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Product-Service Systems across Life Cycle

Comparing PSS design models based on content analysis

Caio Augusto Nunes Marques[a]*, Glauco Henrique de Sousa Mendes[b], Maicon Gouvêa de Oliveira[c]; Henrique Rozenfeld[a]

[a]São Carlos School of Engineering at the University of São Paulo, Av. Trabalhador São Carlense 400,Postcode 13566-590; São Carlos, Brazil
[b]Production Engineering Department, Federal University of São CarlosRod. Washington Luís, km 235, 13565-905, São Carlos, SP, Brasil
[c]Institute of Science and Technology, Federal University of Alfenas, Rod. Jose Aurelio Vilela, n°11.999, 37715-400, Poços de Caldas, MG, Brazil.

* Corresponding author. Tel.: "+55 (16) 33739433" . *E-mail address:* caiomarques@usp.br

Abstract

The combination of products and services in an integrated offer that delivers value through the provision of a required function is recognized as an important strategy for competitiveness and environmental perspectives. Despite its benefits, the design of a Product-Service System (PSS) is considered more challenging than the design of pure products and services. There are proposals of generic models of PSS design processes to support companies when creating their specific models. This paper presents a comparative analysis of the five most cited generic process models, addressing a level of granularity based on process activities, meanwhile other studies have mostly stopped at the phase level. It employed a content analysis approach to perform the comparative analysis. The results show that the analyzed process models prioritize activities related to "Conceptualization" and "Technical Development (Product, Service and Software, Integration)" categories of the PSS design. They also focus on different parts of these categories, being complementary to each other. Thus, this study suggests that companies should not choose only one of them as a reference to create its own PSS design process, but they should look for elements of different models that fit to their purposes and characteristics. At the end, perspectives for future research are discussed.

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Keywords: Product-Service System; PSS design model; Content analysis.

1. Introduction

Companies are seeking to better satisfy their clients' needs through offerings that combines product and services [1,2]. In a Product-Service System (PSS), the value is not only embedded in a physical asset, nor delivered via an ownership transfer, but in a provision of a required function based on a bundle of products and services [3–6]. For example, a PSS provider can sell clean clothes, warm and mobility instead of a washing machine, a heater or a car [4]. This new way of doing business introduces potential benefits to the PSS provider, its customers and the environment [1,6–11].

In the development of a PSS, traditional manufacturers systematically develop "tangible" components as well as create the "intangible" part of the system without the same rigor [12]. The service design process is performed detached from product design process, which leads to insufficient consideration of the interrelationship between products and services during PSS design [13].

The presence of a formal process is accepted as a best practice for product development [12–14]. This is also true for PSS design [15,16]. There is already a set of generic PSS design process models proposed in the literature as can be seen at the reviews conducted by Tukker and Tischner [17], Clayton et al. [18] and Vasantha et al. [19].

It can be noticed by analyzing these models that they have their own particularities. Moreover, they have different focus, comprehend different lifecycle phases and were proposed to be applied on different industries. Then a comparison of the existing models is helpful to support future PSS implementations.

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Tukker and Tischner [17], Clayton et al. [18] and Vasantha et al. [19] had already compared generic PSS design process models. However, their analyses were conducted at the phase level of the process models.

This paper aims at comparing the five most cited PSS generic models, allowing for the understanding of their similarities, differences and gaps. As a result, contributions are expected for both academics and practitioners seeking to advance their knowledge in the PSS design process.

The subsequent sections of this paper are: section 2 presents concepts of process modeling and a short description of the process models analyzed; section 3 explains the methodology; section 4 shows the main results of the analysis; and section 5 discusses the conclusions.

2. PSS design process

A company may be understood as a collection of processes, in which some of them are known as business processes [20]. They can be represented by process models using different formalisms (graphical, textual, symbolic, etc.), including its constituent elements and relationships [21]

The process models have many purposes, such as being the basis for planning and control [21]. To satisfy this purpose, they are usually structured in phases, gates and activities (see this structure in Fig. 1). The phases are the highest level of abstraction in a process model and are separated by moments of evaluation and decision-making, called gates. At last, each phase is represented in detail by its activities.

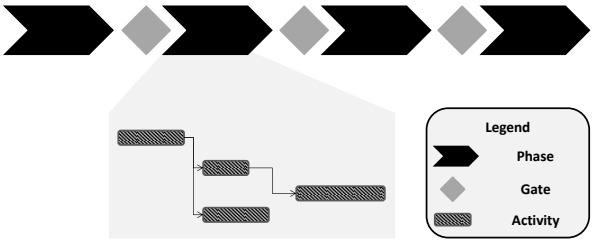

Fig. 1. Schema of generic process elements.

The process structure has been used by review articles that aim at analyzing PSS design models [17-19]. Mendes et al. [22] conducted a systematic literature review of PSS design process models adopting the process approach. Using bibliometric analysis, the authors identified the five most cited papers (models) dealing with PSS process models, presented in Table 1.

Aurich et al. [15] present the "**Integrated product and service design processes"** model for the development of technical services, organized in two dimensions: one related to product design and other to service design. Their model is based on two central points: the systematization of the process for developing technical services and the application of a modularization strategy to promote the integration between product development and service activities.

The process model proposed by Alonso-Rasgado and Thompson [9] is focused on the development of functional products (Total Care Products). Particularly, the "**Fast-track design process**" highlights the iterative design process conducted by the PSS provider and the client. Great emphasis is put on the development of a business proposal [22].

Table 1. The five most cited PSS design process models.

Process model	Author
Integrated product and service design processes – PM1	Aurich et al. [15]
Fast-track design process – PM2	Alonso-Rasgado and Thompson [9]
Service Model – PM3	Sakao e Shimomura [23]
Methodology for Product-Service System (MEPSS) – PM4	Van Halen et al. [16]
The Design Process for the Development of an Integrated Solution – PM5	Morelli [24]

The "**Service Model**" has its origin on the Service Engineering community [22]. Sakao and Shimomura [23] present a process model in which four sub-models (the flow model, the view model, the scope model, the scenario model) are necessary to design PSS.

Van Halen et al. [16] proposed the Methodology for Product-Service System (MEPSS). Among the process models presented in Table 1, "**MEPSS**" is the one which most emphasizes the environmental issues in PSS design [22]. The model is organized in phases, which are structured in steps representing a series of processes. The model also encompasses gates among their phases.

At last, Morelli [24] presents his process model through a case study. The activities of the "**The Design Process for the Development of an Integrated Solution**" are conducted in an iterative manner in two dimensions: the problem space and the solution space [22]. The design of PSS consists of proposing a set of products, activities, and cultural values directly to the customers.

3. Methodology

This paper aims to perform a comparative analysis of the five most cited PSS design process models showed in Table 1 and identified by Mendes et al. [22].

The Content Analysis (CA) was employed to support a systematic analysis of the selected models. CA comprises a set of techniques for analyzing communication/information. Moreover, with this methodology, qualitative data is used for discovering new meanings or concepts contained in written texts [26]. As the five models are described in scientific papers, the code is "written" and the channel is "mass communication", according to the Bardin's [25] classification.

The CA technique employed was the Categorization analysis, which consists of a data reduction technique by means of coding and thematic organization [26]. The following steps were performed:

1. Each process model was decomposed into activities, which represent the unit of analysis;
2. The explanation offered by the authors for each activity was recorded (codes);