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Practical guidelines for designing recycling, collaborative, and scalable business models: A case study of reusing textile fibers into biocomposite products

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ABSTRACT

Our current take-make-dispose economic model faces a vital challenge as it extracts resources from the natural environment at faster rates than that the natural environment can replenish. A circular economy where businesses lower their negative impact on the natural environment by transitioning towards recycling business models (RBMs), one of the four principles of circularity, is suggested as a promising solution. For a RBM to become viable, collaboration among several stakeholders and across several industries is required. In addition, the RBM should be scalable to make a positive impact. Hence, developing RBMs is complex as organizations need to consider multiple principles imposed by the recycling, collaborative, and scalability dimensions of these business models (BMs). In addition, these principles often remain general and not actionable to the practitioners. Therefore, in this study, we researched the practical guidelines for viable RBMs that are also collaborative and scalable. The empirical setting is the reuse of textile fibers to develop biocomposite products. We studied three cases using a research-through-design approach. We contribute to the literature on RBMs by showing the six minimum practical guidelines for recyclability, collaboration, and scalability. We draw implications for within sector collaborations and advance the thought that lease constructs challenge the scalability of RBM.

1. Introduction

Today's societies face many sustainability problems, such as biodiversity loss, chemical pollution, and climate change (Steffen et al., 2015). Our current take-make-dispose economic model faces a vital challenge as it extracts resources from the natural environment at faster rates than that the natural environment can replenish (Ellen Mac Arthur Foundation, 2014). The circular economy, "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops," (Geissdoerfer, Savaget, Bocken and Hultink, 2017a, p.759) offers solutions to mitigate these problems with the environment. Material streams can be reorganized, a value can be preserved, and products can be redesigned. The reorganization of value chains and successfully market sustainable solutions requires suitable circular business models (CirBMs) (Bocken, de Pauw, Bakker and van der Grinten, 2016). These business models (BMs) are specific types of sustainable BMs (e.g., Schaltegger et al., 2016) that specifically aim for solutions for the circular economy (Geissdoerfer et al., 2018).

A particular type of CirBMs is the recycling business model (RBM) (Bocken et al., 2014; Dijkstra et al., 2020; Geissdoerfer et al., 2018; Lüdeke-Freund et al., 2019; Tong et al., 2018). It is considered "the most common Circular Economy process through which used materials are treated so as to make them suitable for reuse" (Urbinati et al., 2017, p.488). RBMs regard closing the loop between the post-use and production, and thereby create a circular flow of resources (Bocken et al., 2016). For RBMs to become viable, they need to connect the downstream and upstream ends of supply chains and need to organize reverse logistics that connect users, raw material suppliers, and parts manufacturers (Lüdeke-Freund et al., 2019). However, the recycling of materials is often downcycling. It results in materials that are of lower quality compared with virgin resources, which is considered a barrier for the transition towards a circular economy (Bocken et al., 2017). In addition, to close the loop, diverse stakeholders among and across several industries need to collaborate (Bocken et al., 2016), and the RBM should also be scalable (i.e., exploit economies of scale) to make a

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positive impact on the environment.

Hence, developing RBMs is complex as organizations need to consider multiple principles imposed by the recycling, collaborative, and scalability dimensions of these BMs. In addition, these principles are general since in research BMs are often used as scientific models to generate theories (Baden-Fuller and Morgan, 2010). Hence, these principles are not actionable, and thus not useful for practitioners (Beer, 2001, 2020). As a result, BMs often fail when they are implemented (Christensen et al., 2016), and many projects with RBMs never scale, and their intended impact remains elusive (Schaltegger et al., 2016). Therefore, there is a need for determining the practical guidelines for viable RBMs (Salvador et al., 2020). Whereas Breuer et al. (2018) propose guiding guidelines for developing sustainable BMs, we have not identified studies that specifically focus on RBMs.

Towards that end, in this study, we build on Breuer et al. (2018) and research the question-what are the minimum practical guidelines for RBMs that also take into account the collaborative and scalability dimensions? Next to reviewing the literature on RBMs, we incorporate insights from collaborative business models (ColBM) and scalability. ColBMs refer to multiple organizations from different types of industries, and with varying roles in the value chain, jointly working together to create value for specific customers (Rohrbeck et al., 2013). The scalability of BMs refers to the role of BMs for organizations to exploit economies of scale (Stampfl et al., 2013). We used a design science approach (Aken, 2004), and the empirical setting is the reuse of textile fibers to develop biocomposite products. We engaged in iterative creation and validation cycles (Romme and Reymen, 2018) undergoing stages of literature review and interviews with practitioners to design RBMs for three cases, and validate the minimum practical guidelines for recycling, collaborative, and scalable BMs.

We make two contributions to the literature of RBMs. First, we propose six minimum practical guidelines for recycling, collaboration, and scalability. These practical guidelines suggest that collaboration within a single sector is not sine qua non for RBMs, but firms may choose vertical integration strategies to cope with the challenges of RBMs. Second, taking into account the importance of resource return flows, studies have suggested that Product Service Systems (PPS) such as lease constructs are ideal. However, recent research indicates that PPS is inadequate due to the restrictions imposed on the customers (Tukker, 2015). We advance the thought that lease constructs challenge the scalability of RBMs.

2. Conceptual background

In this section, we present the main concept of this study, the RBM. We do not attempt to present a comprehensive review of the debate pertaining to RBMs. We present the main challenges and identify the research gap.

2.1. Recycling business models

The literature on BMs in general, and CirBMs in particular, have increased tremendously over the last years (Oghazi and Mostaghel, 2018). A BM can be defined as a conceptual representation of how an organisation functions (Massa et al., 2016); it represents the "design or architecture of the value creation, delivery, and capture mechanisms" (Teece, 2010, p.172). As today's societies face many sustainability problems (Steffen et al., 2015), the circular economy is proposed as offering solutions, requiring firms to transition towards CirBMs (Geissdoerfer et al., 2018). These BMs are "specifically aiming at solutions for the Circular Economy through a circular value chain and stakeholder incentive alignment" (Geissdoerfer et al., 2018, p.714). As such, creating value also for the environment is central within CirBMs (Bocken et al., 2014).

One of the most common CirBMs is the RBM (Urbinati et al., 2017). RBMs are resource strategies to preserve the value of products and materials to minimize the use of virgin materials (Tunn et al., 2019). There is a plurality of concepts of RBMs. For example, Adam et al. (2018) suggest reversed-retailing where manufacturers and recycling companies are the target customers, value is delivered by returning disposed items using the same logistical chains for selling the items, and the captured value lies in selling the disposed items back to the manufacturers. In their framework, Tunn et al. (2019) suggest recycling as a resource strategy that can be divided into two types of purposes, cycling of materials and cycling of materials and products. In the former, recycling is viewed as reusing the materials of end-of-life products for new products, hence reducing the need for virgin materials. In the latter, recycling is viewed broadly as a means to prolong the value of products by refurbishing and remanufacturing products reusing the materials of end-of-life products. The two types of recycling results in slightly different RBMs. In the former, the objective is to decrease the consumer's level of consumptions (compared to current standard consumption practices), stabilize the consumer effort, and the captured value is product-oriented such as product-related services. In also the latter, the objective is to decrease the consumer's level of consumptions (compared to current standard consumption practices). However, the consumer effort is decreased, and the captured value is use-oriented such as subscription models.

In this study, we follow Lüdeke-Freund et al. (2019) as these authors studied the most common RBM patterns based on the BM dimensions of value proposition, value delivery, value creation, and value capture (See Fig. 1). The RBMs are organization-centric and should be seen as part of a more extensive value network with a circular supply chain (Geissdoerfer et al., 2018). Hence, the value proposition regards both products (i.e., products based on recycled materials or recycled production inputs), and services (i.e., take-back management, and waste-handling and processing). The value proposition is delivered by the closing of resource loops between the downstream and upstream ends of supply chains, and organizing reverse logistics that connect users, raw material suppliers, and parts manufacturers (Lüdeke-Freund et al., 2019). End-users become resource providers by returning items that are no longer in use. The manufacturers become the customers, and waste collectors act as suppliers to the manufacturers, hence also called reversed-retailing (Adam et al., 2018). These interactions between the RBM and the circular supply chain results in benefits for the environment. The RBMs regard both biological and technical cycles (Bocken et al., 2016). The biological cycle concerns the process where products (e.g., paper cups) dissipate into natural materials (e.g., dirt). The technical cycle regards the process where technical innovation products (e.g., clothing) are turned into new materials (e.g., fibers). Hence, the value created by recycling is both on the material and product levels and can be either considered downcycling or upcycling. Downcycling refers to converting the waste materials into materials or products of lesser value than the original material. In contrast, upcycling refers to converting the waste materials into materials or products of higher quality or value (Sung, 2015). The created value is captured through additional product revenues or cost savings (Lüdeke-Freund et al., 2019).

2.2. Research gap and contribution

The implementation of RBMs is not without challenges. Materials are often downcycled, which results in materials that are of lower quality compared with virgin resources, and hence, is considered a barrier for the transition towards a circular economy (Bocken et al., 2017). For example, a study of 18 firms in the recycling business in the Netherlands showed that a main barrier of implementing RBMs is the challenge with uncertainties relating to the quality of the waste materials (Vermunt et al., 2019). In addition, collaboration within a value network (Bocken et al., 2016) is essential for the success of RBMs. For example, to cope with uncertainties relating to the quality of the materials, firms strive to work closely with suppliers of the waste material to control for the quality (Vermunt et al., 2019). However, collaboration in itself is a

BM dimensions		CEBM design options for Recycling			
Value proposition	Products	Products based on recycled waste	Reusable or recyclable production inputs		
	Services	Take-back management	Waste handling, processing		
Value delivery	Target customers	Green customers	B2B customers		
	Value delivery processes	Connecting suppliers and customers	Providing products, components, materials, or waste	Taking back used products, components, materials, or waste	
Value creation	Partners and stakeholders	Collectors of products, components, materials, or waste			
	Value creation processes	Recycling of products, components, materials, or waste	Upgrading or upcycling of products, components, materials, or waste	Taking back or recapturing products, components, materials, or waste	Winning back base materials
Value capture	Revenues	Additional product revenues			
	Costs	Waste handling, processing	Resource inputs	Transportation, logistics	

Fig. 1. Design options for a generic recycling business model pattern (adapted from Lüdeke-Freund et al., 2019).

challenge, especially when taking into account the openness and flexibility that is required for collaborative development of sustainable BMs (Oskam et al., 2020). Furthermore, for BMs to be successful, they must be scalable (Amit and Zott, 2001; Täuscher and Abdelkafi, 2018). However, scaling in itself is complex (Björkdahl and Holmén, 2013) as it requires the orchestration of a plurality in organizational and contextual factors (Stampfl et al., 2013) and collaboration among firms (Hultberg and Pal, 2021). A study of 11 firms implementing RBMs in France found that due to the high up-front investments, the return on investments was prolonged, which resulted in limited scalability of the RBMs (Beulque and Aggeri, 2016). Also, a study of twelve US-based small and medium-sized enterprises (SME) and global firms showed that the large firms were better apt in providing global recycling solutions (Veleva and Bodkin, 2018), suggesting that scaling is a determinant factor RBMs. Furthermore, financial capital, a determinant for scalability (Stampfl et al., 2013) is the second most frequented barrier among SMEs (Rizos et al., 2016). Financial capital is crucial for investing in Research and Development (R&D), which is also recognized as one of the challenges of RBMs (Vermunt et al., 2019).

In response to dealing with the complexities of RBMs raised by the recycling, collaborative, and scalability dimensions of these BMs, the literature suggests a myriad of principles. For example, Vermunt et al. (2019) suggest '*retaining product ownership to reduce dependence on third parties*', '*building legitimacy and creating awareness*', and '*experimenting with technology and developing knowledge*', to just name a few. In addition, these principles are often general since BMs are used as scientific models to generate theories (Baden-Fuller and Morgan, 2010). As suggested by Van De Ven and Johnson (2006, p.806), "The purpose of scientific and scholarly knowledge is knowing how to see specific situations as instances of a more general case that can be used to explain how what is done works or can be understood." However, practitioners are occupied with specific problems and the knowledge they require is unique to their experiences. Therefore, principles developed in scholarly work are often not actionable, and thus not useful for practitioners (Beer, 2001, 2020). For example, in three workshops with a diverse group of sustainable entrepreneurs, Konietzko et al. (2020) found that the entrepreneurs focused less on sustainability principles but more on the desirability of their BMs. As a result, BMs often fail when they are implemented (Tukker, 2015), and many projects with RBMs never scale, and their intended impact remains elusive (Schaltegger et al., 2016). Therefore, there is a need for determining the minimum practical guidelines for viable RBMs (Salvador et al., 2020).

There is growing literature that draws from design science and seeks to develop these practical guidelines (e.g., Aagaard et al., 2021; Bocken et al., 2018; Weissbrod and Bocken, 2017). We build on Breuer et al. (2018) who propose four guiding principles for developing sustainable BMs (1. Sustainability orientation, 2. Extended value creation, 3. Systemic thinking, and 4. Stakeholder integration). Whereas these authors focus on sustainable BMs, we have not identified studies that specifically focus on RBMs. As such, we seek to contribute to this literature by identifying the practical guidelines for RBMs.

3. Methodology

3.1. Research strategy

As the aim of this study is prescription-driven and solution-focused rather than description-driven, we use a research approach based on design science methodology (Aken, 2004). The objective of design science methodology is to produce scientific prescriptive knowledge that can be used to design solutions to complex and relevant field problems (Aken, 2004; van Aken and Romme, 2012). A typical product of design science research is '*a set of tested and grounded technological rules*' that can be used by professionals in the field (Aken, 2004). The practical guidelines,[1] that are the central premise of this study, are an example of a set of technological rules. As design is essentially an iterative search process for discovering effective solution to a problem (Hevner et al., 2004) a typical research design to study and test technological rules is a multiple case study (Aken, 2004). The grounding takes place by building upon theory by means of a literature review and through interactions with practice and by testing the guidelines in the field (Aken, 2004; Gregor and Hevner, 2013; van Aken and Romme, 2012). Therefore, we organized the research process into three subsequent phases (i.e., Definition, field-testing, and evaluation) (see Fig. 2 for the steps in the research process). In the definition phase, we developed principles from the literature review and semi-structured interviews with experts. In the field-testing phase, we designed RBMs for three cases using these principles building upon products designed by graduation students, a workshop with value chain stakeholders, semi-structured interviews with potential customers, and semi-structured interviews with representatives of the focal firms from the cases. We also derive the practical guidelines from the designed RBMs. In the evaluation phase, we conducted a cross-case analysis to determine the minimum practical guidelines for collaborative and scalable RBMs. Each phase contained feedback loops (Romme and Reymen, 2018), and through an iterative process, the principles were transformed into practical guidelines as the

[1] The design science literature also refers to the practical guidelines as design propositions (e.g., Romme and Reymen, 2018).

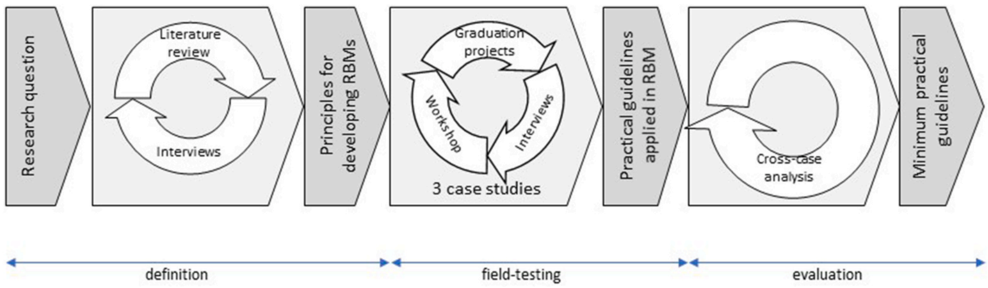

Fig. 2. Research approach (based on Geissdoefer et al., 2016).

former was applied to the RBMs.

3.2. Empirical context

In line with the research question and the chosen methodological approach, we selected the project ‘Reusing Circular Urban Fibers for Urban Sheet Based Products’ (Recurf-Up). Recurf-Up concerns the reuse of textile fibers to develop biocomposite products, a project executed by a consortium of university and industry partners and financed by the Taskforce of Applied Research[2] in the Netherlands. Recurf-Up is a continuation of Recurf, a project regarding the reuse of textile in biocomposites, by the same consortium partners. In Recurf, fibers that were harvested from textile waste streams (e.g., coffee bags from a big coffee producer and waste products from an office furniture manufacturer) were combined with bioplastics to create new biocomposite material (Oskam et al., 2017). The new biocomposite material (i.e., Recurf-material) is lightweight, flexible and contains high acoustic properties. The goal of Recurf-Up was to explore potential products that could be designed with the Recurf-material. In the quest of the consortium partners to ‘close the loop,’ they closely collaborated along the entire value chain-from the take-back of textile, fiberizing the textile, creating non-woven mats with biobased plastics to the manufacturing of products.

We determined that Recurf-Up was suitable for this study due to three reasons. First, the textile industry is one of the most polluting industries in terms of water usage and discharge of chemical waters (Boström and Micheletti, 2016), prompting an urgent need for sustainable solutions. Due to the applied nature of Recurf-Up, tangible solutions were designed next to generate knowledge. Second, Recurf-Up aimed to contribute to the transition towards the circular economy by developing scalable RBMs. It required the design of value propositions, creation, delivery, and capture mechanisms through collaborative efforts of its consortium partners. This context allowed us to test the principles for recycling, collaborative and scalable BMs, and derive practical guidelines. For this purpose, we selected three cases in which distinctive business-to-business products were developed, revolving around the same Recurf-material. However, each case was unique in terms of problem-fit and targeted customers. This uniqueness allowed us to retain a balance between the replicability and generalizability of our findings. The three cases were- 1) a prop-ceiling panel for decorative use in large buildings such as hotels (CeilingsCo), 2) a modular, privacy and noise-reducing screen to use in open co-working spaces (FurnitureCo), and 3) a noise-reducing panel that can also be used as a modular room divider for use in spaces that require excellent acoustics such as lecture halls (InsulationCo). Each case was championed by a firm that was also a partner within the Recurf-Up! consortium. We worked closely with representatives of these firms in designing the RBMs.

[2] The Taskforce for Applied Research (National Regieorgaan Praktijkgericht Onderzoek SIA) is part of the Netherlands Organization for Scientific Research (NWO).

3.3. Research process

Definition: The purpose of this phase is to define the principles from a review of the literature and through interviews with experts (Aken, 2004). These principles were developed by studying the literature of recycling, collaborative, and scalable BMs.

We also conducted semi-structured interviews with a materials expert, a designer with expertise in the design of physical stores of businesses, and a manufacturer of non-woven fleeces (i.e., the primary technique to produce the Recurf-material). The interviews were organized around the BM properties, i.e., the characteristics of the Recurf-material, the potential product applications, the value proposition, and the creation, delivery, and capture of the value.

Field-testing: The purpose of this second phase was to design a RBM for each case that took into consideration the recycling, collaborative, and scalability dimensions. We used documents and archival data regarding the three cases, additional interviews and a workshop with the consortium. The use of multiple sources for the triangulation of the data aids in reducing the researcher’s bias and retrospective sensemaking (Chenail, 2011).

The primary documentation that served as input was graduation theses written by students. For each case, a student at a university of applied science in the Netherlands was assigned a graduation project, where the student designed and created prototypes.[3] As cumulation of the graduation projects, students wrote reports to disseminate the accumulated knowledge. These reports were studied to draft a RBM for each case. We also searched the World Wide Web for non-intrusive documentation (e.g., media and press releases, and the websites of the firms) (Pollock and Lashley, 2014).

In addition, we interviewed representatives of the focal firms in the three cases. The purpose was to gain knowledge of the current BM used by the companies and gain input in the practical guidelines that could be used to design the recycling, collaborative, and scalable BM.

Furthermore, considering that to design, create, and introduce the products into the market requires collaboration from a diverse set of actors across the industry, we conducted a workshop with the Recurf-Up consortium. The partners that participated in this workshop represented all stakeholders of the industry (i.e., waste collectors, R&D institutes, universities, designers, manufacturers, distributors, marketers, and industry representatives) except for certification bodies, government, NGOs, and media organizations. The workshop consisted of collecting views of the participants regarding their unique BMs to contribute to a solution for textile waste. In other words, each participant indicated their views regarding the value they can co-create and distribute, their revenue models, and potential risks and uncertainties.

[3] The setup of the graduation projects was the following. Project description developed in collaboration between the firms and the Recurf-Up project leader were used to recruit students. During the execution of the projects, each student was given two supervisors-one representing the firm and one representing the university of applied science. Students completed their projects in approximately four months.

Finally, to assess the designed RBMs, we conducted follow-up semi-structured interviews with a representative of the focal companies. We evaluated the RBM we created for each specific product. We also conducted semi-structured interviews with potential customers. For each case, we determined potential customers for the RBMs, and interviewed representatives responsible for purchasing decisions. For CeilingsCo and InsulationCo, we interviewed a representative of a hotel who supports managers with procurement. For FurnitureCo, we interviewed a purchasing advisor who provides advice on matters relating to the procurement of services and products. Since the university was in the process of relocating to a new building, we also interviewed the project leader responsible for the new layout, furnishing, and relocation. The interviews covered the topics relating to the expected value benefits of purchased and desired products (e.g., function, price, and aesthetics), the procurement processes (e.g., from need identification, to vendor selection, to payment, and parties involved in the decision-making), and the criteria that influence the procurement (e.g., purchase conditions such as liability insurance). The topic of the value propositions, creations, and delivery of the RBMs was also covered.

Evaluation: The purpose of this last phase was to assess the practical guidelines against the principles (Romme and Reymen, 2018). We also conducted a cross-case analysis to determine the minimum practical guidelines to which recycling, collaborative and scalable BM must meet.

3.4. Data coding and analysis

Following the General Data Rights Regulation (GDPR), we signed consent forms with all interviewees. They were notified of the purpose of the study, the collection method, the use of the data, and were allowed to opt-out of the interview. All interviews were audio-recorded and lasted between 30 and 80 min. All interviews were summarized into reports. These reports were combined with other collected data and analyzed by linking the data with the practical guidelines through cross-case analysis (Miles and Huberman, 1994; Yin, 2017) (see Table 1).

4. The principles for developing recycling, collaborative and scalable business models

In the Definition phase, we developed principles for recyclable, collaborative, and scalable BMs. We identified 17 principles; six for recycling, four for collaborative, and seven for scalable BMs (see Table 2 for an overview of the principles, and Online supplementary materials 1 for an elaborate review).

We build on Breuer et al. (2018) and compare our 17 principles with these authors' four guiding principles for developing sustainable BMs; 1. Sustainability orientation, 2. Extended value creation, 3. Systemic thinking, and 4. Stakeholder integration. First, *sustainability orientation* is the value-based normative reference that organizations should include in their mission and vision. Sustainability is viewed by many as an abstract and broad concept (Leal Filho, 2000). Therefore, it is necessary to clarify the concept. Breuer et al. (2018) suggest three levels 1) the general idea of sustainability, 2) the action-oriented principles of sustainability, and 3) the practical concepts related to sustainability. As a result of clarification of sustainability based on these levels, *sustainability*

Table 1
Overview of collected data.

Sources of data	
Documents	Student reports, media and press releases, company websites
Interviews	Materials expert, store designer, manufacturer of non-woven fleeces, representatives of the firms from the cases, potential customers (hotel and university)
Workshop	Waste collectors, R&D institutes, universities, designers, manufacturers, distributors, marketers, and industry representatives

Table 2
Principles for recycling, collaborative and scalable business.

Breuer et al. (2018)			
Sustainability orientation	Principles for recycling (R), collaboration (C), and scaling (S)		
A value-based normative reference that serves as a guidepost for the stakeholders involved on the levels of the general idea, action-oriented principles, and practical concepts related to sustainability	(C3) Partners have aligned expectations of value outcomes		
Extended value creation			
Generate both monetary and non-monetary value for both market and non-market actors (triple bottom online)	(R3) Technologies that allow for the processing of waste materials into materials and products of higher value	(R5) Manufacturers know material sciences and product designs	(R6) Manufacturers work with process-intensive production methods of composite materials
Systems thinking			
A holistic and systemic approach that applies the concepts of life cycle thinking, product-service systems, and reflecting outcomes throughout the interdependent activities	(R1) Take-back systems that guarantee efficient, predictable, and consistent inflow of materials	(R2) Take-back systems that guarantee inflow of quality materials	
Stakeholder integration			
Acknowledging, integrating, and managing stakeholders' interdependencies and values to align with the sustainability goals of the organization	(R4) Consumers have correct perceptions of products made with recycled materials	(C1) Partners have open attitudes	(C2) Partners are transparent and have trust
	(C4) Balance between the benefits and contributions of the partners		
Scalable	(S1) Technologies that can be automated	(S2) Technological infrastructures that can be expanded	(S3) Generate a positive cash flow
	(S4) Adaptable to different legal regimes	(S5) Create network effects	(S6) Adequate problem-solution fit and simple solutions that match the users' previous knowledge
	(S7) Address large markets or markets with growth potential		

orientation serves as a guidepost for the stakeholders involved in the BM. Taking into consideration the multiplicity of potential values that can be created, partners should define common ground by aligning expectations of value outcomes (Dahan et al., 2010; Oskam et al., 2020; Rohrbeck et al., 2013) and *sustainability orientation* allows partners to align these expectations (Breuer and Lüdeke-Freund, 2017). Therefore, we associate *sustainability orientation* with the principle *Partners have aligned expectations of value outcomes (C3)*.

Second, *extended value creation* regards generating both monetary and non-monetary values for both market and non-market actors (triple bottom line). Many scholars emphasize that sustainable BMs should create economic, environmental, and societal value (e.g., Breuer et al., 2018; Evans et al., 2017; Schaltegger et al., 2016). Advancing this line of thought to RBMs, these BMs should create economic and environmental benefits (Rashid et al., 2013) where the environmental benefit is central (Bocken et al., 2014). To extend the value creation to benefit the environment, resource inflows and technologies that can process the resources into materials and products of higher quality are essential (Lüdeke-Freund et al., 2019). Products are often a combination of multiple materials. For the recycling of these products, it is necessary to separate the materials or find other means of processing the products into new resources. These processes are different from working with virgin materials and hence require new technologies. Furthermore, manufacturers can be misinformed about recycling and the possibilities that recycling offers (Sung, 2015). In particular, manufacturers need supplementary knowledge about material sciences and product design to be able to revise their capabilities to meet the distinctive processes required by working with waste materials and products. Manufacturers need to acquire the capabilities for process-intensive production methods of composite materials. Therefore, we associate *extended value creation* with the principles *Technologies that allow for the processing of waste materials into materials and products of higher value (R3), Manufacturers know material sciences and product designs (R5), and Manufacturers work with process-intensive production methods of composite materials (R6)*.

Third, *systemic thinking* is a holistic approach to BMs as it is required to integrate specialized internal and external knowledge and resources through interdependent activities (Breuer et al., 2018). These authors propose three related aspects of systemic thinking, 1) life cycle thinking, 2) product-service systems, and 3) reflecting outcomes. Especially life cycle thinking is crucial for recycling since there are many alternatives for end-of-life product recovery (Ziout et al., 2014), and recycling is not always the most suitable solution. Furthermore, end-of-life product recovery requires take-back systems (Lüdeke-Freund et al., 2019) that guarantee efficient, predictable, and consistent return flows of quality materials (Sung, 2015) since the purpose of recycling is 'closing the loop.' Therefore, we associate *systemic thinking* with the principles *Take-back systems that guarantee efficient, predictable, and consistent inflow of materials (R1), and Take-back systems that guarantee inflows of quality materials (R2)*.

Finally, *stakeholder integration* is acknowledging, integrating, and managing stakeholders' interdependencies and values to align with the sustainability goals of the organization (Freudenreich et al., 2019). Partners should be open-minded to collaborate with others in areas in which they do not have the expertise (Heger and Rohrbeck, 2012; Oskam et al., 2020), meaning that partners should be transparent with one another (Akkermans et al., 2004) to develop the necessary mutual trust (Rohrbeck et al., 2013) that enables the success of their partnerships (Bstieler, 2006). Furthermore, to avoid partners feeling misused in the collaboration, equitable benefits and contributions are necessary (Oskam et al., 2020). In addition, customers are also important stakeholders in RBM. They should have the understanding that products made from recycled textiles are not necessarily of lower quality compared to products made from virgin materials (Kraaijenhagen et al., 2016). This understanding and a positive image and safety of the product (Calvo-Porral and Lévy-Mangin, 2020) is crucial for a market that is willing to purchase products made with recycled materials. Therefore, we associate *stakeholder integration* with the principles *Consumers have correct perceptions of products make with recycled materials (R4)*, *Partners have open attitudes (C1)*, and *Partners are transparent and have trust (C2)*.

It should be noted that Breuer et al. (2018) do not integrate any aspects of scalability into their guiding principles. Yet, scalability is vital for impact. One important aspect relating to scalability is the technologies that can be automated (principle S1) (Stampfl et al., 2013). Automation allows for cost reduction and the realization of sustainable competitive advantage (Mata et al., 2006). In addition, the technology infrastructure itself should be scalable (principle S2) (Stampfl et al., 2013). Furthermore, financing also plays a crucial role in scaling BMs. Positive cash flow should be generated (principle S3) to offset the high initial costs of the market and the development of the firm's infrastructure (Esposito et al., 2012). Also, the legal regime (principle S4) is vital for scaling BMs as laws can reduce value capture (Planing, 2015). Likewise, the creation of network effects (principle S5) influences the scalability of BMs because network effects generate superior value to customers (Choi and Thum, 1998). Last but not least, scaling is a challenge without a sizable market (principle S7) (Nielsen et al., 2017), and fit between the problem and the solution (Baldassarre et al., 2017). Moreover, the simplicity of the solution that matches the user's previous knowledge (principle S6) (Stampfl et al., 2013) influences the scalability of the BM. In all, the users should understand and be convinced of the value that the product delivers.

5. The practical guidelines applied in recycling business models

In this section, we present the practical guidelines applied in the designed RBMs for the three cases regarding the reuse of textile fibers to develop biocomposite products during the field-testing. The RBMs are presented based on the framework proposed by Lüdeke-Freund et al. (2019). Therefore, we use also this framework to present the practical guidelines (see Table 3 for an overview of the practical guidelines and the RBMs).

5.1. Practical guidelines related to the value proposition

Value proposition consists of products and services (Lüdeke-Freund et al., 2019). The value propositions in the RBMs regarded both product and services. The former offered combinations of values. For example, FurnitureCo's privacy screen proposed two functional values (i.e., lightweight and acoustic properties), and InsulationCo's modular panels are noise-reducing and can also be used as room partitioners. The products are also viewed as aesthetically pleasing, and the mixture of recycled textile is considered *the perfection of imperfection*. Therefore, we suggest that RBMs should offer both functional and beautiful products, next to being made from recycled materials (*PG1*). In addition, the products are positioned in existing product categories (and not new ones) (*PG2*). For example, the privacy screen of FurnitureCo is positioned in the product category of privacy panels for office furniture. Furthermore, the products are designed to work with complementary products (*PG3*). For example, the modular ceiling system developed by CeilingsCo can be retrofitted with LED lights and acoustic panels.

The value propositions in the RBMs are also service-oriented. The firms in our cases provide take-back services (*PG4*) to their customers. These services are for both taking back their products sold when these products reach the end of their life cycle (e.g., CeilingsCo offered the service to uninstall and take back the modular ceiling systems) and recover materials from products sold by third parties. FurnitureCo provided only the latter service because it operated in the higher business-to-business segment, and its products have lifespans of over ten years. When these products are discarded, they are still fit to be used in lower business-to-business segments. Therefore, the choice was made not to offer a take-back of the privacy screens but to encourage that the

Table 3
The practical guidelines and designed recycling business models.

BM Dimensions	Value proposition				Value delivery			
	Products			Services	Target customers		Value delivery process	
InsulationCo	A modular noise-reducing panel that can also be used as a partition wall and made from recycled textile	Partition wall		The panels are taken back when customers would like to discard the product	Buildings containing large indoor spaces where good audio quality is important		Uses returned panels and textile that customers discard	It is visible that the panel is made from recycled textile
FurnitureCo	A modular privacy screen that is lightweight, functions as a sound barrier for desks, and made from recycled textile	Desk privacy panel		The textile is recovered when customers would like to discard of them		Organizations using or providing open workspaces	Uses returned textile that customers discard	It is visible that the entire privacy screen is made from recycled textile
CeilingsCo	An open sculptural modular ceiling system made from recycled textile	Ceiling	LED lights and acoustic panels can be installed within the system	The ceilings are uninstalled and taken back when customers would like to discard the product	Small scale hotels and exhibition centers		Uses returned ceilings and textile that customers discard	It is visible that the acoustic panel is made from recycled textile
Practical guidelines	Develop a product that is functional and beautiful next to sustainable	Develop the product to fit within existing product categories	Design the product to fit with existing complementary products	Provide a take-back service for your customers by collecting the end-of-life product	Focus on a market that is large and standardized	Focus on a market that is growing	Use the waste of a customer directly in the product for that respective customer	Make the recycled component visible
	PG1	PG2	PG3	PG4	PG5	PG6	PG7	PG8

BM Dimensions	Value creation					
	Partners and stakeholders					
InsulationCo	Works with waste collectors, distributors, and transporters around the Cradle to Cradle principles				Works with fire safety certification institute	
FurnitureCo	Works with materials manufacturers and transporters around the WELL building standard			Partners with universities for research on the material		Works with designers who won awards (e.g., Red Dot Award: Design Concepts)
CeilingsCo	Works with material manufacturers, waste collectors, manufacturers of products, distributors, transporters around social design and production principles	Joint investment in resource inputs, manufacturing, sales and distribution logistics	Develops a constitutional contract (i.e., specify the decision rules and do not specify the use of resources) with partners			
Practical guidelines	Work with collaboration partners with whom you have similar ideas/outlooks on sustainability	Work with collaboration partners that want to jointly invest and share the benefits and risks to realize the project (instead of a traditional supplier-buyer relationship)	Develop a working agreement that serves as a governance mechanisms for your partner collaboration	If you do not have knowledge of material sciences in-house, partner with universities or R&D institutes	Work with certification institutes to provide consumer education on the quality of the product	Work with reputable partners that are recognized by your customers (e.g., designers who won awards) to increase the legitimacy of the product
	PG9	PG10	PG11	PG12	PG13	PG14

BM Dimensions	Value creation		Value capture		
	Value creation processes		Revenues		Costs
InsulationCo	Waste textile is purchased, combined with recovered panels and textile from customers, and recycled into the new panels		Sales through distributors		Material processing, design, and production
FurnitureCo		Waste materials from other in-house production lines are combined with recovered textile from customers and upcycled into the privacy screens		Direct sales	Design, production, sales and distribution logistics
CeilingsCo	Recycled textile is purchased, combined with recovered ceilings and textile from customers, and recycled into the new ceilings		Sales through distributors		Product recovery and processing, design, and production
Practical guidelines	Do not rely only on collecting waste materials from your prospective customer, but work with partners who can provide high volumes of waste material so to provide a predictable and consistent inflow of materials	Make use of your waste in your product made from recycled materials	If you are a small firm, sell through distributors	If you are a multinational firm, use direct sales	–
	PG15	PG16	PG17	PG18	

products are resold in low-income markets.

5.2. Practical guidelines related to the value delivery

The value delivery consists of the target customers and the value delivery process (Lüdeke-Freund et al., 2019). The RBMs in our cases are business-2-business and targeted both large and standardized markets (*PG5*) and growing markets (*PG6*). For example, CeilingsCo targeted small scale hotels and exhibitions centers, and FurnitureCo targeted the growing demand for co-working offices (i.e., organizations that use open workspaces for their employees or offer these workspaces as services).

The value delivery processes regarded using the recovered products and materials from a customer directly into the products manufactured for that specific customer (*PG7*) and making the recycled component visible in the product (*PG8*). For example, FurnitureCo's privacy screen was designed and produced by pressing the recycled material into a mold. Due to this design and manufacturing process, the panel does not need any additional material to hold its structural integrity, and the recycled components of the product are visible. As a result, this design enhances the aesthetics of the product.

5.3. The practical guidelines related to the value creation

The value creation consists of the partners and stakeholders and the value creation process (Lüdeke-Freund et al., 2019). The firms in our cases partnered with several stakeholders such as waste collectors, material processors and manufacturers, designers, distributors and transportation logistics. The firms in our cases sought cooperation with partners who had similar basic ideas about sustainability (*PG9*). For example, CeilingsCo pursued sustainable social design and production principles and partnered with a sheltered workshop to manufacture the products. Partnerships are both collaborations in the supply chain and buyer-supplier relationships. On the one hand, there are collaborations between partners who jointly invested in the projects and shared the benefits and risks to provide solutions to the textile waste problems (*PG10*). For example, CeilingsCo collaborated in resource inputs, manufacturing, sales and distribution logics. On the other hand, firms used buyer-supplier relationships. For instance, InsulationCo's core capabilities included material processing, manufacturing, design, and production. Therefore, this firm used buyer-supplier relationships for resource inputs, distribution, and transportation logistics. To facilitate the collaborations, firms developed working agreements (*PG11*). For example, CeilingsCo used a constitutional contract. It is not always the case that the firms have the capabilities for processing waste textiles. However, as these materials are vital for the design, manufacturing, and realization of the products' value propositions, firms that lacked these capabilities partnered with universities or R&D institutes (*PG12*). For example, FurnitureCo partnered with a university to study the characteristics of the Recurf-material. Also, as educating customers on products made from recycled materials is vital for customers to understand these products, firms also partnered with certification institutes (*PG13*). In addition, firms also worked with reputable partners that their customers recognize to increase the legitimacy of their products (*PG14*). For example, FurnitureCo periodically invited external designers recognized by the design community and won awards such as the Red Dot Award: Design Concepts to create new designs of the privacy screens.

The value creation processes regard the activities to create the product or product the service. The firms in our cases did not rely only on collecting waste textile from their (prospective) customers, but also purchased resource inputs from high-volume suppliers (*PG15*). For example, CeilingsCo purchased waste textile that has been processed into Recurf-material, and InsulationCo purchased unprocessed waste textile from one of the leading waste collectors in the Netherlands. On the contrary, FurnitureCo used its waste material produced in-house and combined this recovered waste textile from (prospective) customers. Therefore, we suggest that firms use their waste in their manufacturing of their products made from recycled textile (*PG16*).

5.4. The practical guidelines related to the value capture

The value capture process consists of the revenues and costs structures (Lüdeke-Freund et al., 2019). The smaller firms, in our cases, sold through distributors (*PG17*), and the multinational firm made use of direct sales (*PG18*). The main costs of the firms were product recovery and processing, design, production, sales and distribution logistics.

6. The minimum practical guidelines for recycling, collaborative and scalable business models

In final evaluation phase of the study, we evaluated the minimum practical guidelines for RBMs that are also collaborative and scalable (Section 5) with the principles developed from theory (Section 4). We observed six practical guidelines that were consistent throughout the cases (See Table 4 for an overview of the minimum practical guidelines).

First, we observed that a reoccurring practical guideline throughout the RBMs is to *Develop a product that is functional and beautiful next to sustainable* (*PG1*). Indeed, studies suggest that RBMs should have simple value propositions for customers, based on the previous user knowledge (Stampfl et al., 2013), and have a good fit with the problem that the customer is facing (Baldassarre et al., 2017). Customers are unwilling to sacrifice function (Franco, 2017), suggesting that RBMs should have value propositions for the environment *and* consumers (Boons and Lüdeke-Freund, 2013).

Second, we observed that a reoccurring practical guideline throughout the RBMs is to *Develop the products to fit within existing product categories (PG2)*. Indeed, a principle (*S6*) for scaling BMs is that there is a fit between the problem and the solution (Baldassarre et al., 2017) and is simple to match the user's previous knowledge (Stampfl et al., 2013). The consumer's knowledge of a product determines the risks and the quality that the consumer perceives in that product (Hamzaoui-Essoussi and Linton, 2014). When consumers experience uncertainty regarding recycled products, they are less willing to make a purchase decision (Calvo-Porral and Lévy-Mangin, 2020). A strategy to improve the purchasing intention of products is to position them in existing product categories that are familiar to the consumers (Johnson and Russo, 1984).

Third, we observed that a reoccurring practical guideline throughout the RBMs is to *Provide a take-back service for your customers by collecting the end-of-life product (PG4)*. The motivation for offering take-back services is related to the control over the efficiency, predictability, and consistency inflows of material (*Principle R1*). The core thesis of

Table 4
Evaluation of the minimum practical guidelines against the principles.

Practical guidelines		Principles	
PG1	Develop a product that is functional and beautiful next to sustainable	S6	Adequate problem-solution fit and simple solutions that match the users' previous knowledge
PG2	Develop the product to fit within existing product categories	S6	Adequate problem-solution fit and simple solutions that match the users' previous knowledge
PG4	Provide a take-back service for your customers by collecting the end-of-life product	R1	Take-back systems that guarantee efficient, predictable, and consistent inflow of materials
PG7	Use the waste of a customer directly in the product for that respective customer	R4	Consumers have correct perceptions of products made with recycled materials
PG8	Make the recycled component visible	R4	Consumers have correct perceptions of products made with recycled materials
PG9	Work with collaboration partners with whom you have similar ideas/outlooks on sustainability	C3	Partners have aligned expectations of value outcomes

recycling is giving used materials a new life by substituting the used materials for virgin materials (Geissdoerfer et al., 2017a). Hence, closing the loop and recouping back used materials is vital for RBMs. By offering a take-back service for the customers, firms have direct access to the resource inputs. They can eliminate any unnecessary steps in the value chain to recover these resources, thus increasing the efficiency of material inflows. Also, using the recovered materials directly in the product's manufacturing results in consistency in inflows of resource input. Firms know the source of these resource input. This knowledge improves the predictability of the influx of materials enabling firms to match the supply of resource inputs with the demand of these inputs.

Fourth, we observed that a reoccurring practical guideline throughout the RBMs is to *Use the waste of a customer directly in the product for that respective customer (PG7)*. There are two main reasons for this guideline. As discussed previously, the demand and supply for resource inputs can be better predicted and coordinated. Also, consumers often perceive sustainable products as less quality than products made with virgin materials. However, recycled products do not necessarily have less quality (Kraaijenhagen et al., 2016), and thus manufacturers should provide customers with adequate information about recycled products and their characteristics (Calvo-Porral and Lévy-Mangin, 2020) to change consumers' perceptions of recycled products (*Principle R4*). Making the consequences of the sustainable behavior of customers more tangible makes it easier for them to understand sustainability (Trudel, 2018). Indeed, tangibility is one of the determinant factors of sustainable behaviors (White et al., 2019). Therefore, by using the waste material of the customer directly in the product for that respective customers, the tangibility of the consequences of the consumer's behavior becomes clearer promoting purchasing of the product.

Fifth, to correct consumers' perceptions regarding the quality of products made with recycled materials, we observed that another reoccurring practical guideline throughout the RBMs is to *Make the recycled component visible (PG8)*. The adage 'A Picture is Worth A Thousand Words' suggest that visual images can influence individuals' perceptions. For example, Xue and Muralidharan (2015) found that green visuals increase the positive assessments of environmental claims. Di et al. (2014) found that visual images increase buyers' attention, trust, and conversion rate. Therefore, we suggest that making the recycled components within a product visible to the customers, these images can influence reinforce the positive effects of using waste materials of customers directly into the products for that respective customer.

Finally, we observed that a reoccurring practical guideline throughout the RBMs is to *Work with collaboration partners with whom you have similar ideas/outlooks on sustainability (PG9)*. The motivation for this guideline is to align the expectations of the value outcomes (Dahan et al., 2010; Oskam et al., 2020; Rohrbeck et al., 2013). Values are desired beliefs and attitudes (Breuer and Lüdeke-Freund, 2017), and individuals' values influence their normative behavior (Roccas and Sagiv, 2010). In other words, values influence an individual's expectations. Therefore, working with partners with similar ideas on sustainability influences the alignment of expectations between the partners.

7. Discussion and contribution

This study aimed to research the minimum practical guidelines for RBMs that are also collaborative and scalable. Developing RBMs is challenging as organizations need to take into account multiple principles imposed by the recycling, collaborative, and scalability dimensions of these business models. These principles are often general and not actionable by practitioners leading to failure when the RBMs are implemented (Tukker, 2015), and from those that do succeed, many never scale and reach intended impact (Schaltegger et al., 2016).

We used a design science approach to arrive at insights that apply to practitioners. The research-through-design approach seeks to address this gap by developing practical guidelines that practitioners can use when designing solutions (Baldassarre et al., 2017; Romme and Reymen, 2018). Our findings show that by combining insights from literature and interviews with experts an extensive list of guiding principles was derived for RBMs. By field-testing these principles in interaction with practitioners it was possible to reduce this list to a limited set of practical guidelines for practitioners to use when developing RBMs, while grounding the solution by building upon relevant literature. In this design science approach, we took as researchers the perspective of a player to develop an effective solution to a class of field problems (Hevner et al., 2004; van Aken and Romme, 2012), i.e. developing viable and scalable RBMs. It shows that design science research can help to translate theoretical insights into practical solutions for practice.

We make two contributions to the literature of RBMs. First, the minimum practical guidelines for RBMs can be linked to three recycling and two scaling principles, but to only one collaboration principle. The literature views collaboration as vital for establishing RBMs (Jia et al., 2020). For example, Christensen (2021) suggest that collaboration between municipalities and government-owned waste management companies is a driver for change. Jia et al. (2020) suggest that problems with recycling programs is due to lack of collaboration between government, retailers, and suppliers. Siderius and Poldner (2021) suggest that within sector collaboration is necessary to reduce rebound effects. Indeed, a systematic review of the literature found that "collaborating with value creation business networks are frequently mentioned conditions for the development and successful realization of CBMs" (Hofmann, 2019, p.369). However, studies also found that firms engaging in recycling are also slow to enter into these collaborations as firms lack the foundational trust between partners and the process to start and build trust is time-consuming (Guldmann and Huulgaard, 2020). Therefore, we advance the thought that a minimum practical guideline for RBMs is collaboration when the activities are across multiple sectors. However, collaboration is not a sine que non within a single sector. Firms can also choose vertical integration as strategies to cope with the challenges of collaboration in RBMs. In particular, vertical integration is viewed as a strategy to develop demand for a recycled product (Van Raak and Loorbach, 2014) and to guarantee the consistency of quality of the inflow of materials (Beulque and Aggeri, 2016).

We also contribute to the debate regarding lease constructs as a mechanism to take back resources. As suggested, a recurring practical guideline for RBMs that is also scalable is the guarantee of predictable, consistent, efficient, and quality resource inflows (Singh and Ordoñez, 2016). However, this endeavor is challenging (Franco, 2017) and not yet proven (Sung, 2015). Studies indicate that service systems, which include product take back (Product Service Systems- PPS), is ideal since the firm delivers usage and retains ownership over the products (Bocken et al., 2014). However, recent studies show that the lease construct provides additional benefits only under specific conditions, e.g., when products have high use impact but low durability (Agrawal et al., 2012).

Furthermore, lease constructs are problematic since consumers are constraint in how they can make use of the product (Tukker, 2015). We contribute to this debate by suggesting that the lease construct as a take-back system inhibits the scalability of the BM as well. We suggest that PPS is heavy on the pre-investments (i.e., the inventory should pre-financed by the company), and the recoupment of the investments is stretched over a more extended period. Therefore, there is a long lead time to make a return on the invested assets (ROA).[4] This lead time is especially worrisome for smaller companies. If a firm leases its inventory instead of selling it, *ceteris paribus*, the return on the assets will decrease. Under these conditions, a firm requires more cash to fund its growth.

[4] The ROA shows the efficiency of the company with regards to the firm using its assets. It is calculated by dividing the income by the total assets. Inventory forms part of the current assets, i.e., assets that can be easily transferred into cash (for example, by selling the assets).

Because the cash is not generated internally, these firms rely on external financing. However, investment institutions are reluctant to invest in these circular companies (Fischer and Pascucci, 2017). Hence, the scalability of the firm is hampered when the firm uses a lease construct.

The design-science approach of this study has some limitations. First, further research is necessary to study the applicability of the practical guidelines in other contexts as we focused solely on business-to-business markets and the upcycling of waste textile fibers to create biocomposite products in the Netherlands. Field-testing the extensive set of guiding principles for developing RBMs with other materials may present additional practical guidelines. Second, additional testing of the practical guidelines with third parties can improve the objectivity and extend the applicability of the results (Aken, 2004). Finally, the RBMs that we have designed have not been implemented. Studies suggest that business models proceed through a reiterative process of design and implementation, and the final version of the RBM differentiates from the initial one (Geissdoerfer, Savaget and Evans, 2017b) and may present additional sets of practical guidelines.

8. Conclusion

As our societies face many sustainability problems, advancing to a circular economy and closing resource loops through recycling is a suitable solution. Through there is a plurality in studies advancing principles for RBMs, due to the theoretical nature of these studies, the principles are difficult to put in action by practitioners. In this study, we developed practical guidelines that are minimally required for the successes of RBMs. It is our hope that with these practical guidelines, we can take closer steps to solve the sustainability problems of today.

CRediT authorship contribution statement

Richard A. Martina: Conceptualization, Methodology, Writing – original draft. **Inge F. Oskam:** Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

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References

Aagaard, A., Saari, U.A., Mäkinen, S.J., 2021. Mapping the types of business experimentation in creating sustainable value: a case study of cleantech start-ups. J. Clean. Prod. 279, 123182. https://doi.org/10.1016/j.jclepro.2020.123182.

Adam, S., Bucker, C., Desguin, S., Vaage, N., Saebi, T., 2018. Taking part in the circular economy: four ways to designing circular business models. SSRN Electr. J. https://doi.org/10.2139/ssrn.2908107.

Agrawal, V.V., Ferguson, M., Toktay, L.B., Thomas, V.M., 2012. Is leasing greener than selling? Manag. Sci. 58 (3), 523–533. https://doi.org/10.1287/mnsc.1110.1428.

Aken, J. E. van, 2004. Management research based on the paradigm of the design sciences: the quest for field-tested and grounded technological rules. J. Manag. Stud. 41 (2), 219–246. https://doi.org/10.1111/j.1467-6486.2004.00430.x.

Akkermans, H., Bogerd, P., Van Doremalen, J., 2004. Travail, transparency and trust: a case study of computer-supported collaborative supply chain planning in high-tech electronics. Eur. J. Oper. Res. 53 (2), 445–456. https://doi.org/10.1016/S0377-2217(03)00164-4.

Amit, R., Zott, C., 2001. Value creation in e-business. Strat. Manag. J. 22 (6–7), 493–520. https://doi.org/10.1002/smj.187.

Baden-Fuller, C., Morgan, M.S., 2010. Business models as models. Long. Range Plan. 43 (2–3), 156–171. https://doi.org/10.1016/j.lrp.2010.02.005.

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

Beer, M., 2001. Why management research findings are unimplementable: an action science perspective. Reflections 2 (3), 58–65. https://doi.org/10.1162/152417301570383.

Beer, M., 2020. Making a difference: developing actionable knowledge for practice and theory. J. Appl. Behav. Sci. 56 (4), 506–520. https://doi.org/10.1177/0021886320939613.

Beulque, R., Aggeri, F., 2016. Circular business model innovation: key patterns and challenges to unleash recycling value creation potential. EGOS.

Björkdahl, J., Holmén, M., 2013. Editorial: business model innovation-the challenges ahead, 18. Int. J. Product Development.

Bocken, N.M.P., de Pauw, I., Bakker, C., van der Grinten, B., 2016. Product design and business model strategies for a circular economy. J. Industr. Prod. Eng. 33 (5), 308–320. https://doi.org/10.1080/21681015.2016.1172124.

Bocken, N.M.P., Schuit, C.S.C., Kraaijenhagen, C., 2018. Experimenting with a circular business model: lessons from eight cases. Environ. Innovat. Societal Transit. 28, 79–95. https://doi.org/10.1016/j.eist.2018.02.001.

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

Bocken, Nancy M.P., Olivetti, E.A., Cullen, J.M., Potting, J., Lifset, R., 2017. June 1). Taking the circularity to the next level: a special issue on the circular economy. J. Ind. Ecol. 21 (3), 476–482. https://doi.org/10.1111/jiec.12606.

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

Boström, M., Micheletti, M., 2016. Introducing the sustainability challenge of textiles and clothing. J. Consum. Pol. 39 (4), 367–375. https://doi.org/10.1007/s10603-016-9336-6.

Breuer, H., Fichter, K., Lüdeke-Freund, F., Tiemann, I., 2018. Sustainability-oriented business model development: principles, criteria and tools. Int. J. Entrepreneurial Ventur. 10 (2), 256–286. https://doi.org/10.1504/IJEV.2018.092715.

Breuer, H., Lüdeke-Freund, F., 2017. Values-based netowrk and business model innovation. Int. J. Innovat. Manag. 21 (3) https://doi.org/10.1142/s1363919617500281, 1750028.

Bstieler, L., 2006. Trust formation in collaborative new product development. J. Prod. Innovat. Manag. 23 (1), 56–72. https://doi.org/10.1111/j.1540-5885.2005.00181.x.

Calvo-Porral, C., Lévy-Mangin, J.-P., 2020. The circular economy business model: examining consumers' acceptance of recycled goods, 2020 Adm. Sci. 10 (2), 28. https://doi.org/10.3390/ADMSCI10020028. Page 28, *10*.

Chenail, R.J., 2011. The qualitative report interviewing the investigator: strategies for addressing instrumentation and researcher bias concerns in qualitative research interviewing the investigator: strategies for addressing instrumentation and researcher bias concerns in Q. Qual. Rep. 16 (1), 255–262. https://nsuworks.nova.edu/tqr/vol16/iss1/16.

Choi, J.P., Thum, M., 1998. Market structure and the timing of technology adoption with network externalities. Eur. Econ. Rev. 42 (2), 225–244. https://doi.org/10.1016/S0014-2921(97)00065-2.

Christensen, C.M., Bartman, T., van Bever, D., 2016. September 13). The Hard Truth about Business Model Innovation. MIT Sloan Management Review. https://sloanreview.mit.edu/article/the-hard-truth-about-business-model-innovation/.

Christensen, T.B., 2021. Towards a circular economy in cities: exploring local modes of governance in the transition towards a circular economy in construction and textile recycling. J. Clean. Prod. 305, 127058. https://doi.org/10.1016/j.jclepro.2021.127058.

Dahan, N.M., Doh, J.P., Oetzel, J., Yaziji, M., 2010. Corporate-NGO collaboration: Co-creating new business models for developing markets. Long. Range Plan. 43 (2–3), 326–342. https://doi.org/10.1016/j.lrp.2009.11.003.

Di, W., Sundaresan, N., Piramuthu, R., Bhardwaj, A., 2014. Is a picture really worth a thousand words? - on the role of images in e-commerce. In: WSDM 2014 - Proceedings of the 7th ACM International Conference on Web Search and Data Mining, pp. 633–641. https://doi.org/10.1145/2556195.2556226.

Dijkstra, H., van Beukering, P., Brouwer, R., 2020. Business models and sustainable plastic management: a systematic review of the literature. J. Clean. Prod. 258, 120967. https://doi.org/10.1016/j.jclepro.2020.120967.

Ellen Mac Arthur Foundation, 2014. Toward the Circular Economy—Accelerating the Scale-Up across Global Supply Chains.

Esposito, M., Kapoor, A., Goyal, S., 2012. Enabling healthcare services for the rural and semi-urban segments in India: when shared value meets the bottom of the pyramid. Corp. Govern. 12 (4), 514–533. https://doi.org/10.1108/14720701211267847.

Evans, S., Vladimirova, D., Holgado, M., Fossen, K. Van, Yang, M., Silva, E.A., Barlow, C. Y., 2017. Business model innovation for sustainability: towards a unified perspective for creation of sustainable business models. Bus. Strat. Environ. 26 (5), 597–608. https://doi.org/10.1002/BSE.1939.

Fischer, A., Pascucci, S., 2017. Institutional incentives in circular economy transition: the case of material use in the Dutch textile industry. J. Clean. Prod. 155, 17–32. https://www.sciencedirect.com/science/article/pii/S0959652616320935.

Franco, M.A., 2017. Circular economy at the micro level: a dynamic view of incumbents' struggles and challenges in the textile industry. J. Clean. Prod. 168, 833–845. https://doi.org/10.1016/j.jclepro.2017.09.056. September.
Freudenreich, B., Lüdeke-Freund, F., Schaltegger, S., 2019. A stakeholder theory perspective on business models: value creation for sustainability, 2019 166 J. Bus. Ethics 166 (1), 3–18. https://doi.org/10.1007/S10551-019-04112-Z, 1.
Geissdoerfer, M., Morioka, S.N., de Carvalho, M.M., Evans, S., 2018. Business models and supply chains for the circular economy. J. Clean. Prod. 190, 712–721. https://doi.org/10.1016/j.jclepro.2018.04.159.
Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J., 2017a. The Circular Economy – a new sustainability paradigm? J. Clean. Prod. 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048.
Geissdoerfer, M., Savaget, P., Evans, S., 2017b. The cambridge business model innovation process. Procedia Manufactur. 8, 262–269. https://doi.org/10.1016/j.promfg.2017.02.033. October 2016.
Gregor, S., Hevner, A.R., 2013. Positioning and presenting design science research for maximum impact. MIS Q. 337–355. https://www.jstor.org/stable/43825912.
Guldmann, E., Huulgaard, R.D., 2020. Barriers to circular business model innovation: a multiple-case study. J. Clean. Prod. 243, 118160. https://doi.org/10.1016/j.jclepro.2019.118160.
Hamzaoui-Essoussi, L., Linton, J.D., 2014. Offering branded remanufactured/recycled products: at what price? J. Remanufactur. 4 (1), 1–15. https://doi.org/10.1186/s13243-014-0009-9.
Heger, T., Rohrbeck, R., 2012. Strategic foresight for collaborative exploration of new business fields. Technol. Forecast. Soc. Change 79 (5), 819–831. https://doi.org/10.1016/J.TECHFORE.2011.11.003.
Hevner, A.R., March, S.T., Park, J., Ram, S., 2004. Design science in information systems research. MIS Quat. 28 (1), 75–105. https://www.proquest.com/docview/218119584?pq-origsite=gscholar&fromopenview=true.
Hofmann, F., 2019. Circular business models: business approach as driver or obstructer of sustainability transitions? J. Clean. Prod. 224, 361–374. https://doi.org/10.1016/j.jclepro.2019.03.115.
Hultberg, E., Pal, R., 2021. Lessons on business model scalability for circular economy in the fashion retail value chain: towards a conceptual model. Sustain. Product. Consump. 28, 686–698. https://doi.org/10.1016/J.SPC.2021.06.033.
Jia, F., Yin, S., Chen, L., Chen, X., 2020. The circular economy in the textile and apparel industry: a systematic literature review. J. Clean. Prod. 259, 120728. https://doi.org/10.1016/j.jclepro.2020.120728. Elsevier Ltd.
Johnson, E.J., Russo, J.E., 1984. Product familiarity and learning new information. J. Consum. Res. 11 (1), 542. https://doi.org/10.1086/208990.
Konietzko, J., Baldassarre, B., Brown, P., Bocken, N., Hultink, E.J., 2020. Circular business model experimentation: demystifying assumptions. J. Clean. Prod. 277, 122596. https://doi.org/10.1016/j.jclepro.2020.122596.
Kraaijenhagen, C., Oppen, C., Bocken, N.P.M., 2016. Circular Business: Collaborate and Circulate.
Leal Filho, W., 2000. Dealing with misconceptions on the concept of sustainability. Int. J. Sustain. High Educ. 1 (1), 9–19. https://doi.org/10.1108/1467630010307066.
Lüdeke-Freund, F., Gold, S., Bocken, N.M.P., 2019. A review and typology of circular economy business model patterns. J. Ind. Ecol. 23 (1), 36–61. https://doi.org/10.1111/jiec.12763. Blackwell Publishing.
Massa, L., Tucci, C.L., Afuah, A., 2016. A critical assessment of business model research. Acad. Manag. Ann. 11 (1), 73–104. https://doi.org/10.5465/ANNALS.2014.0072.
Mata, F.J., Fuerst, W.L., Barney, J.B., 2006. Information technology and sustained competitive advantage: a resource-based analysis. MIS Q. 19 (4), 487. https://doi.org/10.2307/249630.
Miles, M., Huberman, A., 1994. Qualitative Data Analysis. Sage.
Nielsen, C., Lund, M., Thomsen, P., 2017. From digital disruption to business model scalability from digital disruption to business model scalability. ISPIM Conference. www.ispim.org.
Oghazi, P., Mostaghel, R., 2018. Circular business model challenges and lessons learned-An industrial perspective. Sustainability 10, 739. https://doi.org/10.3390/su10030739.
Oskam, I., Bossink, B., Man, A.-P. de, 2020. Valuing value in innovation ecosystems: how cross-sector actors overcome tensions in collaborative sustainable business model development. Bus. Soc. 60 (5), 1059–1091. https://doi.org/10.1177/0007650320907145.
Oskam, I., de Jong, M., Lepelaar, M., Nackenhorst, K., Boerema, M., Kate, R. ten, Blauwhoff, D., Pramod, A., 2017. RECURF Hergebruik Van Textiel in Biocomposieten: Van Materiaal Tot Toepassing.
Planing, P., 2015. Business model innovation in a circular economy reasons for non-acceptance of circular business models. Open J. Busin. Model Innovat. 1. https://www.researchgate.net/publication/273630392.
Pollock, T., Lashley, K., 2014. Who needs a shrink when you have Businessweek? *The Routledge Companion to*. https://books.google.com.co/books?hl=en&lr=&id=kC-DBAAAQBAJ&oi=fnd&pg=PA423&dq=Who+needs+a+shrink+when+you+have+Businessweek%3F&ots=qAQBwQHrNa&sig=vT-Q5bR3_kio47MqkKfjsZ_zCbE.
Rashid, A., Asif, F.M.A., Krajnik, P., Nicolescu, C.M., 2013. Resource conservative manufacturing: an essential change in business and technology paradigm for sustainable manufacturing. J. Clean. Prod. 57, 166–177. https://doi.org/10.1016/j.jclepro.2013.06.012.
Rizos, V., Behrens, A., van der Gaast, W., Hofman, E., Ioannou, A., Kafyeke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., Topi, C., 2016. Implementation of circular economy business models by small and medium-sized enterprises (SMEs): barriers and enablers. Sustainability 8 (11), 1212. https://doi.org/10.3390/su8111212.
Roccas, S., Sagiv, L., 2010. Personal values and behavior: taking the cultural context into account. Social Personal. Psychol. Compass 4 (1), 30–41. https://doi.org/10.1111/j.1751-9004.2009.00234.x.
Rohrbeck, R., Konnertz, L., Knab, S., 2013. Collaborative business modelling for systemic and sustainability innovations. Int. J. Technol. Manag. 63 (1/2), 4–23.
Romme, A.G.L., Reymen, I.M.M.J., 2018. Entrepreneurship at the interface of design and science: toward an inclusive framework. J. Busin. Ventur. Insig. 10 https://doi.org/10.1016/j.jbvi.2018.e00094.
Salvador, R., Barros, M.V., Luz, L. M. da, Piekarski, C.M., de Francisco, A.C., 2020. Circular business models: current aspects that influence implementation and unaddressed subjects. J. Clean. Prod. 250, 119555. https://doi.org/10.1016/j.jclepro.2019.119555. Elsevier Ltd.
Schaltegger, S., Hansen, E.G., Lüdeke-Freund, F., 2016. Business models for sustainability: origins, present research, and future avenues. Issue 1, 29. Organization and Environment, pp. 3–10. https://doi.org/10.1177/1086026615599806. SAGE Publications Inc.
Siderius, T., Poldner, K., 2021. Reconsidering the circular economy rebound effect: propositions from a case study of the Dutch circular textile valley. J. Clean. Prod. 293, 125996. https://doi.org/10.1016/j.jclepro.2021.125996.
Singh, J., Ordoñez, I., 2016. Resource recovery from post-consumer waste: important lessons for the upcoming circular economy. J. Clean. Prod. 134, 342–353. https://doi.org/10.1016/j.jclepro.2015.12.020.
Stampfl, G., Prügl, R., Osterloh, V., 2013. An explorative model of business model scalability. Int. J. Prod. Dev. 18 (3/4), 226. https://doi.org/10.1504/IJPD.2013.055014.
Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., Vries, W. de, Wit, C. A. de, Folke, C., Gerten, D., Heinke, J., Mace, G.M., Persson, L.M., Ramanathan, V., Reyers, B., Sörlin, S., 2015. Planetary boundaries: guiding human development on a changing planet. Science 347 (6223). https://doi.org/10.1126/SCIENCE.1259855.
Sung, K., 2015. A Review on Upcycling: Current Body of Literature, Knowledge Gaps and a Way Forward. The ICECESS 2015: 17th International Conference on Environmental, Cultural, Economic and Social Sustainability.
Täuscher, K., Abdelkafi, N., 2018. Scalability and robustness of business models for sustainability: a simulation experiment. J. Clean. Prod. 170, 654–664. https://doi.org/10.1016/J.JCLEPRO.2017.09.023.
Teece, D.J., 2010. Business models, business strategy and innovation. Long. Range Plan. 43 (2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003.
Tong, X., Tao, D., Lifset, R., 2018. Varieties of business models for post-consumer recycling in China. J. Clean. Prod. 170, 665–673. https://doi.org/10.1016/j.jclepro.2017.09.032.
Trudel, R., 2018. Sustainable consumer behavior. Consum. Psychol. Rev. 2 (1), 85–96. https://doi.org/10.1002/arcp.1045.
Tukker, A., 2015. Product services for a resource-efficient and circular economy - a review. J. Clean. Prod. 97 (15), 76–91. https://doi.org/10.1016/j.jclepro.2013.11.049.
Tunn, V.S.C., Bocken, N.M.P., van den Hende, E.A., Schoormans, J.P.L., 2019. Business models for sustainable consumption in the circular economy: an expert study. J. Clean. Prod. 212, 324–333. https://doi.org/10.1016/j.jclepro.2018.11.290.
Urbinati, A., Chiaroni, D., Chiesa, V., 2017. Towards a new taxonomy of circular economy business models. J. Clean. Prod. 168, 487–498. https://doi.org/10.1016/j.jclepro.2017.09.047.
van Aken, J.E., Romme, A.G.L., 2012. A design science approach to evidence-based management. The Oxford Handbook of Evidence-Based Management. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199763986.013.0003.
Van De Ven, A.H., Johnson, P.E., 2006. Knowledge for theory and practice. Acad. Manag. Rev. 31 (4), 802–821. https://doi.org/10.5465/amr.2006.22527385.
Van Raak, R., Loorbach, D., 2014. Context voor bedrijven: meebewegen met de transitie. Ondernemen in de circulaire economie. Nieuwe verdienmodellen voor bedrijven en ondernemers.
Veleva, V., Bodkin, G., 2018. Corporate-entrepreneur collaborations to advance a circular economy. J. Clean. Prod. 188, 20–37. https://doi.org/10.1016/j.jclepro.2018.03.196.
Vermunt, D.A., Negro, S.O., Verweij, P.A., Kuppens, D.V., Hekkert, M.P., 2019. Exploring barriers to implementing different circular business models. J. Clean. Prod. 222, 891–902. https://doi.org/10.1016/j.jclepro.2019.03.052.
Weissbrod, I., Bocken, N.M.P., 2017. Developing sustainable business experimentation capability – a case study. J. Clean. Prod. 142, 2663–2676. https://doi.org/10.1016/j.jclepro.2016.11.009.
White, K., Habib, R., Hardisty, D.J., 2019. How to SHIFT consumer behaviors to be more sustainable: a literature review and guiding framework. J. Market. 83 (3), 22–49. https://doi.org/10.1177/0022242919825649.
Xue, F., Muralidharan, S., 2015. A green picture is worth A thousand words?: effects of visual and textual environmental appeals in advertising and the moderating role of product involvement. J. Promot. Manag. 21 (1), 82–106. https://doi.org/10.1080/10496491.2014.971209.
Yin, R.K., 2017. In: Publications, S. (Ed.), Case Study Research and Applications: Design and Methods.
Ziout, A., Azab, A., Atwan, M., 2014. A holistic approach for decision on selection of end-of-life products recovery options. J. Clean. Prod. 65, 497–516. https://doi.org/10.1016/j.jclepro.2013.10.001.