

# Development of integrated design methodology for various types of product – service systems

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## Abstract

We propose a new generic design methodology for different types of PSS. Product – Service System (PSS) has received much attention recently from academia and industry because of its benefits. PSS can provide customers values and functionalities, as well as physical products, to fulfill economic, social and environmental goals. Many methodologies have been proposed for designing PSSs. Most of the existing methodologies are domain specific and were proposed to solve specific problems in certain projects. Some methodologies are generic but they provide neither guideline to practitioners and designers nor reflect the differences in various PSS types. As a generic approach to guide practitioners and designers in designing PSS effectively, the proposed methodology also takes into account user involvement, business model and organizational structure. The proposed methodology is demonstrated through design examples of different types of PSSs.

*Keywords:* PSS; Product service system; Design methodology; Product service integration; Integrated design methodology

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## 1. Introduction

### 1.1 Product service systems

In conventional manufacturing and production, companies sell products to customers. Today, with the economic crisis, increasing competition among manufacturing companies, growing environmental issues and various customer demands, “selling products only” is becoming more difficult [1, 24, 25]. Providing services together with products can enhance competitiveness, achieve social, environmental, and economic goals, as well as attract and retain customers [3, 4, 19]. Combining products and services is the basis of product service systems (PSS) [17].

Goedkoop et al. [7] defined PSS as “a marketable set of products and services capable of jointly fulfilling a user’s needs. The product/service ratio in this set can vary, either in terms of function fulfillment or economic value”. In this sense, PSS is directly related to functional economy [14]. With PSS, users pay for the use of the solutions not ownership [2]. This “functional thinking” of “hiring products to get jobs done” was mentioned by Bettencourt and Ulwick [3]

and was further discussed by Lim et al. [10] as well as Hussain et al. [8]. We can consider PSS as an integrated system consisting of products, services, and the infrastructure to deliver a solution to a customer to satisfy certain needs [4, 24]. Figure 1, which is adapted from Baines et al. [2], shows the difference between a purchase of a “product” and a purchase of a “PSS”.

The concept of PSS has been discussed since the 1990s. Early works greatly influenced the development of this new field were the works by Goedkoop et al. [7], Mont [14] and Morelli [15]. Research on PSS has ranged from the definition of PSS elements, generation of PSS offerings, representation of PSS, etc. to the evaluation of PSS offerings, sustainable development, design process for integrating products and services etc. [24].

PSSs were classified into types by Baines et al. [2], who merged ideas from Manzini and Vezzoli [13], Tukker [21], and Parkersell [18], as follows:

- Product oriented PSS: Company sells a product with additional services to ensure the working condition of the product. The ownership of the product is transferred to the customer. Services such as: maintenance, repair, recycling, refilling, etc. could be classified into this type.
- Use oriented PSS: Company sells the use or availability of a product not owned by the customer. Examples of this type are product leasing or sharing.

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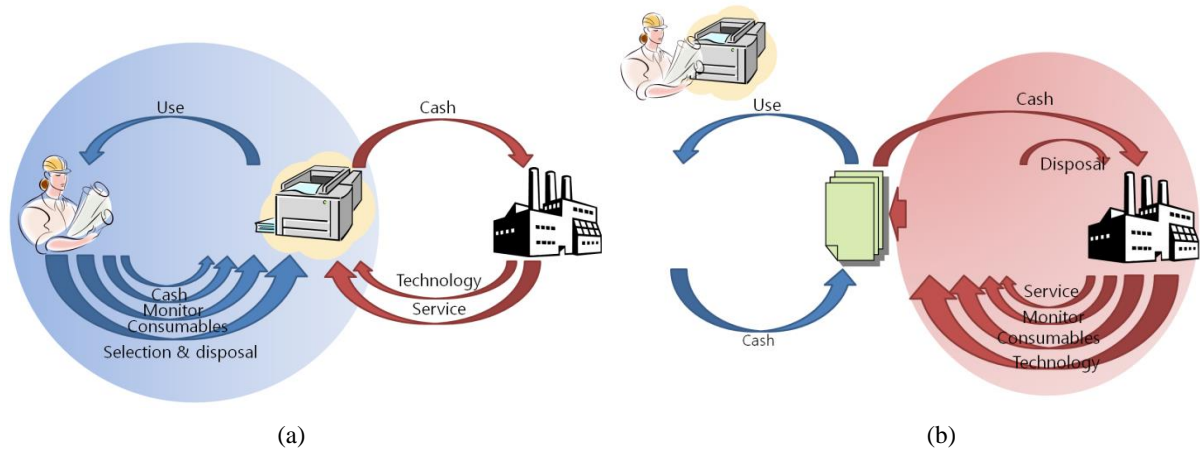


Figure 1. (a) The traditional purchase of a photocopier, (b) the purchase of document management capability.

- Result oriented PSS: Company sells a result or capability of a product not owned by the customer. For example, instead of selling paint to a customer, the company can sell the result, a painted house.

### 1.2 Benefits and challenges for the adoption of PSS

Surveys by Baines et al. [2] and Beuren et al. [4] showed the benefits of PSS to the consumer, provider, environment and society. These benefits result from the higher level of satisfaction, increased competitiveness, decreased environmental impact and materials savings. The main benefit of PSS for the company is that it pushes for continuous business improvement, quality improvement, and better company-customer relationship. Table 1, which is adapted from Beuren et al. [4], shows how the PSS benefits the consumer, provider, environment and society.

Table 1. Benefits of product service systems.

|             | PSS benefits   |
|-------------|--|
| Consumer    | Flexible and personalized service; quality and satisfaction<br>Continuous improvement of products and services   |
| Provider    | Customer loyalty and trust<br>Innovation by monitoring products in use<br>Cost and resources reduction; maximization of results; knowledge created during the development process are sold as consulting and training services; products reused in combination with several different services |
| Environment | Reduction in consumption through alternative use of product; provider responsible for the products and services through take-back, recycling, and refurbishment-reducing waste throughout the product's life; services planned according to the life cycle of the product                      |
| Society     | Public pressure on environmental issues grows<br>Increase in the supply of services; new jobs  |

Although PSS brings plenty of benefits, it is still adopted limitedly in the industry for its potentials. The major challenges in adopting PSS were suggested by Mont [14], Baines et al. [2] and Beuren et al [4]: first, consumers may not be enthusiastic about ownerless consumption; second, the manufacturer may be concerned with pricing, absorbing risks and shifting organization; and third, PSS design and development itself is a challenge. PSS is difficult to design because it is an integrated system consisting of products, services, and delivery infrastructure, and is strongly affected by stakeholders. Developing PSS requires both the involvement of many stakeholders who hold different views and the establishment of a business model and organizational structure. Still, there is no holistic and effective design methodology for PSS.

This paper aims to develop a generic PSS design methodology for different types of PSSs, practical enough to act as a guideline for designers and developers. This design methodology is constructed by analyzing the characteristic of PSS types; the design processes of products and services; stakeholder involvement; and the change in business model and organization structure. This research tackles “differences in PSS design process for various types of PSSs” and “co – creation process”, which are needed to be researched, as pointed out by Vijaykumar et al. [24].

The rest of the paper is organized as follows: Section 2 reviews relevant research, presents the limitations of existing PSS design methodologies and the purpose of this paper. Section 3 focuses on our proposed methodology and its construction process. Section 4 illustrates the proposed methodology with two design examples of PSS design and further discussions. Section 5 presents the concluding remarks and suggests future research.

## 2. Literature review

### 2.1 Methodologies for designing product service systems

Many methodologies for designing PSS are presented in the literature [2, 4, 24]. Some methodologies are case – spe-

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