HOSTED BY
ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Journal of Computational Design and Engineering 3 (2016) 112–120

www.elsevier.com/locate/jcde

Development of a novel set of criteria to select methodology for designing product service systems

Tuananh Tran, Joon Young Park*

Department of Industrial & Systems Engineering, Dongguk University, Seoul, Republic of Korea

Received 8 October 2015; accepted 12 October 2015
Available online 22 October 2015

Abstract

This paper proposes eight groups of twenty nine scoring criteria that can help designers and practitioners to compare and select an appropriate methodology for a certain problem in designing product service system (PSS). PSS has been researched for more than a decade and is now becoming more and more popular in academia as well as industry. Despite that fact, the adoption of PSS is still limited for its potential. One of the main reasons is that designing PSS itself is a challenge. Designers and developers face difficulties in choosing appropriate PSS design methodologies for their projects so that they can design effective PSS offerings. By proposing eight groups of twenty nine scoring criteria, this paper enables a "step by step" process to identify the most appropriate design methodology for a company's PSS problem. An example is also introduced to illustrate the use of the proposed scoring criteria and provide a clear picture of how different design methodologies can be utilized at their best in terms of application.

Keywords: Product service system; PSS; PSS application; PSS design methodology selection

1. Introduction

1.1. Product service system

Product service system (PSS) forms a special case in servitization [36] where a company provides its customers with an offering including physical product and non-physical service. This new concept of providing PSS offering is different from selling product only which is becoming more and more difficult to compete, especially in today's scenario of economic crisis, growing environmental issues and diversified customer demands [37,5,36]. As mentioned in literature, the introduction of PSS can help companies to enhance competitiveness, achieve social, environmental, and economic goals, as well as attract and retain customers [7,28,27,8].

Formally, PSS is defined by many authors, including Goedkoop et al. [10]. In this work, PSS was defined 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". This definition makes the concept of PSS close to functional economy [22] where customers pay for the "function" or the "use" of the solutions, not for the physical products. PSS concept also matches with the thinking of "hiring products to get jobs done" which was mentioned by Bettencourt and Ulwick [7] and was further discussed by Lim et al. [17] and Hussain et al. [12].

Some researchers suggested that PSS could be considered as an integrated system which consists of products, services, and the infrastructure to deliver a solution to a customer to satisfy certain needs [28,27,36]. An example of PSS is the "document management solution" which is discussed in the work of Baines et al. [6]. Conventionally, a customer would buy a physical product which is a photocopier. With the "PSS model", the customer will only "buy" the capability of

*Corresponding author.
E-mail addresses: meslab.org@gmail.com (T. Tran), jypark@dgu.edu (J.Y. Park).
Peer review under responsibility of Society of CAD/CAM Engineers.

http://dx.doi.org/10.1016/j.jcde.2015.10.001

document management and leave the rest of the work (refill, maintenance, replace parts, etc.) to the manufacturer.

Early works on PSS related topics were carried out more than a decade ago with pioneer researchers such as: Goedkoop et al. [10], Mont [22] and Morelli [24]. As summarized by Vasantha et al. [36], 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.

Tukker [34] classified PSS into 3 types 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.
- 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 of PSS and challenges for adoption of PSS in industry

Surveys by Baines et al. [6] and Beuren et al. [8] 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. [8], shows how the PSS benefits the consumer, provider, environment and society. In this sense, PSS is closely related to sustainable development and green technology.

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 [22], Baines et al. [6] and Beuren et al. [8]: 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. Designers and developers need an appropriate design methodology to deal with each design project. There are several design methodologies available in literature but none of them is holistic to work with a wide range of PSS problems and there is a lack of analysis and guidance of possible applications for each methodology.

Table 1
Benefits of product service systems

PSS benefits
Consumer
Flexible and personalized service; quality and satisfaction; Continuous improvement of products and services
Provider
Customer loyalty and trust; Innovation by monitoring products in use 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's 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; Increase in the supply of services; new jobs

2. Literature review

Many methodologies for designing PSS are presented in the literature [36,17,8]. Some methodologies are case-specific, meaning that they are tailored for specific projects, including the ones proposed by Luiten et al. [18], Manzini and Vezolli [19], and Morelli [23,24], etc. These are not generic for a broad range of cases.

Other methodologies are suitable for designing of a broad range of PSSs. Vasantha et al. [36] summarized eight methodologies in the literature that have been detailed, applied, and demonstrated with industrial examples. These methodologies can be applied in complex PSS development influenced by many factors. Table 2 provides the brief description of those eight methodologies. Details of eight methodologies are provided in the work of Vasantha et al. [36].

Vasantha et al. [36] also pointed out major limitations of these PSS design methodologies due to which, none of the methodologies can solve PSS design problems comprehensively. Selection of appropriate methodology for a specific PSS problem is an essential part of PSS implementation. Designers and practitioners need tools and guidelines that can support the selection of the most appropriate methodology for their PSS design problems. One of the well known generic selection tools which is called Decision Matrix can be found in literature [35]. This tool supports the selection of the most appropriate item out of a "collection" through comparing items with one another by scoring them along various criteria with various levels of priority. So far, none of such scoring criteria is available.

By analyzing existing literature on PSS design and development with regards of the perspective of practitioners, this paper aims to propose a new set of scoring criteria which enables a step by step selection process of the most appropriate design methodology using Decision Matrix. This supports