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Review

Towards product-service system oriented to circular economy: A systematic review of value proposition design approaches

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ABSTRACT

Based on service-based value propositions, product-service systems (PSS) are commonly understood as a means to realize circular economy. However, the design of value propositions of circular product-service system is not widely investigated and understood in literature, leading to the lack of guidance for the incorporation of circularity into product-service system design. This study presents a systematic analysis of 46 approaches that can support the design of circular and/or product-service system value propositions in the context of business model innovation. The research methodology is based on a three-step systematic literature review, followed by a critical analysis grounded on content analysis procedures. The 46 approaches identified were classified according to their theoretical and practical characteristics (development level, nature of data, representation style, process type, actors' perspective, and purpose). The results point to a heterogeneity of approaches, although most are focused on the development of business models in a broader scope, with no clear boundaries on value proposition design. A critical analysis is presented in relation to the interface of the design scope of value propositions oriented to circular economy and product-service system. The paper proposes guiding principles that can support effective development of value propositions of circular product-service system at the early stages of the business modeling. A research agenda is outlined and indicates key trends oriented towards the development of an integrated and systemic approach based on a multiple stakeholder perspective, definition of design options of value propositions of circular product-service system, exploitation of perceived value, and more quantitative and empirical studies.

Contents

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1. Introduction

Circular economy has emerged as a new approach for ensuring the accomplishment of industrial and environmental demands towards resource efficiency and an effective value system. This approach emerges in a context in which the traditional production and consumption systems, grounded on the "take-make-dispose" resource model, have challenged the sustainability and the economic growth of companies (Bocken et al., 2016; Nuβholz, 2018). Circular economy aims to improve the current economic system by transforming linear and semi-circular flows into circular ones (Reigado et al., 2017) by slowing, closing and narrowing resources flows (Bocken et al., 2016).

The circularity of businesses can be enhanced through the implementation of product-service systems (PSS) (Lieder and Rashid, 2016; Urbinati et al., 2017; Pieroni et al., 2019a), which comprise integrated solutions of products and services in order to fulfill the customers' needs and generate value (Goedkoop et al., 1999; Boehm and Thomas, 2013). However, nor all PSS necessarily contribute to circular economy (Tukker, 2015; Kjaer et al., 2018). PSS can lead to a number of rebound effects, such as an increased consumption due to easier product access on sharing systems (e.g., car-sharing) or the sale of reused products at lower prices (McAloone and Pigosso, 2018). The development of a PSS for circular economy and its potential contributions to achieve circularity are still not explicit in the literature (Blomsma et al., 2018). In order to ensure enhanced resource efficiency, PSS should be intentionally designed for this purpose (Pigosso and Mcaloone, 2015).

The transition towards the circular economy requires innovations that range from the level of product, process, and technology to business model innovation (BMI) (Yang et al., 2018). A business model articulates the logic and defines the mechanisms and the architecture of how a business creates, delivers and captures value (Teece, 2010). In the context of circular economy, BMI comprises continuous organizational capabilities for companies to design products and services (Rozenfeld et al., 2018) in such a way as to create additional value based on the alignment with circular principles (Nuβholz, 2017) through the configuration of business model dimensions (Nuβholz, 2017; Pieroni et al., 2019a).

A central dimension that guides the BMI is the value proposition, which means that the other dimensions of a business model (such as activities, resources, partners, etc. (Barquet et al., 2013)) are oriented towards the value proposition (Laurischkat and Viertelhausen, 2017). PSS value propositions denote the value that the company may offer to customers and other stakeholders through products and services (Resta et al., 2017). In the context of circular economy, they are grounded on the circular principles and strategies (Aminoff et al., 2017; Nuβholz, 2017), such as access or availability, and result and performance (Blomsma et al., 2019). One of the most important aspect to consider is how to integrate circular principles and strategies into the PSS value proposition (McAloone and Pigosso, 2018).

Despite the importance of the value proposition dimension for BMI, as it reflects how the company creates value (Nuβholz, 2017), the design of PSS value proposition is not currently widely covered in research related to circular economy (Kristensen and Remmen, 2019). Existing studies focus on environmental aspects of PSS value propositions designed considering mainly economic motivations (Matschewsky, 2019). The focus of other studies has only been on a business model level (e.g., Antikainen et al. (2017); Bocken et al. (2019)), which do not provide a deeper understanding of how PSS value propositions could be designed to reach the circular economy. As a consequence, there is a knowledge gap, from theoretical and practical perspectives, on where to start the design of circular PSS value propositions and which approach (i.e., framework, method, tool) to follow. Due to the lack of systematized knowledge on design circular PSS value propositions, there is a clear need to understand existing approaches (Pieroni et al., 2019b) that support the design of value propositions in the PSS and circular economy fields considering the BMI context. Well-ordered knowledge of approaches within both fields helps in clarifying specific aspects related to the PSS design and circular solutions design, and how they can be complemented or integrated.

This paper provides an analysis of existing BMI approaches for value proposition design for circular economy and/or PSS that are currently available in the literature and/or in use in practice. This study aims to answer the following questions: (i) what are the existing approaches for designing circular and/or PSS value propositions? (ii) how can those approaches be classified according to their theoretical and practical characteristics? (iii) which opportunities can be addressed in future research? Deepened understanding of approaches for designing PSS and circular value propositions creates a systematic view of the topic and can support in promoting the integration of approaches for synergistic advantages.

This study provides a catalogue of existing approaches that can support the design of circular and/or PSS value propositions in BMI context, a systematic analysis of the approaches and classification of data related to them based on a framework, an integrated view of guiding principles for designing circular PSS value propositions, and a description of proposals for future research. The main contribution of this paper is a holistic and comparative analysis of the approaches targeting value proposition in the fields of PSS and circular economy to provide a better understanding of their conceptual and practical features, the clarification of characteristics and best practices needed to incorporate circularity in PSS value proposition design, and the identification of opportunities to advance in this research line.

This paper is structured as follows. Section 2 presents the literature background on circular-oriented BMI and PSS value proposition for a circular economy. Section 3 describes the research methodology. Section 4 presents the results. The main findings, discussions and further research opportunities are presented in section 5. The paper ends with section 6, which presents the conclusion.

2. Literature background

2.1. Circular-oriented business model innovation

BMI embraces the ability of companies to create and deliver value to capture business results (Lange and Velamuri, 2014). This concept involves creating entirely new business models or redesigning existing business models within well-established organizations (Massa and Tucci, 2013). BMI enables a systemic perspective on business, while facilitating the structure of the systems beyond the conventional way of creating, delivering and capturing value (Mentink, 2014). It guides the coordination of organizational and technological innovations as well as the involvement of stakeholders within a value network (Zott et al., 2011).

Business models are considered as vehicles for innovation towards circular economy (Nuβholz, 2017; Planing, 2018). As synthesized by Bocken et al. (2018, p. 81), circular business models define "the rationale of how an organisation creates, delivers and captures value to close and slow material loops". The key aspect of circular-oriented BMI is to ensure that the results are restorative and regenerative through the establishment of material standards and information flows that drive circularity (EMF, 2013). Circular business models are different from traditional business models of the linear economy model, due to the intentional incorporation of strategies for slowing, closing and narrowing resource loops (Bocken et al., 2016).

In particular, the BMI towards circular economy requires fundamental changes in the value proposition (Lieder et al., 2018). Circular value propositions should be designed to guarantee long-term capacity and preserve the economic and environmental value of resources (Nuβholz, 2017) through the deliberate use and implementation of principles and strategies of circular economy (Aminoff et al., 2017; Nuβholz, 2017). Proactive management of stakeholders and their cooperation in a co-innovation process (Aminoff et al., 2017) are also relevant aspects for the design of circular value propositions. Prominent emphasis has been given to provide access to functionality based on PSS solutions to achieve the objectives of the circular economy (Tukker, 2015; Lieder et al., 2017).

2.2. PSS value propositions for circular economy

PSS is an alternative for companies to keep innovating in a market where the differentiation of products is no longer enough (Vasantha et al., 2015) and in cases where products are becoming commodities. Since Goedkoop et al. (1999) introduced the term PSS, several definitions have been proposed in literature. Although the reduction of environmental impact can be considered one of the characteristics of a PSS, not all PSS definitions refer to sustainability (Haase et al., 2017).

Based on the variations of offerings, a typology of PSS was proposed by Tukker (2004). PSS is product-oriented when it involves the traditional sale of a product, but additional services are offered to the customer to guarantee product functionality. In use-oriented PSS, the provider delivers the use or availability of a product. Lastly, the PSS is result-oriented when the provider and customer mutually agree on a solution to be delivered (Tukker, 2004).

PSS is a means to realize circular economy when it leads to a reduction in resource consumption while promoting economic growth (Kjaer et al., 2018). As a PSS is not always circular (nor sustainable), there are specific approaches to evaluate the environmental sustainability of PSS, such as Kjaer et al. (2018) and Matschewsky (2019). From a life cycle perspective, Kjaer et al. (2018) consolidated the PSS enablers of resource reduction, which are conditions under which the PSS can be truly considered as circular. They comprise the operational efficiency to minimize the resource demand during the use stage; the product longevity to keep products in use for longer, by means of after-sales service; the intensified use of product through product sharing; and product system substitutions, based on dematerialization as well as shared, reused or recycled products (Kjaer et al., 2018).

According to Pieroni et al. (2018b), different types of PSS can enable different circular strategies, which can be applied concomitantly. Yang et al. (2018) suggest that use-oriented and result-oriented PSS are more appropriate for circular business models, as there is a greater motivation by companies to extend the use of products and to apply the circular strategies. This result is also commented by Pieroni et al. (2018b), who add that result-oriented PSS solutions are less frequent in circular economy cases, but there is an opportunity to be exploited by companies.

The design of PSS value propositions is subject to uncertainties and complexity (Bocken et al., 2018) and raises new managerial challenges by the necessity of rethinking the capabilities on strategic and operational levels, the management throughout the solution life cycle, and the relationship among stakeholders (Pezzotta et al., 2014). In the context of circular economy, PSS value propositions are more dynamic in determining how value is created and, as a consequence, influence the value delivery and capture (Nuβholz, 2017). Especially, a gap remains for how to design PSS value propositions for circular economy in the BMI context, since the systematization of methodological approaches to guiding such a design is still missing.

3. Research methodology

A systematic literature review was conducted to consolidate the state-of-the-art in approaches that can support the design of circular and/or PSS value propositions in a BMI context. This review strategy follows a scientific and structured process which allows building a solid foundation and a reliable knowledge (Tranfield et al., 2003) on the available approaches. The literature review process was conducted based on three phases: (i) review planning, (ii) review execution, and (iii) result analysis (Biolchini et al., 2005).

3.1. Review planning and execution

In the first phase (planning), the search scope was defined and a review protocol was prepared (see supplementary data). The unit of analysis was defined as studies in English within the scope of BMI in the circular economy and PSS fields. The second phase (review execution) encompassed the search, collection, and selection of publications presenting one or more circular-oriented or PSS-oriented value proposition design approaches. The literature search was conducted in the Scopus database (due to the wide range of indexed papers and proven relevance in the fields of research (Falagas et al., 2008; Gaiardelli et al., 2014; Tukker, 2015)).

The search in Scopus was carried out in March 2019 and included two rounds (Table 1) using a common set of primary keywords that combined the terms related to: (i) "value proposition", and (ii) "approach" ("method", "tool", "framework", "methodology", "procedure", "technique", "canvas", and "process model"). The first search round used terms related to circular economy as supplementary search keywords (Pieroni et al., 2019b). To find out approaches related to the PSS domain, a second search round employed keywords related to the major scholarly communities in the fields of PSS and servitization, as presented in previous literature reviews (Boehm and Thomas, 2013; Annarelli et al., 2016; Rabetino et al., 2018). The search resulted in a preliminary set of

Table 1
Search parameters in the first search stream.

Database	Scopus
Fields	title, keywords, abstracts
Search string	*1st search round – Circular Economy domain* ("value propos*") AND ("method*" OR "tool*" OR "framework*" OR "approach*" OR "methodolog*" OR "procedure*" OR "technique*" OR "canvas" OR "process model*") AND ("circular economy" OR "circle economy" OR "circularity" OR "circle" OR "circular" OR "closed loops") *2nd search round – PSS domain* ("value propos*") AND ("method*" OR "tool*" OR "framework*" OR "approach*" OR "methodolog*" OR "procedure*" OR "technique*" OR "canvas" OR "process model*") AND ({advanced service} OR {business solution} OR {complex service system} OR {customer service} OR "custom* solutions" OR {extended product} OR {from products to services} OR {functional sales} OR "integrated product*service" OR {integrated solution} OR "product service" OR "product*service system" OR {service design} OR {service economy} OR {service engineering} OR {service integration} OR {service marketing} OR {service operations} OR {service orientation} OR {service science} OR {service strategy} OR {service transition} OR "service dominant logic" OR "service oriented" OR "serviti*" OR {software as a service} OR {total solution} OR "value*in*use")
Time frame	Until February 2019
Type of retrieved publications	Journal papers, conference proceedings

284 papers (including journal papers, peer-reviewed conference proceedings, and book chapters).

Due to the fact that value proposition for circularity is still an emerging field (Diaz Lopez et al., 2019), only 40 publications were retrieved from the Scopus database. To complement the search, the 94 approaches related to circular-oriented BMI (which might include the value proposition dimension) listed in Pieroni et al. (2019b) were reviewed in a special stream (Table 2).

To evaluate the relevance of the identified studies, three inclusion criteria were defined. Relevant studies are therefore those that:

(i) describe approaches addressing the value proposition design for circular economy and/or PSS (even if they were not developed specifically for this purpose);
(ii) present a sufficient level of information (regarding the foundations and guide reasoning of the approach);
(iii) do not present a sector-specific approach.

Based on those criteria, a three-step screening process was employed for both search streams. The first (in which the title, abstract and keywords were checked for inclusion criteria) resulted in 158 studies, which were further read in the second filter (focused on introduction and conclusion). The resulting studies (113 in total) were read in their totality, resulting in the final selection of 46 studies. Backward and forward searches (Webster and Watson, 2002) were also conducted by reviewing the citations (cross-reference) to identify further relevant studies. Publications from cross-reference were subjected to the same inclusion criteria and screening process applied for the previous streams, which resulted in the addition of 6 studies to the final set. The literature review resulted in 52 publications covering 46 approaches, as different studies describe the same approach (Fig. 1).

3.2. Planning the analysis of the results

To systematize the identified approaches and enable their analysis, a classification framework (Table 3) was iteratively developed by applying categorial and open coding techniques (Dresch et al., 2015). Four categories (a.-d.) were deductively developed through previous literature reviews (Schneider and Scheer, 2003; Pigosso et al., 2011; Bocken et al., 2019; Pieroni et al., 2019b), and complemented by two additional categories (e.-f.) derived from an inductive content analysis (Elo and Kyngäs, 2008).

Table 2
Search parameters in the second search stream.

Dataset	Pieroni et al. (2019b)
Time frame	From 2007 to 2018
Type of retrieved publications	Journal papers, conference proceedings, book chapters, reviews, thesis, toolkits, manuals, online tools, white papers

4. Results

4.1. Descriptive findings

Out of the 52 selected studies, 26 (50% of total) were published in academic journals, 19 (36.5% of total) were retrieved from conference proceedings, and 7 (13.5% of total) from grey literature (non-peer-reviewed publications). Journal papers were published in a total of 17 different academic journals from different knowledge areas, such as sustainability, service science, innovation management, and product design. The Journal of Cleaner Production was the most recurrent, with 6 papers, most likely associated to its scope, which encompasses circular economy and PSS-related research, and with special issues in these fields. Compared to the number of journal papers, the number of conference proceedings was also significant to note, as this seems to indicate the importance of scientific conferences as a means for retrieving emergent knowledge related to BMI for circular economy and PSS design, as these are both nascent fields. The selected publications from grey literature are influential and primarily cover the circular economy domain, since some approaches in this domain are practitioner-focused and have been published in materials produced outside the academic publishing (e.g., websites, white papers, etc.) (Bocken et al., 2019). Fig. 2 shows the distribution of papers by journals and publishing sources.

The distribution of papers by publication year in relation to their focus on circular economy and/or PSS is presented in Fig. 3. Papers on PSS have been published in a time span of nine years, from 2010 to 2018. Although the term "product-service system" was first formally introduced in 1999 by Goedkoop et al. (1999), the number of publications has increased in recent years as literature into scholarly communities of PSS and servitization has only recently linked PSS to value proposition design and BMI (Pohlmann and Kaartemo, 2017). To a certain extent, a uniform distribution of papers can be observed between 2013 and 2018.

From the perspective of circular economy, the first publication on BMI appeared in 2013. As pointed out by Pieroni et al. (2019b), a widespread of the circular economy concept was initiated in this year by institutions such as Ellen MacArthur Foundation (EMF,

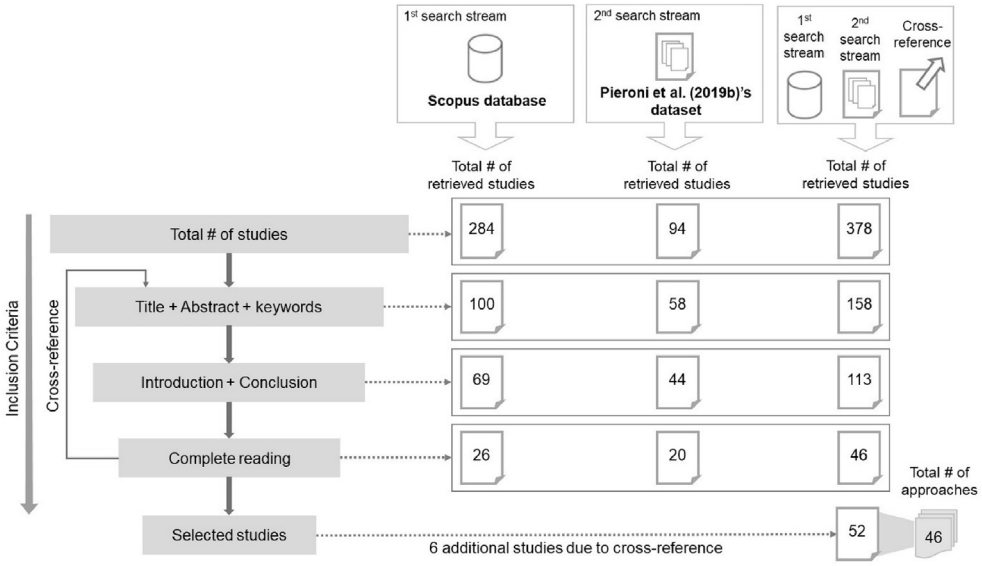

Fig. 1. Literature search procedure and results.

Table 3
Framework for classifying data of approaches.

	Categories	Alternative values	Description	References
a.	Development level	Theoretical	Approach developed only conceptually	Pigosso et al. (2011)
		Experimental	Approach already applied in practical cases for the purpose of validation	
		Consolidated	Approach validated and applied in practical cases by practitioners	
b.	Nature of data	Qualitative	Provide general guidance based on subjective analysis	Pigosso et al. (2011)
		Quantitative	Provide quantification based on objective analysis	
c.	Representation style	Framework	Approach supporting the design of value propositions from a conceptual perspective (e.g., models, typology, taxonomy, etc.)	(Pigosso et al., 2011; Bocken et al., 2019; Pieroni et al., 2019b)
		Guideline	General explanations to guide the design of value propositions	
		Checklist	List of items to be checked or consulted after designing value propositions	
		Visualization tool	Paper-based or computational visual approach used to design value propositions	
		Process model	Evolutionary steps and activities employed in the design process of value propositions	
		Cards/serious game	Board- or computational games employed during the design of value propositions	
d.	Process type	Linear	Process-based approach driven by discrete and consecutive steps	Schneider and Scheer (2003)
		Iterative	Process-based approach driven by repetitions of the involved activities	
		Prototypical	Process-based approach that uses prototypes to communicate/test value propositions	
e.	Actor's perspective	Customer	The value proposition is designed considering only the customer perspective	*Category inductively proposed*
		Stakeholder	The value proposition is designed based on a multi-stakeholder approach, in which the customer is considered a type of stakeholder	
f.	Purpose	Ideation	Focuses on phases needed to generate/create value propositions	*Category inductively proposed*
		Selection	Includes the selection of value propositions	
		Evaluation	Includes the evaluation/assessment of value propositions	
		Implementation/experimentation	Address the development of prototypes to test/ experiment the value propositions with actors	
		Further steps for BM development	After designing value propositions, considers furthers steps/activities needed to develop the entire business model	

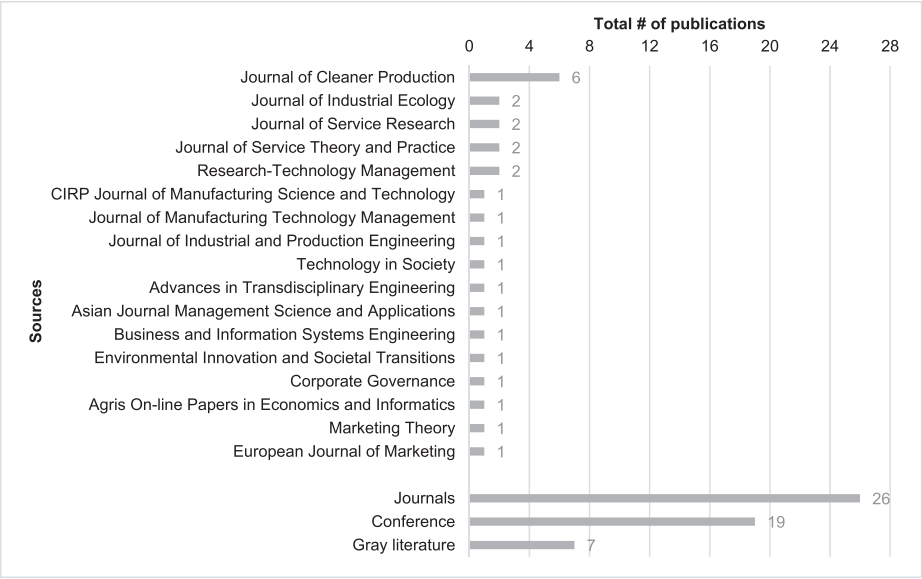

Fig. 2. Distribution of papers by journals and publishing sources.

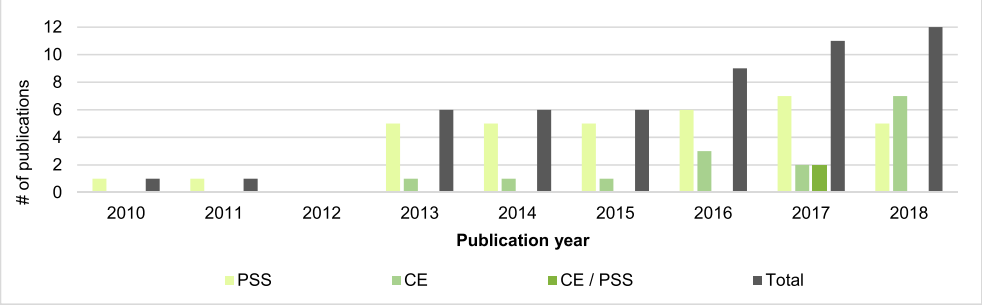

Fig. 3. Distribution of papers by focus and publication year.

2013). Grey literature has been published since 2013, contributing to the knowledge of initiatives and projects on circular economy in industry. The first academic paper covering value proposition design was published only in 2017, which shows the approaches have just recently emerged in the academic sphere. The largest number of publications is observed in 2018, which might be related to several research projects attempting to provide guidance in the design of circular business models through the development of a variety of methods and tools (Bocken et al., 2019). In summary, the rising trend of publications in the circular economy field might be associated to the recent dissemination of this concept, the advancement of the research line in BMI with several research projects being developed, and due to their appeal to academy and industries. However, approaches exploring synergies through the design of circular-oriented and PSS-oriented value propositions were proposed first in 2017 even though PSS is hailed as one of the key business strategies to achieve the circular economy (Lieder and Rashid, 2016).

4.2. Systematic analysis of approaches

The classification of the 46 approaches (described in the Appendix) according to their focus, development level, and representation style is presented in Fig. 4. Approximately 65% of them (30 out of 46) are related to the PSS domain, which is considered more mature than the circular economy domain since research in PSS started in the early 2000s (Rabetino et al., 2018). The concept of circular economy is still contemporary (Pieroni et al., 2019b), presenting a focus on BMI and its stages after 2016 (Fig. 3). In the two approaches that attempt to integrate circular economy and PSS [#22, #26] (Mendoza et al., 2017; Sustainn, 2017), PSS is only seen as a key solution for achieving circularity. Neither of these authors address how the principles and other strategies of the circular economy can guide the design of PSS value propositions.

The majority of the identified approaches (94% of total) are qualitative in nature. This is understandable since the value proposition design is grounded on idea generation and discussions towards value creation (Bocken et al., 2013). Just two approaches related to circular economy [#26, #39] (Joustra et al., 2013; de Jong et al., 2015; Sustainn, 2017) combine both qualitative and quantitative data. However, they only employ numerical data and calculations in later stages of the value propositions design, in order to evaluate the feasibility of the business model. The hybrid nature of these two approaches, identified in the grey literature, is most likely related to their practical application in industrial and economic systems.

Around 37% of the approaches (17 out of 46) were classified as theoretical, 57% as experimental (26 out of 46), whereas consolidated approaches accounted for 7% (3 out of 46). Although the PSS domain is advanced in comparison to the circular economy field, the PSS domain is still under development and some approaches are theoretical. PSS is a complex system and theoretical approaches

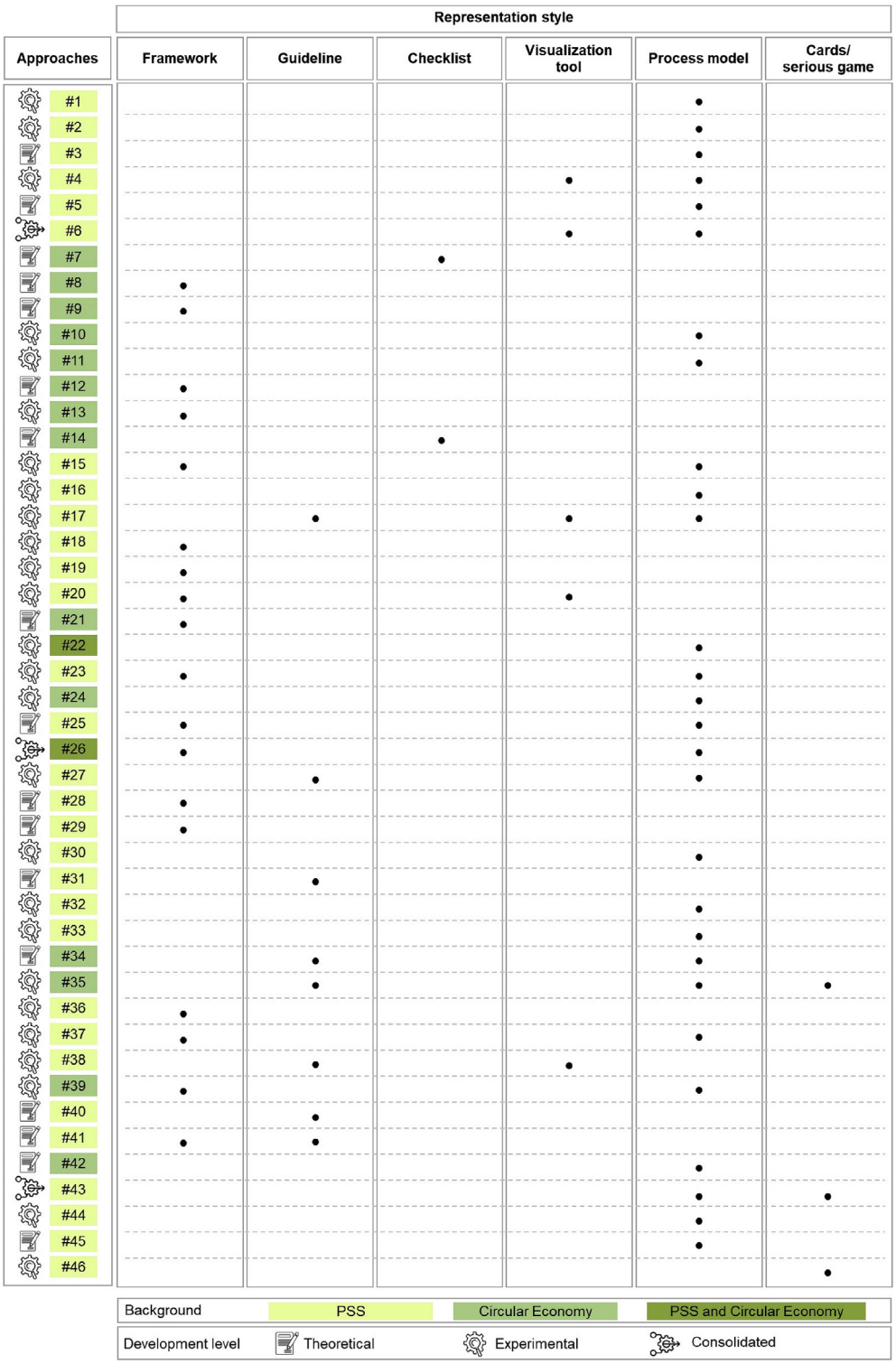

Fig. 4. Classification of approaches that support the design of circular/PSS value propositions in BMI context by their focus, development level and representation style ([#] codes at Appendix).

help to create explanations and predictions to achieve a solid understanding. In the past few years, there has been an effort to validate some approaches in an empirical way. However, these have been tested through case studies, with limitations of: no more than one company per study (e.g., #13 (Nuβholz, 2018), #44 (Leitão et al., 2013)); by means of a limited number of workshops with business practitioners (e.g., #24 (Antikainen et al., 2017)); or by using with researchers/students as the validation subjects (e.g., #4 (Fernandes et al., 2018), #33 (Geissdoerfer et al., 2016)). These limitations indicate that the development of approaches and validation of their applicability at a practical level is still weak.

In terms of the representation style, there are a variety of

different forms and mechanisms considered in the approaches, depending on their focus and development level. While process models and visualizations tools stand out in the experimental and consolidated levels, theoretical approaches are primarily represented in frameworks (model, typologies or taxonomy). The identified models are related to seven main areas:

- business intervention along the product life cycle [#9, #13, #26] (Sustainn, 2017; Manninen et al., 2018; Nuβholz, 2018);
- design and management perspectives in different design levels [#15, #23, #31; #37] (Marilungo et al., 2015; Peruzzini et al., 2015; Pieroni et al., 2016; França et al., 2017; Teixeira et al., 2017);
- value experience as a static concept [#18, #36] (Belal et al., 2014; Shirahada et al., 2015; Äyväri et al., 2017);
- the link between service design and BMI [#25] (Prendeville and Bocken, 2017);
- different types of innovation when modifying or creating value propositions [#28] (Åkesson et al., 2016);
- value creation system [#26, #29] (Wang et al., 2015; Sustainn, 2017);
- knowledge and operational concerns while designing [#41] (Kumar et al., 2014).

Typologies were used to describe the design options of value propositions when developing a circular business model [#8, #12] (Manninen et al., 2018; Lüdeke-Freund et al., 2018). Lastly, a taxonomy [#21] (Urbinati et al., 2017) depicted the modes of circularity adoption along the dimensions of value proposition & interface and value network.

In general, guidelines are represented as textual documents describing recommendations to be followed when designing value propositions [#5, #17, #20, #27, #31, #34, #35, #38, #39, #40, #41] (Frow and Payne, 2011; Joustra et al., 2013; Kumar et al., 2014; Yang et al., 2014, 2017; Bocken et al., 2015; de Jong et al., 2015; Kraaijenhagen et al., 2016; Weetman, 2016; Pezzotta et al., 2016; Pieroni et al., 2016; Baldassarre et al., 2017; Quero and Ventura, 2018). Some of them include examples [#20] (Yang et al., 2017) or key criteria [#35] (Weetman, 2016) that briefly help in translating the recommendations into activities.

Only two approaches were classified as checklists [#7, #14] (Urbinati et al., 2017, 2018; Pieroni et al., 2018a; Ünal et al., 2019). This indicates a tendency to focus on guidance that touches upon the nature of activities to inspire the design of value propositions rather than in checking the process at the end of the design process. Visualization tools were developed to support practitioners in decision-making, especially related to the value proposition evolution related to a variety of data sets:

- potential customers or stakeholders that may impact the design of value propositions [#4, #6, #17, #19, #20, #38] (Bocken et al., 2013, 2015; Short et al., 2013; Pokorná et al., 2015; Äyväri et al., 2017; Baldassarre et al., 2017; Yang et al., 2017; Fernandes et al., 2018);
- list of customer/stakeholder's needs and problems [#4, #6, #19] (Pokorná et al., 2015; Äyväri et al., 2017; Fernandes et al., 2018);
- ideas of products and services [#4, #6, #17, #20, #38] (Bocken et al., 2013, 2015; Short et al., 2013; Pokorná et al., 2015; Äyväri et al., 2017; Baldassarre et al., 2017; Yang et al., 2017; Fernandes et al., 2018);
- multiple types of value [#4, #20, #38] (Bocken et al., 2013, 2015; Short et al., 2013; Yang et al., 2017; Fernandes et al., 2018).

Most of the approaches are represented as process models. In general, these approaches follow a step-by-step structure, describing the activities, the tools or methods to be applied at each step, and the expected outcomes. Information of time and users (in terms of participants' roles) are rarely indicated. The process models may cover different innovation stages until the development of the initial business model. The distribution of the process models according to their purpose and type of process is depicted in Fig. 5.

All of the process models support, in some way, the ideation of value propositions. In this stage, they may present activities related to the preparation of the company, understanding of customers/stakeholders, and the creation of value propositions (e.g., #17, #33 (Geissdoerfer et al., 2016; Baldassarre et al., 2017)), or activities focused only on idea generation [#10, #15, #26] (Teixeira et al., 2017; Sustainn, 2017; Manninen et al., 2018). Even though the approaches integrating PSS and circular economy domains [#22, #26] (Mendoza et al., 2017; Sustainn, 2017) cover the ideation stage, they do not address exactly how to create PSS value propositions towards circular economy. Less than a quarter of the total number of process models cover the stages of selection [#4, #6, #22, #23, #33, #35] (Pokorná et al., 2015; Geissdoerfer et al., 2016; Weetman, 2016; Äyväri et al., 2017; França et al., 2017; Fernandes et al., 2018; Mendoza et al., 2017), evaluation [#6, #10, #22] (Pokorná et al., 2015; Äyväri et al., 2017; Manninen et al., 2018; Mendoza et al., 2017; Fernandes et al., 2018), and implementation/experimentation [#11, #16, #17, #23, #24, #33, #44] (Leitão et al., 2013; Antikainen et al., 2017; Baldassarre et al., 2017; Rau et al., 2017; Bocken et al., 2018). Among these, the process models often go directly to testing value propositions with users/customers rather than selecting or evaluating them first. Around 65% of process models also present steps for developing the entire business model. Although they do not, per se, point exclusively to the essence of value proposition design, they were included in this research since the approaches for BMI include the design of value proposition in the first instance.

Approaches employing cards and games are rarely addressed. They cover the BMI in a way to help players to understand and implement the concepts of circular economy [#35] (Weetman, 2016) or sustainability [#43, #46] (Dewulf, 2010; Breuer and Lüdeke-Freund, 2014). As the design of value propositions involves creativity and abstract activities, gamification principles could be used to support that aim.

Most of the evaluated process models represent linear and iterative process (although, in these approaches, there is a sequence in steps). Two process models in the field of circular economy were classified as linear, which is not related to the meaning of linear economy. It means that the activities of those process models are organized and employed following a step-by-step approach. Despite the influence of agile and design thinking approaches, only 19,5% of the process models follow a prototypical process. This indicates that most of the process models do not indicate the outcomes of experiments to go back-and-forth between steps.

Fig. 6 classifies the approaches according to the actor's perspective. In the context of this research, actors are defined as individuals "involved in planning, searching, selecting, negotiating and evaluating a range of value propositions" (Frow et al., 2014, p. 332). Based on Fernandes et al. (2019), customer is considered as a type of stakeholder. Then, when an approach is classified as related to stakeholder's perspective it means that the approach considers the customers and also other individuals or groups that can impact or be impacted by the value proposition design. Around 50% of the PSS-related approaches consider only the customer's perspective when designing the value proposition. That might be a consequence of the influence of traditional literature that emphasizes the role of customers as key individuals for whom the solution should be addressed in value in exchange flow. On the contrary, most of the

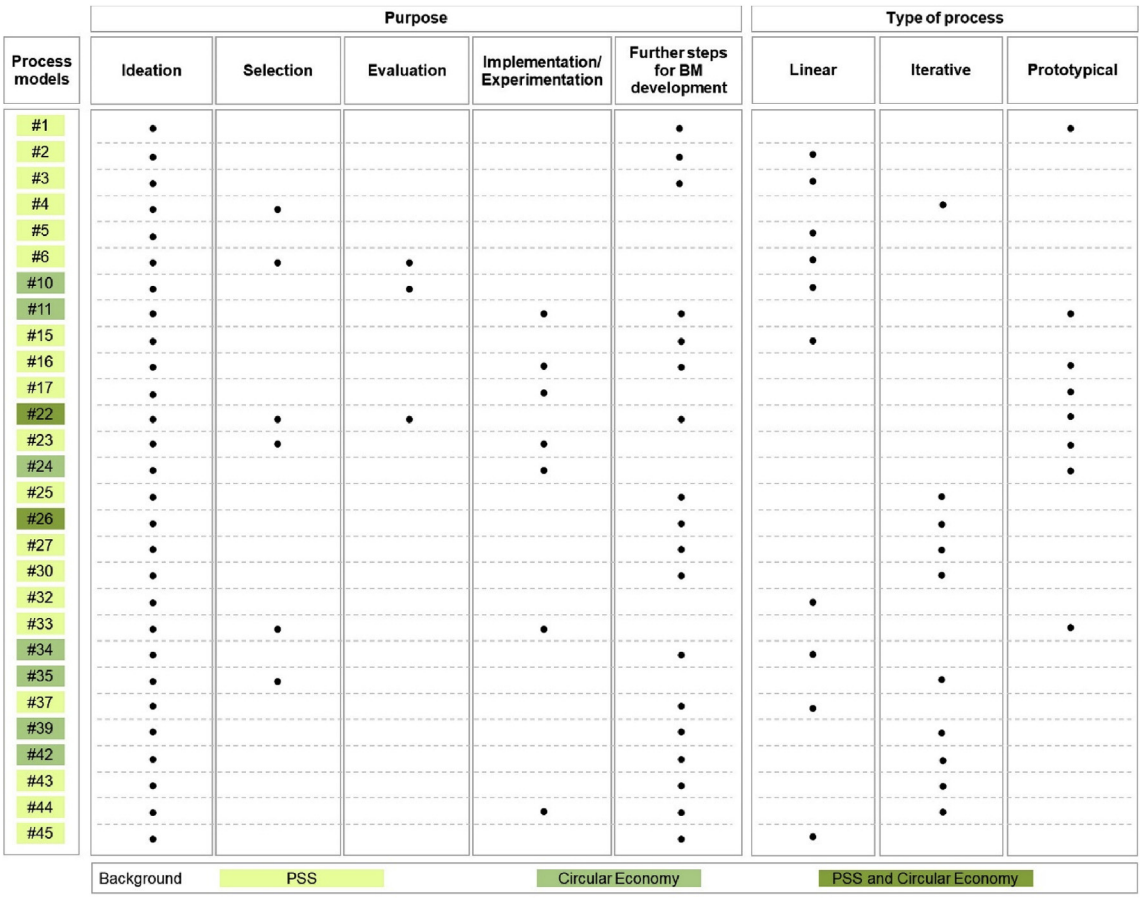

Fig. 5. Classification of process models that support the design of circular/PSS value propositions in BMI context by their purpose.

approaches related to circular economy take the stakeholder's perspective. Some approaches in the circular economy field still consider the customer's perspective [#7, #11, #13, #24] (Antikainen et al., 2017; Urbinati et al., 2017, 2018; Bocken et al., 2018; Nußholz, 2018; Ünal et al., 2019), but more emphasis is given to the importance of integrating and involving different stakeholders due to an enhanced system complexity.

5. Discussion

Although PSS has been labeled as a means to achieve circularity, there are limited considerations in the literature on the design of circular PSS value propositions. PSS is not a panacea for achieving the circular economy or sustainability (Tukker, 2015) because it depends on in-depth transformation of the business model towards that aim. The systematic analysis of the approaches, based on a classification framework, supports the identification of which aspects should be considered to develop a systemic approach that can guide the design of PSS value propositions with the intention of succeeding in circularity. The classification of approaches is important to elucidate which characteristics, in terms of data, style, level, and purpose, are being employed from theoretical and practical perspectives. From this, it is possible to consolidate the specific inputs, features, and principles to be followed, as well as the opportunities that should be addressed when orienting the PSS value proposition design towards the circular economy.

The analyzed approaches are heterogeneous in terms of representation styles. They seem to vary in objective and expected outcomes. In the PSS domain, they include models, guidelines, visualization tools, process models, and serious games. Typologies, taxonomy, and checklists are referred to the field of circular economy, whose representation styles also include models, guidelines, process models, and serious games. Templates used to design value propositions are presented only in the PSS-related literature. Only two typologies and one taxonomy were proposed in the context of circular economy. A clear understanding of possible design options or patterns, through basic terminology, might be useful to support practitioners in designing circular PSS value propositions. We also stand out the potential of gamified approaches as practical mechanisms to support the ideation process while allowing hands-on experience for practitioners.

The process models are comprehensive, describing activities and tips for starting the innovation process. Logics and concepts of process models related to the PSS domain are derived from product development and service development, as had already been argued by Ericson and Larsson (2009). In the PSS scope, the process models focus primarily on the functional needs and problems of stakeholders. In its turn, the design of circular value propositions is oriented by the establishment of a vision based on future-oriented circular economy options. For this reason, the role of the leadership in guiding the design process and pulling teams in the same direction is becoming prominent (Kraaijenhagen et al., 2016). Moreover, the importance of aligning understanding of the theoretical concepts of PSS and circular economy to level the interpretations and interests is recognized (Joustra et al., 2013; Mentink, 2014; de Jong et al., 2015).

In general, existing process models are not sufficiently exhaustive. Although all process models include the ideation stage, there is

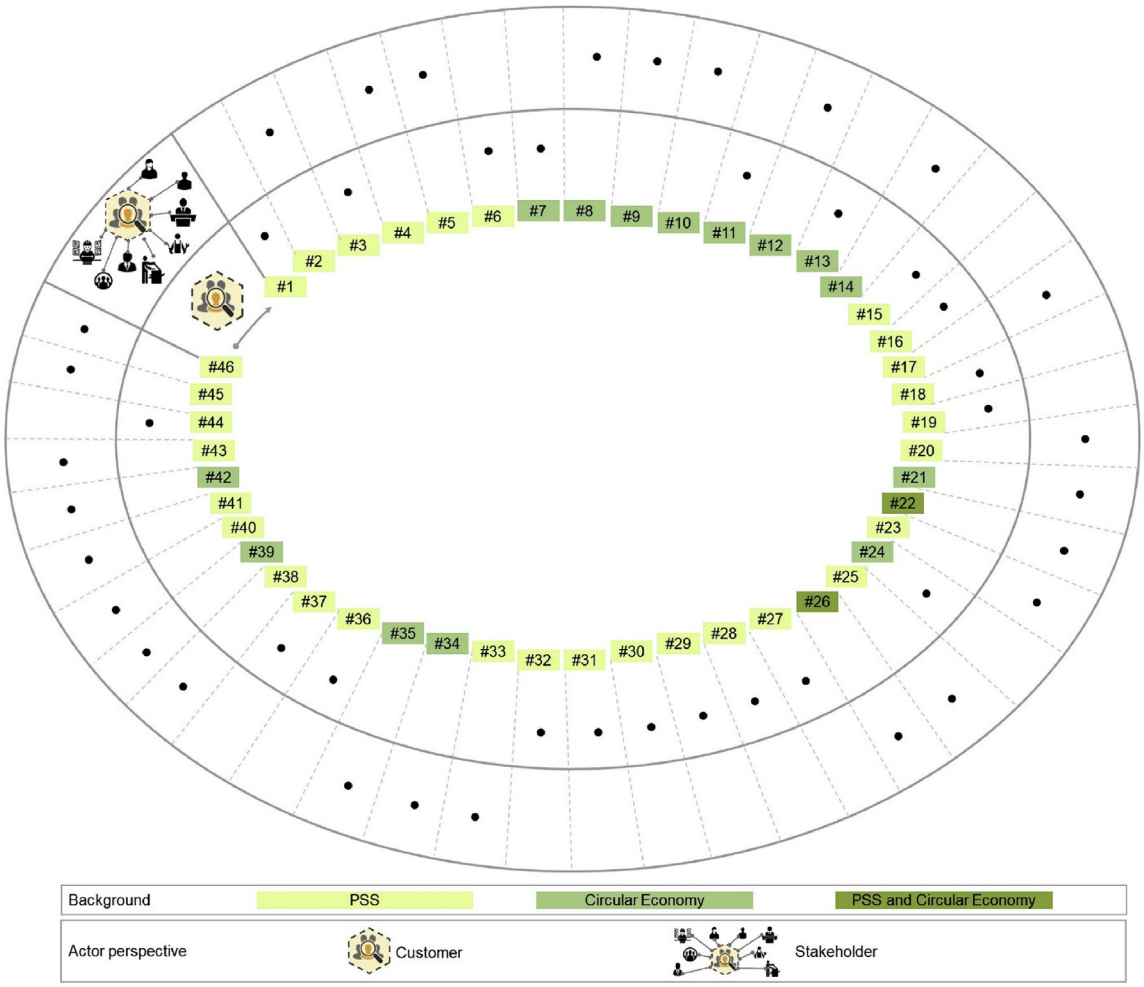

Fig. 6. Classification of approaches that support the design of circular/PSS value propositions in BMI context by the actor's perspective.

a lack of detail on how to identify opportunities or develop ideas of PSS considering the circular economy approach. The selection of value propositions usually follows an intuitive logic based on the link to the vision and the business. In the evaluation stage, there is a lack of consideration of the value that can be perceived from specific value propositions.

None of the approaches proposed a KPI (key performance indicator) to measure the circularity level of the value propositions. It could be developed by intersecting applicable principles and strategies of circular economy, depending on the PSS case, with the potential business, economic, environmental and social benefits. The circularity level could be expressed through different ranges to characterize the benefits of PSS value proposition regarding its relevance to circular economy (e.g., limited, elementary or substantial benefits due to the incorporation of the principles and strategies). Lastly, there is a need to advance towards the experimentation of value propositions through prototype development. This can reduce some uncertainties while providing "learning by doing process" for the innovation team, and support the understanding of the influencing aspects for the business model configuration.

Another key finding is that literature is evolving to a shared-value design through a collaborative system of stakeholders, even though it is still in its infancy. This occurs mostly in the circular economy field, which is characterized by a "complex network of interdependent but independent actors/stakeholders" (Antikainen and Valkokari, 2016, p. 7). Circular PSS value propositions should embed potential value that can be offered to a broader range of stakeholders instead of focusing only on the customer perspective. Multiple stakeholders should be involved in the design process rather than considering the perspectives of limited groups of actors related to either the customer side or the provision side (e.g., manufacturers, suppliers, etc.) (Fernandes et al., 2019). However, only few approaches articulate the value co-creation, e.g., Baldassarre et al. (2017) and Yu and Sangiorgi (2018). For the realization of value through circular PSS value propositions, stakeholders should be treated as active actors in a co-creation process, rather than merely passive audiences.

The scope of sustainability is supported in some approaches. In circular economy field, studies listed sustainability criteria to be considered when developing circular business models (Pieroni et al., 2018a), proposed a framework to help companies in analyzing the contribution of circular business models for sustainability (Manninen et al., 2018), a framework for support the development and implementation of sustainable business models consistent with circular economy principles (Mendoza et al., 2017), and a cycle for business model experimentation (Bocken et al., 2018). Approaches dealing with sustainable paradigm in PSS field vary from the business modeling process (Dewulf, 2010; Bocken et al., 2013, 2014, 2015; Short et al., 2013; Yang et al., 2013, 2014, 2017; Breuer and Lüdeke-Freund, 2017; França et al., 2017; Holgado et al., 2013) to the value proposition design by employing the

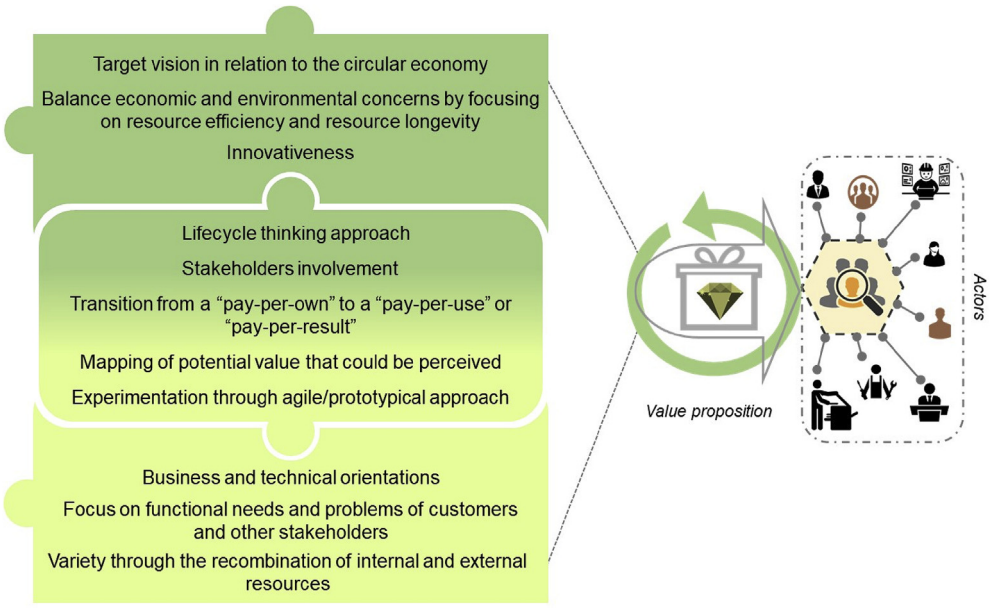

Fig. 7. Integrative view for circular PSS value proposition design.

perspective of design thinking/user-driven innovation to create sustainable PSS value propositions (Geissdoerfer et al., 2016; Baldassarre et al., 2017).

Despite the reasonable number of cataloged approaches in this research, the few approaches focusing specifically on the design of value propositions indicate that literature is more concentrated in the scope of business models (in a broader perspective). These results are consistent with recent consideration in service science literature, which state that there is limited knowledge on how to design value propositions (Åkesson et al., 2016) even though this term ("value proposition") has been widely employed in theory and practice (Frow and Payne, 2011). Thus, considering that the value proposition is the core dimension of the business model, there is a need to move forward in a deep understanding of the aspects that might influence the design of circular PSS value propositions to enhance the synergies between both fields and to help companies to cope with the complexity and uncertainty involved in this process.

To advance this aspect, we propose an integrated view of guiding principles that should be adopted when designing circular PSS value propositions (Fig. 7). The guiding principles were developed based on approaches that describe inherent characteristics that can influence the design of value proposition in both PSS and circular economy fields. Guiding principles described in the gradient area of the puzzle depicted in Fig. 7 are those that commonly come from the PSS and circular economy domains.

A target vision towards the circular economy should be formalized to support the creation of a future business environment oriented to circularity (Kraaijenhagen et al., 2016; Antikainen et al., 2017; Bocken et al., 2018; Mendoza et al., 2017). To create a successful growth strategy, practitioners have to consider economic and environmental concerns when designing value propositions, i.e. apply resource efficiency/longevity strategies in the development of solutions that can lead to economic and business growth (Pieroni et al., 2018a; Nuβholz, 2018). It demands innovativeness to change the value creation model (Antikainen et al., 2017; Pieroni et al., 2018a), aiming for radical innovations resulting from the creative process rather than proposing ad-hoc solutions.

The value proposition design should follow a life cycle thinking approach, i.e. the activities performed in the middle-of-life and end-of-life must be considered since the beginning-of-life (Yang et al., 2013, 2014, 2017; Peruzzini et al., 2015). Combined with this, needs and problems of stakeholders should be identified to ensure contextual understanding of them (Kumar et al., 2014; Marilungo et al., 2015; Wang et al., 2015; Beverungen et al., 2018; Yu and Sangiorgi, 2018). Involvement and cooperation among provider, customers and other stakeholders are essential for a reciprocal relationship since the early stages of design (Antikainen et al., 2017; Baldassarre et al., 2017; Urbinati et al., 2017). Service components should be contemplated in the value proposition, focusing on providing the use availability or a result rather than the product ownership. Companies also need to take into account the potential value that could be perceived by stakeholders. The value propositions should be assessed considering their potential value and their economic and environmental performance (Yang et al., 2014; Weetman, 2016; Antikainen et al., 2017; Pieroni et al., 2018a). Moreover, companies should follow an agile/prototypical approach for the experimentation of value propositions with customers and other relevant stakeholders (Geissdoerfer et al., 2016; Baldassarre et al., 2017; Bocken et al., 2018; Yu and Sangiorgi, 2018).

Business and technical approaches encompassing a long-term orientation should be followed by companies (Peruzzini et al., 2015). This would increase the readiness for integration, adaptability, and accessibility of the value propositions. By having new ideas through creative techniques, practitioners may consider the current offerings of products and services as a starting point for envisioning the creation of value propositions, given the vision related to the circular economy and the stakeholders' needs and problems. It raises awareness of the importance of recombining internal and external resources to design innovative and varied value propositions (Beverungen et al., 2018; Yu and Sangiorgi, 2018).

To advance research on circular PSS value propositions design in BMI context, we also summarize the main proposals for future research. They result from the analysis of the 46 approaches, which enabled the identification of gaps and potential solutions. The proposals are described as follows:

- Integrated, systemic and interdisciplinary approach: this could benefit from the "process model" lenses combined with another representation style, such as visualization tools and gamified approaches. A process model could span all stages of innovation until the development of the initial business model, and be based on an agile/prototypical approach to represent the dynamic nature of activities.
- Design options of circular PSS value propositions: from analysis of real cases, PSS features and circular strategies could be combined in design options to inspire practitioners when designing the solutions.
- Multiple stakeholder approach: identifying who are the stakeholders and involving them in the circular PSS value proposition design through the articulation of knowledge and actions are important activities to be in place before the ideation stage. Stakeholders and customers involvement can be combined based on the identification and prioritization of their needs and problems to be addressed in a co-creation process involving both parties. The selection of the representation style could influence this purpose. For example, gamified approaches can create a risk-free environmental, critical thinking through collaboration between customers and other stakeholders, stimulation of creativity while people can learn from their limitations and mistakes (Riedel and Hauge, 2011; Laurischkat and Viertelhausen, 2017).
- Perceived value: there is a need to determine the multiple types of value that could be perceived by stakeholders, which might include experience, economic, environmental, and social benefits.
- Quantitative (or at least, semi-quantitative) approaches: even if the nature of decision-making related to value propositions is qualitative, there is an opportunity for quantitative methods/tools to support specific stages of the value proposition design, such as its assessment and prioritization. Quantitative measures could be, for example, circularity level indexes of value propositions, or the level of efforts or investments needed to implement them. Multi-criteria decision analysis can also be explored to select the value propositions.
- Empirical studies: more action-oriented research, whether in the same industry sector or in different sectors, is required to increase the maturity of the research.

6. Conclusion

This study consolidated and analyzed the approaches that can support the design of circular and/or PSS value propositions in a BMI context. The research methodology was designed on the grounds of a systematic literature review accompanied by a critical analysis of the findings through content analysis. The resulting 46 approaches were classified according to their development level, nature of data, representation style, type of process, actor's perspective, and purpose.

The main general findings of this study are:

(i) Research on value proposition design of circular PSS is in its infancy;
(ii) The design of circular and PSS value propositions is still being considered independently, claiming for an integrated and systemic design approach, such as a process model combined with visualization tools or gamified approach, for example;
(iii) Lack of a unified description of the design options of value propositions of circular PSS, which could be solved through a combined analysis of PSS features and circular economy principles/strategies based on real cases;
(iv) Process model is the most prevalent representation style, but not all stages for value proposition design are covered in a BMI context. A proposal of process model should cover the stages of ideation, selection, evaluation, and implementation/experimentation;
(v) Stakeholders have been timidly involved in a value co-creation process. Customers and other relevant stakeholders could be invited to articulate their knowledge in ideation sessions to propose balanced solutions for their needs and problems. Gamified approaches could be a potential solution to accelerate their integration in the process;
(vi) The value perceived by customers and other stakeholders through the value propositions are being rarely addressed. Experience, economic, environmental and social value should be identified and used to evaluate the value propositions;
(vii) There is an opportunity to advance research through quantitative and empirical studies.

Connected to these findings, we have proposed a number of guiding principles, ranging from managerial to technical aspects, which can be used as a reference to support the structure of the design process of circular PSS value propositions.

This study contributes to theory by advancing the discussion about the potential synergies between the PSS and circular economy domains by mapping and understanding the foundations of approaches that can support the value proposition design. The systematization of approaches resulted in the guiding principles, which serve as a basis for supporting the development of an integrated and systemic approach. In addition, this study provides an agenda to guide efforts in future research. From a methodological perspective, the framework developed to classify the approaches could be adopted or used as inspiration by researchers when structuring similar types of information in other fields.

Regarding the practical perspective, this study can aid practitioners in building awareness of the existing approaches that can support the design of circular and PSS value propositions. Furthermore, the guiding principles can be used as a basis for reasoning, in order to facilitate the effective development of the value propositions at the beginning of the business modeling.

Limitations of this research can be pointed out. Firstly, backward and forward searches were conducted, which may generate selection bias. To address this limitation, cross-references were subjected to the inclusion criteria and a screening process, but specific rules for choosing papers in the first instance could mitigate selection variability. Secondly, non-peer reviewed publications, which do not follow a scientific rigor, were included. The selection of those publications was supported by analyzes from an academic paper, and grey literature was relevant to guarantee comprehensiveness and capture approaches influencing practitioners' action. Finally, the classification of the cataloged approaches was subjected to the researchers' judgment and, for some approaches, a secondary source was used. We sought to address this limitation by developing a framework for classifying data of approaches and by aligning decisions with a BMI expert.

Future work shall develop an integrated approach to design circular PSS value propositions. A conceptual approach could be prescribed by following the guiding principles and based on the analysis of the existing approaches, focusing mainly on process models. Exploratory case studies could also be conducted to empirically understand the design of value propositions. Once the first version of the approach has been defined, it could be evaluated by experts in the fields of PSS and circular economy and be iteratively improved according to their feedback. The proposed

approach should be further tested in manufacturing companies and evaluated according to its usability and applicability.

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.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2020.120507.

Appendix

Table 4
Approaches supporting the design of PSS and circular value propositions in the context of BMI.

Code	Description	References
#1	Method for recombinant service systems	Beverungen et al. (2018)
#2	Methodology for architecting collaborative PSS of systems	Hein et al. (2018)
#3	Process model for service development towards value creation	Yu and Sangiorgi (2018)
#4	Value ring	Fernandes et al. (2018)
#5	Value proposition planning framework	(Frow and Payne, 2011; Quero and Ventura, 2018)
#6	Value proposition canvas by Osterwalder et al. (2014)	(Pokorná et al., 2015; Äyväri et al., 2017; Fernandes et al., 2018)
#7	Managerial practices for circular business model at customer value proposition	(Urbinati et al., 2017, 2018)
#8	Environmental value proposition table	Manninen et al. (2018)
#9	Environmental value proposition framework	Manninen et al. (2018)
#10	Step-by-step approach of the evaluation framework of environmental value proposition	Manninen et al. (2018)
#11	Approach for circular business model experimentation	Bocken et al. (2018)
#12	Value proposition design options	Lüdeke-Freund et al. (2018)
#13	Circular business model mapping tool	Nußholz (2018)
#14	Sustainable qualifying criteria for designing circular business models	Pieroni et al. (2018a)
#15	Method of management and interaction design for service	Teixeira et al. (2017)
#16	Service design process	Rau et al. (2017)
#17	Process for sustainable value proposition design	Baldassarre et al. (2017)
#18	Value Proposition Builder™ by Barnes et al. (2009)	Äyväri et al. (2017)
#19	People Value Canvas by Wildevuur et al. (2014)	Äyväri et al. (2017)
#20	Value analysis tool	Yang et al. (2017)
#21	Taxonomy of circular business models	Urbinati et al. (2017)
#22	Approach of backcasting and eco-design for circular economy (BECE)	Mendoza et al. (2017)
#23	Framework for Strategic Sustainable Development (FSSD)	França et al. (2017)
#24	Circular economy BMI process	Antikainen et al. (2017)
#25	Systematization of service design tools to support BMI	Prendeville and Bocken (2017)
#26	Circularity canvas methodology	Sustainn (2017)
#27	Service Engineering Methodology (SEEM)	(Pezzotta et al., 2014, 2016)
#28	Value proposition test-driving for service innovation	Åkesson et al. (2016)
#29	Product-service value creation system	Wang et al. (2015)
#30	Product-service value creation process	Wang et al. (2015)
#31	PSS transition framework	Pieroni et al. (2016)
#32	Workshop to define value propositions using service design	West and Di (2016)
#33	Business modeling process from the value proposition	Geissdoerfer et al. (2016)
#34	10 steps towards a circular business	Kraaijenhagen et al. (2016)
#35	Game for whole systems design and business model development in circular economy	Weetman (2016)
#36	Service innovation chart	(Belal et al., 2014; Shirahada et al., 2015)
#37	Technical-business design methodology for PSS	(Marilungo et al., 2015; Peruzzini et al., 2015)
#38	Value mapping tool	(Bocken et al., 2013, 2015; Short et al., 2013)
#39	Workbook 'Guided Choices towards a Circular Business Model'	(Joustra et al., 2013; de Jong et al., 2015)
#40	Sustainable value analysis tool (SVAT)	(Yang et al., 2013, 2014)
#41	Value Understanding, Proposition, and Realization based Services Design (VURSD) approach	Kumar et al. (2014)
#42	Circular Business Model Innovation (CBMI) Framework	Mentink (2014)
#43	Business innovation kit for sustainable BMI for value networks	Breuer and Lüdeke-Freund (2014)
#44	Business model roadmap for PSS	Leitão et al. (2013)
#45	Business modeling process for sustainable manufacturing	Holgado et al. (2013)
#46	Play it forward: a game for designing business models with sustainability principles.	Dewulf (2010)

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