

Product-Service Systems across Life Cycle

# Product-Service System (PSS) design: using Design Thinking and Business Analytics to improve PSS design

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## Abstract

Companies searching for new ways to be competitive in dynamic markets are integrating product and service to better fulfill customer demands and improve sales. A well designed and efficiently developed Product-Service System (PSS) is a solid alternative to achieve this goal. The PSS design should search for new ways to add value for both company and customers. The PSS design model may help the company to innovate, strengthen competitiveness and assure the desired profit. In this paper we propose a methodology that integrates Design Thinking (DT) and Business Analytics (BA) in the PSS design in a way to build a profitable and lasting PSS. Design Thinking is a human-centered and systematic approach to problem solving and is used in the model to deeply understand customer needs and satisfy their emotional requirements considering company's resources and constraints. BA is the capacity to aggregate, to analyze and to use data in a way to optimize the business results. The large quantity of information available from sensors, logs and other machine sources, associated with information and communication technologies (ICT) advances allow companies to collect and analyze a large quantity of data. Through the data analysis, companies may evaluate consumer behavior, sense changes in the market quickly and identify new opportunities to innovate. Furthermore, companies may use the data as a third layer to add value besides the product and service layers. The proposed model addresses a lack in the literature of PSS design and adds relevant information for companies designing or reconfiguring a PSS.

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Peer-review under responsibility of the scientific committee of the 8th Product-Service Systems across Life Cycle

*Keywords:* Product-Service System, Design Thinking, Business Analytics, PSS Design

## 1. Introduction

Current market characteristics are demanding agility and value creation from companies. To achieve these goals, companies are integrating product and service in their offers [53]. One strategy, known as Product Service System (PSS), corresponds to the integration of product and service to deliver the desired functionality and add value to the customer [51]. However, PSS implementation brings new challenges for companies [14], like the service paradox [17] for example.

A well-designed PSS is relevant for the success of the initiative. It must contemplate customer and company perspectives [43] and support the company innovativeness [2]. There is a lack of literature addressing PSS design regarding these topics. Furthermore, PSS offers can be unique, demanding from firms the capacity to design innovative PSS

[53].

This paper proposes a PSS design model addressing innovation and added value. Through a literature review the characteristics relevant for a PSS and the suitable approaches to create an innovative PSS were identified. Design Thinking (DT) and Business Analytics (BA) approaches were selected to enhance the PSS design model proposed.

This paper is structured as follows, in sections 2, 3 and 4 PSS, DT and BA characteristics are presented. Next, in Section 5, the model and recommended tools for its implementation are discussed. Section 6 concludes the paper and proposes further developments.

## 2. Product Service System (PSS)

A system is a collection of entities that interact, so it is

necessary to clarify the PSS elements to achieve a better understanding of such systems. According to [36] and [51], the PSS elements are product, service, supporting network and infrastructure. A recent literature review [10] identified entities (englobing Mont supporting network and infrastructure elements), life cycle and actors as PSS elements.

[17] points out the necessity of PSS offering understanding to effectively design the PSS. [50] [51] proposes that PSS can be classified in product, use or result oriented; which is the prevalent approach for business model definition [45]. [42] classify according to the nature of integration, ownership of product and the role of technology. While [17] classify PSS in terms of orientation (product, use or result oriented), focus (product or service) and nature of integration between customer and PS provider (transaction or relationship based).

Furthermore, there are some aspects that should be considered for an effective PSS design. PSS literature emphasizes features like customer interaction [25] [36] [44] [53], network partnering [36] [53], knowledge creation [20] [21] [32] [40] [47] [55], customer and type of market particularities [35] [45] [51] and integration of product and service in the PSS design [4] [10] [36] [39] [43] [57].

There are different models addressing PSS design [5] [11] [22] [32] [38] [39] [43] [57]. [51] verified three common stages in the PSS design models, namely, analysis; idea generation, selection, refinement and evaluation; and planning and preparing implementation. While [43] identified customer analysis; requirement analysis; PSS design; and PSS test and implementation as common stages in PSS design literature. Among these models, the most applied methods in PSS design are Analytic Network Process (ANP), Analytic Hierarchical Process (AHP), Service Blueprinting and FMEA [10]. Despite the innovation relevance for the business health, there is a lack in addressing this theme in PSS design models.

### 3.Design Thinking (DT)

Design Thinking is a human-centered and systematic problem-solving approach [9] [28] [30]. DT emphasizes the deeply understanding of customers in order to satisfy their emotional requirements as well. According to [9] [24], DT provides the reliability of the analytical thinking and the creativity of intuition thinking to match human needs considering the business constraints. DT translates observation in insights and insights in innovation through an exploratory, iterative and non-linear process [9] [23] [28].

One of the DT advantages is that through this process the company can innovate based on the perspective of the users and consequently maximize the user experience adding value to the product [24]. Furthermore, DT enables to link managers' perceptions, rational analysis, technical, cultural and commercial factors to boost value to the customer and market opportunities for the company [24].

There are different DT models [9] [48] HCD; [24] where it is possible to identify three common phases (Table 1), inspiration, ideation and implementation. According to [9], the DT process is best thought as a system of overlapping spaces rather than an orderly sequence of steps.

Table 1 – DT phases [9].

Phase	Definition
Inspiration	Is the problem or opportunity that motivates the search for solutions, gained through observation, empathy, and immersion in the user's context.
Ideation	Is the process of generating, developing and testing ideas, identifying patterns, defining opportunities and creating solutions.
Implementation	Is the path that leads to the market.

DT is successfully applied in product and service development, and in different kinds of markets (B2B, B2C and B2G). Examples of companies using DT are P&G, Pfizer, Intel and Nokia.

### 4.Business Analytics (BA)

Business Analytics (BA) is the process of patterns identification or mathematics decision models creation from a determined set of data allowing decision making based on data which add value to the company [1] [6] [13]. According to [1] [6] [8], this process of knowledge discovery based in data receives different names in the literature, like business analytics, data mining, data analysis, data science or knowledge discovery.

BA can be classified as descriptive, predictive or prescriptive in terms of objectives; quantitative, qualitative or hybrid regarding to the approach, and make use of structured, semi-structured and unstructured data [14] [19] [54]. Techniques like linear/non-linear regression, logistic regression, time-series model, optimization, clustering, factor analysis, principal component analysis (PCA), neural networks, support vector machines (SVM), Bayesian techniques and survival analysis are used in the BA process [29] [37].

The company can create value from different ways through BA [27] [29] [34]. For instance, it can be used to customer segmentation [7] [16] [34] or product performance evaluation [27] [29] [46]. Examples of companies that are aggregating BA to their PS offers are GE [2], The Michelin Group, Taleris and Daimler Car2Go [3].

### 5. Proposed PSS design model

According to the Schumpeterian economics firms compete through innovation and the ones innovating more efficiently will succeed. The Schumpeterian concepts are applicable for manufacturing and service industries as well [15].

An efficient PSS design should consider the customers and the company perspectives [43]. Furthermore, it should include some innovation steps to search for new ways to add value for both actors. There is a gap in PSS design model literature regarding innovation steps. So, to approach this gap the model

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