canvas [72], more interdisciplinary approaches that bridge the fields of business, design, engineering and sustainability sciences [32], as well as cross-cultural insights, could advance tool development. Judging from the lack of CBMs in large corporations [18,19], there is a potential for better integration of popular tools and approaches used by practitioners (e.g., [72,73]) with academic insight on CE implementation and innovation. In addition, the development of tools in close interaction with practitioners (i.e., businesses) and building on best practice examples could further advance tool development. Secondly, the paper contributes to supporting the development of CBMI tools in research and practice through the development of a 10-criteria checklist (Box 1). It is suggested that this checklist could also support the development of sustainability tools more generally.

Several avenues for future research are suggested to support the operationalization and mainstreaming of CBMs. Future research can contribute to the trialing of new CBMs to find the most suitable ones for businesses [62,103], as well as supporting the organizational change dynamics of transforming businesses' dominant business models for the CE. This may be best supported by action-oriented research approaches that are underpinned by strong theoretical insight and practice review. For this to work in practice, business practitioners would need to be open for higher levels of research involvement, and different types of interactions would need to be designed into research projects. At the same time, academics can become more effective at translating theoretical insight into effective CBMI tools, processes and support—from ideation and design to implementation and testing, and evaluating and improving—to guide CE operationalization in a way that it lives up to 'sustainability expectations' and avoids negative side-effects. This is needed in order not to 'dilute' sustainability or circularity objectives in favor of more conventional business cases that lack a clear positive environmental and societal impact.

To conclude, we encourage researchers from across disciplines to collaborate with practitioners for future tool development, ensure transparency of the tool development and create accessible tool guidance to spur greater uptake of CBMI tools and help 'operationalize' the CE.

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Appendix A Websites/Platforms for CE Practice Tools

The field of the circular economy is rapidly expanding. We focused on the below list of projects, organizations and websites which arose from our current networks and expertise in this field to identify possible tools:

- Sustainable Business Model Blog: https://blog.ssbmg.com
- European Remanufacturing Network: www.remanufacturing.eu
- Circular Economy Toolkit: http://www.circulareconomytoolkit.org/
- Ellen MacArthur Foundation: https://www.ellenmacarthurfoundation.org/
- European Circular Economy Stakeholder Platform: https://circulareconomy.europa.eu/platform/
- MISTRA Resource-Efficient and Effective Solutions: https://mistrarees.se/
- Circular Economy Club: https://www.circulareconomyclub.com/
- CIRCULATOR: http://www.circulator.eu/
- Holland Circular Hotspot: https://hollandcircularhotspot.nl/en/
- CIRCULAB: https://circulab.eu/tools/
- ResCoM platform: https://www.rescoms.eu/
- Gateway for Cradle-to-Cradle: http://www.c2c-centre.com/
- Circulatenews: https://circulatenews.org/
- Circulate design guide: https://www.circulardesignguide.com/
- CIRCit: http://circitnord.com/
- Circular Economy Asia: http://www.circulareconomyasia.org/
- Circle Economy: https://www.circle-economy.com/
- Circular Fashion: https://circularfashion.com/

Appendix B Shortlisted Tools after Second Screening, with 34 of 235 Publications Left

No.	Authors	Title	Reference	Included in Final List?	Criteria for Exclusion
1	Antikainen M., Aminoff A., Kettunen O., Sundqvist-Andberg H., Paloheimo H.	Circular economy business model innovation process—case study	[90]	Yes	N/A
2	Antikainen, Maria; Valkokari, Katri	A framework for Sustainable Circular Business Model Innovation	[23]	No	No clear evidence on practitioner usage as a case is only used to demonstrate the potential of the framework
3	Bocken et al.	Experimenting with a circular business model: Lessons from eight cases	[62]	No	Framework developed from literature and cases, but then not applied with cases
4	Bocken N., Miller K., Evans, S.	Assessing the environmental impact of new Circular business models	[91]	Yes	N/A
5	Bosch T., Verploegen K., Grösser S.N., van Rhijn G.	Sustainable furniture that grows with end-users	[104]	No	Lacks a clear procedure
6	Bressanelli G., Perona M., Saccani N.	Challenges in supply chain redesign for the circular economy: A literature review and a multiple case study	[105]	No	No clear 'tool'

No.	Authors	Title	Reference	Included in Final List?	Criteria for Exclusion
7	Circulab	Circularity Board	[79]	No	No clear procedure or overview of development or overview of tool development
8	Dobes V., Fresner J., Krenn C., Růžička P., Rinaldi C., Cortesi S., Chiavetta C., Zilahy G., Kochański M., Grevenstette P., de Graaf D., Dorer C.	Analysis and exploitation of resource efficiency potentials in industrial small and medium-sized enterprises—Experiences with the EDIT Value Tool in Central Europe	[106]	No	Not explicitly about CE
9	Evans and Bocken	A tool for manufacturers to find opportunity in the circular economy	[92]	Yes	N/A
10	Ferreira F.M., Pinheiro C.R.M.S.	Circular Business Plan: Entrepreneurship teaching instrument and development of the entrepreneurial profile	[107]	No	It is not about the circular economy—circular refers to the shape of the tool rather than content.
11	Geissdoerfer M., Morioka S.N., de Carvalho M.M., Evans S.	Business models and supply chains for the circular economy	[49]	No	No clear tool/ not empirically tested
12	Haines-Gadd M., Chapman J., Lloyd P., Mason, J., Aliakseyeu, D.	Emotional Durability Design Nine—A Tool for Product Longevity	[93]	Yes	N/A
13	Heyes G., Sharmina M., Mendoza J.M.F., Gallego-Schmid A., Azapagic A.	Developing and implementing circular economy business models in service-oriented technology companies	[75]	Yes	N/A
14	Ingebrigtsen S., Jakobsen O.	Circulation economics—A turn towards sustainability	[108]	No	Lacks a clear tool or process
15	Leising E., Quist J., Bocken N.	circular economy in the building sector: Three cases and a collaboration tool	[28]	Yes	N/A
16	Lieder M., Asif F.M.A., Rashid A.	Towards circular economy implementation: An agent-based simulation approach for business model changes	[109]	No	Unclear for others to use, more of a 'black box'
17	Linder M., Williander M.	Circular Business Model Innovation: Inherent Uncertainties	[110]	No	No clear tool or explanation of a 'tool' or process
18	Lüdeke-Freund F., Gold S., Bocken N.M.	A Review and Typology of Circular Economy Business Model Patterns	[50]	No	No clear tool, not empirically tested
19	Manninen K., Koskela S., Antikainen R., Bocken N., Dahlbo H., Aminoff A.	Do circular economy business models capture intended environmental value propositions?	[88]	Yes	N/A
20	Mendoza J.M.F., Sharmina M., Gallego-Schmid A., Heyes G., Azapagic A.	Integrating Backcasting and Eco-Design for the Circular economy: The BECE Framework	[94]	Yes	N/A

No.	Authors	Title	Reference	Included in Final List?	Criteria for Exclusion
21	Nussholz, J.	A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops	[30]	Yes	N/A
22	Nussholz, J.	Circular business model framework: Mapping value creation architectures along the product lifecycle	[111]	Yes	N/A
23	Pajula T., Behm K., Vatanen S., Saarivuori E.	Managing the life cycle to reduce environmental impacts	[112]	No	No clear procedure—more use of existing tools
24	Pigosso, Daniela C. A.; Schmiegelow, Andreas; Andersen, Maj Munch	Measuring the Readiness of SMEs for Eco-Innovation and Industrial Symbiosis: Development of a Screening Tool	[95]	Yes	N/A
25	Saidani M., Yannou B., Leroy Y., Cluzel F.	Hybrid top-down and bottom-up framework to measure products' circularity performance	[113]	No	No clear evidence on practitioner usage as a case is only used to demonstrate the potential of the framework, lack of procedure
26	Scheel C.	Beyond sustainability. Transforming industrial zero-valued residues into increasing economic returns	[114]	No	'Blackbox'—lacks a procedure for reuse
27	Scheepens A.E., Vogtländer J.G., Brezet J.C.	Two life cycle assessment (LCA) based methods to analyse and design complex (regional) circular economy systems. Case: Making water tourism more sustainable	[115]	No	Lacks procedure to make it replicable
28	Sinclair, Matt; Sheldrick, Leila; Moreno, Mariale; Dewberry, Emma	Consumer Intervention Mapping: A Tool for Designing Future Product Strategies within Circular Product Service Systems	[96]	Yes	N/A
29	Urbinati A., Chiaroni D., Chiesa V.	Towards a new taxonomy of circular economy business models	[116]	No	Theoretical framework only
30	van Loon P., Van Wassenhove L.N.	Assessing the economic and environmental impact of remanufacturing: A decision support tool for OEM suppliers	[117]	No	Tested with hypothetical case and lacks a procedure for further use
31	Veleva V., Bodkin G.	Emerging drivers and business models for equipment reuse and remanufacturing in the US: Lessons from the biotech industry	[118]	No	Lacks a clear tool
32	Weissbrod and Bocken	Developing sustainable business experimentation capability—A case study	[82]	No	No clear tested tool—conceptual framework not further tested

No.	Authors	Title	Reference	Included in Final List?	Criteria for Exclusion
33	Whalen K., Berlin C., Ekberg J., Barletta I., Hammersberg P.	'All they do is win': Lessons learned from the use of a serious game for Circular economy education	[83]	Yes	N/A
34	Whalen, K.	RiskandRace: Creation of a finance-focused circular economy serious game	[84]	Yes	N/A

Appendix C Review Protocol

Step 1: First screening

The purpose of this initial screening is to quickly filter out publications that are outside our scope. After dividing the publications equally amongst authors, each author reviews the abstracts, keywords, and titles of his/her publication to identify publications that are:

- *relevant to CE/CE business models*
- *about a tool, process or method (in a broad sense)*

Step 2: Second screening

The purpose of the second screening is to critically analyze the existing tools to ensure they fit with our tool selection criteria. After re-divide the remaining publications and assigning them again to a different author, we now impose our strictest criteria:

- *purpose-made tools for the CE/CE business models*
    - Acceptable example:
        - Pajula et al., (2017) as they talk about the application of LCA etc. to Circularity issues
    - Rejection examples:
        - tools that do not focus on circularity specifically (such as Bocken et al., 2013 value mapping tool or the even more generic ones like Ries' 2011 Lean startup)
- *the tool has been rigorously developed*—e.g., *from both literature and practice*
    - Rejection examples:
        - collections of tools without a clear empirical grounding
        - they are 'consultancy type' of tools without a clear understanding of development and independent usage (e.g., DTU Matche tools)
- *has been tested with potential users and final version used by practitioners (best tools, multiple times) and some evaluation of this process is done*
    - Rejection examples:
        - tools that are not tested and end after the conceptualization phase (e.g., Bocken, Schuit, Kraaijenhagen 2018 is an example—a conceptual business model cycle is developed but then not tested again)
- *a procedure is ready on how others can use it*
    - Acceptable examples:
        - With the Evans and Bocken (2014) toolkit there is a walk-through of the tool so you can use it independently.

- Rejection examples:
  - Tools which are a 'black box' and/ or they cannot be used independently by the user. E.g., many agent-based or modelling tools may do a 'service to a company' by modelling something for them, but the tools cannot be used by the company, or others interested in using the model.
  - Collections of tools—e.g., Pajula et al., (2017)—without insight into individual tool use

References

1. Elkington, J. *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*; Capstone: Mankato, MN, USA, 1997; ISBN 978-1-900961-27-1.
2. Hart, S.L.; Milstein, M.B. Creating sustainable value. *Acad. Manag. Perspect.* **2003**, *17*, 56–67. [CrossRef]
3. Porter, M.E.; Kramer, M.R. Strategy & society: The link between competitive advantage and corporate social responsibility. *Harv. Bus. Rev.* **2006**, *84*, 78–92. [PubMed]
4. Mont, O.K. Clarifying the concept of product–service system. *J. Clean. Prod.* **2002**, *10*, 237–245. [CrossRef]
5. Tukker, A. Product services for a resource-efficient and circular economy—A review. *J. Clean. Prod.* **2015**, *97*, 76–91. [CrossRef]
6. Tukker, A. Eight types of product-service system: Eight ways to sustainability? Experiences from suspronet. *Bus. Strategy Environ.* **2004**, *13*, 246–260. [CrossRef]
7. Bocken, N.; Short, S.; Rana, P.; Evans, S. A value mapping tool for sustainable business modelling. *Corp. Gov. Int. J. Bus. Soc.* **2013**, *13*, 482–497. [CrossRef]
8. Keskin, D.; Diehl, J.C.; Molenaar, N. Innovation process of new ventures driven by sustainability. *J. Clean. Prod.* **2013**, *45*, 50–60. [CrossRef]
9. Bocken, N.M.P.; de Pauw, I.; Bakker, C.; van der Grinten, B. Product design and business model strategies for a circular economy. *J. Ind. Prod. Eng.* **2016**, *33*, 308–320. [CrossRef]
10. Geissdoerfer, M.; Savaget, P.; Bocken, N.M.P.; Hultink, E.J. The Circular Economy—A new sustainability paradigm? *J. Clean. Prod.* **2017**, *143*, 757–768. [CrossRef]
11. Blomsma, F.; Brennan, G. The Emergence of Circular Economy: A New Framing Around Prolonging Resource Productivity. *J. Ind. Ecol.* **2017**, *21*, 603–614. [CrossRef]
12. Ghisellini, P.; Cialani, C.; Ulgiati, S. A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *J. Clean. Prod.* **2016**, *114*, 11–32. [CrossRef]
13. Schmidt-Bleek, F.; Bringezu, S.; Hinterberger, F.; Liedtke, C.; Spangenberg, J.H.; Stiller, H.; Welfens, M.J. *MAIA: Einführung in die Material-Intensitäts-Analyse nach dem MIPS-Konzept*; Wuppertal Institut: Wuppertal, Germany, 1998.
14. Stahel, W.R.; Reday-Mulvey, G. *Jobs for Tomorrow: The Potential for Substituting Manpower for Energy*; Vantage Press: New York, NY, USA, 1981; ISBN 978-0-533-04799-4.
15. Yuan, Z.; Bi, J.; Moriguichi, Y. The Circular Economy: A New Development Strategy in China. *J. Ind. Ecol.* **2006**, *10*, 4–8. [CrossRef]
16. Geng, Y.; Fu, J.; Sarkis, J.; Xue, B. Towards a national circular economy indicator system in China: An evaluation and critical analysis. *J. Clean. Prod.* **2012**, *23*, 216–224. [CrossRef]
17. *Accenture Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth*; Accenture Strategy: Chicago, IL, USA, 2014.
18. Bocken, N.M.P.; Ritala, P.; Huotari, P. The Circular Economy: Exploring the Introduction of the Concept Among S&P 500 Firms. *J. Ind. Ecol.* **2017**, *21*, 487–490. [CrossRef]
19. Ritala, P.; Huotari, P.; Bocken, N.; Albareda, L.; Puumalainen, K. Sustainable business model adoption among S&P 500 firms: A longitudinal content analysis study. *J. Clean. Prod.* **2018**, *170*, 216–226. [CrossRef]
20. Murray, A.; Skene, K.; Haynes, K. The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *J. Bus. Ethics* **2017**, *140*, 369–380. [CrossRef]
21. Nußholz, J.L.K.; Nygaard Rasmussen, F.; Milios, L. Circular building materials: Carbon saving potential and the role of business model innovation and public policy. *Resour. Conserv. Recycl.* **2019**, *141*, 308–316. [CrossRef]

22. Zink, T.; Geyer, R. Circular Economy Rebound. *J. Ind. Ecol.* **2017**, *21*, 593–602. [CrossRef]
23. Antikainen, M.; Valkokari, K. A Framework for Sustainable Circular Business Model Innovation. *Technol. Innov. Manag. Rev.* **2016**, *6*, 5–12. [CrossRef]
24. Eppler, M.J.; Hoffmann, F. Does method matter? An experiment on collaborative business model idea generation in teams. *Innovation* **2012**, *14*, 388–403. [CrossRef]
25. Whalen, K.A.; Milios, L.; Nussholz, J. Bridging the gap: Barriers and potential for scaling reuse practices in the Swedish ICT sector. *Resour. Conserv. Recycl.* **2018**, *135*, 123–131. [CrossRef]
26. Mont, O.; Plepys, A.; Whalen, K.; Nußholz, J.L.K. *Business Model Innovation for a Circular Economy: Drivers and Barriers for the Swedish Industry—The Voice of REES Companies*; Lund University Libraries: Lund, Sweden, 2017.
27. Nußholz, J.L.K. Circular Business Models: Defining a Concept and Framing an Emerging Research Field. *Sustainability* **2017**, *9*, 1810. [CrossRef]
28. Leising, E.; Quist, J.; Bocken, N.M.P. Circular Economy in the building sector: Three cases and a collaboration tool. *J. Clean. Prod.* **2018**, *176*, 976–989. [CrossRef]
29. Linder, M.; Sarasini, S.; Loon, P. van A Metric for Quantifying Product-Level Circularity. *J. Ind. Ecol.* **2017**, *21*, 545–558. [CrossRef]
30. Nußholz, J.L.K. A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops. *J. Clean. Prod.* **2018**, *197*, 185–194. [CrossRef]
31. Achterberg, E.; Hinfelaar, J.; Bocken, N.M.P. *Master Circular Business with the Value Hill*; Circle Economy: Amsterdam, The Netherlands, 2016.
32. Baumann, H.; Boons, F.; Bragd, A. Mapping the green product development field: Engineering, policy and business perspectives. *J. Clean. Prod.* **2002**, *10*, 409–425. [CrossRef]
33. Tyl, B.; Vallet, F.; Bocken, N.M.P.; Real, M. The integration of a stakeholder perspective into the front end of eco-innovation: A practical approach. *J. Clean. Prod.* **2015**, *108*, 543–557. [CrossRef]
34. Magretta, J. Why business models matter. *Harv. Bus. Rev.* **2002**, *80*, 86–92.
35. Richardson, J. The business model: An integrative framework for strategy execution. *Strateg. Chang.* **2008**, *17*, 133–144. [CrossRef]
36. Osterwalder, A.; Pigneur, Y.; Tucci, C.L. Clarifying business models: Origins, present, and future of the concept. *Commun. AIS* **2005**, *16*, 1–25. [CrossRef]
37. Stubbs, W.; Cocklin, C. Conceptualizing a "Sustainability Business Model". *Organ. Environ.* **2008**, *21*, 103–127. [CrossRef]
38. Zott, C.; Amit, R.; Massa, L. The business model: Recent developments and future research. *J. Manag.* **2011**, *37*, 1019–1042. [CrossRef]
39. Massa, L.; Tucci, C.L. Business Model Innovation. In *The Oxford Handbook of Innovation Management*; Dodgson, M., Gann, D.M., Phillips, N., Eds.; Oxford University Press: Oxford, UK, 2014; ISBN 978-0-19-100387-5.
40. Frankenberger, K.; Weiblen, T.; Csik, M.; Gassmann, O. The 4I-framework of business model innovation: A structured view on process phases and challenges. *Int. J. Prod. Dev.* **2013**, *18*, 249–273. [CrossRef]
41. Wirtz, B.W.; Pistoia, A.; Ullrich, S.; Göttel, V. Business Models: Origin, Development and Future Research Perspectives. *Long Range Plan.* **2016**, *49*, 36–54. [CrossRef]
42. Chesbrough, H.; Rosenbloom, R.S. The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Ind. Corp. Chang.* **2002**, *11*, 529–555. [CrossRef]
43. Bocken, N.M.P.; Short, S.W.; Rana, P.; Evans, S. A literature and practice review to develop sustainable business model archetypes. *J. Clean. Prod.* **2014**, *65*, 42–56. [CrossRef]
44. Yang, M.; Evans, S.; Vladimirova, D.; Rana, P. Value uncaptured perspective for sustainable business model innovation. *J. Clean. Prod.* **2017**, *140*, 1794–1804. [CrossRef]
45. Freudenreich, B.; Lüdeke-Freund, F.; Schaltegger, S. A Stakeholder Theory Perspective on Business Models: Value Creation for Sustainability. *J. Bus. Ethics* **2019**. [CrossRef]
46. Evans, S.; Vladimirova, D.; Holgado, M.; Fossen, K.V.; Yang, M.; Silva, E.A.; Barlow, C.Y. Business Model Innovation for Sustainability: Towards a Unified Perspective for Creation of Sustainable Business Models. *Bus. Strategy Environ.* **2017**, *26*, 597–608. [CrossRef]
47. Breuer, H.; Fichter, K.; Lüdeke-Freund, F.; Tiemann, I. Sustainability-oriented business model development: Principles, criteria and tools. *Int. J. Entrep. Ventur.* **2018**, *10*, 256–286. [CrossRef]

48. Yip, A.W.H.; Bocken, N.M.P. Sustainable business model archetypes for the banking industry. *J. Clean. Prod.* **2018**, *174*, 150–169. [CrossRef]
49. Geissdoerfer, M.; Morioka, S.N.; de Carvalho, M.M.; Evans, S. Business models and supply chains for the circular economy. *J. Clean. Prod.* **2018**, *190*, 712–721. [CrossRef]
50. Lüdeke-Freund, F.; Gold, S.; Bocken, N.M.P. A Review and Typology of Circular Economy Business Model Patterns: Circular Economy Business Models. *J. Ind. Ecol.* **2018**. [CrossRef]
51. Ramon, C.-M.; Ricart, J.E. *Competing through Business Models*; IESE Business School: Barcelona, Spain, 2007.
52. Demil, B.; Lecocq, X. Business models evolution: Towards a dynamic consistency view of strategy. *Univ. Bus. Rev.* **2009**, *23*, 86–107.
53. Kumar, S.; Malegeant, P. Strategic alliance in a closed-loop supply chain, a case of manufacturer and eco-non-profit organization. *Technovation* **2006**, *26*, 1127–1135. [CrossRef]
54. Atasu, A.; Guide, V.D.R.; Wassenhove, L.N.V. Product Reuse Economics in Closed-Loop Supply Chain Research. *Prod. Oper. Manag.* **2008**, *17*, 483–496. [CrossRef]
55. Lifset, R.; Graedel, T.E. Industrial ecology: Goals and definitions. In *A Handbook of Industrial Ecology*; Ayres, R.U., Ayres, L., Eds.; Edward Elgar Publishing: Cheltenham, UK, 2002; ISBN 978-1-84376-547-9.
56. Park, J.Y.; Chertow, M.R. Establishing and testing the "reuse potential" indicator for managing wastes as resources. *J. Environ. Manag.* **2014**, *137*, 45–53. [CrossRef]
57. Frosch, R.A.; Gallopoulos, N.E. Strategies for Manufacturing. *Sci. Am.* **1989**, *261*, 144–152. [CrossRef]
58. Velte, C.J.; Steinhilper, R. Complexity in a Circular Economy: A Need for Rethinking Complexity Management Strategies. In Proceedings of the World Congress on Engineering, London, UK, 29 June–1 July 2016.
59. den Hollander, M.; Bakker, C. Mind the Gap Exploiter: Circular Business Models for Product Lifetime Extension. In Proceedings of the Electronic Goes Green 2016+: Inventing Shades of Green, Berlin, Germany, 7–9 September 2016; pp. 1–8.
60. den Hollander, M.C.; Bakker, C.A.; Hultink, E.J. Product Design in a Circular Economy: Development of a Typology of Key Concepts and Terms. *J. Ind. Ecol.* **2017**, *21*, 517–525. [CrossRef]
61. Bakker, C.; Wang, F.; Huisman, J.; den Hollander, M. Products that go round: Exploring product life extension through design. *J. Clean. Prod.* **2014**, *69*, 10–16. [CrossRef]
62. Bocken, N.M.P.; Schuit, C.S.C.; Kraaijenhagen, C. Experimenting with a circular business model: Lessons from eight cases. *Environ. Innov. Soc. Transit.* **2018**, *28*, 79–95. [CrossRef]
63. Intergovernmental Panel on Climate Change. *IPCC Global Warming of 1.5 °C. An IPCC Special Report on the Impacts of Global Warming of 1.5 °C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*; Intergovernmental Panel on Climate Change: Geneva, Switzerland, 2018.
64. McAloone, T.C.; Andreasen, M.M. Design for utility, sustainability and societal virtues: Developing product service systems. In Proceedings of the DESIGN 2004 the 8th International Design Conference, Dubrovnik, Croatia, 18–21 May 2004.
65. Chiu, M.-C.; Chu, C.-H. Review of sustainable product design from life cycle perspectives. *Int. J. Precis. Eng. Manuf.* **2012**, *13*, 1259–1272. [CrossRef]
66. Tan, A.R.; Matzen, D.; McAloone, T.C.; Evans, S. Strategies for designing and developing services for manufacturing firms. *CIRP J. Manuf. Sci. Technol.* **2010**, *3*, 90–97. [CrossRef]
67. Pigosso, D.C.A.; McAloone, T.C. Supporting the Development of Environmentally Sustainable PSS by Means of the Ecodesign Maturity Model. *Procedia CIRP* **2015**, *30*, 173–178. [CrossRef]
68. Knight, P.; Jenkins, J.O. Adopting and applying eco-design techniques: A practitioners perspective. *J. Clean. Prod.* **2009**, *17*, 549–558. [CrossRef]
69. Vallet, F.; Eynard, B.; Millet, D.; Mahut, S.G.; Tyl, B.; Bertoluci, G. Using eco-design tools: An overview of experts' practices. *Des. Stud.* **2013**, *34*, 345–377. [CrossRef]
70. Rossi, M.; Germani, M.; Zamagni, A. Review of ecodesign methods and tools. Barriers and strategies for an effective implementation in industrial companies. *J. Clean. Prod.* **2016**, *129*, 361–373. [CrossRef]
71. Bovea, M.D.; Pérez-Belis, V. A taxonomy of ecodesign tools for integrating environmental requirements into the product design process. *J. Clean. Prod.* **2012**, *20*, 61–71. [CrossRef]
72. Osterwalder, A. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*; Wiley: Hoboken, NJ, USA, 2010; ISBN 978-0-470-87641-1.

73. Ries, E. *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*; Crown Publishing Group: New York, NY, USA, 2011; ISBN 978-0-307-88791-7.
74. Baldassarre, B.; Calabretta, G.; Bocken, N.M.P.; Jaskiewicz, T. Bridging sustainable business model innovation and user-driven innovation: A process for sustainable value proposition design. *J. Clean. Prod.* **2017**, *147*, 175–186. [CrossRef]
75. Heyes, G.; Sharmina, M.; Mendoza, J.M.F.; Gallego-Schmid, A.; Azapagic, A. Developing and implementing circular economy business models in service-oriented technology companies. *J. Clean. Prod.* **2018**, *177*, 621–632. [CrossRef]
76. Geissdoerfer, M.; Bocken, N.M.P.; Hultink, E.J. Design thinking to enhance the sustainable business modelling process—A workshop based on a value mapping process. *J. Clean. Prod.* **2016**, *135*, 1218–1232. [CrossRef]
77. Lewandowski, M. Designing the Business Models for Circular Economy—Towards the Conceptual Framework. *Sustainability* **2016**, *8*, 43. [CrossRef]
78. Sustainn Circularity Canvas: Methodology to Outline Circular Business Models. Available online: http://www.wearesustainn.com/en/2017/03/circularity-canvas-methodology-circular-business-models/ (accessed on 26 February 2019).
79. Circulab Circulab—Circular Economy, You Can Make It Happen. Available online: https://circulab.eu/#board (accessed on 26 February 2019).
80. Sarasvathy, S. Causation and Effectuation: Toward a Theoretical Shift from Economic Inevitability to Entrepreneurial Contingency. *Acad. Manag. Rev.* **2001**, *26*. [CrossRef]
81. Bocken, N.M.P.; Miller, K.; Weissbrod, I.; Holgado, M.; Evans, S. Business model experimentation for circularity: Driving sustainability in a large international clothing retailer. *Econ. Policy Energy Environ.* **2017**. [CrossRef]
82. Weissbrod, I.; Bocken, N.M.P. Developing sustainable business experimentation capability—A case study. *J. Clean. Prod.* **2017**, *142*, 2663–2676. [CrossRef]
83. Whalen, K.A.; Berlin, C.; Ekberg, J.; Barletta, I.; Hammersberg, P. 'All they do is win': Lessons learned from use of a serious game for Circular Economy education. *Resour. Conserv. Recycl.* **2018**, *135*, 335–345. [CrossRef]
84. Whalen, K. Risk & Race: Creation of a Finance-Focused Circular Economy Serious Game. Research in Design Series. In *Product Lifetimes and the Environment, Proceedings of the PLATE 2017, Delft, The Netherlands, 8–10 November 2017*; IOS: Amsterdam, The Netherlands, 2017; pp. 422–425.
85. VITO; Circular Flanders; TU Delft. Radbout University Find a Circular Business Model That Fits You. Available online: http://circulator.eu/ (accessed on 26 February 2019).
86. Pigosso, D.C.A.; McAloone, T.C.; Rozenfeld, H. Characterization of the State-of-the-art and Identification of Main Trends for Ecodesign Tools and Methods: Classifying Three Decades of Research and Implementation. *J. Indian Inst. Sci.* **2015**, *95*, 405–427.
87. Pieroni, M.P.P.; McAloone, T.C.; Pigosso, D.C.A. Business model innovation for circular economy and sustainability: A review of approaches. *J. Clean. Prod.* **2019**, *215*, 198–216. [CrossRef]
88. Manninen, K.; Koskela, S.; Antikainen, R.; Bocken, N.M.P.; Dahlbo, H.; Aminoff, A. Do circular economy business models capture intended environmental value propositions? *J. Clean. Prod.* **2018**, *171*, 413–422. [CrossRef]
89. Madani, K.; Pierce, T.W.; Mirchi, A. Serious games on environmental management. *Sustain. Cities Soc.* **2017**, *29*, 1–11. [CrossRef]
90. Antikainen, M.; Aminoff, A.; Kettunen, O.; Sundqvist-Andberg, H.; Paloheimo, H. Circular economy business model innovation process—Case study. *Smart Innov. Syst. Technol.* **2017**, *68*, 546–555. [CrossRef]
91. Bocken, N.M.P.; Evans, S.; Miller, K. Assessing the Environmental Impact of New Circular Business Models. In Proceedings of the ResearchGate, Toulouse, France, 16–17 June 2016.
92. Evans, J.L.; Bocken, N.M.P. A tool for manufacturers to find opportunity in the circular economy—www.circulareconomytoolkit.org. In Proceedings of the ResearchGate, Cardiff, Wales, 28–30 April 2014.
93. Haines-Gadd, M.; Chapman, J.; Lloyd, P.; Mason, J.; Aliakseyeu, D. Emotional Durability Design Nine—A Tool for Product Longevity. *Sustainability* **2018**, *10*, 1948. [CrossRef]
94. Mendoza, J.M.F.; Sharmina, M.; Gallego-Schmid, A.; Heyes, G.; Azapagic, A. Integrating Backcasting and Eco-Design for the Circular Economy: The BECE Framework. *J. Ind. Ecol.* **2017**, *21*, 526–544. [CrossRef]

95. Pigosso, D.C.A.; Schmiegelow, A.; Andersen, M.M. Measuring the Readiness of SMEs for Eco-Innovation and Industrial Symbiosis: Development of a Screening Tool. *Sustainability* **2018**, *10*, 2861. [CrossRef]
96. Sinclair, M.; Sheldrick, L.; Moreno, M.; Dewberry, E. Consumer Intervention Mapping—A Tool for Designing Future Product Strategies within Circular Product Service Systems. *Sustainability* **2018**, *10*, 2088. [CrossRef]
97. Ries, E. *The Startup Way: How Modern Companies Use Entrepreneurial Management to Transform Culture and Drive Long-Term Growth*; Crown Publishing Group: New York, NY, USA, 2017; ISBN 978-1-101-90321-6.
98. Lofthouse, V. Ecodesign tools for designers: Defining the requirements. *J. Clean. Prod.* **2006**, *14*, 1386–1395. [CrossRef]
99. Bocken, N.; Boons, F.; Baldassarre, B. Sustainable business model experimentation by understanding ecologies of business models. *J. Clean. Prod.* **2019**, *208*, 1498–1512. [CrossRef]
100. van Boeijen, A.; Daalhuizen, J.; van der Schoor, R.; Zijlstra, J. *Delft Design Guide, Design Strategies and Methods*; 2014; ISBN 978-90-6369-327-5.
101. Täuscher, K.; Abdelkafi, N. Visual tools for business model innovation: Recommendations from a cognitive perspective. *Creat. Innov. Manag.* **2017**, *26*, 160–174. [CrossRef]
102. Whalen, K.; Peck, D. In the Loop—Sustainable, Circular Product Design and Critical Materials. *Int. J. Autom. Technol.* **2014**, *8*, 664–676. [CrossRef]
103. Chesbrough, H. Business model innovation: Opportunities and barriers. *Long Range Plan.* **2010**, *43*, 354–363. [CrossRef]
104. Bosch, T.; Verploegen, K.; Grösser, S.N.; van Rhijn, G. Sustainable furniture that grows with end-users. In *Dynamics of Long-Life Assets: From Technology Adaptation to Upgrading the Business Model*; Springer: Cham, Switzerland, 2017; pp. 303–326.
105. Bressanelli, G.; Perona, M.; Saccani, N. Challenges in supply chain redesign for the Circular Economy: A literature review and a multiple case study. *Int. J. Prod. Res.* **2018**, 1–28. [CrossRef]
106. Dobes, V.; Fresner, J.; Krenn, C.; Růžička, P.; Rinaldi, C.; Cortesi, S.; Chiavetta, C.; Zilahy, G.; Kochański, M.; Grevenstette, P.; de Graaf, D.; Dorer, C. Analysis and exploitation of resource efficiency potentials in industrial small and medium-sized enterprises—Experiences with the EDIT Value Tool in Central Europe. *J. Clean. Prod.* **2017**, *159*, 290–300. [CrossRef]
107. Ferreira, F.M.; Pinheiro, C.R.M.S. Circular Business Plan: Entrepreneurship teaching instrument and development of the entrepreneurial profile. *Gestao Prod.* **2018**, *25*, 854–865. [CrossRef]
108. Ingebrigtsen, S.; Jakobsen, O. Circulation economics—A turn towards sustainability. *Int. J. Soc. Econ.* **2006**, *33*, 580–593. [CrossRef]
109. Lieder, M.; Asif, F.M.A.; Rashid, A. Towards Circular Economy implementation: An agent-based simulation approach for business model changes. *Auton. Agents Multi-Agent Syst.* **2017**, *31*, 1377–1402. [CrossRef]
110. Linder, M.; Williander, M. Circular Business Model Innovation: Inherent Uncertainties. *Bus. Strategy Environ.* **2017**, *26*, 182–196. [CrossRef]
111. Nussholz, J. Circular Business Model Framework: Mapping value creation architectures along the product lifecycle. In *Product Lifetimes and the Environment, Proceedings of the PLATE 2017, Delft, The Netherlands, 8–10 November 2017*; IOS: Amsterdam, The Netherlands, 2017.
112. Pajula, T.; Behm, K.; Vatanen, S.; Saarivuori, E. Managing the life cycle to reduce environmental impacts. In *Dynamics of Long-Life Assets: From Technology Adaptation to Upgrading the Business Model*; Springer: Cham, Switzerland, 2017; pp. 93–113.
113. Saidani, M.; Yannou, B.; Leroy, Y.; Cluzel, F. Hybrid top-down and bottom-up framework to measure products' circularity performance. In Proceedings of the International Conference on Engineering Design, 21–25 August 2017; Volume 1, pp. 81–90.
114. Scheel, C. Beyond sustainability. Transforming industrial zero-valued residues into increasing economic returns. *J. Clean. Prod.* **2016**, *131*, 376–386. [CrossRef]
115. Scheepens, A.E.; Vogtländer, J.G.; Brezet, J.C. Two life cycle assessment (LCA) based methods to analyse and design complex (regional) circular economy systems. Case: Making water tourism more sustainable. *J. Clean. Prod.* **2016**, *114*, 257–268. [CrossRef]
116. Urbinati, A.; Chiaroni, D.; Chiesa, V. Towards a new taxonomy of circular economy business models. *J. Clean. Prod.* **2017**, *168*, 487–498. [CrossRef]

117. van Loon, P.; Van Wassenhove, L.N. Assessing the economic and environmental impact of remanufacturing: A decision support tool for OEM suppliers. *Int. J. Prod. Res.* **2018**, *56*, 1662–1674. [CrossRef]
118. Veleva, V.; Bodkin, G. Emerging drivers and business models for equipment reuse and remanufacturing in the US: Lessons from the biotech industry. *J. Environ. Plan. Manag.* **2018**, *61*, 1631–1653. [CrossRef]