CIRCULAR PSS STRATEGIES: AN EXPLORATION OF THE INTEGRATION OF TERRITORIAL RESOURCES

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ABSTRACT

Product service systems (PSS) are frequently cited as key strategies in the transition towards the circular economy (CE). The main aim of the CE is sustainable development (SD), hence, this paper intends to highlight the importance of considering the territory in the design and implementation of circular PSS strategies for ensuring SD. This research is in an early stage, thus, a literature review was conducted to define the main characteristics of circular PSS, and the concepts of the territory, territorial and local resources from a PSS perspective. In addition, an analysis of the state-of-the-art approach of the integration of the territorial scale in the design and development of PSS strategies was conducted. This study contributes to the understanding of the territory and its relevance in the local value creation in circular PSS strategies. Furthermore, the results highlight the relevant role of collaboration and the importance of intangible resources in the mobilisation of other resources in the design of circular PSS strategies.

Keywords: Product-Service Systems (PSS), Local resources, Territorial resources, Circular economy, Sustainability

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1 INTRODUCTION

The increasing environmental, economic and social impacts of our take-produce-use-dispose economic system has led individuals, companies and governments to question the way we manage our relationship with the environment. Transitioning to a more sustainable economic and social system has become necessary for organizations in order to meet economic, social and environmental expectations over time (Porter and Van der Linde, 1995; Tibbs, 2006; Lozano, 2012). To achieve this goal, the circular economy (CE) is currently cited as a promising path to transit to a sustainable economic model. Currently there is no consensus definition of the CE; however, in a recent research paper analysing 114 CE definitions from different fields, Kirchherr *et al*. (2017) defined the CE as an *"economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes… with the aim to accomplish sustainable development… It is enabled by novel business models and responsible consumers"*. This is the CE definition adopted in our research.

One type of innovative business model that is frequently mentioned as important in the transition towards a CE is the Product Service System (PSS). PSS strategies are frequently defined as *"a mixture of tangible products and intangible services, designed in a way that together fulfil the final customer's needs"* (Tukker and Tischner, 2006). They have their roots within the notion of the functional economy developed by Giarini and Stahel (1991), which focuses on selling services to customers rather than products. PSSs are frequently cited as key strategies for decoupling economic growth from resource consumption (Bourg and Buclet, 2005; Buclet, 2014; Bocken *et al*., 2017), as they separate value creation from the consumption of a physical product and focus on functionality instead (Ceschin, 2014; Charter, 2019). However, as underlined by Kjaer *et al*. (2018), PSS strategies do not automatically lead to reduced resource use (Tukker, 2004; Pigosso *et al*., 2010; Kjaer *et al*., 2016) and resource reduction does not necessarily lead to an enhanced performance in terms of sustainability (Andersen, 2007; Bilitewski, 2012).

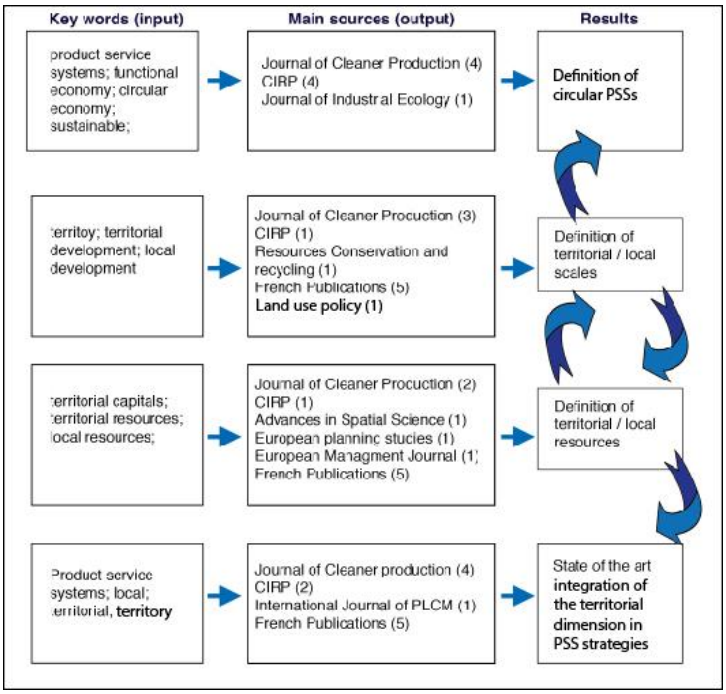
Through the study of PSS as a strategy for transitioning towards a CE, this research intends to highlight the importance of integrating the local characteristics of territories when developing sustainability plans (Figuière and Rocca, 2008; Seghezzo, 2009). To this end, this research adopts the definition of sustainability developed by Figuière and Rocca (2008), which integrates five dimensions (social, economic, environmental, political and territorial) and is further explained in Section 3.1.

Presently, there are a higher number of studies on PSS models oriented towards environmental values than those integrating a more holistic approach to sustainability (Chou, Chen and Conley, 2015). Studies related to PSS design that consider the impacts of integrating local characteristics of territories fostering sustainable development are even more scarce. The macro hypothesis from our research is that PSS strategies are key for mobilizing resources within a territory and lead to a more sustainable performance of the system while reducing resource consumption. Through a literature review, this paper specifically aims to answer three questions: 1) What is a circular PSS? 2) What is a territory, a territorial resource and a local resource from a PSS perspective? 3) How has the territorial approach been integrated in PSS frameworks so far?

2 METHODOLOGY

The aim of this paper is to define what circular PSSs are (considering the five dimensions of sustainability). Additionally, it seeks to determine a definition of 'territory', as well as the territorial/ local resources that are tailored to be used in the design and development of circular PSS strategies. At the same time, this paper identifies the current approaches for integrating territory in the design and implementation of PSS. A literature review analysis was conducted using the research model represented in Figure 1. The key words used for defining search strings were entered in databases such as Scopus, Web of Science and Google Scholar for relevant scholarly (peer-reviewed) publications. In addition, relevant articles were identified through references cited in the articles identified in the search.

Figure 1. Research model



3 RESULTS

3.1 PSS strategies, sustainability and circularity

This research adopts the five-dimensional (5D) sustainability definition from Figuière and Roca (2008). It is focused on human development as the sustainability objective (social dimension). The environment is considered as the limiting factor for anthropic activity (ecological dimension). The economic dimension is considered as a means (not a goal) of reaching social objectives with respect to ecological boundaries. The political dimension defines the development guidelines and must be strong enough to take precedence over economic actors. The political dimension is considered as the place for public debate and long-term societal orientation and decision-making. The territorial dimension from a geographical perspective (see more in Section 3.2) should be considered when adapting global policy to local specificities to develop appropriate solutions. Moreover, in order to achieve sustainability, there is the need for a societal transformation, which also requires institutional, socio-cultural, organizational and technological changes (Gaziulusoy, Boyle and McDowall, 2013). A PSS can be regarded as sustainable only if the socio-technical system in which they operate is a sustainable one (Gaziulusoy, Boyle and McDowall, 2013). Thus, sustainability requires a consideration of broader systems than those considered in the PSS business model definition, such as value generation and delivery (Allais and Gobert, 2016).

The potential of PSS as a strategy in the transition towards sustainable development (SD) has led to the emergence of frameworks such as Sustainable Product Service Systems (S.PSS). These integrate the economic and competitive interests of producers while fostering innovation that results in reducing environmental impacts and improving social cohesion and equity (Vezzoli *et al*., 2014). S.PSS highlights the importance of promoting a greater involvement of local actors, thereby fostering and facilitating the prosperity of the local economy. Other research studying the relationship between PSS and sustainability focuses on economic and environmental outcomes, both positive and negative (Hüer *et al*., 2018), without further explaining the role of these innovations in the sustainability of the societal system. Even though the concept of PSS comes from a strong sustainability perspective, there has been a recent shift of focus from environmental to economic benefits in the last decade (Haase, Pigosso and McAloone, 2017). PSS strategies where the manufacturer retains the ownership of the product are considered to have the biggest potential to benefit the environment (Vezzoli *et al*., 2015), as manufacturers are assumed to be incentivized to optimize their resource consumption by improving the product's life and, through design, potentially giving them a second life (Tukker, 2015). The role of PSS in the CE context and its potential

to establish and maintain CE strategies remains imprecise (Blomsma *et al*., 2018). In addition, from a CE perceptive it is well acknowledge that PSS research is facing challenges due its lack of consideration on the social sustainability dimension (Chen, 2018).
Rebound effects are well acknowledged as threatening the potential of PSS strategies to bring about an absolute dematerialization of the economy (Kjaer *et al*., 2016). As a result, Kjaer *et al.* (Kjaer *et al*., 2018) propose a two-step framework for developing circular PSSs that accomplish absolute resource decoupling. In the first step, four PSS enablers, or CE strategies, of relative resource reduction are identified, and in the second step, three more requirements have to be met for achieving absolute resource decoupling.
Based on the S.PSS framework, we conclude that **circular PSSs are strategies seeking sustainable development (SD) that consider the local characteristics of territories. In addition, these strategies are also key for coupling the reduction of resource consumption with increased business opportunities. The overall aim of these strategies is to balance the production, consumption and well-being of societies** (Kjaer *et al*., 2016).

3.2 Territorial and local scales and PSS

This section intends to first explore the definitions of the local and territorial scales from diverse disciplines, and then propose a definition that is suited to be integrated in a framework for the design and development of circular PSSs.
The term local, as emphazised by Tyl *et al*. (2015), has been mainly researched within the science of economics without a clear definition. A related concept to local production and consumption is the decentralized or distributed economies proposed by Johansson *et al*. (2005), whose paper focused on the development of regional economies. Distributed economies are supposed to make optimum use of local physical and social resources, thereby reducing environmental impact and enhancing social cohesion (Johansson, Kisch and Mirata, 2005). From a design perspective, Manzini (2007) introduces the multi-local society concept as a network of *"local systems"*. The multi-local society should produce and consume locally, however, and exchange what cannot be locally produced. In line with this, Tyl *et al.* (Tyl, Lizarralde and Allais, 2015) developed the concept of multi-local systems as even when a good is locally produced, its location of consumption will often be different.
There are different perspectives that are used to determine a territory; for example, geographical, administrative, economic, social (Simone, Barile and Calabrese, 2018). The concept of the territory is polymorphous and its definition depends on the issues and the different stakeholders considered (Allais, Reyes and Roucoules, 2015). Table 1 presents an analysis of definitions of 'territory' for different disciplines. The disciplines selected provide a firm's perspective and describe the space where these operate.

Table 1. Definition of 'territory' from diverse disciplines

Resources	Description
Administrative (Allais, Reyes and Roucoules, 2015)	Geographical area managed by political entity, representing multiple scales e.g. country, department, regions, city, district.
Geography (Pecqueur and Zimmermann, 2004; Moine, 2006; Gumuchian and Pecqueur, 2007; Buclet, 2014)	Complex and evolving system linking actors, the geographical space they use, develop, manage and landscape. In addition, it is the platform where production and consumption occurs, on which material and immaterial resources flow. In addition, the increased proximity potentially increases the creation and maintenance of synergies.
Economics (Camagni, 2002; Capello, 2004; Simone, Barile and Calabrese, 2018)	Creator of advantages for firms; thus, it is considered as an active element in the development process. Relationships that result in unifying a local production system, a set of actors and representations, and an industrial culture, creating a localized process of collective learning.

Managerial and strategic (Simone, Barile and Calabrese, 2018)	The territory as one of the elements of the competitive advantage of the enterprise. In this vision, territory is itself a resource that consists of resources (tangible and intangible) and of actors (physical persons or organizations) who can potentially increase the resources in the territory.

In the product design field, Allais *et al*. (2015) proposes a definition of a territory from a multidiscipline perspective (geographical, administrative and industrial). Merging these views, they conclude that, due to globalization, a company's sphere of influence (see more ISO26000, 2010) is nowadays rarely localized in one geographical region; thus, it is relevant *"considering the administrative territory and local value creation system in every location of the sphere of influence of the company"*.
From a PSS project perspective, a multidimensional approach seems to be the best for our project. Parting from the definition of territory proposed by Allais *et al*. (2015) we consider **a territory to be a system in which different actor groups interact within the geographical space and engage in value creation activities that lead to the flow of tangible and intangible resources.** In this definition we can observe three main components, the system, the actors and the geographical space. The system is a product of the relations between the society, industrial activities (PSS) and the environment. The geographical space that actors manage in the PSS , it is the container of the flux of resources which characterize the territory in a unique and unrepeatable way (Simone, Barile and Calabrese, 2018) and is the. The actor groups are individuals, companies and organizations which have a direct and indirect influence on the development of the innovations.
Based on the concepts of multi-actor (Buclet, 2011), multi-local systems (Tyl, Lizarralde and Allais, 2015), we conceive of PSS strategies as multi-territorial, as these usually integrate resources from other territories. Local production and consumption can happen within sectors that are not mobile, such as the agricultural sector. However, the logic is different for product service systems which utilize manufactured products, as some of these might be produced in different territories and be displaced to others during the different stages of the life-cycle. Thus, a system involved in various territories must participate in the local dynamism of these territories (Tyl, Lizarralde and Allais, 2015).

3.3 Territorial and local resources

Research on local and territorial resources has been carried out in two main fields: development economics and geography. This section explores the definition of resources from these two perspectives. In addition, an overview of organizational resources is integrated for greater understanding of what resources are for companies and how these are valorised and mobilised.
Territorial resources from an economic development perspective are usually called *"territorial capital"*. As defined in economics, capital is a stock that yields a flow of valuable goods or services (Costanza and Daly, 1992) that are usually valued in monetary terms. There are several definitions of what territorial capital is; however, as underlined by Tóth (2015), all of these definitions highlight the importance of the *"specific local resources and territorial assets that should be exploited and used actively to promote territorial development"*. According to Camagni (2017), territorial capital is a set of localized assets (natural, artificial, human, organizational, relational and cognitive) that comprise the potential of a certain territory. The intangible factors such as networks, relational capital, trust, creativity, connectivity and receptivity are considered to be significant in mobilizing the territory and should be considered as a *"binding material of traditional factors and traditional material assets"* (Tóth, 2015).
From a geographical perspective, Moine (2006) describes the territory as a system which is composed of three main subsystems: actors, geographic space and the system's representation. From this definition he identifies the following elements: the social sphere (actors dictating the dynamics of the territory); geographical space, which is further broken down into three subsystems: the geosystem (natural resources, landscape and ecosystem services), the atrophic system (population, the built environment concerning infrastructure and services) and the social space (social relations on different levels – individual, group and the political and institutionalized space); and, finally, the systems of representation (interconnection of three systems: individual, societal and ideological).
From an organizational perspective, the company considers diverse tangible and intangible assets owned by the companies that are important for sustaining their competitive advantage (Greco, Cricelli and Grimaldi, 2013). The tangible assets of organizations relate mainly to the equipment they use and their

infrastructure, both physical (i.e. access to natural resources) and technological (i.e. sophisticated mainframes or advanced machinery) (Durnev, Morck and Yeung, 2004). Intangible assets have been traditionally divided in two main categories (Nahapiet and Ghoshal, 1998): relationships, also known as "social capital", and knowledge. Another name for the intangible assets of organizations is intellectual capital (Petty and Guthrie, 2000), which is traditionally represented by human, structural/organizational and relational/social capital. In line with this, recent research has expanded this classification, integrating entrepreneurial, renewal and trust capital (Inkinen *et al*., 2017). Furthermore, recent research from Allais *et al.* (2016) concludes that the assessment of intangible assets and capital in a PSS project *"enables [one] to determine which success factors are particularly significant, and to understand how these factors need to be combined and consolidated along the process"*.

From the analysis of territorial capital and resources we can identify two main macro categories, tangible and intangible (Gumuchian and Pecqueur, 2007), which are the same categories observed for organizational assets. Moreover, intangible resources are highlighted as key for the valorisation and mobilization of other resources in the territory and inside of companies. From a territorial perspective, resources do not correspond to individuals, companies and communities on a one-to-one basis (Uwasu *et al*., 2018). These resources are reservoirs which are shared by different actors in the territory and capitalized by the human activities. Therefore, we can conclude that territorial resources are both tangible and intangible, are activated, shared and mobilized by endogenous and external actors, and that not all actors will have the same access to them. Based in the territorial resources categorization of Camagni (Camagni, 2008) and Moine (2006), we classified territorial resources as the following: natural, built environment/ artificial, human, organizational, relational, financial, institutional/political and cultural (Table 2).

Table 2. Categorization of territorial resources. Adapted from Moine (2006) and Camagni (2008)

Resources	Description
Natural	Natural resources, ecosystem services, landscape, cultural heritage, identity and patrimony.
Built environment / Artificial	Infrastructural assets in the territorial planning such as buildings, roads, and services provided, including all material goods which contribute to production process including technological assets.
Human	This are the set of skills that related to skills that affect the productivity of individuals, families, communities and business; i.e. learning, knowledge, innovation and entrepreneurship.
Organizational	Management, communication, value sharing, coordination, trust, strategic alliances, entrepreneurship, know-how that develop systems of production.
Relational	Social networks, collective action capacity individual, group with the political and institutionalized space.
Financial	Economic resources used to develop and operate the projects private or public.
Institutional/ political	Governance on land and natural resources, democratic processes in decision making.
Cultural	Traditions, value sharing, engagement in private and public initiatives, ideologies, sense of belonging.

3.4 PSS strategies the territory

This section explores the integration of the territorial dimension in the design and development of PSS strategies. Traditionally PSS have been classified as product oriented, use oriented and results oriented (Hockerts, 1999). However, for understanding the consequences of the strategies in sustainable development (SD) a more specific classification is needed. This must differentiate strategies complementing a traditional offering that increases the profitability of the company from those innovative strategies that part with the traditional ways we meet the needs of the market (Buclet, 2014). As a result, Buclet (2014) proposes a typology of six levels, of which the first four highlight the need for organizational innovation when adopting the PSS model only, and the fifth and sixth integrate the territorial organization of the actors at the heart of the strategies. For the fifth level, the aim is to satisfy the needs of a territory, i.e. mobility. Cooperation is, thus, essential for the company providing the service. For the sixth level, the objective is to increase the cooperation of actors at a territorial scale, thereby placing emphasis on the process of co-design. This potentially restores the local production of physical media needed for providing the service and leads to the sharing of knowhow between actors both inside the territories and outside, thus allowing the local dynamics to enrich endogenous knowledge.

The S.PSS framework suggests that the empowerment of local economies could happen by means of enhancing local cultural characteristics, regenerating or enhancing unused and discarded artefacts, promoting or adapting systems, using regenerated local natural resources, and promoting local based and network structured enterprises or initiatives (Vezzoli *et al*., 2015). The proposition of a territory-based PSS by Vadoudi *et al.* (2015) integrates Geographic Information Systems (GIS) to consider the site-specific characteristics of the territory in the life cycle of a PSS network, in order to improve the sustainability performance of the system. More recently, a theoretical framework for PSS sustainability developed by Allais and Gobert (2016) is composed by three levels parting from PSS project network, territory and institutional framework. As such, this framework underlines the importance of assessing intangible assets and territorial capital when mobilizing a PSS project during the design and operation phases.

There are only a few methods that can support the design of PSSs which integrate the local or territorial dimension (Tyl, Lizarralde and Allais, 2015). Two examples are the MEPSS tool (MEPSS tool, no date) which is a PSS design software that integrates a local approach through the empowering/ valorising of local resources guidelines, and the PSS business model toolkit from Jégou F. *et al.* (2013), which utilizes a territorial approach to innovate local solutions for cities and involve the needs of various stakeholders.

From these results we can conclude that the local and territorial scales are vital in the design and development of PSS strategies, as they foster self-sustaining territories, thereby reinforcing the local economy and relations within actors both in- and outside the territory. The integration of the territorial scale generates a more dynamic flow of local resources and enhances the identification of key stakeholders that can collaborate to design innovative ways to satisfy the needs of the local system. In addition, the territory is an important scale for measuring and improving the sustainability performance of PSS solutions.

4 DISCUSSION AND CONCLUSION

This paper highlights the incorporation of the territorial dimension as key in the design and development of circular PSS strategies from both a SD and CE perspective. Sustainable development is the main aim of CE; thus, circular PSS strategies seek environmental and social benefits that couple the reduction of resource consumption with enhanced business opportunities. The overall aim of these strategies is to balance the production, consumption and well-being of societies (Kjaer *et al*., 2016).

Our study proposes a definition of ‘territory’ to be used in the design and development of circular PSSs parting from the multidisciplinary analysis of the concept off territory by Allais *et al*. (2015). Thus, we define a territory as a system in which different actor groups interact within the geographical space and engage in value creation activities that lead to the flow of tangible and intangible resources.

Extending the concepts of multi-actor (Buclet, 2014), multi-local systems (Tyl, Lizarralde and Allais, 2015), we conceive of PSS strategies as being multi-territorial as these use and mobilize resources from other territories.

The territory seems to be a relevant dimension for understanding the interactions between society, nature and industrial activities in circular PSSs. It is a scale that allows for the better understanding of resource

fluxes for capturing the material impact of the interactions between nature and society (Buclet and Donsimoni, 2018) and establishing and measuring societal objectives. The integration of the territory and its resources are used as levers for companies and industries to be more competitive (Simone, Barile and Calabrese, 2018) without further questioning if their activities contribute to the sustainable development of the territory (Buclet, 2014). Thus, the integration of the territory in the design and development of circular PSSs is important for enhancing the possibility of a territory to fulfil its own needs in innovative ways; enhance the creation and maintenance of relationships and cooperation of actors (endogenous and exogenous), building on its collective capabilities; and for having a clear understanding of the sustainability impacts of the innovations in the socio-technical system. As such, we support the notion that the more a socio-technical system uses territorial resources, the more embedded it will be in its territory, thus matching its sustainability objectives (Allais and Gobert, 2016).

Our results regarding the definition of local resources in a PSS strategy suggest that resources should be viewed from both a territorial and an organizational perspective. Parting from the analysis of the economic and the geographic definitions, we can say that resources in a territory are both tangible and intangible, and that they are constructed and categorized as natural, built environment/artificial, human, organizational, relational, financial, institutional/political and cultural. Our study highlights the role of intangible resources in the mobilization of other resources inside firms and the territory, as well as sustainability performance (Allais and Gobert, 2016). As such, different frameworks categorizing resources for territorial and community development have been proposed; however, there is still a lack of empirical studies that describe the interactions between these and how they may be deployed by communities (Pigg *et al*., 2013).

The local and territorial approaches have been highlighted as key in the implementation of PSS, however, there is a still lack of research that studies the role of territories from a firm and PSS perspective. Our research confirms the previous results of Tyl *et al*. (2015) that highlight the lack of tools and frameworks integrating this dimension in the design and development of PSS strategies. The frameworks identified (a) classify PSS according to the integration of the territory for measuring their contribution to SD (b) include guidelines for valorising and integrating local resources in the design of PSS; (c) propose the integration of geographic information in the design for integrating territorial specifications; and (b) highlight the importance of considering the PSS network, the territory and the local institutional framework for sustainable design and operation phases.

Recent research highlights the role of industrial designers in the development of PSS strategies in the incorporation of local resources and enhancing the value co-creation of PSS strategies (Diehl and Christiaans, 2015; Sumter, Bakker and Balkenende, 2018). To this end, collaboration is highlighted as relevant in the value creation process of circular PSS. Thus, our future research aims to understand the complex interactions between stakeholders in the design and development of PSS strategies, identify the factors triggering different actors to participate in the PSS and integrate territorial resources. In addition, we aim to understand how this process (collaboration) enhances the capabilities of stakeholders and the territory. We intend to develop a framework that allows firms to identify territorial resources and collaborate with key stakeholders within a territory when designing a circular PSS.

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