



Overcoming barriers towards Sustainable Product-Service Systems in Small and Medium-sized enterprises: State of the art and a novel Decision Matrix

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ABSTRACT

The Sustainable Product-Service Systems are a promising approach based on a Triple Bottom Line perspective of the sustainability. However, its practical and effective adoption is still very limited and addresses significant barriers for the manufacturing firms. Furthermore, this emergent topic has been discussed by literature mainly in large company's context, turning in a very limited and immature stage the current body of knowledge for the Small and Medium-sized Enterprises (SMEs). Thus, considering the significance of small companies to the global economy and their intrinsic difficulties, the purpose of this study was to identify the main barriers involving the transition towards Sustainable Product-Service Systems in manufacturing Small and Medium-sized Enterprises as well as the strategies to overcome them. A systematic literature review of the past two decades was organized capturing the state of the art of the area. Findings reveal that internal barriers associated with intrinsic characteristics of SMEs become still more sensitive during the transition (e.g., limited financial resources, the lack of competences, follower mentality and resistance to change). As well as, barriers related with the novelty of Sustainable Product-Service Systems models require new attitudes to small companies (e.g., changing mindsets from product ownership to use, replacing the value of exchange by value in use involving long-term relations, understanding the Product-Service Systems concept) and particularly highlight the lack of models/methods supporting this transition. The practical contribution of this study is in organise a comprehensive body of knowledge on strategies to overcome barriers towards Sustainable Product-Service offering. Moreover, an innovative decision matrix supporting decision-makers during the Sustainable Product-Service System development was proposed from the literature review findings.

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1. Introduction

Several factors enable manufacturing firms to attain a competitive advantage based on service innovation (Mennens et al., 2018).

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Moreover, the sustainability has become one of the critical factors for long-term business success (Yang et al., 2017) and many manufacturers today are striving to offer high value-added Product-Service System (PSS) due to increasing competition and environmental pressure. However, PSS development activities face a variety of challenges such as a high level of customisation, hidden requirements in product use phase, potential conflicts of design attributes and internal complexity of service processes (Song and Sakao, 2017). Besides, although the PSS domain emerged from the sustainability field, its practical development and application in this domain is not matured yet (Vasanth et al., 2015, 2012).

Initially, the PSS was developed as a more sustainable alternative in comparison with traditional product-sales, primarily through better and more intensive use of materials (Sundin et al., 2015). By shifting from traditional offer to an integrated solution of product-services, it was assumed that PSS could reduce the environmental impact and provide benefits for the PSS provider and the consumer in economic and social ways (Vezzoli et al., 2015). However, currently, there is in the literature the understanding that sustainability is not an intrinsic characteristic of PSS business models (Doualle et al., 2015; Pigosso and McAloone, 2016; Boucher et al., 2016). Several recent studies have discussed that the environmental performance of PSS can indeed, in some cases, be worse if compared to traditional products offer (Kjaer et al., 2016; Pigosso and McAloone, 2016; Barquet et al., 2016b).

Studies have demonstrated that PSS business models actually might have an adverse effect on the environmental issues resulting only in economic benefits (Barquet et al., 2016a; Halme et al., 2004; Tukker, 2015; Doualle et al., 2015). Recently, Pigosso and McAloone (2016) concluded that, despite their substantial potential for enabling increased environment performance, the PSSs are not intrinsically environmentally sustainable. Boucher et al. (2016, p. 1) recently agreed: “The PSS concept was initially considered to be a promising initiative to influence on sustainable production and consumption patterns. However, it is now stated that PSS does not necessarily lead to sustainable solutions”. Consequently, abroad this discussion, a perspective defined as Sustainable Product-Service Systems (SPSS) has received attention from scholars.

The SPSS is defined as “an offer model providing an integrated mix of products and services that are together able to fulfil a particular customer demand (to deliver a ‘unit of satisfaction’), based on innovative interactions between the stakeholders of the value production system (satisfaction system), where the economic and competitive interest of the providers continuously seeks environmentally and socio-ethically beneficial new solutions” (Vezzoli et al., 2015, p. 2). Barquet et al. (2016a, p. 436) also defined SPSS as being “an approach to achieve benefits in the three dimensions of sustainability”. SPSS aimed at maximising environmental and social performance in products, services or PSS offer (Maxwell et al., 2006). Therefore, based on these definitions, differently by traditional PSS assumptions that are more focused on customer’ needs, economic dimension and eventually environmental results, the SPSS is intrinsically embedded in a Triple Bottom Line perspective of sustainability. The SPSS offer is effectively a win-win proposition: environmentally, socio-ethically and economically sustainable at the same time (Vezzoli et al., 2015, 2012).

However, although SPSS innovations represent a promising approach to more sustainable servitization, its practical adoption is still very limited. This occurs because the most of the cases of SPSS offers are radical innovations, involving significant corporate, cultural, behavioural and regulatory challenges (Ceschin, 2013; Vezzoli et al., 2015), giving rise to several difficulties not only in large companies but, especially, in the context of the SMEs. Nowadays, “there are about 22 million SMEs in the EU28, representing 99 of every 100 businesses, employing 89 million people (2 in every 3 employees) and generating around €3700 trillion in added value (Viesi et al., 2017, p. 363)”. However, for SMEs, this transition becomes more problematic due their intrinsic characteristics and the barriers associated (e.g. economic constraints, poor managerial skills, lack of formalized planning, difficulties to attract skilled personnel and to update technological know) hindering the provision of sustainable business (Pardo et al., 2013; Orloff and Heinz, 2015).

Although in recent years there is a growing body of literature that recognises the importance of SMEs, there is very little scientific

understanding regarding the implementation process of SPSS models into SMEs context. This is a critical aspect because the SMEs plays a central role in the economy and to the maintenance of employment in EU (Clegg et al., 2017; Orloff and Heinz, 2015; Bos-Brouwers, 2010). On the whole, the literature demonstrates that the economic performance of SMEs has a pivotal role in the global economy to both well-developed and emerging nations. “An increasing number of academics, policymakers, and government and non-government agencies are turning their attention to SMEs, because SMEs – as major contributors to societies and economies – may play an important role in achieving sustainable development goals (Bhamra et al., 2018, p. 233)”. Nevertheless, little is known about the phenomena of sustainable servitization, and it is not clear what factors more affect the SMEs towards this transition process (Sundin et al., 2015; Rapitsenyane, 2014; Pardo et al., 2013). Consequently, nowadays, the generalizability of much-published research on this issue still is very problematic.

Our research also demonstrates that, although extensive research has been carried out on PSS field, no single study still exists discussing and consolidating in an integrative framework the prescriptive strategies to overcome the barriers towards SPSS in SMEs. In order to exemplify this previous assumption, performing the query TITLE-ABS-KEY, with the strings “Sustainable Product-Service System” AND “SME” on Scopus, only 3 contributions were obtained. However, none of these contributions focuses on the barriers or in guidelines to overcome them in SMEs. We conclude, therefore, that little or none attention has been paid to this topic in particular.

Reinforcing these research gaps, several recent studies corroborate other critical reasons that justify the motivation of this research focusing on SPSS in SMEs. Thus, our study responds to recent calls for investigating how SMEs can successfully make the transition towards competitive SPSS business models. Recently, Bhamra et al. (2018, p.233) reinforced the contribution of our study arguing that “[...] SMEs need more targeted information about how to implement the PSS concept. They need to better understand the feasibility of the PSS model for their structures. They need an ability to discern the drivers and barriers to PSS design and development. And, they need to understand the perceptions of their supporters as regards PSS.”

Aligned with this previous assumption, is not easy to transfer key findings regarding the capabilities necessary for the service business to SMEs, which generally feature different strategies, capabilities, and resource (Paola et al., 2012; Gebauer et al., 2010). Also, the servitization process is a not yet mature phenomenon for manufacturing SMEs (Rondini et al., 2018; Adrodegari et al., 2017; Wiesner et al., 2017; Kowalkowski et al., 2013; Hernández-Pardo et al., 2012; Tonelli et al., 2009). In sum, little is known about service infusion in SMEs (Kowalkowski et al., 2013) justifying the motivation and relevance of our research.

Additionally, other critical reasons for SMEs engage the transition towards SPSS must be considered. First, in many cases, radical innovation can only be achieved with business model innovation, such as the case of SPSS offers (Orloff and Heinz, 2015, p. 20). Also, without combined product with service innovation, manufacturing SMEs run the joint risks of failing to defend existing markets as well as not developing new markets (West and Nardo, 2016). Finally, eroding product margins (Paola et al., 2012) intensive competition (Paola et al., 2012; Doualle et al., 2016) and maximize customer value (Peillon et al., 2018) are strong reasons to SMEs add servicized business models.

Hence, considering that the current background for SPSS transition to SMEs is fragmented and still insufficient to support the shift towards SPSS models for the small business, to fill this research gap the research question that emerges is the following:

What are the main barriers and lessons learned involving the transition to SPSS within SMEs into practice and how overcomes these barriers? The managerial relevance of this study is in to identify and present new insights into manufacturing SME' managers, policymakers, and academics to implement SPSS business models successfully. Also, this research extends the current theoretical framework on PSS and SPSS in SMEs driving new researches avenues to this domain, enriching the body of knowledge in the field of sustainable servitization of manufacturing firms.

This study makes an original scientific contribution to research on SPSS in SMEs in two manners. First, contributes providing a structured and comprehensive review of literature offering several insights that emerged from literature available. Second, our research proposes an innovative Decision Matrix supporting SMEs and decision-makers during the SPSS transition. Finally, corroborating the importance of our work, recently Reim et al. (2015, p. 62), concluded in a comprehensive literature review on the state-of-the-art on PSS models that, “[...] there is an increased need to synthesize the findings of existing studies and provide directions for future research on the important topics of PSS business models and tactics”. This present need occurred because of the rapid growth of the researches in this field, contributes to problems associated with accumulating and systematizing research findings.

The remainder of the article is organized in the following manner. Section 2 introduces the research context and the literature, and Section 3 presents the research method and the protocol of systematic review carried. Section 4 details the findings as well as introduce the innovative SPSS Decision Matrix supporting the decision-making process developed from the findings observed in the literature. Section 5 discusses the research results and their managerial and scientific implications to the cleaner production, sustainability and SMEs literature. Finally, section 6 concludes the study and presents the main research directions to advance in this relevant domain.

2. Research context

The literature evidences in several ways that the transition towards SPSS is not an easy journey and that many are the difficulties hindering a sustainable provision of product-service oriented offers to large and especially to SMEs (Vezzoli et al., 2015; Salazar et al., 2015; Kjaer et al., 2016; Pardo et al., 2013; Orloff and Heinz, 2015). A possible reason is that there are significant differences between the business models of large companies and SMEs. Policies, as well as theories and instruments suited for large companies, do not necessarily lead to successful outcomes within an SME (Bos-Brouwers, 2010).

Another disadvantage is regarding the current research framework accumulating. Most of the literature focuses mainly on the large and multinational companies, overlooking the significant contribution for SMEs. However, at least 80% of all global enterprises are considered SMEs (Moore and Manning, 2009). According to the European Commission (2011, 2016), the SMEs represent over 99% of European enterprises and around two-thirds of European employment. Therefore, due to the significance of SMEs, specifications and critical directions towards SPSS business models diffusion for SMEs represent a topic essential for the world economy (OECD, 2010).

Besides, considering specifically some intrinsic characteristics of SMEs (Bos-Brouwers, 2010), the SPSS transition can turn still more difficult in small business. First, considering the financial aspects, the failure of innovation projects, as a new SPSS offer, may be disastrous to SME due to their economic constraints. Difficulties attracting venture capital and investments and the high fixed costs for technological investments also can be critical for scaling up new

SPSS business models. Second, on the owner/manager perspective, the poor managerial skills (planning, inadequate delegation, lack of functional expertise or support), the high dependency on persons for survival and the lack of formalized planning, can turn more difficult the implementation of SPSS offer. Third, the difficulties to attract skilled personnel and to update technological knowledge may also affect a successful SPSS due to the new necessary design and sustainable competencies. Hence, considering these difficulties and the economic significance of small business to the global economy, it is necessary to comprehend which strategies have potential to mitigate these core disadvantages faced by SMEs to obtain a more fluid transition towards SPSS business models.

Due to this, the SPSS is still an immature research topic in the available literature and so far directed to large companies. Consequently, there is a clear gap in the literature regarding its implementation and diffusion specifically in SMEs context. We demonstrated that the literature focused on this domain is scarce and, as a result, the operational deployment at the concrete level of the industrial SMEs economy is very limited (Clegg et al., 2017; Boucher et al., 2016; Nada and Ali, 2015; Pardo et al., 2012). In this context, this research focuses specifically on SPSS business models in the context of capital goods manufacturing SMEs. To fill this gap, a systematic literature review of the leading scientific databases has been performed. As a result, this study extends the current literature on this specific domain, contributing to the understanding of the adoption of SPSS business models in SMEs. More in particular, in the following section, the research method adopted to address the research objectives is described.

3. Materials and methods

To advance and extend the current research framework investigating the SPSS transformation in manufacturing SMEs, the present study consisted of a systematic literature review, driving new research avenues to this field. The specific focus is on researches related to SPSS transformation in capital goods manufacturing SMEs and its barriers and tactics to overcome these constraints. The main advantages of the systematic literature review are twofold, understanding the state of the art of the research domain and aiding the identification of useful knowledge (Dresch et al., 2015; Tranfield and Denyer, 2003; Moher et al., 2009). In this sense, the research protocol (Dresch et al., 2015), was adopted and structured as follows.

Initially, in step 1 of the search process, was performed the planning research process, contemplating the definition of the issue and conceptual framework. In this case, our research aims to comprehend what are the main factors involving the transition process to SPSS in manufacturing SMEs context into practice. The research question of this study is: what are the factors involving the transition process to SPSS within SMEs into practice? The authors of this study performed all the stages of the systematic literature review process.

Next, step 2 considered identify the publications and applying practical screening. As well as, apply the search strategy, keywords, period, databases, inclusion/exclusion criteria, and eligibility/coding. For the keyword and Boolean operator's definition, initially, a preliminary analysis was performed on previous systematic literature review papers focused on PSS domain. An initial list of keywords was extracted from the following papers: 'State-of-the-art of design, evaluation, and operation methodologies in product service systems' by Qu et al. (2016), 'Product-Service Systems (PSS) business models and tactics - a systematic literature review' by Reim et al. (2015), and the 'Product-service systems: a literature review on integrated products and services' (Beuren et al., 2013) and 'State-of-the-art in product-service systems' (Baines et al., 2007).

As a result, an initial set of keywords frequently used by

academics in the PSS domain could be organized. Next, a preliminary search combining the keywords 'PSS', 'Sustainable Product-Service System', 'SME' and 'Small and Medium-sized Enterprises' was conducted in Scopus database aiming to identify a more comprehensive set of keywords specifically related with 'Sustainable Product-Service System' in SMEs domain. Thus, other keywords were identified and added. Indeed, due to the limited literature identified about SPSS in SMEs, a broader keywords list was included in the step of the full search process, aiming to capture all the potential papers related to the SPSS transition in manufacturing SME available in scientific databases.

Finally, to conduct the final search process, the combinations of the keywords found (Table 1) with 'SME' and 'Small and Medium-sized Enterprises' were performed in the field Title, Abstract, and Keywords of Scopus and ISI Web of Knowledge (WoS) databases. To exemplify, one of the several combinations used to perform the screening was the following: 'Sustainable Product-Service System' & 'SME'. The WoS and Scopus coverage the most relevant scientific databases in Engineering, Natural Science and Arts/Humanities and not necessarily index the same journals (Mongeon and Hus, 2016).

Previous literature review studies on PSS also applied a similar search strategy to reveal the state of the art in this domain (Reim et al., 2015). Complementary, additional records were identified through other sources. In this case, was performed the search process at databases ProQuest Dissertations & Theses and Google Scholar to locate studies such as PhD theses or even peer review papers not obtained by scientific databases, using the combinations of keywords adopted in the principal search process. The criteria adopted for the selection of studies in Google Scholar were the same criteria adopted in stage 3 of the search process. As a result, two PhD theses (Hernandez-Pardo, 2012; Rapitsenyane, 2014) were selected after the inclusion and exclusion analysis.

The use of complementary search to Scopus and WoS contributed to a more accurate assessment. Moreover, types of citing documents significantly differed between disciplines, suggesting that a broad range of academic non-journal publications not be indexed in WoS but are accessible through others database (Mongeon and Hus, 2016). Finally, the most cited articles on references of papers also were analysed and, if considered adherent with the inclusion/exclusion criteria, were included in analyses.

The step 3 consisted of applying the theoretical screening criteria. In this stage, the first definition is related to the search period adopted. The search period considered was between January/1995 and October/2018. In this stage, the search process adopted (Moher et al., 2009) is detailed (Fig. 1). The next definition is about the inclusion and exclusion criteria. The eligibility criteria adopted for inclusion of studies for full analysis were as follows: (i) papers investigating the transition process to specifically in SPSS in capital goods manufacturing SMEs (ii) studies proposing artefacts (i.e. methods, models or tools); on this topic; (iii) papers clearly demonstrating practical evidence/results on SPSS deployment in capital goods manufacturing SMEs; (iv) studies in English language. Besides, the exclusion criteria adopted were the following: (i) studies with high quantitative or statistical bias making it difficult to capture qualitative insights and lessons learned; (ii) pure theoretical and conceptual papers; (iii) studies investigating the transition into large companies or in non-manufacturing SMEs (e.g., software, tourism, commercial, sharing companies); (iv) we used only formal literature, does not including for example books, grey research, and reports; (v) studies demonstrating low methodical rigour.

In step 4 was performed the final filtering and process analysis. The data collected from each study were used to detect relevant findings related to the barriers for SPSS diffusion in SMEs, as well as, how they could influence the SPSS transition and the sustainability performance in manufacturing SMEs. To perform the analysis of

Table 1
Search strings and results.

Search strings	Scopus	Web of Science
Sustainable product-service system	3	–
Product-service system	32	–
Product-service	137	1
Servitization	18	6
Sustainable Service	1	4
Industrial product service system	1	–
Service engineering	5	–
PSS	26	1
IPSS	–	19
Service-dominant logic	8	5
Servicification	–	–
Functional product	4	–
Functional product development	–	–
Integrated product service engineering	–	–
Integrated product service offering	–	–
Functional sales	–	–
Dematerialisation	3	–
Service infusion	–	–
Product-to-service	–	–
Post mass production paradigm	–	–
Service-oriented	–	–
Integrated solutions	–	4
Product bundling	4	–
Hybrid offerings	–	–
Sharing economy	2	–
Shared economy	–	–
Circular economy	25	5
Total	269	45

these studies, the open coding content analysis technique was employed, aiming at certifying if the publication considers the sustainability perspective on the transition to SPSS. The study yielded a portfolio of twenty-two selected studies, revealing the absence of researches on this topic.

During the process analysis, notes and headings were synthesized in a spreadsheet in association with our research goal. After presenting the main metadata results and descriptive analyses, the synthesis, based on configurative analyses (Gough, Oliver and Thomas, 2012), was considered. The open questions in literature reviews studies designed to explore a topic broadly are best answered using a configurative review. In the configurative analysis, the review questions tend to be answered with qualitative data gathered from more heterogeneous primary studies, which are interpreted and explored throughout the review to generate and explore the theory (Gough, Oliver and Thomas, 2012; Dresch et al., 2015). Thus, the results and contributions are discussed in depth in the next sections.

4. Results

4.1. Contextualizing the field

Initially, the state of the art of the studies in PSS, SPSS and both applied in SME context were compared. Table 3 exemplifies the total of published articles, and the respective matching keywords searched in the field Title of the Scopus database.

By analysis in Table 3, relevant findings can be highlighted. First, it is possible to verify an increasing number of published studies from 2010 regarding 'Product-Service System' field. Around 89% of PSS' studies were published from 2010. In addition, a noteworthy consideration aspect evidenced is that the number of publications doubled from 2011 to 2015.

Furthermore, an increasing interest in Sustainable Product-Service System topic in recent years could be evidenced in the literature available. Regarding these results (51 records) in Table 3,

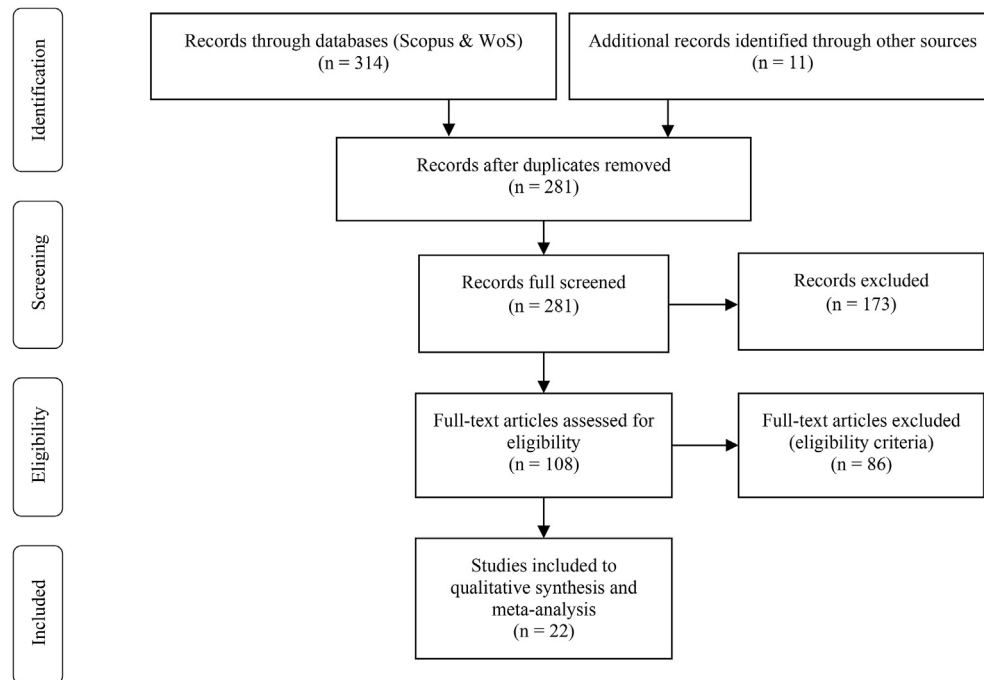


Fig. 1. Research process.

it still is possible to affirm that the body of knowledge existent can be considered still very limited. We found a little number of studies specifically on the intersection between ‘Product-Service System & SME’ and, particularly, regarding ‘Sustainable Product-Service System & SME’. These numbers indicate that the theoretical background on PSS and mainly SPSS in SMEs context is very restricted (Bacchetti 2017; Boucher et al., 2016; Pardo et al., 2012). Therefore, the recent increase interest by SPSS in SMEs confirms the hypothesis that this relevant domain is in infancy and fragmented stage of research.

Furthermore, a network of interactions (Fig. 2) was constructed using NodeXL software (Smith et al., 2010) to determine how occur

the interaction between the scholars and to improve the understanding of this topic. The network of interactions was based on the number of citations of each author among the selected studies. Authors without citations were not considered in the graphic representation, and the number of citations in the selected papers was collected manually. The arrows point towards the author that was cited. Smaller dots that did not include an arrow represent authors that mentioned another researcher, but they were not cited by anyone in the network. The primary outcome was that the most cited studies among the authors of this subject were, respectively, Kowalkowski et al. (2013), Gebauer et al. (2010), and Hernández-Pardo et al. (2012).

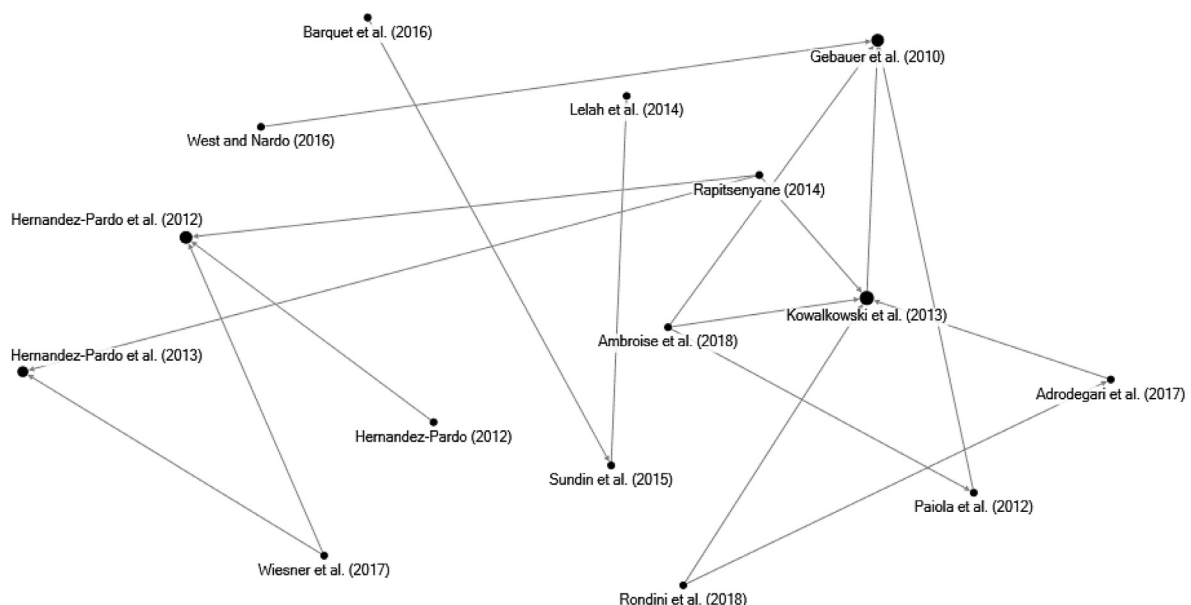


Fig. 2. The network of interactions of the scholars.

Kowalkowski et al. (2013), adopted an explorative approach to investigate how SMEs construct new value constellations that enable value creation through servitization. Findings on the transition process for service infusion in SMEs were obtained from information from 13 SMEs. Already Pardo et al. (2012) present an approach to identify opportunities to develop SPSS in SMEs. In order to develop the model, a study with 16 manufacturing SMEs was carried out. A set of barriers and opportunities for a successful transformation were noted. Finally, Gebauer et al. (2010), focus on how SMEs from the capital goods manufacturing sector develop service business.

In order to enrich the analyses and the comprehension of the state-of-the-art in this domain, the software Publish or Perish (Harzing, 2007) was used to identify the dissemination of these studies considering the total number of citations of each study (Table 2). It is a software that retrieves and analyzes academic citations, and the data were collected (in October 2, 2018) considering the citations in Google Scholar. The criteria used to analyse citations was the following: the quantity of citations denotes the sum of all citations received by the study in the literature since the publication.

Findings show that the studies with highest total citations are, respectively, Kowalkowski et al. (2013) with 130 citations, Gebauer et al. (2010) with 84, followed by Orloff and Heinz (2015) and Hernández-Pardo et al. (2012), both with 45 records. Publish or Perish also was used to understand the dissemination of all selected studies calculating the average of total citations per year. This index represents the number of citations received divided by the number of years since the publication of the study.

The results demonstrated that the studies with the highest dissemination until the moment are Kowalkowski et al. (2013) with 26 citations per year, Adrodegari et al. (2017) with 11 citations, Gebauer et al. (2010) with 10,5 citations per year and Hernández-

Pardo et al. (2012) with 7,5. These related studies may be considered as potential representative researches and possible bottom-line to new investigations in this domain.

4.2. Main barriers towards Sustainable Product-Service Systems in manufacturing Small and Medium-sized Enterprises

Besides, considering specifically intrinsic characteristics of SMEs, the transition towards SPSS can be still more difficult. Several barriers extracted from transitional case studies are highlighted in the available literature. Aiming to ensure qualitative rigour in inductive research, we applied the methodology proposed by Gioia et al. (2013). This methodology is an approach useful to the articulation of concept development designed to bring rigour to inductive research procedures.

Therefore, in the first stage of this methodological process, an in-depth analysis of the findings and conclusions of the studies was performed. Next, a micro-level categorization of barrier categories of main ideas retrieved from findings and conclusions was organized. As a result, layers of abstractions were proposed by analyzing the results of literature exploration. The same process also was adopted to obtain the categories of guidelines indicated by the literature.

For instance, Rapitsenyane (2014) summarised as main SMEs' constraints: the lack of finance and poor market performance of products contributing to enormous low profit margins; the low engagement in innovation activities; low design awareness and follower mentality; lack of clear business strategy; negative experiences from tried/failed collaborations causing scepticism to new projects; and limited understanding of sustainability only to the economic dimension, turning environmental and social gains to low priorities for SMEs.

Pardo et al. (2012) also found similar barriers, such as limited

Table 2
Selected studies.

#	Author(s)	Title	Citations
1	Orloff and Heinz (2015)	Sustainable product service systems in small and medium enterprises - from a case study on textile leasing to a Design Thinking Workshop for Sustainable Product-Service System Development.	45
2	Lelah et al. (2014)	Scenarios as a Tool for Transition towards Sustainable PSS.	10
3	West and Nardo (2016)	Creating product-service system opportunities for small and medium-size firms using service design tools.	5
4	Lelah et al. (2012)	Collaborative network with SMEs providing a backbone for urban PSS: a model and initial sustainability analysis.	15
5	Hernández-Pardo et al. (2013)	Exploring SME Perceptions of Sustainable Product-Service Systems.	19
6	Doualle et al. (2016)	Design of sustainable product-service systems (PSS): towards an incremental stepwise assessment method.	8
7	Adrodegari et al. (2017)	PSS business model conceptualization and application	11
8	Gebauer et al. (2010)	Service business development in small and medium capital goods manufacturing companies	84
9	Rapitsenyane (2014)	Supporting SMEs adoption of sustainable Product Service Systems: a holistic design-led framework for creating competitive advantage.	1
10	Sundin et al. (2015)	Sustainability indicators for Small and Medium-sized Enterprises (SMEs) in the transition to provide Product-Service Systems (PSS).	10
11	Xing and Ness (2016)	Transition to product-service systems: principles and business model.	4
12	Hernandez-Pardo (2012)	Designing sustainable product service systems: a business framework for SME implementation.	–
13	Hernández-Pardo et al. (2012)	Sustainable Product-Service Systems in Small and Medium Enterprises (SMEs): Opportunities in the Leather Manufacturing Industry.	45
14	Kowalkowski et al. (2013)	Any Way Goes: Identifying Value Constellations for Service Infusion in SMEs.	130
15	Wiesner et al. (2017)	Integrating requirements engineering for different domains in system development – lessons learnt from industrial SME cases.	8
16	Rondini et al. (2018)	A simplified approach towards customer and provider value in PSS for small and medium-sized enterprises.	–
17	Peillon et al. (2018)	Service and customer orientation of corporate culture in a French manufacturing SME.	–
18	Goduscheit and Faullant (2018)	Paths Toward Radical Service Innovation in Manufacturing Companies - A Service-Dominant Logic Perspective.	1
19	Ambroise et al. (2018)	The environment strategy-structure fit and performance of industrial servitized SMEs.	1
20	Paiola et al. (2012)	Service Business Development in Small- to Medium-Sized Equipment Manufacturers.	28
21	Bacchetti (2017)	A design approach with method and tools to support SMEs in designing and implementing Distributed Renewable Energy (DRE) – solutions based on Sustainable Product-Service System (S.PSS).	–
22	Tonelli et al. (2009)	A Framework for Assessment and Implementation of Product-Service Systems Strategies: Learning From an Action Research in the Health-Care Sector	17

Table 3
Number of publications per year versus keywords.

Year	'product-service system'	'product-service system & SME'	'sustainable product-service system'	'sustainable product-service system & SME'
2000	1		1	
2001	2		2	
2002	1			
2003	5		1	
2004	2			
2005	6			
2006	11		1	
2007	12			
2008	16		1	
2009	32			
2010	42		3	
2011	52			
2012	69		3	
2013	82	1	4	1
2014	89		4	
2015	113		10	
2016	110		7	
2017	100		8	
2018	111	1	6	
Total	861	2	51	1

knowledge and awareness in social and environmental subjects, lack of knowledge/awareness of sustainability and lack of a business strategy. Barriers related to organisational weaknesses obscure the possibility to design and implement SPSS. Explicit barriers blocking the transition are the misunderstanding of the PSS concept, undervalued and unclear design practices, disarticulated use of Information and Communications Technology (ICT) and a worrying lack of trust and collaboration in the supply chain. The assumption that giving SMEs access to ICT will make them more competitive is only partially valid. These difficulties can be partially explained because, if the SMEs are not able to integrate the technologies with their main production processes and if they do not have a business strategy where technology can play a role, similar problems will be repeated.

Orloff and Heinz (2015) identified as main barriers the management commitment during the initial implementation of SPSS, internal conflicts between sales and service, recognition of market demands, problems to pricing services, difficulty in balancing the overall performance with social/ecological issues and problems with low-value products. They reinforce that these difficulties also can become success factors if perfected. Finally, they argued that the success in sales mainly depends on the communication of the leasing-contract to convince customers by savings. Potential internal conflicts between sales and service and shift to service mindset are solved by putting customer satisfaction at the centre of attention. The problem of pricing services is solved through a transparent cost structure. The stronger market competition and the lack of market demand are minimized with benchmarking on a national level with competitors and having a bigger sales team on the SME level.

Pardo et al. (2013) also found similar barriers and added complements with new variables, such as the lack of understanding within SMEs about what sustainability means and what the implications are for them to transform their operations towards sustainability, lack of formal business strategies with a design process suggests that work is needed on this area before thinking about developing SPSS. They also highlighted as barriers the organisational resistance in SMEs, substantial investments required, complexity, the balance between sustainable business principles, public acceptance, financial uncertainty, the absence of demand, and complicated relationships between stakeholders. Furthermore, there are barriers related to ICT waste or non-use, obsolescence of

products, the unknown effect of ICT, equipment and application, rebound effects, lack of knowledge, substantial investments required, re-materialisation. Finally, it is not yet clear how the academia, policymakers, non-governmental organisations and the public can work together, how they can give support and what mechanisms should be used to develop PSS in SMEs (Pardo et al., 2013).

The sustainable infusion and awareness depend on the size and on resources such as time, specialised, the personal interest of employees and maturity or time working in sustainable issues of SME (Sundin et al., 2015). There is a lack of understanding about the changes required to their current business models and how these changes may be undertaken progressively and measure the impacts on the transition (Xing and Ness, 2016).

Problems regarding the need for change management in the business also are explored by literature. The main challenges, to Lelah et al. (2014), are moving the business model based on transactions to a model based on relationships, requiring global planning, changes in management practices and rethink business models replacing the value of exchange by value in use, involving long-term relations. Lelah et al. (2012) highlight the difficulty in changing the mind-sets from product ownership to use, share responsibility for system performance between provider and the user, and the lack of tools linking the micro-system of the company and its process of development of products/services to the sustainability expectations of society.

Pardo et al. (2012) found a complex situation with internal and external actors involved in the SMEs investigated, detecting a lack of connection in strategic terms between the adoption and use of ICT with the other areas (i.e. design and sustainability). The obstacles (short-term management, tight financial budgets, etc.) can be overcome if the inclusion of concepts to develop SPSS is performed through partnerships with Universities, Consultancies, Government Agencies or any organisation with the capacity to support organisational projects in SMEs. The lack of awareness about the mean of sustainability to the Operations Management activities within SMEs results in incorrect actions taken by the SMEs in the environmental/social domain. From these obstacles of pointed by the literature, an integrated classification of barriers can be summarised (Table 4). Although the related barriers are not an exhaustive list, they represent the most significant difficulties faced by SMEs according to the literature available.

On the one hand, these findings reveal some expected internal barriers resulting from intrinsic characteristics of SMEs that becomes still more sensitive during the SPSS transition. Such for example, we highlight the lack of financial resources, financial vulnerability, and short-term management view that can turn still more difficult the engagement in business model innovations such is the case of a SPSS offer.

In line with these findings, the lack of competences (i.e. in high management, employees, knowledge on PSS concepts and advantages) also restrict SMEs establishes a clear vision of sustainability based on Triple Bottom Line perspective. The lack of business strategy, internal formalized process, sums up to lack of models/methods guiding the transition and the absence of an orchestrated ecosystem, increase the unsuccessful risks to the manufacturing SMEs.

On the other hand, the outcomes shown several barriers directly related to the nature and novelty of PSS and SPSS business models that require new attitudes to be adopted by the company. For

instance, change mindsets from product ownership to use, replace the value of exchange by value in use involving long-term relations, design/sustainability competencies and a general misunderstanding of the changes required. Barriers related to the weak market performance of products and difficulty in recognition of market demands occurs mainly due to social reasons and the difficult to change existing customers' habits (Ceschin, 2013). In a nutshell, it is possible to deduct that the development of SPSS in SMEs will be an activity thoroughly tricky. Indubitably, the constraints are more critical than the large companies faced. However, some lessons learned from empirical studies, discussed in the next section, presents the potential to mitigate these problems scaling-up a successful transition.

4.3. Main lessons learned towards Sustainable Product-Service Systems in manufacturing Small and Medium-sized enterprises

The organisation of knowledge accumulate regards transition

Table 4
Main barriers.

Category	Code	Barriers	Author (s)
Financial	B-FI1	Lack of financial resources.	(5), (8), (9), (10), (13), (14), (15), (16), (18), (20).
	B-FI2	Financial vulnerability.	(1), (8), (9).
Market	B-MK1	Poor market performance of products.	(9).
	B-MK2	Difficulty in recognition of market demands.	(1), (5), (7), (20).
Behaviour	B-BH1	Low engagement in innovation activities	(9).
	B-BH2	Follower mentality.	(9), (14).
	B-BH3	Mental models.	(8), (9).
Competencies	B-CM1	Lack of sustainability and design awareness.	(5), (9), (12), (13), (21).
	B-CM2	Lack of managerial competencies.	(8), (15), (22).
	B-CM3	Lack of design competences.	(5), (9), (12), (18), (19), (21).
	B-CM4	Lack of sustainability competencies.	(5), (9), (10), (21), (22).
	B-CM5	Knowledge gaps.	(4), (5), (7), (8), (9), (18), (19), (20).
Motivation	B-MT1	Past negative experiences in the project, cause scepticism to new initiatives.	(9)
	B-SU1	Sustainability awareness limited to economic perspective.	(2), (10).
Sustainability (TBL)	B-SU2	Limited knowledge and awareness in social and environmental issues.	(9), (10), (13).
	B-SU3	Lack of understanding about what the implications toward sustainability transition.	(5), (12).
	B-SU4	Difficulty to balance the overall performance with social and ecological issues.	(5).
	B-SU5	Products with low value are an obstacle to sustainability performance.	(1).
	B-ST1	Lack of business strategy.	(1), (5), (8), (9), (11), (12), (16), (19), (20).
Organisational	B-ST2	Difficult balancing sustainable business principles.	(1), (11).
	B-OR1	Organisational weaknesses and change resistance.	(5), (12).
	B-OR2	Organisational culture.	(1), (2), (9), (17), (20).
	B-OR3	Internal organisational conflicts between sales and service.	(1), (20).
	B-OR4	Low diffusion and waste in ICT.	(5), (12), (13).
	B-OR5	Short-term management practices.	(13).
SPSS process	B-OR6	Need of replacing the value of exchange by value in use involving long-term relations.	(2), (7).
	B-SP1	Lack of understanding of SPSS concept.	(5), (12).
	B-SP2	The complexity of PSS.	(5).
	B-SP3	Need for large investments.	(5).
	B-SP4	Lack of understanding of the changes required.	(5), (10), (11), (12).
B-SP5	Lack of tools linking the company' micro-system and its process of PSS development to the sustainability expectations of society.	(3), (4), (5), (9), (21).	
Methods and tools	B-MT1	Lack of frameworks, models, method and specific guidelines suited to SMEs orienting the transition.	(1), (2), (3), (6), (7), (15), (16), (21), (22).
	B-MT2	Lack of a comprehensive method for assessing SPSS sustainability	(11).
Supply Chain and Network	B-SC1	Lack of trust and collaboration in the supply chain hampering the orchestration.	(8), (9), (12), (18), (19), (20), (22).
Human Resources	B-HR1	Lack of social competencies to the leading positions.	(10).
	B-HR2	Lack of a SPSS leader/champion pulling the transition.	(11).
Products	B-PR1	Low-value products are resulting in low-profit margins and low competitive advantage.	(20).
Leadership	B-LE1	Low management commitment in the initial implementation of SPSS.	(1), (8), (10), (11).
Stakeholders	B-ST1	Difficult relationships between stakeholders affecting SME performance.	(2), (5), (7), (8), (9), (19), (20), (21).
	B-ST2	Changing mindsets from product ownership to use-centred.	(1), (2), (4), (8), (9), (19), (20).
Orchestrated Ecosystem	B-OE1	Lack of an organized ecosystem (i.e. academia, policymakers, governmental organisations, public) supporting SPSS transition.	(13).
Customer	B-CU1	Public/user acceptance and product-orientation of customers	(14), (20).
	B-CU2	Need for replacing the value of exchange by value in use involving long-term relations.	(2), (7), (10).
	B-CU3	Share responsibility between the provider and the end user.	(10).

studies as well as on the lessons learned found in this work may help to mitigate the adverse effect of several constraints faced by SMEs towards SPSS offers. Thus, this section explores this perspective. According to [Lelah et al. \(2014\)](#), before moving towards SPSS, first, the SME must formulate the problem it faces. Moreover, starting with a small part of the business and then extending to the whole organisation might be the best alternative to overcome difficulties related with business structure, including relationships within the value network, organisational culture and, mental models.

[Xing and Ness \(2016\)](#) indicate that careful design of business cases is required to increase resource efficiency, while even more consideration is necessary to increase social sustainability via affordability and to generate increased employment. Fundamental principles must be considered to obtain a successful SPSS offer. For instance, the product should have relatively high market value or relatively high selling prices in comparison with other similar products, durable/long physical life and should be designed with minimal footprint and with a modular structure. Regarding the service offer, it is indicated that the product be owned by the service provider and that, connected to this, some basic service options should be possible (e.g., leasing or renting, desktop support, performance monitoring and maintenance contract, take-back system), constituting PSSs with their modular combinations. The service should contribute to increase environmental values of ownership and reduce total cost of ownership.

Regarding the business model, some fundamental principles are indicated ([Xing and Ness, 2016](#)), including to define who customers are, the customer values, the processes (both internal and external) to engage and interact with customers, what resources and assets to possess and utilise, what and how revenue can be generated and associated with cost implications. Furthermore, the SPSS offer needs to be market-oriented and customer-focused and able to address a particular customer value network and to fulfil functional, economic, environmental and social demands. Regarding employees, some specific actions should be undertaken: to train in new skills associated with PSS, reward systems, monitor/report the PSS performance in meeting service requirements and measure/control environmental and economic performance in different scenarios.

Accomplish the risk, cost, profit and business sustainability analysis to economically, financially and environmentally characterise the possible SPSS strategies to SME are important guidelines ([Tonelli et al., 2009](#)). As well as, to develop a marketing plan to promote the new business model in the market, both versus existing and new customers. Furthermore, specific support for its transformation based on frameworks and guidelines for managing PSS proposals is also recommended. Lastly, it is essential to verify the availability of human resources, infrastructure and ICT competencies in SME. Similarly, [Lelah et al. \(2012\)](#) complement that SMEs must be supported by an ICT backbone facilitating communication of data within the network. A detailed description and role of the user and his activities during value creation must be done. Others lesson learned must consider the co-creation of value by the user to provide a basis for exploring possibilities across the supply chain network.

Aligned with these previous findings, [Orloff and Heinz \(2015\)](#) from the customer perspective, indicated as guidelines that (i) capturing user needs fosters empathy with the customer's processes; (ii) a user-centred firm culture paired with high top management is a key for long-term PSS success; (iii) understanding that creates value are competencies necessary to adopt on customers' processes; (iv) a routine of personal contact between employees and customers, and (v) close relations along the value chain with both designers and customers. Additional factors related to SPSS offer also include the existence of portfolio management, sustainability orientation, engaging in networks, the presence of a catalyst

leader, internal competencies regarding products/services and short communication routes for fast decision-making and flexibility in strategic decision-making. Regarding the sequence of the transition process, they suggest first to design the service aspects and then to match the corresponding product part of the PSS especially valuable for sustainable outcomes due to the high dematerialisation potential.

Critical factors associated with the continuous innovation of SPSS are the existence of a transparent cost structure for long-term planning, investments for products and production, company's rooted identity in regional structures, continuous innovation behaviour, supportive integration of the employees is vital for continuous innovation in the long-term. Workshops (e.g., Design Thinking) enable manufacturing SMEs to explore the potential of PSS as they are fast and inexpensive compared to normal R&D activities ([Orloff and Heinz, 2015](#)). External support such as training and financial support is an essential element in the positive perception and disposal of SPSS to SMEs ([Pardo et al., 2012](#)).

Lessons learned also include to integrate design activities, for example, SPSS design and ICT, with virtualisation, production, evaluation of prototype, up to recovery, repair, and resale of products. This will result in the development of a collaborative platform between SMEs using ICT to support the optimization of the production, improving the decision-making ([Pardo et al., 2012](#)).

Additional principles to move towards the SPSS transition emphasizing the design activities were found ([Rapitsenyane, 2014](#)). First, the involvement of designers through a strategic design approach gives benefits demonstrating differentiation through services in manufacturing SMEs. This involvement can incrementally expose SMEs to SPSS and its benefits since they mostly perceive it as a worthwhile route. Second, the flexibility of designers and their adaptability to different situations, mainly to use design capabilities in non-design led product-oriented SMEs can promote radical innovations concepts like SPSS. Third, key design leadership capabilities should be developed throughout the process are crucial and effective in engaging SMEs in the design of SPSS. Fourth, creating design awareness in SMEs would not only contribute to the building differentiation potential but also build other related capabilities, as in sustainability issues. In short, design capabilities (e.g., identify user needs) can make a significant contribution in the mindset change of SMEs towards a fluid product-service transition ([Sassanelli et al. 2015; 2016](#)).

Use ongoing projects as a starting point for a transformation toward SPSS will accelerate the transition ([Pardo et al., 2013](#)). This recommendation confirms a limited understanding of the PSS concept and areas suitable to be filled with a complete presentation of the implications, benefits, main features and opportunities of a SPSS business model. Similarly, the use of Empathy map tool resulted in quickly identify pains/gains for the stakeholders and to share lessons learned with mixed groups ([West and Nardo, 2016](#)).

[Rapitsenyane \(2014\)](#) also highlighted the engagement aspect. The engagement in innovation activities and use of technology can reduce the complacency with small gains and the follower mentality of SMEs. Still, for SMEs, to embrace environmental and social SPSS sustainability pillars, it is essential that interventions clearly demonstrate environmental and social practices with financial gains. The use of a system success factors extensive list, addressing suggestions for common problems like a checklist, places the availability of designers with sustainable design capabilities at the centre of its implementation and reduces of chances for failure of intervention.

Generally, there is low user involvement in the SMEs' product development approaches contributing to poor sales performance. However, the user-centred design approaches could close this gap ([Rapitsenyane, 2014](#)). [Salazar et al. \(2015\)](#) argue that the key factor to

success is the understanding of customer' needs to maintain long and short-term satisfaction. All the same, a balance must be found between the satisfaction of needs and environmental aspects. To make this, products and services with different functional units representing the same level of service for users have to be compared.

In the same way, the external collaborative arrangement, through a partnership with other SMEs, experts, entities and so on can be seen as a guideline (Rapitsenyane, 2014). To conclude, the lessons learned were classified into appropriate categories as follows (Table 5). They are useful for understanding the micro-foundations for the successful transition towards SPSS business model in several related categories.

From the analysis of guidelines cited in the literature, a new category related to ICT emerged. A comprehensive set of guidelines could be organized from empirical studies. Even though some items could be classified into other categories, this guidelines list can be systematically used to found pathways during the transition process towards SPSS, supporting the decision-making process and solving problems faced by the SME. The set of guidelines contemplates aspects to be considered at the Beginning, Middle and, End of Life of SPSS life cycle of a SPSS. A complementary correlation analysis was performed between barriers and lesson learned resulting in an innovative matrix presented in the next section.

4.4. The SPSS Decision Matrix: a tool supporting Small and Medium-sized enterprises towards Sustainable Product-Service Systems

From the findings of the empirical literature regarding barriers or problems and lesson learned presented previously in guidelines format, several complementary correlations between them could be identified. They were appropriately organized in an artifact on the matrix format. More useful research is a need in various PSS contexts associating the design processes. Results from case studies research are very useful for obtaining a generalizable theory of the PSS field (Cook, 2014). In this sense, the proposed matrix follow the Cook' proposition, being developed from the results of empirical studies on SPSS transition.

This matrix also responds to recent calls of literature specific on SPSS in manufacturing SMEs for better artefacts linking the SMEs' micro-system and the SPSS development (Rondini et al., 2018; Bacchetti, 2017; West and Nardo, 2016; Orloff and Heinz, 2015; Rapitsenyane, 2014; Lelah et al., 2014, 2012). Consequently, a matrix supporting the decision-making process by SMEs managers during the transition process towards SPSS was proposed (Fig. 3) from our findings. In sum, the main objective of the matrix is to support SMEs managers as well as practitioners to find guidelines to minimize or even solve difficulties faced during the SPSS transition.

The matrix correlates barriers faced by a SME with a collection of guidelines in order to minimize the impact of these respective barriers. The procedures to organise the correlations involved three main stages. In the first stage was considered the findings indicated by selected studies from the literature review (Table 2). In this stage was performed the qualitative content analysis of the studies emphasizing the sections of discussion, findings and conclusion of works in order to identify possible correlations among the obstacles and lessons learned. "Qualitative content analysis is a method for systematically describing the meaning of qualitative data, done by assigning successive parts of the material to the categories of a coding frame (Schreier, 2014, p. 170)."

The five steps (Familiarize, Generate codes, Identify themes, Construct relation, and Interpretation) were adopted (Robson, 2011) as follow. The first step involves familiarize with the data, by successive reading and re-reading the documents and noting

principal ideas. The second stage was to generate the primary codes by inductive interaction with the documents. Also, in this step, the primary extracts from the data are systematically coding. The third contemplated identifying themes and gathering the data relevant to the potential theme. In the fourth step, was developed the primary correlations and classification. Finally, the content analysis closed with the final interpretation of information summarizing the relational patterns identified.

For example, when a correlation or cause-effect analysis was highlighted by the study as being critical or fundamental, this correlation was classified as strong (+++). Following the same strategy, when the interaction was indicated as moderated or typical, hence it was classified as medium (++) and if described by studies as being weak or low relevance, it was classified as weak (+). To conclude this first stage, when the content analysis no indicated none interaction or cause-effect analyses, it was classified as null or no significant, corresponding to the blank spaces in the matrix. In the second stage, in order to conclude this process, two academics in the topic of SPSS systematically review the results obtained in the qualitative content analysis.

To perform the third and last stage, we made successive sections of review by applying the inductive and abductive approach in order to ensure the quality of results and correlations inserted in the matrix. A similar procedure also was adopted by Paiola et al. (2012, p. 45) investigating the servitization of manufacturing SMEs. "Often (or even usually), researchers will come across an already known order and a theory to explain it. That is why both qualitative induction and abduction are part of entirely routine scientific work. Both complement each other" (Reichertz, 2014, p. 131). Thus, in order to obtain internal validity, we reviewed the research reports and documents resulting from the first stage. This procedure ensures validity and reliability and often led participants to provide more detailed information.

Thus, as a result, the decision matrix must be interpreted in the following manner: considering a respective difficulties/barriers (axis 'x') faced by SME in any stage of transformation process towards SPSS or during the development of a specific SPSS offer to the market, the correspondent guideline (s) (axis 'y') must be internally analysed and then selected for the further implementation by the enterprise, if appropriated.

In order to prioritize the selection of variables, the intensity of correlation resulting from literature was classified, as a result of the process above mentioned, in four main categories: null/no significant (blank), weak (+), medium (++) , strong (+++). Strong correlations must always be prioritized. Therefore, we suggested that SPSS practitioners, managers, and academics can use the matrix in a practical manner, by adopting three different strategies as described below.

4.4.1. Applying the matrix to overcome current difficulties

The first possible strategy to apply the matrix within SMEs is considering the specific context of a SME in analysis and their problem (s) or barriers (s) faced - at the moment of analysis - that need to be overcome. This first way to use the matrix can be done selecting the correspondent guideline (s) matched as strong correlation (+++). It means that, if the SME faced the barrier (axis 'x'), then the guideline (s) to overcome these barriers are analysed and selected (axis 'y'). We detail this first manner of use with an example as follow.

For example, if one constraint mapped during or before the SPSS transition in the SME in analysis is the poor market performance of products (B-MK1), some correspondent guidelines found in the matrix to overcome this barrier with strong correlation (+++) included: to develop a value proposition offer market-oriented and customer-focused fulfilment functional/sustainability needs (L-M1)

Table 5
Primary lessons learned and guidelines.

Category	Code	Lesson learned and guidelines	Author(s)
SPSS Process	L-SP1	Clearly formulate and understand the problem and share the scenario before moving towards SPSS.	(2), (3), (22).
	L-SP2	Conduct the SPSS transition in a gradual form over time.	(2), (5), (22).
	L-SP3	Develop a detailed design of offer based on sustainability, considering actors, stakeholders, channels etc.	(5), (6), (7), (11), (21).
	L-SP4	Established external partnership (large companies, suppliers, entities, governmental, universities, SME partners, consulting) to develop a robust value proposition to the customer.	(7), (14), (20).
	L-SP5	Define precisely the type of PSS suited to customer needs.	(1), (7), (19), (20).
	L-SP6	Develop the service offer based on customisation, modularity and in portfolio options (i.e. leasing or renting, desktop support, performance monitoring and maintenance contract, take-back system).	(1), (11), (14), (21).
	L-SP7	Explore design capabilities to create radical innovations concepts in the offer.	(5), (9), (18).
	L-SP8	Adopt structured guidelines and frameworks for managing the development of SPSS proposals.	(22).
Product	L-P1	Choice a product with relatively high market value or high selling prices to develop the SPSS offer.	(11).
	L-P2	Prioritize in the SPSS offer to develop a new or choice an existent product with a long physical life cycle, minimal footprint and modular structure.	(11).
Sustainability (TBL)	L-P3	Involve products' target customers and users in product development.	(1), (4), (9), (11), (22).
	L-S1	Proposed a value proposition based on sustainable-oriented service contributes to increasing environmental values of ownership.	(6), (11).
	L-S2	Carry out sustainable-oriented risk analysis.	(22).
	L-S3	Develop sustainability indicators in cooperation with current/future customers suited to SME' needs according to sector activity.	(6), (10).
	L-S4	Implement actions within SME to increase the design awareness (training, consulting, partnership etc).	(3), (5), (6), (11), (13), (21).
Customer	L-S5	The value proposition should clearly demonstrate financial gains in environmental and social practices.	(5), (12).
	L-CU1	Define the PSS champion in the client company to facilitate communication and results.	(11).
	L-CU2	Precisely define the target customers, needs and their values.	(1), (4), (7), (8), (11), (14), (18), (19), (22).
	L-CU3	Establish channels and internal/external business process to engage and communicate with customers based on co-creation of value.	(7), (8), (11), (14), (22).
	L-CU4	Define business indicators in partnership with target customers.	(6), (10).
Marketing	L-CU5	The top management should implement actions/process for dissemination of user-centred culture in the SME.	(1), (8), (9), (17), (19).
	L-M1	Develop a value proposition offer market-oriented and customer-focused fulfilment functional and sustainability needs.	(4), (6), (18), (22).
	L-M2	Develop a marketing plan to promote the offer.	(22).
	L-M3	Make national and international PSS and SPSS benchmarking.	(22).
	Organizational	L-O1	Implement a business strategy or change management principles based on value proposition within the SME.
L-O2		Implement a business process to continually monitor sustainability performance of offer (e.g., a routine of personal contact between employees and customers, meeting service etc.).	(1), (6).
L-O3		Implement a fast and flexible process (e.g., fluid communication) for strategic decision-making.	(1), (12).
L-O4		Implement a transparent cost structure for long-term planning and pricing service.	(1), (8), (20).
Human Resources	L-HR1	Implement reward systems and the integration of the employees.	(1), (11).
	L-HR2	Search external support need regarding training.	(12).
Competences	L-C1	Developed internal capabilities in design activities.	(5), (6), (9), (19), (22).
	L-C2	Established external partnership (entities, governmental, universities, SME, consultant) to close the gap of internal competencies.	(13), (14), (21)
Financial	L-C3	Implement training in new skills explicitly associated with SPSS offer.	(12), (21).
	L-F1	Carried out risk, cost, and profit analysis in the scenario of SPSS offers.	(7), (12), (22).
ICT activities	L-F2	Identify external financial support and develop a financial offer mapping.	(5), (11), (13).
	L-I1	Implement ICT support facilitating the PSS network communication and decision-making.	(4), (5), (13), (18), (22).
Supply Chain and Network	L-I1	Use ICT along the life cycle of SPSS (i.e. design, virtualisation, production, evaluation, recovery, repair/resale, collaborative platform).	(5), (9), (13), (22).
	L-SC1	Use ICT support exploring possibilities across the supply chain network.	(4), (18).
Leadership Behaviour	L-SC2	Adopt proactive behaviour aiming collaborative partnership in the supply chain network with other SMEs, entities, large companies, experts etc.	(1), (14), (18), (20).
	L-L1	Choose a catalyst leader to pull the transition process.	(1), (11).
Methods and Tools	L-B1	Continuous innovation behaviour in business processes user-centred and value proposition-oriented.	(1), (9), (17) (20).
	L-MT1	Implement flexible and hands-on workshops (Design Thinking, Canvas etc) involving customers to develop innovative value proposition in SPSS offers.	(1), (3), (21).
	L-MT1	Use a systems success factors guidelines or checklist addressing suggestions for faced problems along the transition.	(9), (22).
Motivation	L-M1	Analyse previous successful SPSS cases in SMEs from government-funded projects or literature fostering internal motivation towards SPSS.	(1), (9).

managers to choose the guidelines in all three ways of using the matrix is the prioritisation of guidelines that have a substantial relation or impact (++++) affecting at the same time as many barriers as possible. Especially in SMEs, characterised by gaps of knowledge, the matrix can be useful, assisting the decision-making process. Individually, these guidelines can also be classified as short, medium and long-term actions. Therefore, we suggest making a choice of combining these criteria. Moreover, customised versions of this matrix oriented to traditional PSS or even to a particular context (segment of the business, type of PSS, etc.) can be developed from our initial proposal.

5. Discussion

The systematic review of the literature showed several evidences confirming that the transition towards SPSS is not an easy journey and that many difficulties hinder a sustainable servitization of SMEs. The difficulties are partially explained by the limited literature available about SPSS in the SMEs context. Consequently, the operational deployment at a concrete level in manufacturing SMEs is very limited around the world (Clegg et al., 2017; Boucher et al., 2016).

Corroborating this previous assumption, was possible to verify the prevalence of significant differences in innovating business models between the large companies (i.e. resource abundance companies, focus on mid to long-term planning, a high degree of formalisation) when comparing with SMEs (i.e. short-term planning, a low degree of formalisation, scarce resources). Based on the results, we conclude that despite selected studies have been developed in manufacturing SMEs, several main obstacles cited by the authors are considered intrinsic for manufacturing SMEs, while other barriers could be classified as more generic and maybe valid to other sizes of enterprises.

In order to clarify these outcomes, examples of barriers found (Table 4) that can be considered genuine for SMEs include, the lack of financial resources (Goduscheit and Faullant, 2018; Gebauer et al., 2010; Rapitsenyane, 2014; Sundin et al., 2015; Hernández-Pardo et al., 2012; Wiesner et al., 2017; Paiola et al., 2012), the financial vulnerability (Orloff and Heinz, 2015; Gebauer et al., 2010), the follower mentality (Rapitsenyane, 2014), short-term management practices (Hernández-Pardo et al., 2012), difficult relationships between stakeholders affecting SME performance (Adrodegari et al., 2017; Lelah et al., 2014; Hernández-Pardo et al., 2013; Paiola et al., 2012; Bacchetti, 2017). Moreover, other obstacles mapped could be added to this list.

On the other hand, examples of some barriers that could be classified as more generic and possibly applicable to other sizes of enterprises, as the large companies, includes, the difficulty in recognition of market demands (Hernández-Pardo et al., 2013; Adrodegari et al., 2017; Paiola et al., 2012), the difficulty to balance the overall performance with social and ecological issues (Hernández-Pardo, 2012), organisational culture (Lelah et al., 2014; Rapitsenyane, 2014; Peillon et al., 2018; Paiola et al., 2012) among others. Thus, we can conclude that there is an interesting further research opportunity to explore if effectively this distinction exists and if is relevant to the performance of SMEs. In this sense, our study gives a relevant contribution to this topic offering several guidelines to the small business interested in adding value to their offer with the addition of services.

Furthermore, by analysing the content of the literature review mapped, it was found that the state of the art investigating in capital goods manufacturing SMEs the transition process to SPSS is organized into distinct categories: (i) studies on models supporting the transition, (ii) studies understanding how the transition occurs and suggesting guidelines, (iii) studies assessing the transition and

(iv) publications developing specific tools supporting a sustainable transition.

Another interesting outcome is that most of the studies were performed within the Industrial Engineering and Design disciplines by scholars of these fields. Academics from the Design field, generally, emphasised the human interfaces in systems design, while the Industrial Engineering mindset emphasised in pragmatic and oriented value proposition point of view on systems. In our opinion, based on the gaps in the literature and in the current body of knowledge mapped, the proposition of further researches integrating these two areas will present more potential to achieve robust SPSS models for the dissemination of SPSS models in manufacturing SMEs.

In this same direction, Tukker (2015) found that the main detailed PSS design methods available in the literature are not yet mature and that tools are still missing, potentially leading to a lack of emphasis on requirements that should drive PSS design. The results showed that this actual problem along the SPSS transition is reinforced in the specific case of manufacturing SMEs due to the lack of reference methods oriented to small business particularities.

Our results also indicated that only a few limited studies within this domain are dedicated to the context of developing economies and low-income countries. Recently, studies performed in developing economies have been conducted in a specific domain of SPSS and with strong socio-environmental motivation (e.g. the case of Distributed Renewable Energy in PSS business models in Africa and others countries (Emili et al., 2016; Vezzoli et al., 2015; Costa and Diehl, 2013). Finally, the concentration of studies in Europe indicated that the Europe Union funded projects are a relevant source of knowledge of empirical-based investigations about the topic.

Furthermore, some barriers related with low-value products resulting in low-profit margins can be a very critical factor in low incoming economies or in developing nations, where usually the customers consider the criteria 'cost' as a factor determinant for the purchase. Thus, to overcome this difficulty, more radical innovations based on radical value proposition are needed. Radical value propositions may contribute to advance in theory building on SPSS transition in manufacturing SMEs in this specific context. In order to support the transition process, findings indicated that SMEs must develop clear objectives and select suitable indicators for their context. Besides, structured SPSS methodologies, the establishment of partnership and the engagement in networks are the most enablers towards a successful transition in small companies due to their recognised limitations.

5.1. Implications and contributions for the small business context

A contribution of our research, from both theory and practical perspective, is in promote the consolidation and categorization of the mains barriers involving the transformation process towards SPSS to the manufacturing SMEs. From analyses of results, forty-four types of barriers were classified into seventeen categories. If on the one hand, findings reveal that several internal barriers associated with intrinsic characteristics of SMEs (e.g., lack of financial resources and financial vulnerability, lack of managerial, design and sustainability competencies, etc.) will become still more substantial during the SPSS transition.

On the other hand, findings showed that there are barriers directly related to the nature and novelty of PSS and SPSS business models, requiring new attitudes to be adopted by small business. Some examples are the change of mindsets from product ownership to use, the need of replacing the value of exchange by value in use involving long-term relations, the lack of understanding of SPSS concept, the lack of models/methods guiding the transition, among others. Connected with these outcomes, Tukker and Tischner

(2006) already stated that the firms have to assess carefully if they can competitively develop and deliver their PSS and if consumers can buy it.

We argued that these previous findings have important implications for developing SPSS in SMEs. Consequently, the barriers associated with the characteristics of SMEs and related to the novelty of SPSS need to be carefully considered by SME' managers in an integrated manner before the transition process starts.

Moreover, the outcomes obtained make several contributions to the current prescriptive literature on this domain. Our findings allowed indicating a comprehensive relation of several lessons learned from empirical studies organized in guidelines format serving as a strategic orientation to mitigate the barriers faced by SMEs scaling-up a successful transition. In addition, based on analyses and interaction of barriers and lesson learned mapped in the literature, an innovative matrix supporting the decision-making process by the SMEs during the transition process to SPSS was proposed.

On the whole, our results also suggested that the drivers fostering the transition towards a more sustainable and service-oriented firm resulted in several competitive benefits. In summary, the main drivers are related to economic motivation, the need for differentiation, the creation of market opportunities and the meeting of customer and sustainability demands.

Particularly the outcomes provide further support for the hypothesis that the motivation for sustainability is based on a strong belief that PSS helps to become more sustainable. This commonly occurs when the SME have already had past activities or projects in the direction of sustainability. These results also are corroborated by previous literature. For instance, [Tukker and Tischner \(2004\)](#) and, recently, [Sundin et al. \(2015\)](#), state that the primary motivations are related to business, integrating high-value solutions to attend market demands, putting the company in a better competitive position in the value chain, and sustainability, referring to enjoy the sustainable potential of SPSS business models.

Nevertheless, the observations from the literature demonstrated that the main benefits and advantages resulting from the SPSS transformation in SMEs context are related to the increase of competitiveness, sales, customer's loyalty and satisfaction and sustainability improvement. Moreover, the evidence from the findings suggests that the reduced dimension, the dynamism and flexibility of SMEs, when reflected in a fluid internal/external communication process, are relevant enablers of a successful SPSS transition process. These factors allow more efficiently to manage changes and proceed responsibly towards a more servitized firm.

This work also contributes to existing knowledge on the transformation process of SMEs towards SPSS models. In summary, taken together with the empirical findings from the literature and aiming to support the small companies to make the shift towards more sustainable service-oriented solutions, it was possible to obtain from transversal analyses of literature two significant implications and theoretical insights:

- *In first place, it is possible to hypothesise that in SMEs context, the transition process towards SPSS must be performed incrementally instead than radically.*
- *In second place, the engagement of manufacturing SMEs during the transition in partnership and networks to develop the SPSS offers has potential to minimize the competencies gaps and enable more innovative, complete and competitive value propositions to the marketing.*

These strategic transitions rules also are corroborated by the external literature dedicated to SME economy. Some studies reveal that SMEs have to join their efforts together to overcome these

limitations through collaboration ([Boucher, 2012](#); [Bos-Brouwers, 2010](#)). Engaging in networks is very helpful by allowing them to mutually learn from each other about the SPSS introduction and further developments ([Pardo et al., 2012](#); [Orloff and Heinz, 2015](#)). Hence, the establishment of an external partnership and stakeholder interaction, involving, for example, large companies belonging to supply chain, suppliers, entities, governmental, universities, SMEs partners and consulting, will help the SMEs to develop robust value proposition to the customers.

The findings in this work, while preliminary, also suggests that transformation toward SPSS models must be conducted gradually and incrementally by the SME, due the several constraints associated with lack of both internal competencies (i.e. in design, sustainability, management) and financial resources. This limited competence also turns more difficult to SME to comprehend external factors, such as customer/user existing behaviours and lifestyle, how the service provider is perceived, regulatory challenges, financial reasons.

Lastly, in this sense, it is noted that the two transitions rules - gradual and incremental transition - are related to each other. This interaction occurs because the intensity of engagement of manufacturing SMEs in strategic partnership and networks will impact on the learning, on the internal capabilities and in the velocity of their transition process towards SPSS. Wrapping up, our analysis revealed a very recent movement of studies investigating the transition towards SPSS. Thus, the added value of this research is to establish a structured and comprehensive discussion which highlights exciting insights enriching the stock of knowledge on the transition towards SPSS business models in manufacturing SMEs.

5.2. Theoretical contributions

The scholars devoted to discussing the production of new knowledge and theory building mechanisms agree on the prevalence of two primary perspectives or views. On the one hand, the empiricists scholars see the theory as a means of the cumulative product of the progressive acquisition of knowledge. And in this perspective, the theory is seen as the summation of empirical observation. It is possible to affirm that this is the dominant contemporary perspective among scholars. While, on the other hand, the rationalist perspective, see the theory development as a means of knowledge abstraction. That means, theory as occurs prior to empirical observation. Consequently, for these scholars, new knowledge is more likely to come from the interpretation of past and seminal texts, as is the case of literature reviews studies ([Suddaby, 2014](#)). Furthermore, this author also argued that is the appropriated combination of both perspectives increase the potential to produce new and valid value and knowledge.

Our research combine aspects of both previous perspectives discussed. On the one hand, our study organizes several insights retrieved from empirical-based studies selected following a structured protocol review. Also, on the other hand, our research also extends the current body of knowledge available establishing the interpretation of these findings from literature proposing a novel artifact, organized in the format of a Decision-making Matrix ([Fig. 3](#)) supporting SMEs during the transition towards SPSS models. "Knowledge accumulation simply cannot occur without a conceptual framework" ([Suddaby, 2014](#), p. 408).

The results of our work are in line with the arguments proposed by [Suddaby \(2014\)](#), [Van de Ven \(2007\)](#) and [Whetten \(1989\)](#) regarding the generation of valid knowledge and theoretical contribution aspects. To [Suddaby \(2014\)](#) what effectively produce understanding and valid knowledge is (i) the division of activities across a scientific community; (ii) the commitment of academics with the knowledge production; (iii) the awareness of theory

building is essentially a flawed and human activity requiring constant correction and validation). Moreover, Van de Ven (2007) stated that a theory simplifies and explains a complex real-world phenomenon. He also argues that the theory building process involves three activities. First, to conceive a theory applying abduction. Second, to elaborate the theory applying deductive logic. Third, to test or evaluate the theory with inductive reasoning (Van de Ven, 2007, p. 101).

Van de Ven (2007, p. 102) advances stating, although these three previous activities are important for the process of generation of valid knowledge and theory building, not all scholars choose to perform creating, constructing, and evaluating theories. In the academy practice, some academics emphasize creating theories, others constructing and modelling theories, while others focus on evaluating theories already constructed. In line with these assumptions, Whetten (1989, p. 493) concluded that “The common element in advancing theory development by applying it in new settings is the need for a theoretical feedback loop. Theorists need to learn something new about the theory itself because of working with it under different conditions. That is, new applications should improve the tool, not merely reaffirm its utility.” Thus, in this context, it is possible to affirm that our research is a value-added contribution to theory development, proposing to the academics and practitioners a novel artifact (Fig. 3). Complementarily, we recommend that the Decision-making Matrix need be successively tested and improved in iterative cycles of application in different conditions faced by SMEs (e.g., business segments, SPSS categories, etc.).

5.3. Implications for the theory and practice on cleaner production and the sustainability challenges

Our research findings also are connected with previous literature discussing the Cleaner Production (CP) and sustainability challenges resulting in theoretical and practical implications. “Cleaner production is defined as the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner production can be applied to the processes used in any industry, to products themselves and to various services provided in society (UNEP, 2004, p. 21).”

The debate on the challenges of transition towards CP practices in SMEs has been extensive among scholars. The Journal of Cleaner Production, for example, was one of the pioneers scientific journals in this discussion. A historical analysis in Scopus database shows that, already in 1994, in the origins of this journal, the second volume published interesting studies discussing the hard challenges faced by small companies regarding the transition towards CP. Nonetheless, still today, this is a very contemporaneous debate. Besides, the literature reveals several convergent aspects among CP and SPSS approaches connecting with our previous findings as we discussed below. Particularly, outcomes from empirical studies discussing CP in SMEs were selected to enrich this debate.

For example, Gardstrom and Norrthon (1994, p. 201) argued on the importance of acceptance of CP by SMEs, for both the environment and for competitiveness. However, “They might not have the capacity (personnel, money or knowledge) to start CP projects” (Gårdström and Norrthon, 1994, p. 202). Then, while SMEs may seem as cornerstones of sustainable development (Hoof and Lyon, 2013), several challenges continue to be the same since the last decades until nowadays.

Evidence retrieved from 1934 CP projects developed by 972 SMEs demonstrated that on average waste recycling and waste prevention projects yielded higher economic and environmental

value than energy efficiency and water conservation projects (Hoof and Lyon, 2013). They also showed how SMEs from emerging economies could contribute to significant economic and environmental benefits. Thus, these findings in the field of CP are in consonance with our debated conducted in the SPSS field.

Our study demonstrated that the SPSS models also contribute for relevant economic, social and environmental benefits for SMEs (Bacchetti, 2017; Hernández-Pardo et al., 2013; Rapitsenyane, 2014), and a synergic interaction between both CP and SPSS disciplines can be confirmed. Hoof and Lyon (2013) show how voluntary CP-based projects developed by means of public-private partnerships can generate significant environmental improvements. These results are in agreement with our findings that corroborate the same assumption. Our research uncovered that this kind of partnership employed in CP projects also is valid for incentive the SPSS infusion in SMEs, mainly in the first stages of the transformation process towards a more servitized company. One of the main contributions of public-private partnerships is in minimize the knowledge and financial gaps intrinsically prevalent in SMEs before and during the SPSS transformation (Adrodegari et al., 2017; Kowalkowski et al., 2013; Paiola et al., 2012; Hernández-Pardo et al., 2013; Doualle et al., 2016).

Another relevant enabler to both CP programs and SPSS offers in SMEs is related to explore possibilities across the supply chain network. To improve CP infusion in SMEs Vieira and Amaral (2016) recommend reinforce network – mainly to supply information and assistance, to increase the external environmental pressure along the supply chain, and internal awareness about environmental impacts, technology transfer and funds. “While several successful models of the sustainable SME are evolving, it may be that networks of SMEs will become essential for addressing the systemic problems that underlie industrial ecology, enterprise resilience, and global supply chain sustainability (Moore and Manring, 2009, p. 276).

This previous finding corroborates the ideas of Goduscheit and Faullant (2018), Orloff and Heinz (2015), Paiola et al. (2012) among others authors discussing the phenomenal of sustainable servitization in SMEs. Furthermore, networked SMEs provide much financial and organisational efficiency that enable the development of technologies and markets essential to achieve the sustainable development (Moore and Manring, 2009, p. 281). Although the engagement in networks could be fostered by governmental and public policies, the literature reveals that the proactive behaviour of SMEs aiming to establish partnerships (with others SMEs, entities, large companies, etc) enable the value creation in sustainable business models, such as the case of both CP and SPSS models.

Our outcomes also demonstrate to be consistent with other studies discussing the role of indicators in sustainable initiatives. As a consequence, one of the issues that emerge from the literature is regarding the role of adoption of an appropriated set of indicators during the transition process to both CP programs and SPSS models. Howgrave-Graham and Berkel (2007) found the indicators can be used for estimating the level of CP uptake in SMEs. Regarding sustainability assessment in SPSS offers, Sundin et al. (2015) suggests as guidelines that (i) the sustainability indicators should be adjusted to each SME’ needs according to sector activity, (ii) the number of indicators needs to be limited as much as possible to minimize extra work and that the PSS offer and, (iii) the indicators need to be developed in cooperation with current and future customers. Thus, when developing different scenarios for SPSS models, the indicators will be used for assist the choice and decisions. The customer satisfaction also is an important economic indicator (Sundin et al., 2015) to be considered. These findings have important implications for the development of appropriated indicators in the SMEs context. In order to increase the internalisation and

effective use, the set of indicators, to both CP and SPSS must be simultaneously defined avoiding possible conflicts and ensuring effective integration. Finally, it is interesting to note that these guidelines to sustainability assessment of SPSS also can be adopted to develop metrics in CP programs.

It is essential to the SMEs aiming to achieve a sustainable transition, to implement changes in their production systems with CP practices. They also need to recognise that the CP consists of a social investment favouring sustainability demands, providing a better quality of life for all society (Oliveira Neto et al., 2017). Similar problem is noted in SPSS literature dedicated to SMEs, concerning the limited knowledge and awareness in social and environmental issues (Sundin et al., 2015; Rapitsenyane, 2014; Hernández-Pardo et al., 2012) and the sustainability awareness restrict to economic perspective (Lelah et al., 2014; Sundin et al., 2015). These conclusions also agree with the findings of other empirical studies.

For example, evaluating the sustainability and the energy efficiency of about 500 European SMEs, Viesi et al. (2017) found that key constraints to energy efficiency are related firstly to the lack of awareness and commitment of SMEs management. Moreover, some of the intervention points to increase the sustainability, and the energy efficiency includes more financial support, provide knowledge and advisory services for SMEs, education/awareness programs, tools tailored for cluster or type of productive activities among others relevant aspects. These barriers and guidelines are consistent with those found in our research (Tables 4 and 5). The same also is valid for the typical implementation barriers (i.e. institutional, market, organisational, behavioural and technological barriers) reported by Lopez et al. (2019) investigating 143 cases of business model innovation for Resource-efficiency, Circularity and CP.

A guideline to foster the infusion of CP practices in SMEs also passes by selecting benchmarking and success case from similar

SMEs, rather than large enterprises (Gärdestrom and Norrthon, 1994). This finding is in line with the ideas of Orloff and Heinz (2015) that argued as a guideline for a successful SPSS transition to perform benchmarking with competitors. Hence, these scholars from CP and SPSS field agree that benchmarking activities support the transfer of concrete ideas to the SMEs more successful. From these evidence, we concluded that the use of benchmarking and success cases enable both, the CP and SPSS infusion. Therefore, our study offers some important insights into research on CP and SPSS by structuring a set of barriers and guidelines classified into categories that also can be analysed for CP projects. Finally, the mapping of main barriers faced by SMEs will enrich the process of estimation of return on investment ratio towards sustainable initiatives.

Considering the inherent lack of financial resources of SMEs and the discussion above, the literature demonstrated that the attractiveness of return on investment of new programs could influence the inclination of SMEs to adopt sustainable initiatives, such for example, CP or SPSS offers. This is a natural movement considering the competition with large firms and the cash flow difficulties for small companies. In this sense, it is prudent to note that the implementation of profitable SPSS models has the potential to support the CP practices within SMEs. As well as, the infusion of profitable CP programs will pavement the path to further SPSS offers. This synergy occurs because the Tripple Bottom Line aspects existent in both disciplines are interlinked and has reinforcing relation. Consequently, the complementarities among both approaches can be represented (Fig. 4).

Furthermore, these findings provide further support for the following general hypothesis derived from this congruence. The inherent business and economic motivation (highlighted in the bottom of the cone at Fig. 4) for the implementation of SPSS offers (Tukker, 2015) lead to improvements on the capabilities for investment in environmental and social initiatives resulting in

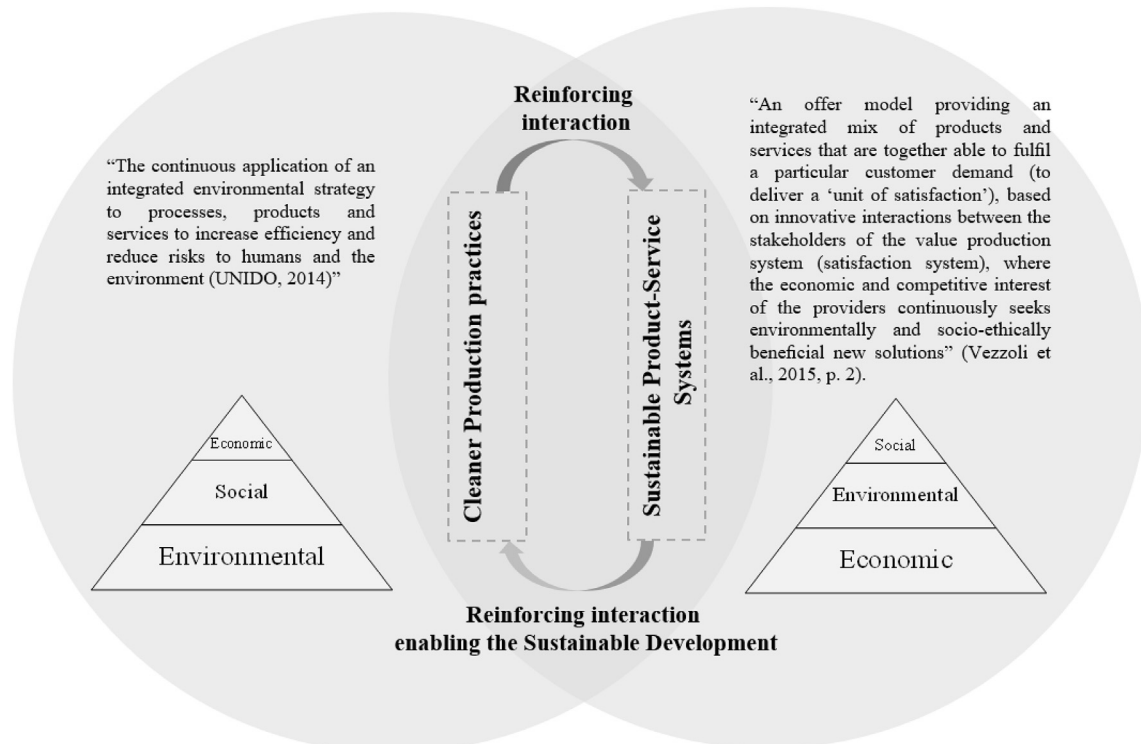


Fig. 4. Complementarities between CP and SPSS proposals.

benefits in these dimensions to the firm. The investments are derived from a better financial stability, and these benefits will be perceived more directly by SME and users.

Similarly, the intrinsic environmental motivation (highlighted in the bottom of cone at Fig. 4) of CP programs will foster the overall environment efficiency, resulting in social benefits (for the SME, users and society) due to increasing overall efficiency and risks reduction for society/environment, habilitating saving costs (i.e. in the production system, process and services) or even margin increasing to the company. Therefore, the hypotheses evoked here is that the adequate combination among CP and SPSS initiatives carry potential to increase the attractiveness of return on investment of new sustainable programs influencing the inclination of SMEs to adopt more sustainable models. As a natural path, we also recommend that these proposed findings need to be empirically evaluated.

6. Conclusions and research directions

Considering that the existing fragmented and insufficient background regarding SPSS transition in SMEs do not support a fluid transition process, this study aimed to comprehend the factors involving the transition towards SPSS into practice. Findings have clarified the benefits, barriers and strategic guidelines to overcome the barriers to the transition. A set of forty-four types of barriers were classified into seventeen categories, and forty-four guidelines to overcome these barriers were organized in fifteen categories in an innovative matrix supporting the decision-making process.

Comparing with traditional PSS offers, the challenges faced by manufacturing SMEs to a sustainable (TBL) transition found several factors in consonance. These challenges involve, for instance, the general difficulty in the transition from the traditional business model of selling products to service and value-oriented model (Kowalkowski et al., 2017; Cook, 2014). This shift increases the SMEs' vulnerability due to their limited resources available and to the internal lack of specific competencies not only about management but also sustainability and design of SPSS. Instead, frequently, large companies can more easily obtain and internalise this type of competences, disposing of more resources for mobilisation.

Another critical challenge faced by SMEs deals with the lack of adequate and suited methods and tools supporting the transition towards SPSS considering their entire life cycle (Meier et al., 2010; Cook, 2014; Cavalieri and Pezzotta, 2012). The outcomes and gaps from consolidated SPSS literature evidenced that most of the available methodologies are best suited for large companies. Furthermore, for a successful exploration and use of these

methodologies, generally, it is necessary external support to the company, guiding the application methodologies, the use of tools and the internal analysis of SME along the transition journey. Several methodologies with this intention were developed in past years within EU-funded projects oriented to large companies. Accordingly, the application as a routine and internalisation of these approaches need the support of a project member or a consultant to the SMEs context. Regarding further researches, the main perspectives fostering an evolutionary framework on SPSS in manufacturing SMEs might be summarised into research avenues (Table 6).

Although the results of this research contribute to the advance in theory building on SPSS transition in SMEs, certain limitations should be considered. Initially, the selected studies consider empirical researches investigating the transition process to SPSS specifically in capital goods SMEs, as well as qualitative studies in this field. Others eligibility criteria could eventually be adopted for selection. Second, studies written in a language different than English have been excluded. This research also used only formal literature available in scientific databases, does not include books or grey literature.

The current research contributes to several points of academic interest. For example, recent comprehensive studies corroborate the relevance and contribution to theory-building of this research. The extensive analysis of the state of the art on servitization field in Baines et al. (2017) suggested the increase of global awareness on the importance of services to manufacturers. However, some topics, especially related to servitization process, remain undeveloped. Moreover, the service growth in product-based firms is one of the most active service research domains and is still open to a variety of conceptualisations (Kowalkowski et al., 2017). In this sense, our study contributes to extending the current theoretical framework on SPSS in SMEs driving new researches avenues to this domain.

"Because of the potential of SPSS to deliver social well-being and economic prosperity while operating within the limits of our planet, the research community has been inspired to analyse cases in diverse sectors, to increase the understanding of the potential benefits, drivers and barriers, and to develop and to test methods and tools to be able to enhance the array of SPSS that are implemented globally. This is urgently needed because, despite all the knowledge and experience that has been accumulated, there remain gaps in the research as well as a significant gap in how all this knowledge is transferred to implementation" (Vezzoli et al., 2015, p. 3). Considering this statement, to conclude, it is possible to affirm that the relevance of this investigation is in presenting new insights for the capital goods SME' managers, policymakers

Table 6
Research directions.

Research avenue	Research gap	Research opportunity
SPSS transition and modelling	<ul style="list-style-type: none"> The absence of artefacts (i.e. frameworks, models, methods) enabling the risk, cost and profit analysis, to help SME to conduct the organisational changes and systematically detail the SPSS offer along the life cycle. 	<ul style="list-style-type: none"> To provide artefacts helping the realisation of sustainable analysis using scenarios and studies.
Empirical studies	<ul style="list-style-type: none"> Lack of empirical studies exploring the transition towards SPSS in SMEs. 	<ul style="list-style-type: none"> The opportunity of longitudinal and cross-sectors empirical studies looking for transition patterns and best practices (through research projects involving the collaboration of different countries); Determine the core of minimum capabilities necessary to support the transition as well as approaches to unlock design and sustainability leadership capabilities.
ICT	<ul style="list-style-type: none"> Lack of low complexity and quantitative-based assessments tools aiming to measure the social and environmental impact of CP and SPSS in SMEs. 	<ul style="list-style-type: none"> To develop frameworks guiding SMEs in choosing more suitable ICT systems and increasing their diffusion internally; To define the role of the Industry 4.0 (i.e. digitalisation, IoT, Big Data and so on) and the number of potential companies in low-income countries; Connections of SPSS in SMEs into Circular Economy models.

and academic community to successfully implement SPSS business models in small companies with real impact in the society. This will result in a functional openness to the SMEs also address Circular Economy principles by innovating their business models (Bocken et al., 2014; Franco, 2017). Circular Economy is a design-based approach, of both products, services, and PSSs and their related business models, to achieve sustainability with the aim of avoiding resource depletion and prolonging systems' lifecycle (The Ellen MacArthur Foundation, 2015). On the whole, the guidelines resulting from this research may represent the first steps supporting small companies to effectively move towards a Circular Economy under a genuine TBL sustainable perspective.

Declarations of interest

There are no personal or financial conflicts of interest associated with this study.

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References

- Adrodegari, F., Sacconi, S., Kowalkowski, C., Vilo, J., 2017. PSS business model conceptualization and application. *Prod. Plann. Contr.* 28 (15), 1251–1263. <https://doi.org/10.1080/09537287.2017.1363924>.
- Ambroise, L., Prim-Allaz, I., Teyssier, C., Peillon, S., 2018. The environment-strategy-structure fit and performance of industrial servitized SMEs. *J. Service Manage.* 29 (2), 301–328. <https://doi.org/10.1108/JOSM-10-2016-0276>.
- Bacchetti, E., 2017. A design approach with method and tools to support SMEs in designing and implementing Distributed Renewable Energy (DRE) solutions based on Sustainable Product-Service System (S.PSS). *Procedia CIRP* 64, 229–234. In: <https://doi.org/10.1016/j.procir.2017.03.064>.
- Baines, T.S., Lightfoot, H.W., Evans, S., Neely, A., Greenough, R., Peppard, J., Wilson, H., 2007. State-of-the-art in product-service systems. *Proc. IME B J. Eng. Manufact.* 221 (10), 1543–1552. <https://doi.org/10.1243/09544054JEM858>.
- Baines, T., Bigdeli, A.Z., Bustinza, O.F., Shi, V.G., Baldwin, J., Ridgway, K., 2017. Servitization: Revisiting the State-of-the-art and Research Priorities. *Int. J. Oper. Prod. Manag.* 37 (2), 256–278. <https://doi.org/10.1108/IJOPM-06-2015-0312>.
- Barquet, A.P., Seidel, J., Seliger, G., Kohl, H., 2016a. Sustainability factors for PSS business models. *Procedia CIRP* 47, 436–441. In: <https://doi.org/10.1016/j.procir.2016.03.021>.
- Barquet, A.P., Seidel, J., Buchert, T., Galeitzke, M., Neugebauer, S., Oertwig, N., Rozenfeld, H., Seliger, G., 2016b. Sustainable product service systems – from concept creation to the detailing of a business model for a bicycle sharing system in Berlin. *Procedia CIRP* 40, 524–529. In: <https://doi.org/10.1016/j.procir.2016.01.127>.
- Beuren, F.H., Ferreira, M.G.G., Miguel, P.A.C., 2013. Product-service systems: a literature review on integrated products and services. *J. Clean. Prod.* 47, 222–231. <https://doi.org/10.1016/j.jclepro.2012.12.028>.
- Bocken, N.M.P., et al., 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>.
- Bos-Brouwers, H.E.J., 2010. Corporate Sustainability and Innovation in SMEs: Evidence of Themes and Activities in Practice. *Bus. Strateg. Environ.* 19, 417–435. <https://doi.org/10.1002/bse.652>.
- Boucher, X., 2012. Economic and Organizational Transition towards Product/Service Systems: The Case of French SMEs. In: Camarinha-Matos, L.M., Xu, L., Afsarmanesh, H. (Eds.), *Collaborative Networks in the Internet of Services. PRO-VE 2012. IFIP Advances in Information and Communication Technology*, vol. 380. Springer, Berlin, Heidelberg.
- Boucher, X., Brissaud, D., Shimomura, Y., 2016. Editorial: Design of sustainable product service systems and their value creation chains. *CIRP J. Manuf. Sci. Technol.* 15, 1–2. <https://doi.org/10.1016/j.cirpj.2016.09.005>.
- Bhamra, T., Hernandez, R.J., Rapsitsenyane, Y., Trimmingham, R., 2018. Product Service Systems: A Sustainable Design Strategy for SMEs in the Textiles and Leather Sectors. *She Ji J. Des. Econ. Innovat.* 4 (3), 229–248. <https://doi.org/10.1016/j.sheji.2018.07.001>.
- Cavaliere, S., Pezzotta, G., 2012. Product-Service Systems Engineering: State of the art and research challenges. *Comput. Ind.* 63 (4), 278–288. <https://doi.org/10.1016/j.compind.2012.02.006>.
- Ceschin, F., 2013. Critical factors for implementing and diffusing sustainable product-service systems: insights from innovation studies and companies' experiences. *J. Clean. Prod.* 45, 74–88. <https://doi.org/10.1016/j.jclepro.2012.05.034>.
- Clegg, B., Little, P., Govette, S., Logue, J., 2017. Transformation of a small-to-medium-sized enterprise to a multi-organisation product-service solution provider. *Int. J. Prod. Econ.* 192, 81–91. <https://doi.org/10.1016/j.ijpe.2017.01.012>.
- Cook, M., 2014. Fluid transitions to more sustainable product service systems. *Environ. Innov. Soc. Trans.* 12, 1–13. <https://doi.org/10.1016/j.eist.2014.04.003>.
- Costa, J.C., Diehl, J.C., 2013. Product-service system design approach for the base of the pyramid markets: practical evidence from the energy sector in the Brazilian context. *Proc. Conf. MPDES* 48–51, 2013.
- Doualle, B., Medini, K., Boucher, X., Brissaud, D., Laforest, V., 2016. Design of sustainable product-service systems (PSS): towards an incremental stepwise assessment method. *Procedia CIRP* 48, 152–157. In: <https://doi.org/10.1016/j.procir.2016.04.074>.
- Doualle, B., Medini, K., Boucher, X., Laforest, V., 2015. Investigating Sustainability Assessment Methods of Product-service Systems. *Procedia CIRP* 30, 161–166. In: <https://doi.org/10.1016/j.procir.2015.03.008>.
- Dresch, A., Lacerda, D.P., Antunes Jr., J.A.V., 2015. *Design Science Research: A Method for Science and Technology Advancement*. Springer, p. 161.
- Ellen MacArthur Foundation, 2015. *Towards a Circular Economy: Business Rationale for an Accelerated Transition* doi: 2012-04-03.
- Emili, S., Ceschin, F., Harrison, D., 2016. Product-Service System applied to Distributed Renewable Energy: A classification system, 15 archetypal models and a strategic design tool. *Energy for Sustain. Develop.* 32, 71–98. In: <https://doi.org/10.1016/j.procir.2016.04.074>.
- European Commission, 2016. User guide to the SME Definition. Available in: <http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition/>.
- European Commission, 2011. *Minimizing Regulatory Burden for SMEs. Adapting EU Regulation to the Needs of Micro-Enterprises*. Final report. European Commission, Brussels, Belgium.
- 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>.
- Gårdström, T., Norrtho, P., 1994. Implementation of cleaner production in small and medium-sized enterprises. *J. Clean. Prod.* 2, 201–205. [https://doi.org/10.1016/0959-6526\(94\)90044-2](https://doi.org/10.1016/0959-6526(94)90044-2).
- Gebauer, H., Paiola, M., Edvardsson, B., 2010. Service business development in small and medium capital goods manufacturing companies. *Manag. Serv. Qual.: Int. J.* 20 (2), 123–139. <https://doi.org/10.1108/09604521011027561>.
- Gioia, D.A., Corley, K.G., Hamilton, A.L., 2013. Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organ. Res. Methods* 16 (1), 15–31. <https://doi.org/10.1177/1094428112452151>.
- Goduscheit, R.C., Faullant, R., 2018. Paths Toward Radical Service Innovation in Manufacturing Companies – A Service-Dominant Logic Perspective. *J. Prod. Innovat. Manag.* 35 (5), 701–719. <https://doi.org/10.1111/jpim.12461>.
- Gough, D., Oliver, S., Thomas, J., 2012. *An Introduction to Systematic Reviews*. Sage Publications, London, p. 304.
- Halme, M., Jasch, C., Scharp, M., 2004. Sustainable home services? Toward household services that enhance ecological, social and economic sustainability. *Ecol. Econ.* 51 (1–2), 125–138. <https://doi.org/10.1016/j.ecolecon.2004.04.007>.
- Harzing, A.W., 2007. Publish or Perish. Available from: <http://www.harzing.com/pop.htm>.
- Hernández-Pardo, R.J., Bhamra, T., Bhamra, R., 2012. Sustainable product-service systems in Small and Medium Enterprises (SMEs): Opportunities in the leather manufacturing industry. *Sustainability* 4, 175–192. <https://doi.org/10.3390/su4020175>.
- Hernández-Pardo, H.R.J., 2012. *Designing Sustainable Product Service Systems: a business framework for SME implementation*. Doctor of Philosophy. Loughborough University, p. 358.
- Hernández-Pardo, H.R.J., Bhamra, T., Bhamra, R., 2013. Exploring SME perceptions of sustainable product-service systems. *IEEE Trans. Eng. Manag.* 60, 483–495. <https://doi.org/10.1109/TEM.2012.2215961>.
- Hoof, B.V., Lyon, T.P., 2013. Cleaner Production in Small Firms Taking Part in Mexico's Sustainable Supplier Program. *J. Clean. Prod.* 41, 270–282. <https://doi.org/10.1016/j.jclepro.2012.09.023>.
- Howgrave-Graham, A., van Berkel, R., 2007. Assessment of cleaner production uptake: method development and trial with small businesses in Western Australia. *J. Clean. Prod.* 15, 787–797. <https://doi.org/10.1016/j.jclepro.2006.07.004>.
- Kjaer, L.M., Pagoropoulos, A., Schmidt, J.H., McAloone, T.C., 2016. Challenges when evaluating Product/Service-Systems through Life Cycle Assessment. *J. Clean. Prod.* 120, 95–104. <https://doi.org/10.1016/j.jclepro.2016.01.048>.
- Kowalkowski, C., Witell, L., Gustafsson, A., 2013. Any Way Goes: Identifying Value Constellations for Service Infusion in SMEs. *Ind. Mark. Manag.* 42 (1), 18–30. <https://doi.org/10.1016/j.indmarman.2012.11.004>.
- Kowalkowski, C., Gebauer, H., Oliva, R., 2017. Service growth in product firms: Past, present, and future. *Ind. Mark. Manag.* 60 (1), 1–7. <https://doi.org/10.1016/j.indmarman.2016.10.015>.
- Lelah, A., Mathieux, F., Brissaud, D., Vincent, L., 2012. Collaborative network with SMEs providing a backbone for urban PSS: a model and initial sustainability analysis. *Prod. Plann. Contr.* 23, 299–314. <https://doi.org/10.1080/09537287.2011.627660>.
- Lelah, A., Boucher, X., Moreau, V., Zwolinski, P., 2014. Scenarios as a Tool for Transition towards Sustainable PSS. *Procedia CIRP* 16, 122–127. In: <https://doi.org/10.1016/j.procir.2014.01.015>.
- Lopez, F.J.D., Bastein, T., Tukker, A., 2019. Business Model Innovation for Resource-

- efficiency, Circularity and Cleaner Production: What 143 Cases Tell Us. *Ecol. Econ.* 155, 20–35. <https://doi.org/10.1016/j.ecolecon.2018.03.009>.
- Maxwell, D., Sheate, W., van der Vorst, R., 2006. Functional and systems aspects of the sustainable product and service development approach for industry. *Journal of Cleaner Production* 14 (17), 1466–1479. <https://doi.org/10.1016/j.jclepro.2006.01.028>.
- Meier, H., Roy, R., Seliger, G., 2010. Industrial product-service system e IPS2. *CIRP Ann. - Manuf. Technol.* 59, 607–627.
- Mennens, K., Gils, A.V., Odekerken-Schröder, G., Letterie, W., 2018. Exploring antecedents of service innovation performance in manufacturing SMEs. *Int. Small Bus. J.* 36 (5), 500–520. <https://doi.org/10.1177/0266242617749687>.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., 2009. The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med.* 6 (7), e1000097. <https://doi.org/10.1371/journal.pmed1000097>.
- Mongeon, P., Paul-Hus, A., 2016. The journal coverage of Web of Science and Scopus: a comparative analysis. *Scientometrics* 106 (1), 213–228. <https://doi.org/10.1007/s11192-015-1765-5>.
- Moore, S., Manning, S., 2009. Strategy development in small and medium-sized enterprises for sustainability and increased value creation. *J. Clean. Prod.* 17, 276–282. <https://doi.org/10.1016/j.jclepro.2008.06.004>.
- Nada, N., Ali, Z., 2015. Service value creation capability model to assess the service innovation capability in SMEs. *Procedia CIRP* 30, 390–395. In: <https://doi.org/10.1016/j.procir.2015.02.218>.
- OECD, 2010. High-Growth Enterprises: What Governments Can Do to Make a Difference. OECD Studies on SMEs and Entrepreneurship. OECD Publishing. <https://doi.org/10.1787/9789264048782-en>.
- Oliveira Neto, G.C., Leite, R.R., Shiba, F.Y., Lucato, W.C., 2017. Framework to overcome barriers in the implementation of cleaner production in small and medium-sized enterprises: Multiple case studies in Brazil. *Journal of Cleaner Production* 142 (Part 1), 50–62. <https://doi.org/10.1016/j.jclepro.2016.08.150>.
- Orloff, D., Heinz, S.M., 2015. Sustainable product service systems in small and medium enterprises - from a case study on textile leasing to a Design Thinking Workshop for Sustainable Product-Service System Development for Sustainable Product-Service System Development. Master Thesis in Sustainability Science. Universität Luneburg, p. 160.
- Paiola, M., Gebauer, H., Edvardsson, B., 2012. Service Business Development in Small- to Medium-Sized Equipment Manufacturers. *J. Bus. Bus. Market.* 19 (1), 33–66. <https://doi.org/10.1080/1051712X.2011.593023>.
- Pardo, H.R.J., Bhamra, T., Bhamra, R., 2012. Sustainable Product-Service Systems in Small and Medium Enterprises (SMEs): Opportunities in the Leather Manufacturing Industry. *Sustainability* 4, 175–192.
- Pardo, H.R.J., Bhamra, T., Bhamra, R., 2013. Exploring SME perceptions of sustainable product-service systems. *Eng. Manage. IEEE Trans.* 60, 483–495. <https://doi.org/10.1109/TEM.2012.2215961>.
- Peillon, S., Dubruc, N., Mansour, M., 2018. Service and customer orientation of corporate culture in a French manufacturing SME. *Procedia* 73, 91–95. In: <https://doi.org/10.1016/j.procir.2018.03.331>.
- Pigosso, D.C.A., McAloone, T.C., 2016. Maturity-based approach for the development of environmentally sustainable product/service-systems. *CIRP J. Manuf. Sci. Technol.* 15, 33–41. <https://doi.org/10.1016/j.cirpj.2016.04.003>.
- Qu, M., Yu, S., Chen, D., Chu, J., Tian, B., 2016. State-of-the-art of design, evaluation, and operation methodologies in product service systems. *Comput. Ind.* 77, 1–14. <https://doi.org/10.1016/j.compind.2015.12.004>.
- Rapitsenyane, Y., 2014. Supporting SMEs adoption of sustainable Product Service Systems: a holistic design-led framework for creating competitive advantage. PhD thesis. Design School, Loughborough University, UK.
- Reichert, Jo, 2014. Induction, Deduction, Abduction. In: Flick, Uwe (Ed.), *The Sage Handbook of Qualitative Data Analysis*. Sage Publications Ltd, London, UK, pp. 170–184. ISBN 9781446208984.
- Reim, W., Parida, V., Ortqvist, D., 2015. Product e Service Systems (PSS) business models and tactics e a systematic literature review. *J. Clean. Prod.* 97, 61–75. <https://doi.org/10.1016/j.jclepro.2014.07.003>.
- Robson, C., 2011. *Real World Research*, 3rd Ed. Wiley.
- Rondini, A., Matschewsky, J., Pezzotta, G., Bertoni, B., 2018. A simplified approach towards customer and provider value in PSS for small and medium-sized enterprises. *Procedia CIRP* 73, 61–66. In: <https://doi.org/10.1016/j.procir.2018.03.330>.
- Salazar, C., Lelah, A., Brissaud, D., 2015. Eco-designing Product Service Systems by degrading functions while maintaining user satisfaction. *J. Clean. Prod.* 87, 452–462. <https://doi.org/10.1016/j.jclepro.2014.10.031>.
- Sassanelli, C., et al., 2016. Design for Product Service Supportability (DfPSS) approach: a state of the art to foster Product Service System (PSS) design. *Procedia CIRP*, pp. 192–197. In: <https://doi.org/10.1016/j.procir.2016.03.233>.
- Sassanelli, C., et al., 2015. Towards a lean Product Service Systems (PSS) Design: state of the art, opportunities and challenges. *Procedia CIRP* 191–196. <https://doi.org/10.1016/j.procir.2015.02.123>.
- Schreier, Margrit, 2014. *Qualitative Content Analysis*. In: Flick, Uwe (Ed.), *The Sage Handbook of Qualitative Data Analysis*. Sage Publications Ltd, London, UK, pp. 170–184. ISBN 9781446208984.
- Smith, M., Ceni, A., Milic-Frayling, N., Shneiderman, B., Mendes Rodrigues, E., Leskovec, J., Dunne, C., 2010. NodeXL: a free and open network overview, discovery and exploration add-in for Excel 2007/2010/2013/2016. <http://nodexl.codeplex.com/> from the Social Media Research Foundation. <http://www.smrfoundation.org>.
- Song, W., Sakao, T., 2017. A customization-oriented framework for design of sustainable product/service system. *J. Clean. Prod.* 140, 1672–1685. <https://doi.org/10.1016/j.jclepro.2016.09.111>.
- Suddaby, R., 2014. Editor's comments: Why theory? *Acad. Manag. Rev.* 39, 407–411. <https://doi.org/10.5465/amr.2014.0252>.
- Sundin, E., Elin, N., Lelah, A., 2015. Sustainability indicators for Small and Medium-sized Enterprises (SMEs) in the transition to provide Product-Service Systems (PSS). *Procedia CIRP* 30, 149–154. In: <https://doi.org/10.1016/j.procir.2015.02.155>.
- Tonelli, F., Taticchi, P., Sue, E.S., 2009. A Framework for Assessment and Implementation of Product-Service Systems Strategies: Learning From an Action Research in the Health-Care Sector. *WSEAS Trans. Bus. Econ.* 7 (6), 3020–3319.
- Tranfield, D., Denyer, D., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *Br. J. Manag.* 14 (3), 207–220. <https://doi.org/10.1111/1467-8551.00375>.
- Tukker, A., 2015. Product services for a resource-efficient and circular economy- A review. *J. Clean. Prod.* 97, 76–91. <https://doi.org/10.1016/j.jclepro.2013.11.049>.
- Tukker, A., Tischner, U., 2006. Product-services as a research field: past, present and future. Reflections from a decade of research. *J. Clean. Prod.* 14 (17), 1552–1556. <https://doi.org/10.1016/j.jclepro.2006.01.022>.
- Tukker, A., Tischner, U., 2004. *New Business for Old Europe: Product-Service Development, Competitiveness and Sustainability*. Greenleaf Publishing, Sheffield.
- UNEP, 2004. Available in: http://www.unep.fr/shared/publications/other/webx0072xpa/manual_cdrom/guidance%20manual/pdf%20versions/part1.pdf.
- Vasantha, G., Roy, R., Lelah, A., Brissaud, D., 2012. A review of product-service systems design methodologies. *J. Eng. Des.* 23 (9), 635–659. <https://doi.org/10.1080/09544828.2011.639712>.
- Vasantha, G.V.A., Roy, R., Corney, J.R., 2015. *Advances in Designing Product-Service Systems*. J. Indian Inst. Sci. 95, 429–447.
- Van de Ven, A.H., 2007. *Engaged scholarship: A guide for organizational and social research*. Oxford University Press, Oxford.
- Vezzoli, C., Ceschin, F., Diehl, J.C., Kohtala, C., 2012. Why have 'Sustainable Product-Service Systems' not been widely implemented? Meeting new design challenges to achieve societal sustainability. *J. Clean. Prod.* 35, 288–290. <https://doi.org/10.1016/j.jclepro.2012.05.050>.
- Vezzoli, C., Ceschin, F., Diehl, J.C., Kohtala, C., 2015. New design challenges to widely implement 'Sustainable Product e Service Systems'. *J. Clean. Prod.* 97, 1–12. <https://doi.org/10.5281>.
- Vieira, L.C., Amaral, F.G., 2016. Barriers and strategies applying Cleaner Production: a systematic review. *J. Clean. Prod.* 113, 5–16. <https://doi.org/10.1016/j.jclepro.2015.11.034>.
- Viesi, D., Pozzar, F., Federici, A., Crema, L., Mahhub, Md S., 2017. Energy efficiency and sustainability assessment of about 500 small and medium-sized enterprises in Central Europe region. *Energy Policy* 105, 363–374. <https://doi.org/10.1016/j.enpol.2017.02.045>.
- West, S., Nardo, S.D., 2016. Creating product-service system opportunities for small and medium size firms using service design tools. *Procedia CIRP* 47, 96–101. In: <https://doi.org/10.1016/j.procir.2016.03.218>.
- Whetten, D.A., 1989. What constitutes a theoretical contribution? *Acad. Manag. Rev.* 14, 490–495.
- Wiesner, S., Nilsson, S., Thoben, K.D., 2017. Integrating requirements engineering for different domains in system development – lessons learnt from industrial SME cases. *Procedia CIRP* 64, 351–356. In: <https://doi.org/10.1016/j.procir.2017.03.013>.
- Xing, K., Ness, D., 2016. Transition to product-service systems: principles and business model. *Procedia CIRP* 47, 525–530. In: <https://doi.org/10.1016/j.procir.2016.03.236>.
- Yang, M., Evans, S., Vladimirova, D., Rana, P., 2017. Value uncaptured perspective for sustainable business model innovation. *J. Clean. Prod.* 140 (3), 1794–1804. <https://doi.org/10.1016/j.jclepro.2016.07.102>.