

Product-Service Systems across Life Cycle

## Product-service systems characterization based on life cycle: application in a real situation

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### Abstract

Given the offer of products, which are losing their competitive value, companies begin to seek solutions to improve their market position through the inclusion of services. The development of product-service systems (PSS) is a solution that has been discussed by the academia in recent years, resulting in an increasing number of publications. The literature not only shows a growing interest in PSS but also points out some research gaps such as the lack of characterization of a PSS and the difficulty of identifying a PSS. In this sense, this paper proposes an application of a framework that characterizes a PSS in a real situation. The aim is to check if the real situation presents the characteristics of a PSS highlighted by the framework. The framework presents conceptual elements throughout the life cycle of a PSS: Requirements definition of a PSS; Development of a PSS; Implementation of a PSS; Monitoring a PSS; and Post-use disposal of a PSS. These elements are intended to identify the characteristics of PSS for each stage of the cycle. The real situation identified in the existing literature on PSS presents basic characteristics of a PSS, it contains its four main factors: product, service, actors network and infrastructure and presents the similarity of the three types of PSS (product-oriented, use-oriented and results-oriented). Thus, the framework is applied in the practical case to identify characteristics of PSS. This application is carried from a questionnaire based on conceptual elements arranged in stages of the life cycle of the PSS. The responses were analyzed highlighting main conceptual elements characteristics. With the information obtained from the questionnaire, the results demonstrate the company's current situation and the PSS characteristics that could be implemented.

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### 1. Introduction

The effects caused by the raise in production and consumption in the past years have shown that product availability itself isn't enough for a competitive strategy [1]. Including services into products is being considered as a great business opportunity because it is hard to copy by competitors [2]. With products being manufactured in large aiming to reduce production costs to obtain competitive prices in longer life cycle [3]. The consumer replaces the product more frequently [3]. Frequent product replacement is a recent problem that raises the amount of waste on environment as a result of inappropriate product discard [1]. Furthermore,

consumer doesn't know where the products are destined in the end of the life cycle [4].

Society is worried about the raise in waste amount and is looking for alternatives to make the situation better [4]. For that, one solution that aims to lower environmental issues caused by the growing product consumption is the Product-Service System (PSS).

PSS offers functionalities to consumers aiming to reduce environment impact [5], being a business opportunity that is being widely discussed by researches worldwide and they emphasize that it is a trend that must be considered by companies [6]. A raise in the amount of articles written about PSS has been notices in the past years, showing that the

Academia is interested about it [7]. From 2011 to 2013, the number of papers increased drastically, indicating a fast growing interest in PSS. Papers published from 2011 to 2013 represents 78,8% of the total [7].

However, a Gap has been identified by [4, 8 and 9]: there is the need of empirical analysis. These analysis aims to contribute to the PSS theory that is complex and needs researches about its practical adoption [10].

The criteria used to identify a PSS business must be explored because a PSS isn't solely an offer of products and services but also the planning of all the elements involved (called Actors Network) and the needed infrastructure to attend all the business levels and, mainly, to be planned accordingly to its life cycle [11], [12] and [13].

The motivation to develop this paper was the difficulty to identify if a business is a PSS and not only the offering of products and services. So it makes necessary to consider the conceptual elements identified in all stages of the PSS life cycle (its characteristics elements). Given the scarcity of empirical work about PSS and the difficulty of identifying whether a business is a PSS, the research question is: what criteria should be used to identify a PSS based on its life cycle? These criteria are presented in this paper as conceptual elements which aim to characterize a PSS based on the literature. Moreover, a real case is analyzed.

**2. Literature Analysis**

Services are increasingly being considered as business opportunities due to its competitive differential and for being hard to be copied by competitors [2]. The inclusion of different kinds or services offers to consumer's customization so new business models are being created, strategically transferring product sales to service provision [15] and [2]. There are three reasons to this strategically transfer [2]: (i) competition on product sales, (ii) value added from service provision, (iii) product servitization changing the product physical properties to increase functionality. Consumer uses the product function without having it.

Product-service system is a business opportunity that is considered a trend by the researches. It aims at solutions that decrease the environmental issues caused by intense product consumption and aims to be a competitive business model for companies that look for competitive differentiation. This differentiation is related to service inclusion to add value to the offer products.

The main benefits of PSS are related to continuous business improvement with innovation on quality and looking to progressively satisfy the consumer needs [16]. With this providers can build long term relationships with consumers that become loyal. Besides that, all the obtained info from this relationship can be used on new systems development to improve its performance [13]. This way companies can improve their position on the value chain increasing their innovation potential [17]. Companies can also contribute to the lack of resources and environmental degradation becoming responsible for products and services aiming to reduce waste [3].

A PSS must be planned at the systemic level [18, 13], considering all the life cycle based on products, services, actors network and infrastructure. This planning must be continuously improved being adapted to the consumer needs. For this it is necessary to involve the consumer on the creation stage, valuing their ideas and through all the system use as the consumer knowing the system important aspects of it can be known.

Market faces continuously changes and the PSS is a way of following this change through the connection with all the involved actors. However, it is necessary to involve the companies too, adapting their traditional structures focusing on product use and service provision. Manufacturing companies need to set their internal production to allow efficient associated product and services delivery [19]. The change to a PSS is complex and needs more researches about services that must be offered with products, aiming continuous consumer satisfactions [20]. The execution actions and process to deliver products and services must also be researched [21].

The product life cycle must be linked to the service life cycle [22, 23]. Services are offered to consumers and products are used as a way to this service provision. The PSS behavior must be analyzed through its life cycle [24]. Although the PSS life cycle is present in the literature it is not shown on a wider and bigger approach [11, 12, 13], in other words, the complete PSS life cycle, respecting all of its stages (Figure 1).

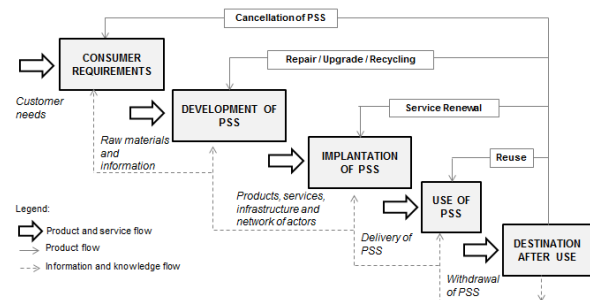


Fig.1. Life cycle PSS.

This paper highlights the PSS life cycle on a systemic way (Table 1), aiming to be used as a base to conceptual elements identification in the literature to characterize practical situations and if this situation can be considered as PSS or not.

Table 1. PSS life cycle stages

Life cycle stages	
Requirements of PSS	Attend a consumer that uses a PSS
PSS development	How a PSS must be developed
PSS implementation	How a PSS must be used by the consumer
PSS monitoring	Attendance improvements obtained from information gathered through the use
PSS post use destination	Analysis of each situation at post use stage

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