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State-of-the-art of design, evaluation, and operation methodologies in product service systems

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ABSTRACT

Product service systems (PSS) – integration of products and services – with aims to achieve economic profit and reduce environmental impacts, is a hot issue in academia. The purpose of this study is to comprehend the state-of-the-art in the field of PSS design, evaluation, and operation methodologies (PSS-DEOM) by conducting a systematic literature review. Up to 258 publications related to PSS-DEOM were reviewed and divided into three categories: PSS design methodologies (PSS-DM), PSS evaluation methodologies (PSS-EM), and PSS operation methodologies (PSS-OM). Based on the findings, future research trends were proposed and discussed.

Contents

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1. Introduction

The concept of product service system (PSS), also named as "functional sales" [1], or "functional products" [2], was proposed by the United Nations Environment Program (UNEP) in the late 1990s. Its core idea is to provide solutions to customers by integration of "products" and "services", meeting customers' requirements while reducing resource consumption and environmental impact at the same time.

Under traditional manufacturing modes, manufacturers usually spare no effort to promote product sales in order to earn more money and increase their market share. They seldom pay attention to the products' end-of-life, which usually results in waste of limited resources and environmental problems. With the approaching of economic globalization and much fiercer competition, more and more manufacturers realize that the possibility of making profit by selling products is rather limited and it is hard to maintain competitive advantage. In this case, they are considering business model transformation, integrating products and services which can not only improve efficiency but also result in positive economic and environmental impacts. In service-oriented business models, the way for service providers to make money is related to their services and in this case, products turn to be a part of operating costs. Therefore, they will try their best to prolong the life of products and increase use frequency. Undoubtedly, this will reduce material flow in the economic system and improve customer satisfaction.

Up to now, many scholars [3–5] have conducted PSS review through different perspectives. To implement PSS successfully, we need to present the bottleneck of research in this field very well. With the intention to understand state-of-the-art of PSS design, evaluation, and operation methodologies (PSS-DEOM for short), we would like to address this issue by conducting a systematic literature review to demonstrate how PSS is designed, evaluated, and operated in business practices. With the aid of Scopus database, we selected 258 publications related to PSS-DEOM. After a systematic literature review, we carefully analyzed the proposed methods in PSS and discussed future research trends.

This paper is organized as follows. Section 2 deals with methodology applied in the study, including selection and analyses of references. Findings and results are listed in Section 3 through the following three categories: PSS-DM, PSS-EM, and PSS-OM. Based on this, future research trends are proposed and discussed in Section 4, and Section 5 concludes the paper.

2. Methodology

2.1. Selection of references

Tukker [5] developed a method to search PSS publications with the help of Scopus database. We adapted his method and selected references in two steps. Firstly, we searched with different terms of product service system with the aid of Scopus database, which contains abstracts and citation information of articles published in scientific journals, books, and conference proceedings, covering a wide research range from science, technology, medicine, to social science, arts and humanities. It can also track and analyze particular paper intelligently with a visual presentation of the results. Compared with Web of Science and Google Scholar, as an ideal tool for electronic literature search, Scopus includes extensive journals and topics. Initial search with "product service system" (with quotation marks to restrict searching) generated 836 documents (status on 8 May 2015). To focus on high-quality articles, documents were refined to journal articles, which produced 281 articles. Besides, we focused only on English articles for easiness of comprehension, and this resulted in 251 articles. Moreover, citations of these publications were used as an important criterion under the assumption that articles with zero or only one citation would not be influential enough to be considered. This procedure reduced the amount of articles to 183. Since the purpose of this study is to focus on PSS-DEOM, these 183 publications were double checked on the basis of titles and abstracts to determine whether they were related to PSS-DEOM or not. This produced 125 articles ultimately. Full texts of these 125 articles were downloaded for further research. Similarly, we applied other search terms such as "extended products", "servitisation", "functional sales", "hybrid offerings", "product service bundling", and "value bundle" with an intention to be all-inclusive and repeated the above searching strategies. Note that different search terms may result in similar articles. It is quite necessary to pay special attention to those duplicates and omit them. Table 1 shows initial search results and filtered articles as to different search terms. The total number of filtered articles is 139, with 76 related to PSS-DM, 19 to PSS-EM, and 44 to PSS-OM.

Tukker [5] assumed that the authors with most frequently cited papers and most PSS publications would be the leading figures in PSS research. Based on this assumption, we conducted further search by checking the publication record of the authors of top 10 papers by citation (≥55) in Scopus and top 10 authors who

Table 1
Initial search results and filtered publications for different search terms (status on 8 May, 2015).

Search term	Total publications	English journal articles	Publications (≥2 citations)	Filtered articles			
				Design	Evaluation	Operation	Sum
Product service system	836	251	183	71	18	36	125
Extended products	295	155	118	1	1	0	2
Servitization	217	66	39	0	0	7	7
Functional sales	13	4	4	2	0	0	2
Hybrid offerings	16	10	5	1	0	0	1
Product service bundling	4	2	1	0	0	1	1
Value bundle	23	8	4	1	0	0	1
Total	1404	496	354	76	19	44	139