PRODUCT-SERVICE SYSTEMS (PSS): THE USE OF PRINCIPLES IN THE CREATIVE PROCESS OF PSS

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ABSTRACT

The process of creating PSSs has several characteristics that make it complex, since it involves not only tangible and quantifiable products, but also services, typically qualitative, with several variables and actors involved. Most of the tools currently used in PSS assist the structuring process of the system, but explore the creation process just intuitively, based on the designer's experience. Some authors emphasize the heuristics and principles use as cognitive strategies that lead to high potential creative thinking. Thus, the following study identified some prominent authors who propose principles focused on the quality and sustainability of products and services, in order to explore their potential. The method used included a theoretical study, followed by an exploratory case study. The present article, besides contributing to the detection of emphases and gaps in the literature, demonstrates by means of practical application, the designer's interaction with inventive principles in the process of creating PSSs.

Key Words: Product-Service-System, Creativity, Sustainability, Heuristics principles.

1. INTRODUCTION

The Product-Service System (PSS) presents itself as an innovation strategy, changing the focus of businesses from the design and sale of physical products only, to the sale of a products and services system that are able to meet the specific demands of customers (Manzini, Vezzoli, 2002). In this context, it is important to highlight the importance of the service sector in relation to other economic activities that compose the national GDP. In 2018, the sector represented 75.8% of Brazil's GDP (IBGE, 2019). In this way, the strategic importance of the service sector in the economic development is highlighted, which, in addition to generating value, better living conditions and jobs, enhances the competitiveness of companies.

However, according to Manzini and Vezzoli (2002), companies face barriers in designing, developing, delivering PSS and implementing the necessary changes in corporate culture to support more systemic innovation and business-oriented services. According to the authors other barriers faced by companies include the lack of knowledge and experience in terms of: Methods and tools for designing services; Tools that can be used to evaluate and implement PSS; Service management systems; Skilled entrepreneurial personnel in the development and provision of services, and life cycle cost calculation methods.

Marques (2018) also points out that the adoption of PSS business models by manufacturing companies still represents a complex transition. Since these companies adopt approaches based on a traditional perspective to design and develop their integrated solutions, that is, they project the "tangible" part of the product and adopt intuitive processes and methods to develop the "intangible" elements (services). In this context, Pinhanez (2009) states that innovation in services based on science and technology suffers from lack of research, with very superficial studies being carried out. From this premise, one way of deepening the ideas generated for the service sector would be, for example, through methods and tools of creativity. One method recognized by having a logical structure, with patterns and repeatability is the heuristic method. Heuristics can be defined as cognitive strategies applied to project problems that lead the designers to a space of diverse, unexplored solutions, generating more creative ideas of high potential (Yilmaz et al., 2010).

The main goal of heuristics is not only to generate several solutions by pure trial and error or brainstorming. The heuristics work as devices that contribute to reduce the average number of solutions to be sought, helping to generate ideas with greater potential for innovation and finding a way to solve complex problems (CHU et al., 2010) and drawing attention to the most relevant aspects of the problem (Renkl et al., 2009).

The following study aims to highlight some tools for developing PSSs that use or do not use heuristics, in order to perform a comparative analysis of the interaction of beginner designers in PSS with these tools. The intention is to highlight emphases and gaps in the creation process. The research refers to an exploratory case study that had the participation of twelve Design students. The context of analysis occurred within an intensive course (Pilot Course) of two weeks (30 hours), offered to undergraduate students. The Pilot Course was formulated as part of an initiative of the LeNS (Learning Network on Sustainability). This network has obtained funding from the Erasmus+ Program to implement an action plan on curriculum development aimed at promoting a new generation of designers (Design Educators and Researchers) capable of developing Design for Sustainability (DfS), Sustainable Product Service System (S.PSS) applied to the Distributed Economy (DE). The method used in this article is of qualitative nature and counted on an asystematic bibliographic research, followed by an exploratory case study and analysis through the application of a questionnaire.

2. PSS, TOOLS AND HEURISTICS

A PSS can be defined as the result of an innovation strategy, which consists of a combination of tangible products and intangible services designed to be able to meet the needs of final customers (Tukker and Tischner, 2006). Vezzoli et al. (2018) adds the perception of the sustainability potential of the PSS approach, emphasizing that this business model is mainly aimed at decoupling value creation from increased resource consumption.

Vasantha et al. (2016) highlight several elements that influence the PSS, such as: Actors from different areas and with different levels of involvement in the PSS; The environment, considering the multiple points of contact and interactions; Several activities at each stage of the PSS life cycle; Innovation and the addition of value (economic, social and environmental); among others. The synthesis and management of contexts involving numerous elements and actors is a complex task and demands a holistic view of all PSS interactions.

According to Forcelini et al. (2018), techniques that involve heuristic principles can support when dealing with complex systems, generating solutions at the time and place where they are necessary, independently of spontaneous creativity, which allows manifesting the creative potential of each member of the team. In addition to promoting a better interaction between the components of a creative team, they standardize the creativity, making the success of the project not depend on the people considered naturally creative.

Tassi (2008) developed in his thesis, through the cooperation between research groups of the Department INDACO (Polytechnic of Milan), an open platform of knowledge that describes several tools of Service Design Tools[1]. According to the author in recent years, several tools that have been implemented are able to face the highest level of

[1] Platform Online: Service Design Tools. Disponível em: <http://www.servicedesigntools.org/about> Acesso 19 jan 2019.

complexity and also communicate the intangible aspects of the project, such as time and experience. Some tools appear several times with different objectives and in different categories, indicating, for example, that some characteristics of the tools used in the first part of the process can be taken and used later to communicate the project in the implementation phase or even during the delivery. For example the blueprint tool, which according to the author's classification can be a useful tool in the "Invisioning" and "Implementation" stages. The use of heuristics is proposed by Tassi (2008) only once in the "Prototype Testing" phase of the idealized system.

In the unsystematic bibliographical survey, other tools were found in the PSS that make use of heuristics, it is possible to emphasize here the SDO-MEPSS tool (Sustainability Design Orienting-Product Service System Methodology). This is an online platform that has as general objective of guiding the design process for sustainable PSS solutions. The tool, in addition to the principles, integrates an analysis and checklist roadmap, which guides designers in the analysis of environmental, social and/or economic priorities (Vezzoli, 2010).

As a starting point for the adoption of PSS solutions for more sustainable scenarios, Vezzoli (2010) proposes principles directed to the three dimensions, social, environmental and economic. The principles are usually accompanied by guidelines and examples of how to apply them.

Another relevant tool is the Matrix DM+PSS, which presents a diagram that visualizes potential areas where Distributed Manufacturing (DM) can contribute to improve the development of PSS. The tool has a set of 35 scenario cards/principles that show the potential benefits of applying DM to the PSS. The tool makes it possible to generate ideas with each card. The DM principles presented in the scenarios can be integrated into the PSS project considering all stages of the life cycle (Petrulaityte et al., 2017).

3. METHOD

The present study follows a qualitative approach of interpretive nature. According to Polaine et al. (2013), quantitative data do not reflect the subjective reasons why people cease to use certain services.Firstly, an informational phase was developed, in which a bibliographical survey was made aiming contents related to: Concepts of PSS; Creativity tools directed to PSS; Heuristic methods in the creative process, and others related to these issues. The study also had practical observations carried out in an exploratory case study, focusing on the direct observation of the use of the creativity tools in a pilot course, which occurred between October 16th and 27th, 2017 in the Graduation Course of Design in the Federal University of Paraná. According to Yin (2004) the exploratory case study is a strategy that aims to analyze real-life situations. Data collection consisted of direct observations, video recording and gathering of documents produced by the students before, during and after the creativity sessions. In the analysis phase, after using the creativity tools, the students were instructed to respond to a previously structured questionnaire, recording their perceptions regarding the methodology used and the application of the tools.

4. RESULTS OF THE APPLICATION OF CREATION TOOLS FOR PSS

During the exploratory study in the classroom, the SDO-MEPSS tools (Sustainability Design Orienting-Product Service System Methodology) proposed by Vezzoli (2010), and the Matrix DM+PSS (Petrulaityte et al., 2017), have been applied based on the heuristics principle. Six other tools were also applied (which do not use principles in their structure). These are briefly described below (table 4.1):

[Table 4.1] Synthesis of tools applied in the PSS course / Exploratory Study (Font: Silva et al (2012); Segura & Vidal (2016); <mepss-sdo.polimi.it/mepss>; <servicedesigntools.org>; <lens-brazil.org/course> (2017)

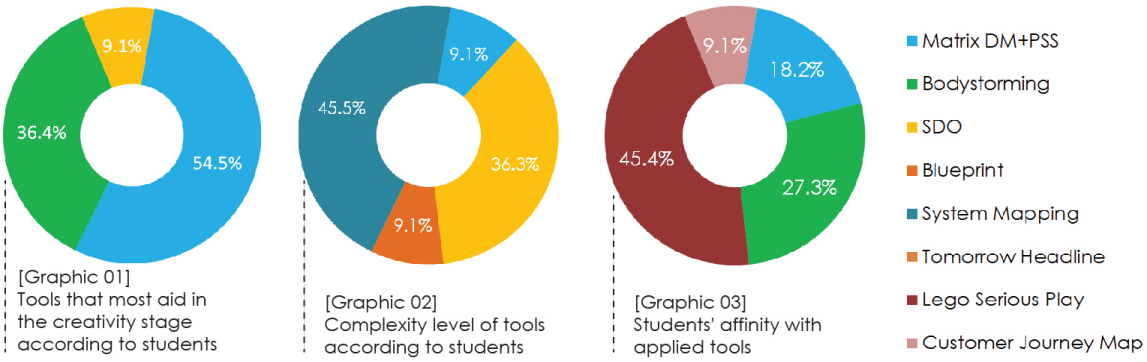
Tools	Description
Bodystorming	A technique in which designers and other stakeholders use their body language to create or represent ideas about interactions and settings around a given experience. The technique allows real situations to be simulated by real people, so one of its advantages is the possibility of immediate feedback on how a specific idea would fit into the target context (SEGURA & VIDAL, 2016)
System Mapping	A visual description of the technical organization of the service: the different actors involved, their mutual relationships and the flows of materials, energy, information and money through the system (SERVICE DESIGN TOOLS, 2014).
Blueprint	It is a matrix that represents visually and schematically the complex system of interactions that characterize a service provision. In this representation, the different points of contact of the service are mapped, that is, the visible and/or physical elements with which the client interacts, and also the client actions and all the interaction with the company from the visible operations to those that occur in the backstage (SILVA et al, 2012).
Lego Serious Play®	A method that facilitates the process of meeting, communicating and solving problems. Each participant or team constructs their own 3D model using specially selected LEGO® elements. These 3D models serve as a basis for group discussion, knowledge sharing, improving group problem solving, using visual and kinesthetic skills (Official Site, LEGO® SERIOUS PLAY®).
Customer Journey Map	It is a graphical representation of the customer relationship stages with a product or service, which describes the key steps taken before, during and after purchase and use (SILVA et al, 2012).

Tomorrow Headline	Consists of fiction articles published in magazines that the designers create. The "fake" article makes possible a future projection in order to understand the kind of impact that the service will have on society. This tool is also a way to visualize the idea and make it more tangible, more real and more univocally perceived between the team and the stakeholders (IDEO, 2002).

In order to evaluate the creativity tools, a questionnaire was developed with ten multiple choice questions in which students should justify each choice. The completed questionnaire was answered by eleven of the twelve students who participated in all the activities proposed during the course.

The course was divided into ten sessions, as follows: (i) General introduction to the fundamentals of PSS and classroom objectives; (ii) Understanding the problem through the Blueprint and System Mapping; (iii) Definition of the satisfaction unit with the development of Personas and the principles use of Sustainable Design Orienting Toolkit (SDO); (iv) First creation session with application of Matrix DM+PSS tool; (v) Second creation session with the application of Bodystorming techniques and Tomorrow Headlines (vi) Mockup with Lego Serious Play®; (vii) Contact with the user and feedback from stakeholders (viii) PSS detailing with Storyboards; (ix) Preparation for final presentation using Customer Journey Map; and (x) Final presentation.

Thus, in order to understand the student's perceptions regarding the different tools used, the questionnaire involved all the tools applied during the course, not just those used in the creativity sessions. It was assumed that the creative process does not only comprise the creation phase, but the whole discussions made during the two-week course. The following chart shows the tools that students consider to be the key to the creative process (Graphic 01 - Figure 1).



[Figure 1] some graphs with the result of the survey questionnaire (Font: Authors, 2019)

The most voted tool was the DM+PSS Matrix (54.5% - 6 students), followed by Bodystorming (36.4% - 4 students) and SDO (9.1% - 1 student). The students justify their choice by highlighting that the DM+PSS Matrix was the one that enabled the generation of alternatives with greater detail and definition by the team. The tool helped them to think "outside the box" and have "unusual" ideas for the project. The principles and examples presented on the 35 tool cards were also considered to be of great help in the generation of alternatives. However some students point out that not always the examples seemed to fit the reality proposed by the course. The second most voted tool, Bodystorming, was described by students as being of a rapid understanding and use, allowing a greater comprehension of the real scenario. They highlighted that the tool permits to think of solutions to a problem as it happens, having you as an active participant in the experience. It was also noted that the tools make possible to see if a solution thought in paper would be possible to apply in real life.

The SDO tool stands out in the students' perceptions by enabling different views regarding sustainability that would go unnoticed in the concept creation process. However, SDO-MEPSS tools ranked second in order of complexity to be applied. Students stressed that the site is not very intuitive, which makes it difficult to use (36.3% - 4 students), as shown in Graphic 02 - Figure 1.The System Mapping tool was considered the most difficult to apply (45.5% - 5 students). The greatest difficulty identified was to understand the whole process, taking into account all stakeholders, not only those who are direct and easier to notice. Then align all the relationships between each of these characters on a single map, in a intelligibly way, was also highlighted as a process hard to understand.

Students also ranked the tools according to affinity (Graphic 03 - Figure 1). The Lego Serious Play tool ranked first (45.4% - 5 students), followed by Bodystorming (27.3% - 3 students), DM+PSS Matrix (18.2% - 2 students) and Customer Journey Map, with 9.1% (1 student). The interactivity and ability to easily view and change the PSS scenario with Lego Serious Play meant that most students had a greater affinity with the tool. They highlighted that was much easier to visualize and modify the service they were designing through this tool. The process was considered dynamic and stimulating for the generation of ideas. However, through the observation made, it was noticed that some scenarios built with Lego elements, ended up not including some key interactions for the effectiveness of the PSS.

In order to understand the need for improvements in the tools for the creation stage, students were asked about the need to add examples and principles that would indicate reference paths (examples for the application of the tool). All the answers were positive and some students justified that one of the factors that helped apply the DM+PSS Matrix was to actually have principles and examples on the cards. These principles and examples facilitat-

ed the understanding of the process and allowed more ideas to be created, reducing the time and amount of numerous extra explanations and frustration when using the tool. Therefore, it is understood that the existence of check lists, cards or even principles guiding the creation with the Lego elements, for example, could make this tool considered by the users the most effective in generating ideas, in addition to being the one that brings more affinity.

As a conclusion of the questionnaire, the students were able to write, in a discursive and optional way, suggestions for the future disciplines. The most recurring factors in this phase were: the duration of the course and the use of principles and examples in each tool. The students indicated an interest in having more time to dedicate to the research of each of the tools and also to the interviews with the users of the proposed services. In addition, they indicated that the presence of principles with examples of application of each of the tools would greatly facilitate the understanding and generation of ideas, especially when the time dedicated to each tool is short.

5. CONCLUSIONS AND DISCUSSIONS

Considering the complexity of the development of PSS (Product-Service-System), whose creative process must consider the several points of contact and actors, as well as tangible and intangible systems, among other factors involved, it can be concluded that the development of strategies and tools that guide the creative thinking in a systematic way, as proposed by heuristics, is essential for raising creativity and innovation potential.

The Pilot Course demonstrated the importance of tools that use and do not use heuristics for PSS creation. However it was reported by students that the inclusion of properly exemplified heuristic principles aided in the generation of unexpected ideas considered of high creative potential. The conceptual accumulation of the tools that occurred during the course has clearly provided more confidence to students to generate a variety of ideas with an adequate understanding of the problem and possible solutions scenarios.

It was also observed in the questionnaire that the tools that applied principles and examples stood out in the process of creating ideas. As emphasized by Forcelini et al. (2018), the use of heuristic principles promote a better interaction among the participants, and when they are exemplified with external cases, the knowledge of everybody involved is uniformized, so that the success of the project does not depend on the people considered naturally creative. However, it is also clear the need and importance of the process of analogy and abstraction in order not to get stuck in the same existing idea.

It is also possible to highlight the results achieved in the questionnaire, the SDO-MEPSS tool, for example, was considered by users as the third most helpful in the process of generating ideas due to the use of heuristics, however it was also considered the second most complex. That is, the ability of a tool to support the creation is not related to its ease of application or the affinity that the user has with it. However, the difficulty in dealing with the tool may distract the designers, being important to use tools that bring this balance between playfulness and systematics. The use of these tools provided greater collaboration among design students, teachers and users. Future initiatives should be undertaken in order to expand the study and increase the reliability of the research.

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