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## THE CONCEPT OF PRODUCTS AND SERVICES INTEGRATION – ANALYSIS OF SCIENTIFIC PUBLICATIONS

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**Abstract.** Currently, global economy tends to turn into *functional* economy what triggered the birth of new terms and research fields such as integration of products and services (in literature termed: Product-Service Systems). Though the subject is often discussed in scientific and academic publications, there are still many aspects of developing and delivering integrated solutions to customers insufficiently explored or even neglected. The paper presents the concept of an integrated product-service solution. The analysis of publications in terms of research topics connected with Product-Service Systems was carried out and the achieved results were discussed.

**Keywords:** product-service systems, integrated product-service offerings, literature review, term co-occurrence/bibliometric analysis.

**JEL Classification:** L10, L21, L80, O14.

### 1. Introduction

The current global economy tends to turn into *functional economy* or *service-based* economy and the process of the industry sector *servicization* can be observed as well. The development of a *Service-based Economy* triggered the birth of new terms and research fields. One of them is a Product-Service System as a solution of selling products and services as integrated offerings. The term joins three notions: “product”, “service” and a “system”, thus, first and foremost, it is crucial to define them, to fully understand the idea of its integration into one solution. Goedkoop *et al.* (1999) proposes the following approach: if a product is a tangible good which is manufactured to be sold; a service means an activity which is done (by a human or automated system) to gain an economic profit, and a system is a collection of elements including relations between them, the integrated solution, i.e. “product-service system (PSS)” can be define as a set of products and services that are sold on the market and can jointly fulfil customer needs. This definition was the first one that appeared in the literature, although the idea of mix offerings had existed on the market place already for some time. The subject

is relatively novel and still widely discussed in academic publications. The analysis of scientific literature published in recent years has been carried out in terms of problems discussed and research fields connected with service-oriented solutions as well as the identification of top ten cited papers and authors that specialized in this field. The results of such analysis may be helpful to identify needs for future research or gaps to be filled in this area. The study was based on the collections of following databases: Web of Science (WoS), Scopus, Emerald Insight and Springer. This choice was determined by the databases accessibility for the author.

## **2. The concept of product and service integration**

The idea of combining a product and service in one offering is not new (car rental or apartment hiring), but they were usually separately planned, designed and developed. An integrated approach to this kind of offerings emerged when the concept of perceiving it as a system solution first was introduced in the literature. The easiest and most common way to deliver a mix of products and services is to offer product-oriented (e.g. after-sales) services. The Product-Service System approach, however, goes further and combines a product with services, which create significant added value for the customer, are sold inseparably with the product, and are basically a main source of manufacturer's profit. Services and products become joined in packages with various shares, which depends on the needs of an industry or sector. At the same time it is essential that the outcomes or benefits of a PSS are manifold (e.g. cost effectiveness, sustainable use of resources or less environmental burden) and not less important than the key benefit of PSS – which is the creation of value for the customer (Durugbo *et al.* 2010). The PSS concept concurs with the idea of sustainable economic growth due to its capability to more effective use of resources, and its potential to decrease the consumption of material goods (Goedkoop *et al.* 1999). In the literature many definitions of integrated solution of products and services were proposed. Table 1 contains few definitions of PSS proposed both in scientific publication and doctoral theses, as a result of a comprehensive analysis of the new research field.

Not only is there a lack of one valid definition of this kind of solution but also there is a lot of different points of view on naming it in the literature (product/service systems, product service-system, product-service system, product-service offering or simply integrated offerings).

The basis of product-service offering may be a service (e.g. the health care or restaurant service) and a product sale (e.g. electric cables) or manufacturing (aerospace spares and engines), which are then transformed into offering that integrates both – a product and a service – into a system solution. The examples of such solutions are presented in the Table 2.

Table 1. Definitions of a product-service system (source: own elaboration)

Author	Definition
Goedkoop <i>et al.</i> (1999)	“A marketable set of products and services capable of jointly fulfilling a user’s need.”
Mont (2002)	“A system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models.”
Manzini, Vezzoli (2003)	“An innovation strategy, shifting the business focus from designing (and selling) physical products only, to designing (and selling) a system of products and services which are jointly capable of fulfilling specific client demands.”
Baines <i>et al.</i> (2007)	“An integrated product and service offering that delivers value in use.”
Tan (2010)	“A system of integrated products and services that companies develop and deliver in order to fulfil a need with their customer.”
Ostaeyen (2014)	“An integrated offering of products and services with a revenue mechanism that is based on selling availability, usage or performance.”

Table 2. Product-service system solutions across industry sectors (source: based on Durugbo *et al.* 2010)

Industry	Product-Service System solution	Reference
Basic materials	Improved processes in acquiring value from the use of chemicals which derives from cost savings	(Tukker, Tischner 2006)
Consumer goods	Convenient transportation Organic vegetables subscription system Educational items and toys library	(Rexfelt, Ornas 2009) (Manzini <i>et al.</i> 2002) ( <i>ibid.</i> )
Consumer services	Improved feeding and health	(Evans <i>et al.</i> 2007)
Health Care	Improved health care	(Ajai <i>et al.</i> 2009)
Industrials	Availability of equipment Remote monitoring and control management of equipment Better work experience by i.e. workspace planning, leasing, ergonomic trainings, reparations, refurbishment Extended range of services along the value chain from milk production to filling the final product	(Erkoyuncu <i>et al.</i> 2009) (after Thurston 2013 in: Kozłowska 2015) (Tan <i>et al.</i> 2007) (Meier <i>et al.</i> 2010)
Oil and gas	Convenient oil and gas availability and delivery	(Neely 2009)
Telecommunication/ Technology	New business configuration to meet customer needs	(Wirtz 2001)
Utilities	Reduction in material use and waste generation	(Tasaki <i>et al.</i> 2006)

It is noteworthy that in the literature the application of the integration of services into company's offer is most common the industry of machinery and equipment (in other words the investment goods sector). Undoubtedly, in this sector, where companies were focused on the product and experienced in its design, development and sale, it is very challenging to include services into company strategy. Such change impacts organization at many levels – from operational, through technical or technological, to even human level. Table 3 summarizes the differences between selling products and selling performance (which in fact the service provision becomes) and this way the fundamental shifts for the manufacturer to become a service provider are defined (Tan 2010).

Table 3. The differences between selling a product and selling a performance (source: Tan 2010)

Sale of a product (industrial economy)	Sale of a performance/result (service economy)
The object of the sale is a product.	The object of the sale is a performance/ customer satisfaction/result.
The seller is liable for the manufacturing quality (defects).	The seller is liable for the quality of the performance (usefulness).
Payment is due for and at the transfer of the property rights (an “as-is, where-is” principle).	Payment is due pro rata if and when the performance is delivered (a “no fun, no money” principle).
The work can be produced centrally or globally (production); product can be stored, re-sold, exchanged.	The work has to be product in situ (service), around a clock, no storage or exchange is possible.
Property rights and liability are transferred to the buyer.	Property rights and liability remain with the fleet manager.
Advantages for the buyer: – Right to a possible increase in value; – Status value as when buying performance.	Advantages for the user: – High flexibility in utilisation; – Little knowledge necessary; – Cost guarantee per unit of performance; – Zero risk; – Status symbol as when buying product.
Disadvantages for the buyer: – Zero flexibility in utilization; – Own knowledge necessary (e.g. driver's license); – No cost guarantee; – Full risk for operation and disposal.	Disadvantages for the user: – No right to a possible increase in value.
Marketing strategy = publicity, sponsoring	Marketing strategy = customer service

### **3. The analysis of publications related to PSS**

#### **3.1. Methodology of the study**

For the purposes of this analysis, following steps were undertaken. As a first step, search for publications on products and services integration were conducted in four scientific databases: Web of Science (2015), Scopus (2015), Emerald Insight (2015) and Springer (2015). This choice was determined by the databases accessibility for the author. As the Product-Service System notion is considered as a basic idea in this research field (Durgbo 2013), therefore this term was used to investigate into publications on the subject matter. Next, a literature review was carried out based on papers found in the mentioned above databases. The Scopus and Web of Science searching results were, subsequently, analysed with the usage of VOSViewer application to examine the co-occurrence of terms in articles that were found in the searching process, and maps of co-occurrence has been created. Finally, a bibliometric analysis (number of publications per year, top ten authors in terms of the articles number, top ten articles in terms of citation) was carried out and its findings has been discussed at the end of this article.

#### **3.2. The research topics analysis**

In the literature many aspects of the integrated product-services solution has been proposed or researched. As a result of the search in the Scopus database, using the PSS term as a searching phrase and with the limitation of a publish date between 2001 and 2015, 1984 matches has been found. Within the results, the PSS shortcut was applied to refine the searching outcomes and 593 articles were selected this way. Then, the text file, collecting the summary of the searching results – articles titles, abstracts and source information – has been exported, and a term co-occurrence map based on a text corpus has been created with the usage of VOSViewer software (Fig. 1). Terms (words) have been extracted from the field: Title and abstract, and the minimum number of occurrence of a term was set to 3. With this settings 40 terms met threshold. The circle on the map represent the item (the term that was found more than 3 times in the analysed file). The bigger the circle, the higher the term occurrence score. The items are clustered in groups of one colour on the basis of an occurrence score, where colours range from blue (low score), through green (average score), to red (high score). Furthermore, the closer the circles are, the more often terms co-occurrence, and the thicker the line connecting them – the more significant the weight of co-occurrence. Hence, it can be noticed that items like: product, service, system, study, approach, result, method, industry, development or research occurred most frequently in analysed papers. On the other hand, words: value, model, use, customer and stakeholder or demand belong to one cluster (green colour) – what means they appeared in close neighbourhood (one paper) more often than with other terms, and have an average occurrence score.



What is noticeable that the Web of Science database collection appears to be more coherent and precise – there is much more publication on PSS in general, and also the red cluster, which present the highest score of terms occurrence, is more directly related to the PSS notion. The number of papers found is much higher than in Scopus, thus it means that the WoS collection is more comprehensive in terms of researched topics. The words that appeared most frequently in a close neighbourhood with PSS are: provider, offering, prototype, effectiveness, design process, maintenance, customer requirement, conceptual design, service element, new concept, delivery, ips2 – so the papers in WoS seem to be more specific and precisely connected with studied topic.

In the next step of this study, the search of publications was conducted in following databases: Web of Science, Scopus, Elsevier, Springer and Wiley, using the terms: “product-service system”, “servicization” and “product service integration” as a searching phrase. In this way the main study topics connected with PSS were identify manually. To each topic only few exemplary references are given in the Table 4, however, the number of references informs likewise about the overall number of publication that was found on each topic.

Table 4. Different aspects of PSS discussed in scientific publications (Source: own elaboration)

Classification	(Tukker 2004; Gaiardelli <i>et al.</i> 2014)
Cost estimation	(Roy, Erkoyuncu 2011)
Delivery	(Morlock <i>et al.</i> 2014)
Designing	(Aurich <i>et al.</i> 2008; Geum, Park 2011; Maussang <i>et al.</i> 2007)
Evaluation method for designing	(Yoon <i>et al.</i> 2012)
Development	(Tan <i>et al.</i> 2007; Tan 2010; Boughnim, Yannou 2005; Morelli 2006)
Engineering	(Pezzotta <i>et al.</i> 2012; Cavalieri, Pezzotta 2012)
Integrated knowledge management	(Dongmin <i>et al.</i> 2012)
Planning	(Steven, Richter 2010)
Quality assessment	(Waltemode <i>et al.</i> 2012)
Requirement analysis	(Durugbo 2013)
Review papers	(Mont, Tukker 2006; Reim <i>et al.</i> 2015; Oliveira <i>et al.</i> 2015; Baines <i>et al.</i> 2007; Beuren <i>et al.</i> 2013)
Sustainability	(Maxwell <i>et al.</i> 2006; Vezzolli <i>et al.</i> 2014)
Validation	(Exner <i>et al.</i> 2014)
Classification	(Tukker 2004; Gaiardelli <i>et al.</i> 2014)
Cost estimation	(Roy, Erkoyuncu 2011)

On the basis of these findings the yet unexplored topics can be determined as well as future challenges and, most of all, needs. But also, the authors experienced in specific area of research may be identified. In the matter of gaps that emerge from the conducted study, one can conclude that there are numerous fields that are still neglected and insufficiently explored e.g. planning and designing of product-service system solution in respect to different types of PSS, strategic analysis at the earliest stages of integration services into company’s strategy, tools and methods for testing and validation of developed PSS solutions or, likewise, a practical aspects of realization and developing of such solutions, and customer behavior and experiences with PSS.

### 3.3. Bibliometric analysis of the publications on Product-Service System

Four databases were searched for publications on PSS to assess the popularity of the research field. The choice of database was determined by the accessibility to the author. Figure 3 presents the publications number between 2001 and 2015. The augmented number of papers published in last five years can be noticed, therefore this topic is somewhat relevant and up-to-date. The Springer database collects the highest number of papers about PSS, it should be noticed however that although some authors suggest that it is enough to analyse the Scopus database (Reim *et al.* 2015) or Web of Science database (Oliveira *et al.* 2015) there is a significant difference between the results of the search in each databases. As the same phrases were used during the search, one can conclude that the collection gathered in each databases rather complement than duplicate each other.

In the next step, the author’s goal was to identify the researchers with a significant contribution into PSS research fields, therefore the top ten authors were identify in the Scopus database (the only one that enable to filter the search result in terms of the papers authorship), and they are as follows: Shimomura (29 papers), Meier (16 papers), Sakao (16 papers), Chu (15), Jiang (15), Kimita (15), Roy (15), Durugbo (14), Krcmar (13) and Akasaka (12).

Lastly, the list of top ten articles published between 2001 and 2015 with the highest citation number were generated on the basis of the Web of Science and Scopus searching results and are gathered in the Table 5 and Table 6.

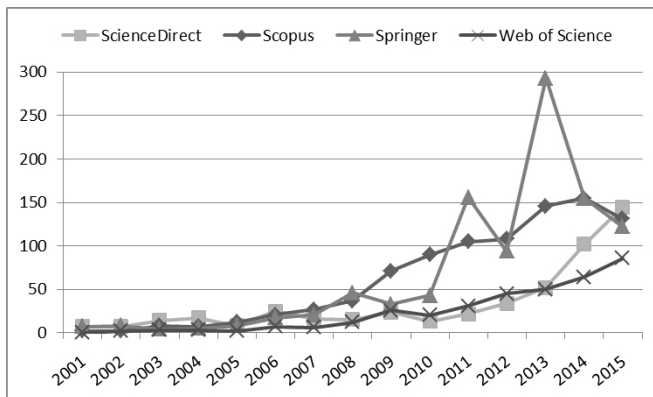


Fig. 3. Number of publications in different databases per year (source: own elaboration)



Table 5. Top ten cited articles at the Scopus database (source: own elaboration)

Article	Times cited
“State-of-the-art in product-service systems” (Baines <i>et al.</i> 2007)	268
“Industrial Product-Service Systems – IPS <sup>2</sup> ” (Meier <i>et al.</i> 2010)	182
“Life cycle oriented design of technical Product-Service Systems” (Aurich <i>et al.</i> 2008)	142
“Review of sustainability terms and their definitions” (Glavic, Lukman 2007)	103
“Service, services and products: rethinking operations strategy” (Spring, Araujo 2009)	73
“Services, products, and the institutional structure of production” (Araujo, Spring 2006)	68
“The transfer and application of Product Service Systems: from academia to UK manufacturing firms” (Cook <i>et al.</i> 2006)	67
“Towards an operations strategy for product-centric servitization” (Baines <i>et al.</i> 2009)	66
“Does the potential of the use of LCA match the design team needs?” (Millet <i>et al.</i> 2007)	62
“Mindful consumption: a customer-centric approach to sustainability” (Sheth <i>et al.</i> 2011)	61

Table 6. Top ten cited articles at the Web of Science database (source: own elaboration)

Article	Times cited
“Clarifying the concept of product-service system” (Mont 2002)	473
“State-of-the-art in product-service systems” (Baines <i>et al.</i> 2007)	469
“Industrial Product-Service Systems – IPS <sup>2</sup> ” (Meier <i>et al.</i> 2010)	239
“Product-services as a research field: past, present and future. Reflections from a decade of research” (Tukker, Tischner 2006)	176
“A strategic design approach to develop sustainable product service systems: Examples taken from the ‘environmentally friendly innovation’ Italian prize” (Manzini, Vezzoli 2003)	168
“Developing new product service systems (PSS): methodologies and operational tools” (Morelli 2006)	128
“The transfer and application of Product Service Systems: from academia to UK manufacturing firms” (Cook <i>et al.</i> 2006)	87
“Functional and systems aspects of the sustainable product and service development approach for industry” (Maxwell <i>et al.</i> 2006)	78
“Product service systems in the automobile industry: contribution to system innovation?” (Williams 2007)	75
“Institutionalisation of sustainable consumption patterns based on shared use” (Mont 2004)	73

#### **4. Discussion and limitation**

The results of the above presented analysis provide basics in the subject of products and services integration. It is also a source of knowledge of different aspects of this solution that has been already investigated into by different researchers. The study reveals that the issues like: designing, planning, delivery or engineering of PSS has been quite often raised in scientific publications. The industrial application of integrated offerings is also one of the most commonly presented in the literature. However, there are issues that has not been studied yet, e.g. assessment tools for PSS, the study of customer behavior and experiences with PSS, and also the strategic analysis issues at the earliest stages of integration services into manufacturing company's strategy.

The obvious limitation of the study is the capability of the software used to examine the occurrence and relations of the terms connected with the Product-Service System concept. VOSViewer enables to develop the co-occurrence map on the basis of files exported from two academic databases only: the Scopus and the Web of Science. Though these are one of the largest and most popular repositories of scientific papers published worldwide, they definitely collect only part of all of the publications. Furthermore, they must be analysed separately (to aggregate data from different databases previously data processing is needed, with the use of another software e.g. Pajek). However, it can be noticed that the map created on the basis of Scopus resources differs from the Web of Science map, thus analyses conducted on both may be considered as complementary to each other.

The other constraint is the database choice, which was determined by the accessibility of the scientific databases for the author, and the range of databases tools for bibliometric study (only the WoS and Scopus enable to gain the information about citation number). The detailed analysis of publications was done by author itself therefore it may be influenced by the personal judgment on the importance or adequacy of a particular publication to the studied topic. However, the author believes that the outcomes of the analysis can be a valuable source of knowledge for assessing the potential of PSS as a research area and may also be useful for those who are looking for basic information on the integrated products and services solution.

#### **5. Conclusions**

The changes in global economy establish new challenges to all market players and researchers and create business and scientific opportunities as well. The idea of integration products and services into one offering, which applies a system approach as a key feature, is one of them. The result of analysis presented in the paper reveals that despite of many topic raised in scientific literature and high popularity of the topic in last decades, there are still many unanswered question and insufficiently explored fields, both in theory and in practice, in this area e.g. the lack of coherent tools for planning and designing of product-service system solution in respect to different types of PSS,

the lack of strategic analysis methodology at the earliest stages of integration services into manufacturing company's strategy or the lack of studies on customer behaviour and experiences with PSS. It turned out that the industrial application of PSS is most frequently discussed in scientific papers. The results of above presented analysis allowed to identify the top ten authors in regards to the publications number, and papers in terms of citation number in this research field as well.

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