

7th Industrial Product-Service Systems Conference - PSS, industry transformation for sustainability and business

## Bibliometric Analysis of the Product-Service System Research Field

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### Abstract

The interest for the product-service system (PSS) approach has increased substantially in the last decade. New born research fields such as the PSS require the understanding of their knowledge structure as well as of their evolving structure of research collaborations. In this sense, the research field is better explained, supporting the alignment among new studies and an improved performance in the knowledge building. There are already papers in the literature that addressed the state-of-the-art in PSS, providing important guidance. However, they have not still focused on quantitative metrics, which are capable of providing a supplementary perspective. Therefore, this study aims at developing a bibliometric analysis of the PSS research field, looking for its current situation and possible evolution in terms of knowledge creation, collaboration networks and geographical distribution. A sample of 118 PSS papers published from 2002 to 2013 was collected in the Web of Science Database. Vantage Point, UCINET and NetDraw software was used to perform the bibliometric analysis. The results show a huge increase of the research field after 2011 and a balanced distribution of papers among authors. Europe and Asia are assigned to the majority of studies, showing strong collaboration networks among their institutions. Furthermore, journals with the highest number of PSS papers and the most cited papers are identified as well as the predominant knowledge topics addressed within the period. This study provides a holistic view of the PSS research field. It provides metrics regarding publications, which are useful for new entrants to identify the state-of-the-art and to understand their possible contributions to the research field. In addition, the investigation of collaboration networks shows the research groups in activity, highlighting opportunities for new collaborations and supporting the development of scientific policies. Finally, this study adopts quantitative metrics that can be reused for other studies in the future to update the status of the PSS research field or to perform similar analysis for other fields.

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Peer-review under responsibility of the International Scientific Committee of the 7th Industrial Product-Service Systems Conference - PSS, industry transformation for sustainability and business

*Keywords:* product-service system; bibliometric analysis; network analysis; literature review

### 1. Introduction

The product-service system (PSS) has emerged as one of the most important business options for the future of the industrial organizations. PSS consists of a new business concept in which organizations shift their focus from delivering physical products to solutions combining physical products with services that are capable of fulfilling customers' needs and reducing environmental impact [1, 2].

PSS studies include subjects related to servitization and service-dominant logic. These terms consider an important trend of modern economy, related to the predominance of

service organizations in developed countries [3]. This fact has motivated producers of physical goods to look for opportunities of aggregating services to their products. As a result of the potential advantages of employing PSS, the interest in using it has grown quickly among practitioners and academics.

PSS as such can be considered a new research field. The first scientific paper dealing with PSS indexed in the Web of Science database was published in 2002, in spite of the existence of PSS publications dated before this year, which were not indexed in this important scientific repository. Since then, many papers have been published, contributing to the

growth of the PSS body of knowledge. However, as a new research field, it requires an in depth analysis of the state-of-the-art, aiming at clarifying what has been already investigated and what will need further investigation to support a systematic development of new knowledge. Furthermore, research centers and collaboration networks are also in formation, once new researchers are entering the area and selecting their topics of interest and potential partners.

There are already literature reviews that provided important guidance about fundamental concepts, research lines and requirements for future research. Tukker and Tischner [4] drew attention to the importance of improving the scientific rigor in terms of revisiting existing theories related to PSS field, such as business management and research method. Baines et al [5] developed a comprehensive analysis of the state-of-the-art in PSS and provided a list of findings. For example, they also stated that the existent PSS methodologies are largely founded on conventional processes, lacking the development required to introduce a complete product-service system. Lightfoot et al. [6] identified the main research communities dealing with PSS theories and described their main characteristics and contributions. Beuren et al [7] proposed an update of the Baines et al. [5]'s study by including publications from 2006 to 2010. As a result, they reinforced the importance of addressing stakeholders, property transfer, analysis of consumer behaviour and of providing service experience based on the research presented by Geum and Park [8]. Boehm and Thomas [9] conducted a systematic literature review focused on three knowledge fields which have been contributed with PSS theories: information system, business management and engineering and design. These authors claimed that although there were literature reviews on PSS, they were not clear and systematic, undertaking qualitative approaches in most of times. Demirkan et al. [10] argue about the relationship between the business and technological aspects, which seems relevant for the PSS field.

Based on the aforementioned papers, this study identified an opportunity to investigate PSS using quantitative metrics, which are capable of providing a supplementary perspective of the evolution of the research field over the last years. Therefore, this study aims at developing a bibliometric analysis of the PSS research field, looking for its current situation and possible evolution in terms of knowledge creation, collaboration networks and geographical distribution.

## 2. Methodology

A systematic literature review provides an understanding of the current knowledge based on scientific publications, leading to the identification and description of the state-of-the-art about a selected subject as well as underpinning the proposal and development of new researches [11, 12]. Bibliometric analyses are often conducted as an essential part of systematic review, since they clarify information concerning the progress of knowledge creation based on quantitative metrics of scientific production. The implementation of bibliometric analyses are linked to the current potential of scientific databases, whose technological

advance have permitted registering and controlling of worldwide scientific production.

The source of information chosen for this study was the ISI Web of Science. This scientific database embraces the core academic journals related to the subject of interest, and it also has a thorough and structured description of its indexed papers, which is essential to perform bibliometric analyses. The search conducted in Web of Science covered papers published from 2002 to 2013 whose title or abstract included the following keywords: "product service system" or "servitization". As a result of this search string, 131 papers were identified. It should be noted that conference papers were not considered in this study.

Once the sample of 131 papers was established, the first step of the review process consisted of checking in the title and abstract whether the papers in the sample were in fact about product-service system. This verification was performed through a double-check process involving two researches. At the end, 13 papers were removed, resulting in a final sample of 118 journal papers concerning product-service system. It is noteworthy that this number is superior, considering only the Web of Science database, to those presented by other works, especially Beuren et al [7]. This might be explained by the date of data collection or by the terms used in the search or by the combination of terms employed. It is impossible to present the full list (appendix) with these articles due the page limitation.

The next step of the study was applying the bibliometric analysis. To this end, the VantagePoint bibliometric software was employed. It is a tool that supports a comprehensive and effective compilation of papers' metadata, generating data required for histograms, charts and network analyses. When network analyses were required, UCINET software was used to compile network data and NetDraw software used to plot network charts. The following analyses were performed in this study: number of papers per year, number of papers per author, number of papers per institution, number of papers per journals, the most used keywords, the most cited papers and the most cited references. In addition, the following networks were built: co-authorship network, institutional network, keywords network and co-citation network. The main function of these networks is checking the relationship characteristics among interconnected groups. For example, central nodes in a co-citation network indicates papers often used as reference in a research field. It should be noted that thresholds were applied in the development of these analyses and networks in order to assure that essential information could be properly presented. Finally, results provided were interpreted and underpinned the description of knowledge creation, knowledge distribution and research collaboration for the product-service system field.

## 3. Bibliometric Results

### 3.1. Number of papers per year

Fig. 1 illustrates the distribution of the 118 papers over the years. It can be noted that the first paper about product-service system indexed in the Web of Science occurred in 2002. Then,

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