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Towards sustainable servitization: A literature review of methods and frameworks

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Abstract

Service-based business models have attracted growing interest as means to capture sustainable value. There is still unclear terminology and lack of understanding on how servitization can locate sustainability as central value. The purpose of this study is to consolidate the terminology and methods for servitization, to identify factors and elements that contribute to a sustainability perspective. The followed methodology includes a comprehensive literature review, further analyzed through a conceptual framework using an evidence-based approach. The findings of this study will clarify existing terminologies and frameworks while supporting the development of service-based business models that avoid the sustainability paradox of servitization.

Keywords: servitization; service-based business models; sustainability; product-service systems (PSS)

1. Introduction

Achieving sustainable organizations and companies is top priority in today's world. Finding sources of sustainable competitive advantage is highly necessary, especially when considering the high amount of uncertainty that companies experience [1]. In the past, economic benefits were commonly expected to lead the description of a sustainable firm. Today, the increasing environmental concerns, consequence of a long period of linear economy, have shown that immediate actions are required.

The constant increase in production capacity, the unlimited number of customers a company can reach in one click, and the ever-growing number of products and services that reach the market everyday do not cease to amaze. From a research perspective, globalization and new technologies have removed boundaries between study disciplines, creating room for multidisciplinary research [2]. This can potentialize results of collaboration; or on the contrary, it can hinder the visibility of useful resources, making concepts fluid and researchers biased.

Servitization is a field that has attracted interest from multidisciplinary teams [3]. Its implementation has allowed manufacturers to maintain competitive advantage when exposed to competitive pressures [4]. However, organizations attempting to understand how they can find sources of competitive advantage by joining the servitization trend, find a broad variety of different methods in which sustainability can be embedded as part of business models. Unfortunately, the way in which the environmental and social aspects of sustainability are addressed in servitization and product-service systems has not been consistent [5]. Terms such as "PSS" or "servitization" have been assumed by many to have automatic environmental benefits, but this is not always the case. Some business models can even have counterproductive effects when

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not planned correctly [5], environmental advantages do not fall on organizations as Newton's apple. In this paper, we refer to this phenomenon as the sustainability paradox of servitization.

This study identifies a gap in literature between the research work that looks at the development of service-based business models and the inclusion of sustainability in the core of business development [6]. This paper aims to clarify existing terminologies and analyze methods and frameworks that support the development of service-based business models that avoid the sustainability paradox of servitization. To do this, it poses the following research question:

What are the currently available methods to adopt sustainable service-based business models?

This paper presents the theoretical framework in Section 2 which provides context for the rest of the article. Section 3 describes the followed methodology for the literature review. Section 4 presents the results of the literature review. Finally, Section 5 discusses the results and provides concluding remarks.

2. Theoretical framework

This section introduces the concepts of servitization and the sustainability paradox of servitization to contextualize the study performed.

2.1. Servitization

In its first appearances, in the 1980s, the concept of *servitization* [7] was defined as the transition of firms and industries, in which their core businesses and value generation experiences a shift by developing added services to acquire and retain customers, and to create competitive advantage. It could be argued that this definition succeeds in describing the status of many companies still today.

This field has been highly dynamic, proposing new concepts and terms to integrate, describe and guide this transition. Some authors tightly couple the term of servitization coupled with concepts such as competitive advantage and sustainability [8]. Some argue that the servitization of industry, by promoting added services, could extend a product's life cycle [9] and therefore, could be a driver for less tangible assets involved in economic transactions [10]. This idea is often referred to as *dematerialization*, which consists of using fewer physical assets or material resources to meet customers' needs and generate economic revenue.

2.2. Sustainability paradox of servitization

Within the context of Product-Service Systems (PSS), some authors have positioned themselves as strong sustainability advocates [11] claiming that the PSS business models inherently have lower environmental impacts than traditional ones, or that at least environmental improvements are an established goal [9]. However, it has proven wrong in some case studies that suggest a possible "rebound effect", that PSS increases the demand for products/services [12], by overusing products when ownership is not fully on the hands of the customer. An example has been seen in exercises of shared laundry-mats, where customers increased the use of washing machines or began to make use of dryers, which removed the potential environmental advantages of this shared service [13].

The suggestion of the dematerialization as consequence of servitization opened the door for a research niche that viewed servitization as way of achieving environmentally sustainable companies, and customers. This idea of sustainability advantages was strengthened by the dramatic increase of environmental awareness partly caused by the consolidation of organizations whose main aim is to promote sustainability principles among governments, companies and societies [9, 14]. Creating more environmentally sound decisions requires awareness, planning and strategy development [15].

3. Methodology

The literature review was developed through the following three main stages suggested by [16].

1. Planning the review
2. Conducting the review
3. Reporting and dissemination

This methodology was followed because its argument embeds the strict development of unbiased outcomes and reliable knowledge on context-sensitive research topics. Therefore, this literature review was conducted through the selection of keywords through iteration with the co-authors, attempting to integrate those keywords that cover the field of research:

The keywords were combined into the following search string (TITLE-ABS-KEY ("servitization" OR "product-service systems" OR "product service systems" OR "service-based business models" OR "service transition" OR "digital servitization" OR "green servitization" OR "advanced services") AND TITLE-ABS-KEY ("sustainab*" OR "green")) The search was conducted on SCOPUS. The results of the process are summarized in Figure 1.

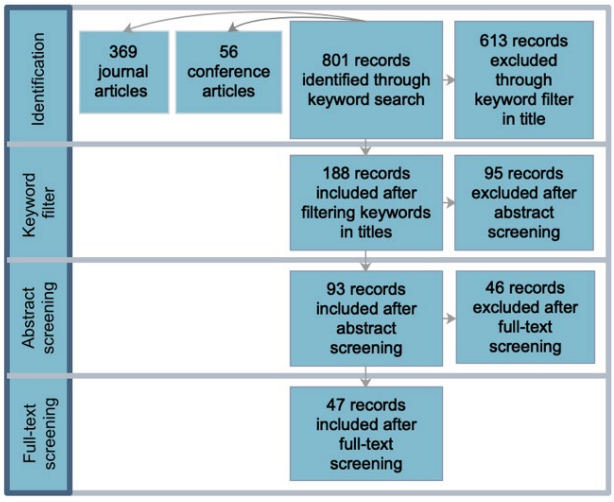

Fig. 1. PRISMA Diagram of review process

This query provided us with 801 entries; out of which 369 were journal articles and 326 were conference articles. The

remaining 106 were a mix of reports, book chapters, articles languages other than English; these were not included.

The conference articles were filtered to consider only those from 2019 and forward. This decision was based on the assumption that methods and frameworks from before 2019 have been evolved into journal publications. This provided a final list of 56 conference articles.

The 369 journal articles and 56 conference articles were then filtered to see if the title contained the keywords "framework", "method", "model", "assess", "design", "evaluate", which gave a result of 188 articles, out of which 30 were conference papers and 158 were journals.

The abstracts of these 188 papers were screened, and 93 papers were selected for further scrutinization based on their potential to contribute to answering the research question posed. This process was further expanded by reviewing the full texts before final inclusion in analysis. Finally, 47 articles were selected for extensive review.

4. Results

The results of the literature review are summarized in 5 main categories: (1) definitions of servitization or PSS, (2) lifecycle stage of the offering in which the framework or model is applied/focused, (3) inclusion of sustainability KPIs in the framework or method, (4) perspective of the method or framework, (5) applicability, usability and functionality of the method or frameworks. This are further represented in Figure 2 for visibility of the way in which the literature review was performed and which elements were analyzed in each method/framework.

In the context of this study, a framework is identified as a structure, a logical way to classify something. On the other hand, a method is an action, a way of doing something.

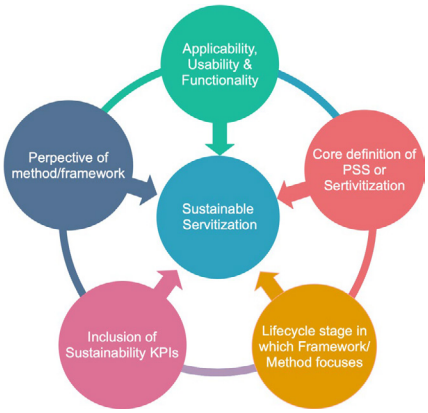

Fig. 2. Conceptual framework used for literature analysis

4.1. Definition of servitization and PSS

The articles analyzed came as a result of the same keyword search, however there was a slight variety in the core concept used to define their area of study. For instance, 3 of the 47 files included a definition of servitization [17-19]. Also, 2 of them used the keywords "PSS" however mainly referred to Circular Business Models [20, 21]. Then, 32 of them included the definition of PSS [11, 19, 22-50], where 8 of them did not include sustainability elements in the definition [24, 40-42, 45-48]. It could be worth mentioning that from this list, the most recent definition is of 2011. Then, two attempted to define sustainable PSS [6, 51] and 1 of them defined Smart PSS [52].

Last, 2 of them refer to Industrial Product-Service Systems [17, 53]. In total, 30 of the definitions included some type of sustainability element in it, while the other 17 identify the transaction and business purpose as the main motivation to transition from traditional manufacturing to servitization.

4.2. Lifecycle stage of the offering in which the framework or method centers

The contributions found in the literature review included 28 frameworks and 19 methods. Figure 3 shows how the number of frameworks and methods distribute, based on the lifecycle stages of the studied offering where they had the most impact, where 40 [6, 8, 11, 17, 19, 20, 22, 23, 25, 28, 29, 31-38, 40, 43-51, 53-58] of the contributions have impact on the Beginning-of-Life, 6 [11, 38, 39, 51-53] in the Middle-of-Life and 2 [39, 51] in End-of-Life stage.

Fig. 3. Distribution of frameworks and methods along lifecycle stages.

4.3. Inclusion of sustainability KPIs in the frameworks or methods

The analyzed articles included 28 frameworks and 19 methods. Within this selection, there was high variety in the level of depth to which they contribute to transition from traditional manufacturing to servitization. A summary of the results of this analysis is found in Table 1.

Table 1. Analysis of methods and frameworks.

Type	Sustainability Included
Methods	[8, 17, 18, 20, 21, 24, 27, 33, 36, 37, 43, 49, 52, 54-56, 58]
Frameworks	[6, 11, 25, 28, 31, 32, 44, 46, 51]

Examples of the KPIs included in methods and frameworks are summarized in Table 2.

Elements or assessment points per pillar of sustainability
Environmental sustainability elements
• Considers environmental sustainability qualitatively • Considers the environmental impact of remanufacturing, reconditioning, product assembly, product cleaning and disposal. • Design variables • Emissions • Empower/valorise local resources • Energy consumption • Environmental friendliness and efficiency in the use of raw materials • Lifecycle emissions • Raw material use • Resource depletion

• System life optimization • Transportation & distribution reduction
Social sustainability elements
• Empower/valorise local resources • Fundamental issues (e.g., child labour, health and safety, corruption, freedom of religion and opinion, among others) • Improve equity and justice about stakeholders • Influential on economics and environment (e.g., allocation of profits, physical work conditions, psychological and organizational work conditions, job satisfaction, sustainable business partners, freedom of expression)
Economic sustainability elements
• Added value for customers • Empower/valorise local resources • Energy consumption • Life cost for the company • Long-term business development • The net present value for the company • Payback period • Raw material use • System life optimization • Total cost of ownership or use • Transportation & distribution reduction
Holistic sustainability elements
• Some tools and methods do not explicitly include KPIs, but the framework includes economic, ecologic, and social aspects as one of the upper levels' evaluation points. • Map of sustainability (TBL) and efficiency. • Maps of stakeholder requirements into the three sustainability dimensions

4.4. Perspective of method or framework

The methods and frameworks analyzed were also reviewed to understand under which perspective they are designed, out of the 47 selected files, 10 of them included and considered to some extend the customer needs and requirements [6, 11, 28, 31, 40, 43, 48, 53, 56, 57], while the other 37 were mainly centered in the company as the main designer and decision maker.

4.5. Usability, usefulness, and functionality

Measurement of a method/framework success is an important element of the approach followed in this review, given that they are typically refined until stable and further tested in wider environments [59]. Method/framework success was judged in response to a set of criteria: usability, usefulness, and functionality, see Figure 4. Usability indicates whether the process was easy to implement. Functionality describes whether the process does what it was designed to do. Usefulness was evaluated by looking at organizational impact.

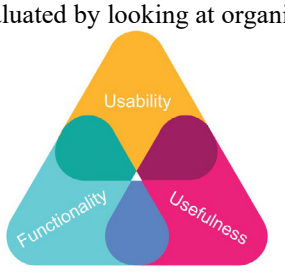

Fig. 4. Elements analyzed for method or framework success

Regarding **functionality**, some outcomes of the frameworks included that:

- the amount of feedback and data dictates the functionality of the framework [29], as well as the source of the data which could vary between stakeholders [24, 60].
- the use of frameworks has supported to sell the value of sustainability to technology developers [55], particularly if the concerns are translated into technical attributes [43, 56].
- Frameworks and methods support and clarify the impact of the different stages on sustainability [17, 33].
- Frameworks provide a way of better communicating value perspective between the different stakeholders [8, 25]. Visualization of potential for new solutions [50] and scenarios [22] could be created.
- Support organizing ideas in a collaborative manner shortened the time of their products to market [35].
- The integration of services in methods and frameworks could enable to support better EOL strategies [39].
- A reflection from the authors included that following up a project to see if the ideas created are actually implemented and record their impact could help understand the actual functionality of the tool [23].

From the perspective of **usability**:

- Frameworks designed for business-to-business require re-work and re-design to translate them into a business-to-consumer environment [29].
- Value functions and control was quick and intuitive for the user [55].
- A major challenge was to connect the different perspectives of value within the stakeholders [17].
- Visualizations played an important role; clearer visuals could support the usability of the tool [21].
- Users require familiarization with the elements that it includes [33].
- Some authors reflected on the potential of developing a software that supports visualization in frameworks [35, 36], or computerized tool support [19, 44].
- From those frameworks and methods that somehow integrated TRIZ, they suggest that it requires significant adaptation of the methodology from a pure engineering context to one which is service driven [58].

When regarding **usefulness**:

- Some frameworks have the potential to contribute but are limited by the generic approach [44], requiring more specific and explicit descriptions to achieve better results [8, 19, 20, 49, 54], along with other simplification of processes and algorithms [52].
- Some authors suggest the use of KPIs (a more quantitative approach) [27, 34] to show contribution to the SDG goals [8].
- Positive comments were noticed from frameworks that attempted to integrate the customer and the company to identify potential value [28, 57].

- It could be useful to include the effects of technology advancement [23], market competition, operating conditions, and logistics on the life cycle performance fitness, costs, and environmental impacts of product-service configurations [36].
- From the perspective of service design, one of the authors claimed that the used infrastructure enables a better exchange of information and knowledge among different substages of the service network [39].
- In general, further validation was suggested to ensure that decision makers relate to the framework [43, 48].

5. Discussions and conclusions

The last decades have proven to be challenging for many organizations. Companies find themselves in need to find sources of sustainable value and achieve competitive advantage to stay in the market. There are increasing pressures and incentives to include sustainability in their strategies such as regulations, company social responsibility indexes, sustainability reporting and consumer demands. Although researchers and practitioners continuously propose efforts to do this in a methodological way, there is still room for systematization of concepts and methodologies.

Therefore, this paper aimed to clarify existing terminologies and frameworks that develop and support service-based business models while contributing to avoid the sustainability paradox of servitization. To do so, this study explored in a systematic way the state of the art in the sustainability aspect of servitization by analyzing it through a conceptual framework.

The main findings of this article include the understanding that there are still many definitions of servitization or PSS. These concepts are not understood equally by all authors and contributions. Specifically, some include sustainability, and some do not.

Also, the review showed a significant number of methods and frameworks that focus on Beginning-of-Life or design stages. This could mean that there is a gap in the lack of methods that focus on middle and End-of-Life. This could be justified by the many claims which argue that design is the lifecycle stage with the most potential influence. However, existing products in the market, products in use and those approaching End-of-Life need strategies to avoid increasing environmental consequences.

Additionally, the inclusion of sustainability KPIs in the framework or method are thought to be relevant to successfully embed this principle in business development. However, the extension of inclusion of KPIs in the framework was varied, many of them had a generic and more simple approach which shows in further comments from the authors.

This review also identified that most of the articles proposed methods and frameworks from the company's perspective. This could mean that there is room to integrate the user in a bigger extend, as well as other stakeholders.

Through the analysis of applicability, usability and functionality of the methods or frameworks, this study attempted to visualize the currently available methods and frameworks. Based on the findings of this literature study, it could be assumed that there is still room for new methods and frameworks with a better balance between quantitative and qualitative integration, digital support, more specific descriptions, increased involvement of KPIs, consideration of external factors, and extensive validation in different industrial sectors. Future research could develop based on the observations from the existing methods and frameworks to develop tools that enable servitization in a sustainable manner.

The findings of this paper aim to guide decision makers, organizations, and researchers by consolidating and unifying various concepts and methodologies around service-based business models and servitization, while highlighting the elements that contribute to sustainability.

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