PRODUCT-SERVICE SYSTEMS DEVELOPMENT PROCESS: SYSTEMATIC LITERATURE REVIEW

Barbara Tokarz
barbaratokarz@icloud.com, Industrial Technology Department, Santa Catarina State University (UDESC), Brazil
Bruno Tokarz
btokarzbr@gmail.com, Industrial Technology Department, Santa Catarina State University (UDESC), Brazil
Délcio Pereira
delcio.pereira@udesc.br, Industrial Technology Department, Santa Catarina State University (UDESC), Brazil
Alexandre Borges Fagundes
alexandre.fagundes@udesc.br, Industrial Technology Department, Santa Catarina State University (UDESC), Brazil
Fernanda Hänsch Beuren
fernanda.beuren@udesc.br, Industrial Technology Department, Santa Catarina State University (UDESC), Brazil

ABSTRACT

This paper presents a systematic literature review on Product-Service Systems (PSS), focusing on its development processes. Product Service Systems (PSS) are a sustainable industrial solution, delivering an integration of products and services instead of products only – a model still not broadly recognized. A literature search encountered 87 non-duplicated papers, employed at identifying existing approaches on PSS development, according to its lifecycle stages. The main approaches per stage were presented, as well as those with a focus on sustainability. Since manufacturing companies need support on delivering PSSs solutions to customers, this research takes a step forward into a practical assistance approach.

Key Words: Product-Service System; Development Processes; Lifecycle Stages.

1. INTRODUCTION

Product-Service System (PSS) is a business model that sells not only products, but an integration of products and services in order to fulfill customers' needs and guarantee their loyalty through individual offers (Alix & Zacharewicz, 2012; Vezzoli et al., 2018). It's a process of servitization of products, close to functional economy for the sale of a function instead of physical products, found to bring more profit to companies than the offer of products only (Alix & Zacharewicz, 2012; Mont, 2002).

PSSs are seen as a solution related to sustainable development (Kim et al., 2015; Tran & Park, 2016; Vezzoli et al., 2018). With the uncovering symptoms of environmental decay, consumers have been pressuring companies to produce in a sustainable way. A service-oriented economy could be the direction to take on this matter (Mont, 2002; Vasantha, Roy, Lelah, & Brissaud, 2012). This servitization process is comprehensibly translated into the PSS business model, which has been emerging as a trend among industries (Park & Yoon, 2015).

As this process is not yet recognized as the traditional product-based manufacturing process, industries require support in terms of tools, methods and processes that assist them through the producing transition (Vasantha et al., 2012). They need help delivering solutions to customers that are not necessarily product-based. Some assisting development approaches have been proposed in the literature, but there's still a gap on practical approaches (Tran & Park, 2016) and on the ones directly related to sustainability (Vasantha et al., 2012).

Authors (Aurich, Fuchs, & Wagenknecht, 2006; Baines et al., 2007) have stated the importance of designing PSS through its lifecycle. Mourtzis, Fotia, and Vlachou (2017) express that there isn't an only stated cycle for PSS. For example, Wiesner, Freitag, Westphal, and Thoben (2015) proposed a PSS cycle based on Beginning, Middle and Ending of Life ideas, while Kim et al. (2015)'s work covers a cycle with five steps: design, production, sales, usage and disposal.

With that in mind, the purpose of this paper is to identify the main approaches related to PSS development, as well as the approaches that have a sustainable focus. The paper is organized as follows: this section presented a background on the subject. Section 2 presents the research methodology, while section 3 explores the approaches we gathered. Finally, section 4 states some concluding remarks.

2. RESEARCH METHODOLOGY

This paper encompassed a search for existing PSS development supporting methodologies. The search was conducted in Scopus and Web of Science academic databases, through the following key words: "product service system" AND (methodology OR tool) AND (development OR developing OR implementation OR implementing OR modeling). The key words were sought on the papers' title, abstract and key words, considering papers published from 2008 to 2017.

A total of 195 non-duplicated articles was found and skimmed, looking for those papers that would bring us the PSS approaches we were looking for. This analysis resulted in 87 papers, which were entirely read. The PSS development approaches mentioned on the 87 papers were congregated and classified according to the PSS lifecycle stage they attended and their emphasis – or not – on sustainability.

3. RESULTS AND DISCUSSION

We chose to work with a cycle proposed by Beuren, Sousa-Zomer, and Cauchick-Miguel (2017) that covers the phases of PSS requirements definition, development, implementation, monitoring, and destination after use. PSS requirement definition phase aims at attending consumer's needs by organizing a set of pre-requisites for the PSS (Beuren, Pereira, & Fagundes, 2016; Marques, Cunha, Valente, & Leitão, 2013). The development phase shows how a PSS must be developed, integrating products, services, actor's network and infrastructure (Beuren et al., 2016; Beuren et al., 2017). PSS implementation covers product installation and service implementation (Marques et al., 2013). PSS monitoring gathers data from the system and decides either PSS should continue operating or not (Beuren et al., 2017). Destination after use includes replacement, recycling, and/or product take-back (Zhu, Gao, Li, & Tang, 2012).

From the 87 analyzed papers, 133 PSS approaches were congregated. Those are related to any stage of the PSS lifecycle, although most of them were found to be related to the first two phases of the cycle – result probably explained by the key words employed on the search. Table 1 shows a few of the main approaches associated with each lifecycle stage. We chose to present two of them to each stage, selected by the amount of times they were cited as being employed on that specific stage of the cycle.

[Table 1] PSS Main Approaches per Lifecycle Stage

Lifecycle Stage	PSS Approach	Approach References[1]
PSS Requirements Definition	Service Explorer	(Bertoni, Bertoni, & Isaksson, 2013; McKay & Kundu, 2014; Park & Yoon, 2015; Pezzotta, Pirola, Pinto, Akasaka, & Shimomura, 2015; Tran & Park, 2016)
	Quality Function Deployment	(Cavalieri & Pezzotta, 2012; Haber & Fargnoli, 2017; Morelli, 2009; Pezzotta, Pirola, Rondini, Pinto, & Ouertani, 2016; Wiesner, Marilungo, & Thoben, 2017; Yoon, Kim, & Rhee, 2012)

[1] These are the references contained in our 87-paper library. The owners and developers of the approaches might not be on this list.

PSS Development	MePSS	(Dimache & Roche, 2013; Geum & Park, 2011; Sakao, Sandström, & Matzen, 2009; Yoon et al., 2012; Zine, Kulkarni, Ray, & Chawla, 2016)
	Product Service Blueprint	(Bertoni et al., 2013; Geum & Park, 2011; Kim et al., 2015; Lim, Kim, Hong, & Park, 2012)
PSS Implementation	FMEA	(Cavalieri & Pezzotta, 2012; Pezzotta et al., 2016; Yoon et al., 2012)
	PSS Board	(Lim et al., 2012)
PSS Monitoring	System Dynamics	(Lee, Geum, Lee, & Park, 2012; Lee, Han, & Park, 2015)
	Discrete Event Simulation	(McKay & Kundu, 2014)
Destination After Use	Practical Design Framework	(Tran & Park, 2014)
	Lifecycle Model	(McKay & Kundu, 2014)

From the same 87 papers, we also selected the PSS approaches with some emphasis on sustainability. Not every PSS developed brings environmental or social benefits, and, during development, the system needs to be carefully conceived toward that direction (Vasantha et al., 2012; Vezzoli et al., 2018).

The Methodology for Product Service System Development (MePSS) is a method to design PSS through customers' needs and strategic analysis (Park & Yoon, 2015; Zine et al., 2016), providing the involved ones with a practical approach and a big picture of the system's condition. Many authors (Bandinelli & Gamberi, 2011; Cavalieri & Pezzotta, 2012; Vezzoli, Ceschin, Diehl, & Kohtala, 2015) cite MePSS as one of the main approaches to design a PSS. Others (Dimache & Roche, 2013; Sakao et al., 2009) state the use of MePSS in PSS development as a sustainable approach.

Geum and Park (2011) developed a tool called Product Service Blueprint to assist on PSS development. They declare that the approach is an adaptation of Service Blueprint to PSS, aiming at reflecting PSS characteristics, i.e. customer value, economic value and sustainability (Geum & Park, 2011; Lim et al., 2012). Some authors (Bandinelli & Gamberi, 2011; Geum & Park, 2011) point to the application of a Sustainable Product and Service Development (SPSD) method related to developing PSS in a sustainable way. The method has a great focus on sustainability, as it measures environmental and social aspects related to the conceptual development of a PSS.

Lee et al. (2012) listed several studies on how to measure sustainability on a PSS and developed a dynamic and multidimensional approach for PSS, integrating the three pillars of sustainability with a simulation tool. Kim et al. (2015) describe a set of 94 evaluation criteria for PSS with a main focus on sustainability, quality and cost, presenting a background review on the need of developing the scheme.

4. CONCLUDING REMARKS

This paper presented a literature review on Product-Service System development approaches. The approaches were gathered from the literature and classified according to the PSS lifecycle stage they attended and their emphasis – or not – on sustainability. Some of the main approaches were displayed and exploited on the paper.

Most of the approaches were concentrated on the first phases of the cycle, probably from the choice of keywords employed on the search. As for future researches, it's suggested that the search would be expanded, in order to cover the final stages of the PSS cycle as well. As Product-Service Systems are emerging sustainable industrial approaches, this research is relevant as a step into covering the gap expressed by Tran & Park (2016).

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