

The 9th CIRP IPSS Conference: Circular Perspectives on Product/Service-Systems

Empirical Studies on Product-Service Systems – A Systematic Literature Review

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Abstract

The aim of this paper is to increase the understanding of empirical PSS research, and provide insights for future directions in PSS research. Based on an in-depth systematic literature review of 70 journal articles, it was found that PSS practices have been widely applied across various geographical and research areas. The majority of empirical research employed qualitative research method while large scale quantitative studies are still scarce. In addition, a large portion of product-oriented PSS studies demonstrate that PSS is still in its early development stage in terms of evolution. With regard to research themes, PSS design related studies are the focus of more than 40% studies.

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Keywords: Product-service systems; Literature review; Empirical studies

1. Introduction

The rising global population, accelerating technological development, increasing resource usage and intensifying environmental impacts make sustainability as the key issue for the entire society. With such a trend, product-service systems (PSS) have become an emerging issue in both academia and industry. As an ‘integrated bundle of products and services which aims at creating customer utility and generating value’ [1], PSS is one of the most effective instruments that moves society towards sustainability [2]. According to its evolution, the classical categorization of PSS includes product-oriented PSS, use-oriented PSS, and result-oriented PSS [3].

Since the clarifying of the PSS concept [4], PSS research have been reviewed by many scholars from different perspectives, including the establishment of key PSS domains [3], overview of the PSS design methodologies [5], contribution of knowledge production to PSS [6], and supporting framework for product-, use- and result-oriented business models [7]. PSS in different fields such as Information Systems, Business Management, and Engineering & Design [1] and special geographic area such as EU [8] have been reviewed as well. In addition, especially through

lifecycle assessment, the challenges when evaluating PSS have been identified [9]. In summary, PSS research has progressed well [2] and PSS design seems to be still in its initial stages of development [5].

Similar to other theories, the real world PSS practices are important. However, none of the existing review papers specially focused on empirical studies in PSS. As empirical studies in PSS is still limited [10], and a better understanding of the existing studies will shed light on the future direction and contribute to PSS development. Therefore, this paper aims to present a systematic literature review (LR) about empirical PSS research in the existing publications, and thus provide an overview to the development routes of PSS research.

In section 2, we will describe the search strategy and present the descriptive analysis. The detailed review results based on the categorization of product-, use-, result-oriented PSS and others will be presented in section 3, and concluded with future directions in section 4.

2. Search strategy and descriptive analysis

Considering the aim, we limited the language to English and the search strings to ‘product service system*’, ‘product-

service system*', 'empirical*', 'operation*', and 'appl*' to identify journal articles published between 1995 and 2016 using online database Scopus. The initial 357 articles were then filtered on the basis of titles and abstracts, and reduced to 70 articles. As we focus on real world empirical studies, those articles with hypothesized, exemplar, or simulated cases were not included. These 70 articles were downloaded and analyzed in terms of the research objectives, methodologies, application status and findings. As no relevant articles were found before 2006, the main body of this systematic review comprises 70 peer-reviewed journal articles published from 2006 to 2016.

Figure 1 shows the distribution of publications over year. It shows that the majority of the papers were published since 2012 or later, which accounts for about 80% of all the papers reviewed. This may be due to the well processing of PSS development and the calling for empirical research [2].

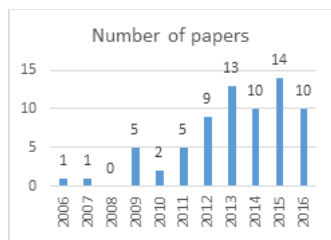


Fig.1. Distribution of publications over year

The distribution of the articles by journal shows that the empirical studies in PSS are scattered across 33 journals, which demonstrates the wide acceptance of PSS. 14 journals with at least 2 articles in our review are listed in Table 1, and cover 73% of the articles. The Journal of Cleaner Production is the leading source with 11 articles, followed by Journal of Manufacturing Technology Management, International Journal of Operations and Production Management, International Journal of Operations and Production Management, and International Journal of Production Research.

Table 1 Journals with at least two articles in the review

Journal	Number of articles
Journal of Cleaner Production	11
Journal of Manufacturing Technology Management	6
International Journal of Operations and Production Management	5
International Journal of Production Research	5
CIRP Journal of Manufacturing Science and Technology	4
Business Process Management Journal	3
Expert Systems with Applications	3
CIRP Annals - Manufacturing Technology	2
Computers in Industry	2
Journal of Intelligent Manufacturing	2
Mathematical Problems in Engineering	2
Production Planning and Control	2
Service Industries Journal	2
Sustainability	2

With regard to the methodology used, qualitative case study approach dominates with 59 articles (accounts for 84% of all the papers), followed by quantitative surveys with 6 papers. The remaining 5 papers employed a combination of both methods. In addition, single case study articles account for 64% of the case study research (38 papers). This confirms that most of the existing literature on PSS were based on case studies and application of survey or large number of cases was scarce [2, 10].

Linking to the categorization of PSS, 36 articles fall into product-oriented PSS (51%), 12 articles fall into use-oriented PSS (17%), 16 articles fall into result-oriented PSS (23%), and the remaining 6 papers are mix, or specifically indicated by the authors as service-oriented. To some extent, the results indicate PSS is still in its early stage in terms of evolution.

Based on the aims and focuses of the papers reviewed, we divided them into 7 themes (Figure 2a) as PSS design approach, approaches facilitating PSS design, PSS transformation drivers (factors and approaches that initiate the product-service transition), PSS status quo, PSS evaluation, PSS function (extension or application of PSS concept), and PSS impact (including economic, environmental, and social impacts). Articles related to PSS design account for 44% of all the articles. This is not surprising as the design of a new PSS is one of the most challenging tasks for companies due to its rare existence in the market.

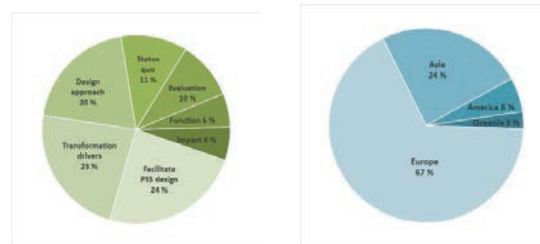


Fig. 2. Themes in the LR

Fig. 2b. Distribution of publications over area

As normally the first author organizes the research, we identified the distribution of publications over area by analyzing the first author's affiliation (Figure 2b). European studies (including UK) dominate with 47 articles (67%), followed by Asia with 17 articles (24%). America and Oceania contribute to the remaining 6 articles. It should be noted that there is only one paper first authored by a researcher in US, indicating a lack of attention to PSS practice in US. For the studies in Europe, researchers in UK, North Europe, and Germany altogether contribute to 80% of the papers. In particular, studies in UK focus more on PSS transformation drivers (8 papers, about 44% of UK studies). For the 17 articles in Asia, the top three contributors are China (7 articles, 41%), Japan (18%), and Taiwan (18%). In particular, the studies in China focus on approaches facilitate PSS design (71% of the papers in China).

3. Empirical PSS studies

3.1. Empirical product-oriented PSS studies

In this LR, 36 papers belong to product-oriented PSS, and the top three themes involved are PSS transformation drivers (12 articles, 33%), approaches facilitating PSS design (10 articles), and PSS design approach (5 articles). We will discuss the findings in detail in terms of the research themes.

Under the 'PSS transformation drivers' theme, the transfer of PSS concept from academia to industry was more likely to be completed in the firms which had already used the service type of transaction and built the requisite capability to support

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