UNIVERSITY OF SÃO PAULO
ENGINEERING SCHOOL OF SÃO CARLOS
DEPARTMENT OF PRODUCTION ENGINEERING

**CRIAÇÃO DE PROPOSTAS DE SISTEMA PRODUTO-SERVIÇO NO
FUZZY FRONT-END**

Ana Paula Bezerra Barquet

São Carlos
2015

Ana Paula Bezerra Barquet

**CRIAÇÃO DE PROPOSTAS DE SISTEMA PRODUTO-SERVIÇO NO
FUZZY FRONT-END**

Doctoral thesis presented to the Engineering
School of São Carlos, University of São Paulo, to
achieve the title of Doctor in Production
Engineering

Concentration area: Process and Operation
Management

Supervisor: Prof. Tit. Henrique Rozenfeld

São Carlos
2015

AUTORIZO A REPRODUÇÃO TOTAL OU PARCIAL DESTE TRABALHO,
POR QUALQUER MEIO CONVENCIONAL OU ELETRÔNICO, PARA FINS
DE ESTUDO E PESQUISA, DESDE QUE CITADA A FONTE.

B223c Bezerra Barquet, Ana Paula
Criação de Proposta de Sistema Produto-Serviço no
fuzzy front-end / Ana Paula Bezerra Barquet; orientador
Henrique Rozenfeld. São Carlos, 2014.

Tese (Doutorado) - Programa de Pós-Graduação em
Engenharia de Produção e Área de Concentração em
Processos e Gestão de Operações -- Escola de Engenharia
de São Carlos da Universidade de São Paulo, 2014.

1. Sistema Produto-Serviço. 2. Fuzzy front-end. 3.
Proposta. 4. Modelo de negócio. I. Título.

FOLHA DE JULGAMENTO

Candidata: Farmacêutica **ANA PAULA BEZERRA BARQUET**.

Título da tese: "Creation of proposals of product-service systems on the fuzzy front-end".

Data da defesa: 05/03/2015

Comissão Julgadora:

Prof. Titular **Henrique Rozenfeld (Orientador)**
(Escola de Engenharia de São Carlos/EESC)

Prof. Associado **Daniel Capaldo Amaral**
(Escola de Engenharia de São Carlos/EESC)

Prof. Dr. **Glauco Henrique de Sousa Mendes**
(Universidade Federal de São Carlos/UFSCar)

Prof. Dr. **Eduardo de Sensi Zancul**
(Escola Politécnica/EP-USP)

Prof. Dr. **Timothy Charles McAloone**
(Technical University of Denmark)

Resultado:

aprovada

APROVADA

APROVADA

Aprovada

aprovada

Coordenador do Programa de Pós-Graduação em Engenharia de Produção
Profa. Associada **Daisy Aparecida do Nascimento Rebelatto**

Presidente da Comissão de Pós-Graduação:
Prof. Associado **Paulo César Lima Segantine**

Abstract

BARQUET, A. P. B. **Creation of Product-service systems (PSS) proposals in the fuzzy front-end**. 2015. 224f. Tese (Doutorado). Escola de Engenharia de São Carlos, Universidade de São Paulo, São Carlos, 2015.

Product-service systems (PSS), defined as a system of products, services, infrastructure, and networks that aims to satisfy customer needs, support business innovation and has the potential to lead to improved environmental performance. The adoption of PSS requires modifications in the business model of companies or even the creation of new ones. The decision to modify or create business models occurs in the fuzzy front-end through the development of proposals. In this sense, the creation of PSS proposals might assist the adoption of PSS business models in enterprises. However, companies still need support to adopt PSS business models due to three main reasons. First, most of the studies about PSS business models mention its importance but do not explore which content should compose such models. Second, PSS business models are explored considering a partial view of business model dimensions. Finally, there is a lack of methods and tools that support the adoption of PSS business models in the fuzzy front-end. Thereby, the aim of this study is to develop a method, named Configurator of PSS Proposals, to cope with these challenges and assist the creation of PSS proposals for current or new business models. By means of systematic literature review, consulting with experts and an explorative case study, the method was developed. It is composed by eight steps and each step addresses a business model dimension, e.g. value proposition. The steps encompass a range of tasks that must be performed in order to create a PSS proposal. To support carrying out the tasks, a help element is available. This help contains additional information to support the utilization of the method, such as: examples of companies that adopted PSS and hints of practices, methods and tools. To evaluate the method, it was applied through a case study in the context of a research project. The aim was to create a PSS proposal for a bicycle concept and verify whether the method reach its purpose, i.e. is able to support the creation of a PSS proposal. Final considerations include contributions and limitations of this study. An example of contribution of the method is provision of a shared knowledge about PSS between different areas of expertise. As limitation, the lack of application of the method in a real case is highlighted. Additionally, future research is addressed based mainly on the insights gathered in the second case study, e.g. the inclusion of new tasks and relations between them.

Keywords: Product-service system; fuzzy front-end; proposal; business model.

Resumo

BARQUET, A. P. B. **Criação de Propostas de Sistema produto-serviço (SPS) no fuzzy front-end**. 2015. 224f. Tese (Doutorado). Escola de Engenharia de São Carlos, Universidade de São Paulo, São Carlos, 2015.

Sistema produto-serviço (SPS), definido como um sistema de produtos e serviços, infraestrutura e networks e que visa aumentar a satisfação de clientes, auxilia na inovação nos negócios e tem o potencial de levar à melhoria de desempenho ambiental. A adoção de SPS requer a criação ou modificação dos modelos de negócios das empresas. A decisão de criar ou modificar um modelo de negócio ocorre no fuzzy front-end por meio da criação de propostas. Desta forma, acredita-se que criação de propostas para SPS auxilia na adoção de modelos de negócio para SPS. No entanto, empresas requerem auxílio na adoção de modelos de negócio para PSS devido a três principais motivos. Primeiro, a maioria dos estudos sobre modelos de negócio para SPS mencionam sua importância, porém não exploram o conteúdo que deve compor esses modelos. Segundo, pesquisas sobre modelos de negócio para SPS levam em consideração uma visão parcial das dimensões de modelos de negócio. Finalmente, é constatada a carência de métodos e ferramentas que auxiliem na adoção de modelos de negócio para PSS no fuzzy front-end. O objetivo desse trabalho é desenvolver um método, denominado Configurador de Propostas de SPS, que guie empresas na criação de propostas de SPS para negócios novos e existentes. Por meio de revisão sistemática de literatura, consulta com especialistas e um estudo de caso exploratório, o método foi desenvolvido. Ele é composto por oito passos e cada passo aborda uma dimensão do modelo de negócios, como por exemplo, proposição de valor. Ainda, cada passo engloba várias tarefas que devem ser executadas para que a proposta de SPS seja criada. Como suporte para realizar as tarefas, um elemento ajuda foi criado. Este elemento inclui exemplos de empresas que adotaram SPS e dicas de práticas, métodos e ferramentas. Com objetivo de avaliar o método, uma aplicação no contexto de um projeto de pesquisa foi realizada, por meio de um estudo de caso. O objetivo dessa aplicação foi criar uma proposta de SPS para um conceito de uma bicicleta e verificar se o método alcança seu propósito, que é ajudar na criação de propostas de SPS. Considerações finais incluem contribuições e limitações do estudo. Um exemplo de contribuição do método é o fornecimento de um conhecimento compartilhado sobre PSS entre diferentes áreas de conhecimento. A falta de aplicação do método em um caso real é uma das limitações deste trabalho. Adicionalmente, pesquisas futuras são sugeridas, como por exemplo, a inclusão de novas tarefas no método e novas relações entre elas, conforme sugerido pelos participantes do segundo estudo de caso.

Palavras-chave: Sistema produto-serviço; fuzzy front-end; propostas; modelos de negócio.

Table of Contents

1. Introduction.....	14
1.1 Context.....	14
1.2 Gap	15
1.3 Goal	18
1.4 Contribution and structure of the research	18
2. Research Method	20
2.1 Methodologic Aspects	20
2.2 Research Structure	22
3. Fuzzy Front-end and Business Model	31
3.1 Fuzzy Front-end.....	31
3.1.1 Characteristics	31
3.1.2 Conceptual Model	32
3.2 Business models.....	34
3.2.1 Dimensions	35
3.2.2 Business model design	36
3.2.3 Business Model Change	38
4. Product-Service System (PSS)	41
4.1 Concept.....	41
4.2 Classification.....	42
4.2.1 Product, use and result-oriented	42
4.2.2 Function-, availability-, and result-oriented	44
4.3 General characteristics	45
4.4 Benefits.....	46
4.5 Environment Issues	47
4.6 Practical examples of PSS.....	48

5. PSS business model.....	50
5.1 Concepts	50
5.2 Business model reference	52
5.3 Content of PSS business models	52
5.4 Methods to support PSS business model creation	54
5.4.1 PSS Innovation Scan (TUKKER; HALEN, VAN, 2003)	54
5.4.2 Methodology for Product-Service System (MEEPS)(HALEN et al., 2005)	
6. Creation of the first version of the Configurator of PSS Proposals	58
6.1 Context of the Configurator of PSS proposals utilization.....	58
6.1.1 Creation of PSS proposals in the fuzzy front-end.....	58
6.1.2 Relevant terms	59
6.2 Characteristics of the Configurator of PSS proposals	60
6.3 Elements of the Configurator of PSS proposals	61
6.3.1 Step 1: Analysis of the business context.....	63
6.3.3 Step 3: Definition of PSS characteristics	66
7. Application of the Configurator of PSS proposal in a case study	68
7.1 Company profile	68
7.2 Execution of the case study.....	69
7.2.1 Step 1: Analysis of the business context.....	69
7.2.2. Step 2: Creation of PSS alternatives	70
7.2.3 Step 3: Definition of PSS characteristics	77
7.3 Insights from the Configurator application	82
7.3.1 Advantages of the Configurator.....	82
7.3.2 Disadvantages of the Configurator	83
8. Creation of the second version of the Configurator of PSS Proposals.....	85

8.1 Removal and creation of steps.....	86
8.2 Addition of content on each step.....	87
8.2.1 Methods and tools	88
8.2.2 Development of the content.....	92
8.2.3 First round of experts evaluation.....	113
8.2.4 Literature reviews on service and PSS attributes	117
8.2.5 Second round of experts evaluation	123
8.2.6 Deployment of attributes in tasks.....	126
8.2.7 Inclusion of help in the method	133
8.3 Considerations about the second version of the method	139
9. Test of the Configurator of PSS proposals	141
9.1 Profile of the research project	141
9.1.1 Profile of the researchers.....	141
9.1.2 Result of the research project: PSS concept	142
9.2 Application of the method	144
9.2.1 Introduction to the method	144
9.2.2 Step 2: Configure Customer Segment.....	146
9.2.3 Step 3: Configure Value Proposition.....	147
9.3.3 Step 4: Configure Customer Relationship.....	148
9.3.4 Step 5: Configure Business Processes and Network of Partners.....	149
9.3.5 Step 6: Configure Resources.....	150
9.3.6 Step 7: Configure Revenue Streams	151
9.3.7 Step 8: Configure Cost Structure	152
9.3.8 Tasks 5.9 to 5.14	153
9.3 Considerations about the application	153
9.4 Evaluation of the method	154

9.4.1 Evaluation from Knowledge Management Researcher	156
9.4.2 Evaluation from Process Modelling Researcher.....	157
10. Final Considerations	159
10.1 Results obtained.....	159
10.2 Contributions and limitation of the research	160
10.3 Future research	162
References	164
Appendix 1 – SLR Protocol.....	181
Appendix 2 – SLR Protocol.....	187
Appendix 3 – Configurator of PSS proposals.....	193
Appendix 4 – PSS proposal for the Pedelec case.....	253

List of Figures

Figure 1 - Research approach, methods and phases	22
Figure 2 – Conceptual model of the fuzzy front-end	33
Figure 3 - Canvas Business Model.....	37
Figure 4 – Template for business model design	38
Figure 5 – Types of PSS.....	42
Figure 6 - Six steps of the PSS innovation scan	55
Figure 7 – Five steps of MEEPS.....	57
Figure 8 – Context of the definition and development of proposals	59
Figure 9 - The steps, inputs and outputs of the proposed method.....	62
Figure 10 - Inputs and outputs of Step 1.....	63
Figure 11 - Inputs and outputs of Step 2.....	65
Figure 12 - Inputs and outputs of Step 3.....	66
Figure 13 – Representation of the method with the disadvantages	85
Figure 14 – Steps of the Configurator of PSS proposals	126
Figure 15 – Steps and the content of the Configurator of PSS proposals...	139
Figure 16 - Representation of the second version of the Configurator of PSS proposals.....	140
Figure 17 - Drawing from the first ideas for the PSS concept.....	143
Figure 18 – Introduction part of the method.....	145
Figure 19 - Instructions on how to use the method.....	145
Figure 20 – Part of the step 2 of the method	146
Figure 21 – Part of the step 3 of the method	148
Figure 22 – Part of the description of options and attributes placed in the method	148
Figure 23 – Part of step 4 of the method	149

Figure 24 – Consulting step 3.5 of the method.....	149
Figure 25 – Part of the step 5 of the method	150
Figure 26 – Part of the step 6 of the method	151
Figure 27 – Part of step 7 of the method.....	152
Figure 28 – Part of task 8 of the method	152
Figure 29 – Evaluation of the method and the proposal by Participant C...	156
Figure 30 - Evaluation of the method and the proposal by Participant D ...	157

List of Tables

Table 1 - Stages of SLR	27
Table 2 - Description of the business model dimensions.....	36
Table 3 - PSS advantages for customers and companies	46
Table 4 - Business model definition within PSS context	51
Table 5 – Business model reference within PSS context.....	52
Table 6 - PSS characteristics classified according to business model dimensions	53
Table 7 – Research topic utilized to deploy elements of the method	61
Table 8 –Meaning of acronyms of Figure 9	62
Table 9 - Alternatives derived from types of PSS and business model change	65
Table 10 - PSS alternatives of Company A	70
Table 11 - Modifications of alternative 1	72
Table 12 - Modifications required for of alternative 2	74
Table 13 - Modifications required for of alternative 3	75
Table 14 - Modifications adressed on alternative 4	76
Table 15 - Disadvantages and actions of improvement on the Configurator	85
Table 16 - Business model reference for PSS.....	86
Table 17 – Characteristics of strategies and possible variations	88
Table 18 – Example of elements from templates strategy and protocol	90
Table 19 – Example of a feature and possible specifications	91
Table 20 – Examples of characteristics and attributes.....	91
Table 21 – Correspondence between terms used on different reseach.....	92
Table 22 – Clarification of the terms attributes and options	93

Table 23 – Attributes of customer segment identified on typologies of product development projects.....	93
Table 24 - Attributes of value proposition identified on typologies of product projects	95
Table 25 – Attributes of processes and activities identified on typologies of product development projects.....	99
Table 26 - Attributes of partnership identified on typologies of product development projects.....	100
Table 27 - Attributes of resources identified on typologies of product development projects.....	101
Table 28 - Attributes of customer segment identified from typologies of PSS	103
Table 29 - Attributes of value proposition identified from typologies of PSS	104
Table 30 – Attributes of customer relationship identified from typologies of PSS.....	105
Table 31 – Attributes of processes and activities identified on typologies of PSS.....	107
Table 32- Attributes of distribution channel identified on typologies of PSS	108
Table 33 – Attributes of partnership identified from typologies of PSS.....	109
Table 34– Attribute of resource identified on typologies from PSS.....	110
Table 35 – Attributes of cost structure identified from typologies of PSS...	110
Table 36 - Attribute of revenue streams identified from typologies of PSS	111
Table 37 – Dimensions covered by attributes of PSS and product project.	112
Table 38 – Profile of the experts	114
Table 39 – Attributes excluded from the database (information available later)	114
Table 40- Attributes excluded from the database (not proposal related)	115

Table 41 – Attributes excluded from the database (options not relevant) ...	115
Table 42 – Attributes created from mixing or derivation of other attributes and their respective dimensions before and after the evaluation.....	116
Table 43 – Attributes created and their respective dimensions.....	116
Table 44 – Attributes identified on service project typologies	118
Table 45 – Attributes from service project typologies included on the PSS configuration database.	119
Table 46 - Attributes included on the PSS configuration database	120
Table 47 – Modification on attributes and options of the PSS configuration database	121
Table 48 – Options included on attributes of the PSS configuration database	122
Table 49 - Profile of the experts.....	123
Table 50 – Attributes removed from the PSS configuration database	124
Table 51– Modification of attributes of the PSS configuration database.....	125
Table 52– Number, title of steps and business model dimension corresponding.....	125
Table 53 – Tasks of step 1	127
Table 54 - Tasks of step 2	128
Table 55 – Tasks of step 3	128
Table 56 – Tasks of step 4	129
Table 57 – Tasks of step 5	130
Table 58 – Tasks of step 6	131
Table 59 – Tasks of step 7	132
Table 60 – Tasks of step 8	132
Table 61 – Symbols to represent the help	133
Table 62 – Correspondence between step, task and examples of real cases.	133

Table 63 - Correspondence between step, task and hints of practices.....	135
Table 64 - Correspondence between step, task and methods and tools....	136
Table 65 - Correspondence between steps and tasks related	138
Table 66 – Relations developed for the method.....	138
Table 67 – Profile of the researchers participating on the case study	141
Table 68 - Benefits recognized through the PSS offer and the needs attend by them	147
Table 69 – Partial results of task 6.6	151
Table 70 – Partial results of task 8.3	153
Table 71 - Evaluation criteria utilized, questions and elements evaluated .	154
Table 72 – Question 19 of the evaluation questionnaire	155
Table 73 – Weak and strong points according to participant C	157
Table 74 - Weak and strong points according to participant D	158
Table 75 – Elaboration of strings.....	182
Table 76 - Elaboration of strings	185
Table 77 - Elaboration of strings	188

List of Abbreviations and Acronyms

B2B - Business-to-business

B2C - Business-to-consumer

B2G - Business-to-government

CVP – Customer Value Proposition

CRC - Collaborative Research Centers

EoL – End-of-life

IPS2 - Industrial Product-Service System

PSS - Product-Service System

SLR – Systematic Literature Review

USP – University of Sao Paulo

1. Introduction

1.1 Context

Growing competitiveness and market demands drive companies on seeking new ways to create and deliver value to their customers. Develop high quality products and offer low prices and are not enough when it comes to reach differentiation and superiority among manufacturing enterprises. Other factors are essential, e.g. to consider sustainability and innovation aspects on the business. In this sense, the approach named Product-Service System (PSS) is pointed as an alternative for enterprises aiming to include these factors in their businesses.

PSS is an approach that changes the focus of the business from the development and selling of physical products to a system composed by products and services, which can comply with clients' specific needs (MANZINI; VEZZOLI, 2003). Tan (2010) defines PSS as a new approach that integrates activities and competences of an organization and intensifies the relationship between clients and partners in the value chain. Tan (2010) and Manzini e Vezzoli (2003) believe that the development of PSS is an expansion of product development scope.

Environmental and economic benefits can result from PSS implementation. E. g. when the PSS provider owns the product, it can have parts recovered through end-of-life strategies, such as recycling, remanufacturing and reconditioning when the product reaches end-of-life. Thereby, after recovered, it can be commercialized again and start another use phase. The utilization of less resources to launch the product back into the market results in both environmental and economic benefits (MONT, 2002; BAINES et al., 2007). In addition, economical motivation to adopt PSS is related to the increase of profit by delivering services and not just selling products (MEIER et al., 2010).

The PSS is an alternative for companies seeking business innovation. The paradigm of developing solutions only in the form of physical products to be sold must be broken, because value is not necessarily provided through the sale of the product, but by means of the functionality or result it can generate. Thereby, PSS does not address only the configuration of service and product components, but also

the configuration of business models (GELBMANN; HAMMERL, 2014). Business models represent how companies create and deliver value to its clients based on their strategic choices (ELBERS, 2010) and enable to express simplified description and representation of the business logic of a firm (OSTERWALDER et al., 2005).

Tan (2010) states that the business model concept is useful to characterize PSS, since its implementation often requires the redefinition or creation of new business models (TISCHNER et al., 2002).

The decision about creating or modifying a business model takes place in the fuzzy front-end. The fuzzy front-end is a planning phase that encompasses activities performed prior to the development of technologies (KOEN *et al.*, 2001), products and/or services or new business (OLIVEIRA *et al.*, 2011). It is during the fuzzy front-end that ideas and concepts are shaped and justified before they receive approval to move to development stages (SPERRY; JETTER, 2009). The fuzzy front-end has as input the identification of an idea or opportunity and outputs a proposal for new product, service, technology or business (COOPER, R. G., 2001; CRAWFORD; BENEDETTO, 2006). The proposals, also named as business case (COOPER, R. G., 2001) (OLIVEIRA *et al.*, 2011), covers information about the potential market to be reached, customer needs and technical and financial analyses to support final decision-making (KOEN *et al.*, 2001).

In this sense, the creation of PSS proposals on the fuzzy front-end might support the adoption of PSS business models. This study defines PSS proposal as a document elaborated based on strategies, ideas, opportunities or concepts and created during fuzzy front-end, which contain the description of PSS business a company intends to develop. These proposals need to be evaluated and selected to be further developed.

1.2 Gap

Recent PSS studies highlighted the fact that business models are essential to implement PSS successfully (MONT et al., 2006; MEIER; BOSSLA, 2013; REIM et al., 2014). However, orientation on how companies should plan and implement PSS business models is still very limited (BAINES et al., 2007; MEIER et al., 2010; REIM et al., 2014).

The lack of guidance on how to create PSS business model might be related to some factors. First, there is a lack of agreement about the definition of PSS business model (RESE et al., 2012) because there is few fundamental research developed on business models for PSS (MEIER; BOSSLA, 2013). Yet, several studies define PSS as a business model per se (GOEDKOOPE et al., 1999; TUKKER, 2004; KUO et al., 2010; NEMOTO et al., 2013). In that case, they do not explore which content should compose such business models.

Other researches discuss about PSS characteristics, elements or attributes when addressing the content of PSS business models (MANZINI; VEZZOLI, 2003; TAN; MCALOONE, 2006; ISAKSSON et al., 2009; GRÖNROOS, 2011; RESE et al., 2013). These characteristics are dispersed on the literature although their identification and systematization might facilitate the creation of PSS business models. Through the acknowledgement of these characteristics, companies might discover new opportunities in their current business models or identify new ideas that can become future successful businesses (TAN; MCALOONE, 2006).

Second, these studies explore PSS business models taking into account a partial view of a given business model, i.e. they consider just some business model dimensions. Business models are complex systems, therefore it is suggested to decompose it in subsystems known as dimensions. Dimensions should be analyzed in detail in order to reach a deeper understanding of business models (RESE et al., 2012).

The investigation of partnership to deliver PSS (KRUCKEN; MERONI, 2006) and financial aspects of PSS (ERKOYUNCU et al., 2011) are examples of exploring distribution channels and cost structure respectively, which are two business model dimensions. Nonetheless, it is important to consider the complete set of business dimensions when defining a business model, e.g. value proposition, customer segment, revenue streams.

Business model researchers affirm, that the examination of only a few business model dimensions might lead to partial optimization of the business (LINDER; CANTRELL, 2001). In the PSS literature, some authors agree in this regard, when they state that clients and suppliers involvement, distribution channel, activities during the whole product lifecycle, partners network, product type, clients

need, product and service strategies and stakeholders relationship should be explored in order to create PSS business models (MANZINI; VEZZOLI, 2003; TAN, 2010). However, there is a lack of research that takes into account all these aspects in an integrated manner. Thereby, an incomplete view of PSS business model is generated and disseminated.

Third, there is a lack of methods and tools that support the adoption of PSS business models in the fuzzy front-end. PSS Researches do not differentiate between activities executed in the planning phases, like fuzzy front-end, from the ones performed for PSS implementation (TAN, 2010).

Wagner et al. (2012) performed a systematic literature review with the purpose to analyze the fuzzy front-end for PSS development. The authors concluded that none of the studies identified provides a useful method or tool for PSS on the fuzzy front-end. The need for a systematic and holistic method to plan and implement PSS is stated. Meuris et al. (2014) also affirm that the existing methods and tools for PSS are insufficient for an exclusive use in the fuzzy front-end.

Additionally, there is a low common understanding between the different functional areas that should work together to plan a business for PSS. The combination of a set of competences and qualifications from the tactic and strategic management level is a key aspect for developing PSS business models. The requirement of a multifunctional team becomes relevant when considering the dimensions of a PSS business model, such as value proposition and revenue streams (MEIER; BOSSLA, 2013). Yet, both the need to have a lifecycle overview and the product-service integration enhance the challenge of acquiring a broad diversity of information and knowledge that should come from different parts of the value chain (JOHANSSON *et al.*, 2011).

Jetter (2003) states that a reason for the lack of tools encompassing the knowledge of different expertise areas is the difficulty to consider the variety of visions and languages from those areas in order to give a holistic and systematic understanding for all involved.

In order to create PSS proposals on the fuzzy front-end, the holistic and multifunctional overview suggested by Jetter (2003), Johansson *et al.* (2011) and Meier; Bossla (2013) is required since it covers the business development and the

need of knowledge and information from different areas of expertise. Thus, the creation of PSS proposals provides a holistic overview and also supports the understanding on how to develop a PSS business model.

Finally, few researches investigate PSS on the fuzzy front-end. Kuo (2010) treats the decisions of selecting PSS offers. Nevertheless, the author considered only the PSS commercialization to make the selection. Lin *et al.* (2010) researched about the selection of PSS strategies aiming to verify which is the best way to integrate different types of products and services. Thus, the focus was only on products and services and no other business information relevant for the development of PSS proposals was considered.

Meuris *et al.* (2014) developed a framework named Product Service Innovation Framework (PSIF), an IT tool which aims at integrating various methods and models to be used on early PSS design phases in one development environment. The purpose of this framework is to assist the design phase and the business model creation is not the focus.

No methods and tools for to support the creation of PSS proposals were identified in the literature.

1.3 Goal

The goal of this research is to develop a method that guides the creation of PSS proposals for a current or new business model. The method, named Configurator of PSS Proposals, might be used during fuzzy front-end phase.

1.4 Contribution and structure of the research

Despite PSS is an approach that is growing in importance on academic literature and research, it is a new topic for enterprises. Therefore, its literature is composed mainly by exploratory and descriptive studies, which cover concepts, challenges and benefits of PSS. Aiming to give a step further, this research seeks to improve PSS literature by proposing a prescriptive method to help in the creation of PSS proposals.

In addition, this study aims to increase the understanding and thus stimulate the adoption of PSS by companies.

This research is organized in ten sections. On section 1, context, goal and contribution are presented. Section 2 describes the research method, which involves methodologic aspects and research structure. Section 3 present a literature review about PSS and section 4 about fuzzy front-end and business model. Section 5 explores PSS business models literature. Section 6 presents the development of the first version of the method, named Configurator of PSS proposals, detailing the context of utilization of the method and the elements that compose it. Section 7 describes the application of the method by means of a case study aiming to test and improve the Configurator of PSS proposals. Section 8 shows the improvements that led to the proposition of the second version of the method. The second version is also applied in another case study. This application is presented on section 9. Finally, section 10 exhibits the final considerations, including limitation of this research and suggestion of future studies.

2. Research Method

This chapter presents the methodologic aspects and research structure utilized to reach the goal of this study.

2.1 Methodologic Aspects

The nature of a research varies according to the evolution of its knowledge field. Four levels of evolution can be identified: exploratory, descriptive, prescriptive and normative (KARLSSON, 2009).

The initial development stage of a knowledge field is characterized by researches on concepts, typologies and definitions and is classified as exploratory. On the next level, named descriptive, the description of phenomena that generate structures and standards can be observed (KARLSSON, 2009).

The third level, known as prescriptive, enables the creation of models and representation of relationship between components. Thus, it is possible to find the prescription of new models in order to explain phenomena. On the next and last level are the normative researches, which aim to understand casual relationships and thus predict effects and elaborate tools to implement concepts on practical cases (KARLSSON, 2009).

Therefore, following the four levels of evolution in a knowledge field, a research must be able to explore before describe, identify components before define relationships between them in order to, finally, be able to predict effects (KARLSSON, 2009).

This research can be classified as prescriptive as it proposes the creation of a method to support the elaboration of PSS proposals. Since this research aims to resolve problems faced by companies and generate academic and empirical knowledge, this study is considered applied research (KARLSSON, 2009).

Concerning the research approach, researches can be classified as inductive or deductive. On the one hand, the inductive approach characterizes a study that starts from knowledge acquired empirically and utilize it to propose new theories about the phenomena observed. On the other hand, the deductive approach

emcompasses first the development of a conceptual and theoretical structure that should be further tested. The conceptual structure of this study is the configurator of PSS proposals. Before testing it, the method is improved by the execution of a case study to refine theory. Therefore, a second and improved version of the method is tested. When the tested structure is corroborated, the theory is established as a valid. However, as Karl Popper stated, no theory can be proven by means of a finite amount of observations. In order to be falsified, a theory requires only one contradictory observation. Therefore, a theory can never be proven as completely true since there is always a possibility of falsifying it. In order to test the theory, hypotheses are created and attempt to falsify them though empirical applications are made. This approach is named hypothetic-deductive (GILL; JOHNSON, 2002).

This study advocates the hypothesis that the Configurator of PSS proposals can support the creation of PSS proposals. In order to test this hypothesis a case study is performed. It can be noticed that the case study method is utilized in two moments and for two different reasons. This is in accordance with Eisenhardt (1989), who affirms case studies can be utilized to refine as well as to test theories.

Moreover, Dul e Hak (2008) state that the execution of a single case study is the preferable research strategy to test propositions when experiments cannot be performed, which is a common situation on management field research. A single study is utilized to test the hypothesis of this research. One study cannot provide generalization, but can be used to enhance the utility of the theory. However, even if the hypothesis is not refuted on this case study it does not mean that the same hypothesis cannot be falsified on future cases.

Figure 1 shows the relationship between the research approach, methods and research phases.

Figure 1 - Research approach, methods and phases (Adapted from (PIGOSSO, 2012))

2.2 Research Structure

This study is organized in five phases, which encompass:

- Exploration of knowledge and existing theories by means of literature review;
- Theoretical development of the Configurator of PSS proposal (first version);
- Case study to explore and to improve the Configurator of PSS proposal;
- Theoretical development of the Configurator of PSS proposal (second version).
- Case study to test and to try to refute the Configurator of PSS proposal;

Each of these phases is divided in activities, as described next.

Phase 1- Exploration of previous knowledge and existing theories

The execution of this phase aims at acquiring knowledge about researches been developed on PSS field and the identification of gaps concerning this topic.

Moreover, concepts and definitions concerning other topics of this research are presented, named fuzzy front-end and business model.

Activity 1.1 Literature research about Fuzzy front-end and Business models

This activity involves the description of concepts, inputs and outputs, as well as stages of the fuzzy front-end. Furthermore, business models are defined and characterized. In addition, the one utilized as reference on this study is explored. The results of this activity are presented in section 3.

Activity 1.2 Literature research about PSS

Concepts, classifications, characteristics, benefits, practical examples of PSS adoption are addressed. The results of this activity can be visualized in section 4.

Activity 1.3 Literature research about PSS business models

This activity explores definitions of PSS business models. In addition, business model utilized as reference on the PSS literature are presented as well as the content of these business models, i.e. PSS characteristics. Methods that support the adoption of PSS business model are also presented. Results of this activity are shown in section 5.

Phase 2 - Theoretical development of the Configurator of PSS proposal (first version)

Phase 2 presents the development of the first version of the Configurator of PSS proposals. Details about the creation of the method are explained. The activities of phase 2 are described below and are presented in section 6.

Activity 2.1 Contextualize the method

Elements described on phase 1 are utilized to explain the context in which the Configurator of PSS proposals should be utilized. Yet, relevant terms for this study are also clarified.

Activity 2.2 Characterize the method

This activity aims to describe the goal and scope of the method. In addition, the user of the method is defined as well as the variables that influence the time

required to apply the method. Finally, the requirements to use the method are clarified as well as its expected results.

Activity 2.3 Structure and content of the method

This activity embraces the definition of the elements of the method based on research topics addressed by the literature review (phase 1). Examples of elements of the method that should be defined are steps, inputs and outputs.

Phase 3 – Empirical development of the Configurator of PSS proposals

The third phase of the research presents an application of the first version of the Configurator. This application is carried out by means of a case study. The goal of this phase is to explore how the Configurator should be used based on the practical experience gained in a real application. This type of case study provides new insights and ideas on how to better structure theory taking into account the observed results (VOSS *et al.*, 2002). Thereby, the improvement of the Configurator is based on the results observed during its application. The results of this phase are available on section 7.

The activities of Phase 3 are:

Activity 3.1 Planning the case study

The tasks of this activity embraces answering some questions in order to plan the execution of the case study (VOSS *et al.*, 2002):

- Which are the goals of the case study?
- Which are the units of analysis?
- What are the topics of interest that should be explored?
- How many cases are going to be performed?
- Which are the criteria to select the company and person that should participate in the case?
- What instrument is going to guide the execution of the case?

The goal of the case study is to enhance the Configurator of PSS proposals through a real case. The unit of analysis is the business unit responsible for planning or improving business. The topic of interest is the creation or improvement of business models through a PSS adoption.

Thereby, the company selected to participate on the case must be wishing to start a PSS business or improve a current one. This covers product or service oriented companies, PSS providers, startups and new business units.

The execution of the case study occurs by means of a workshop with members of one selected company. The method utilized to acquire data is direct observation (VOSS *et al.*, 2002) performed during the workshop.

The criteria to select the company are two:

- The interest to adopt or to improve a PSS business model;
- The availability of at least two representatives of different functional areas with interface on the development of product and services, such as marketing, sales, engineering and manufacturing to participate on the case study.

Finally, the instrument used to guide the case is the Configurator of PSS proposals itself.

Activity 3.2 Execution of the case study

The case study is conducted following the steps of the Configurator of PSS proposals. The tasks carried out to apply the configurator are:

- Schedule meetings with the company in order to present the Configurator and to make the invitation for participating on the case study;
- Apply the Configurator by means of workshops with company representatives;
- Register the results of the application;
- Collect and register feedback of the company representatives regarding the application of the Configurator.

Activity 3.3 Systematize the insights gathered during the case study

This activity covers the analysis of the insights collected by means of the application of the Configurator. The insights are registered through notes made by the author during the execution of the case. These insights are classified in two types, which are: advantages and disadvantages of utilizing the Configurator. The tasks of this activity are:

- Identify the insights;

- Describe the disadvantages highlighted.

Phase 4 - Theoretical development of the Configurator of PSS proposal (second version)

During this phase, the first version of the Configurator of PSS proposals is improved by means of the insights gathered on the case study (Phase 3), resulting in the second version of the Configurator.

Activity 4.1 Define actions of improvement

After the systematization of the insights to be taken into account on enhancing the Configurator, the improvements are described and justified based on the disadvantages pointed out in the Configurator. The methods applied to deploy the actions of improvement are:

- Systematic literature reviews;
- Assessments within experts.

Activity 4.2 Systematic literature review

The systematic literature review (SLR) is a technique utilized to map the different studies published about a specific topic, which supports the elaboration of synthesis about its current status of knowledge (BIOLCHINI *et al.*, 2007). The SLR provides higher levels of confiability, transparency and replication possibilities (COOK *et al.*, 1997) as it is a systematic approach (CONFORTO *et al.*, 2011).

Conforto *et al.* (2011), based on Levy e Ellis (2006), define SLR as a process of collecting, understanding, analyze, synthesize and evaluate a set of scientific articles in order to create a scientific theoretical basis about a specific topic.

A roadmap was developed by Conforto *et al.* (2011) in order to provide steps to perform systematic literature reviews. This roadmap, named SLR roadmap, was created based on the best practices used on the execution of SLR in other knowledge field, such as medicine, and aims to support SLR on the field of operations management.

The SLR roadmap is composed by 15 stages organized in three phases. Table 1 summarizes each of the roadmap stages. It should be pointed out that the stage 1.6 is not applied on this research, which means qualification criteria are not

utilized. In this sense, if an article is selected to be completely read and it presents relevant information for this study, it will be included independently from the impact factor of the journal, research method and amount of citations. The main explanation for the decision of not performing stage 1.6 relies on the fact that PSS literature is new and most of the publications can be found on conferences and not in high impact journals. The protocol used on the SLRs can be visualized on Appendix 1.

Table 1 - Stages of SLR

Stages	
1.1	Problem: description of the problem that the SLR aims to solve.
1.2	Goal: definition of the goal of the SLR, which is the starting point to define the inclusion criteria.
1.3	First sources: exploration of articles, journals and data base that are relevant for the study and useful to define the key words and the main authors and papers of the research field.
1.4	Strings: definition of the set of key words and the operators between them (AND, OR, NOT). The strings should be tested before deciding about utilize them on the study.
1.5	Inclusion criteria: aim to ensure that the sample of articles identified is in accordance with the goal of the SLR.
1.6	Qualification criteria: ensure the quality of the sample of articles and might include impact factor of the journal, research methods, amount of citations.
1.7	Method and tools: definition of search stages, filters, tools to store data.
1.8	Timeline: estimation of the time required to perform the SLR.
2.1	Execution of search: search on each data base selected, using the strings defined. Adaption of the strings might be necessary and new cycles of search required.
2.2	Analysis of results: encompasses the read of the articles and use of the search filters. This analysis can also lead to the identification of other articles, by means of the cross references.
2.3	Documentation: store the articles in software that allows the management of references and extraction of data from a SLR.
3.1	Alerts: register alerts in the main journals on the research by means of the strings. This action can support the monitoring of new publications.
3.2	Registration: selected articles must be organized through the support of a reference management software.
3.3	Summary of results: the summary of results should present the main authors, evolution of knowledge, terms utilized.
3.4	Theoretical models: when the SLR is based in a hypothesis, the model resulted from the prove or disprove of this hypothesis is the main result of the SLR.

One of the major differentiators of the SLR roadmap procedure is the interactivity of the activities its stage 2. It means that after conducting the search and analyzing and documenting the results, an adaptation of the search strings may be

required. In that case, the three activities mentioned should be repeated, which leads to a new cycle of research.

Activity 4.3 Assessments within experts

This activity aims to evaluate the new content of the Configurator (generated through systematic literature reviews). The evaluation might involve experts from innovation, business management and PSS fields. Based on their previous knowledge, experts are able to evaluate content and contribute to its improvement (LANCASTER, 2005). The evaluation is performed by means of interviews with the experts using a questionnaire. The questionnaire inquires the experts about the relevance of the new content of the method for supporting the creation of PSS proposals. The planning of such interviews are based according to Lancaster (2005):

- Define the goal of the interviews and the topics to be assessed;
- Identify and approach the experts;
- Schedule the interviews;
- Conduct the interviews.

Activity 4.2 Systematization results

Results gathered from the SLRs and experts evaluations are systematized to support the development of the second version of the method.

Phase 5: Verification of the application of the Configurator of PSS proposals

The goal of this phase is to verify if the application of the Configurator of PSS proposals support the creation of PSS proposals during the fuzzy front-end. The results of this phase are presented on section 9.

The Configurator is applied by means of a case study. Dul and Hak (2008) define this case study method as a qualitative investigation of one or more cases on their real context. As already mentioned, the execution of case studies relies on different purposes and the goal on phase 5 is to try to refute a theory by testing it (VOSS *et al.*, 2002).

The execution of the case study occurs by means of a workshop with members of an academic multidisciplinary research project in the engineering field. The insights and opinions of the participants are acquired and registered during the

workshop. Together with an evaluation questionnaire, they are utilized to evaluate whether the application of the Configurator supports the creation of PSS proposal. The activities of Phase 5 are:

Activity 5.1 Planning the case study

As mentioned on Phase 3, the tasks of this activity embraces answering some questions in order to plan the execution of the case study are (VOSS *et al.*, 2002):

- Which are the goals of the case study?
- Which are the units of analysis?
- What are the topics of interest that should be explored?
- How many cases are going to be performed?
- Which are the criteria to select the company and person that should participate in the case?
- What instrument is going to guide the execution of the case?

First, the goal of the case study is to verify the application of the Configurator of PSS proposals in a case of creating or improving a PSS business model when strategies, ideas, concepts or opportunities are available.

The unit of analysis is to be part of the specific research project in the engineering field and responsible for developing business models. The topic of interest is the creation or improvement of PSS business models.

As already mentioned on 2.1 Methodologic Aspects, the hypothesis will be tested in one case study. The researches selected to participate on the case must be members of the academic multidisciplinary research project in the engineering field and from different knowledge areas of expertise, such as development of product and services, marketing and manufacturing. Yet, they should be interested to adopt or improve a PSS business model. The instrument used to execute the case is the Configurator of PSS proposals itself.

Activity 5.2 Execution of the case study

The case study is conducted following the steps of the method Configurator of PSS proposals. The tasks carried out to execute the case are:

- Schedule meetings with the members of the project selected to participate on the case in order to present the Configurator;
- Apply the Configurator by means of workshops with them;
- Register the results of the application;
- Evaluate the Configurator with the participants of the case.

Activity 5.3: Analysis of the results

In order to assess whether the hypothesis of the research is confirmed or rejected, the participants of the case study should evaluate the Configurator and the results obtained by means of its application. To reach this aim, a questionnaire is answered by the ones participating in the case.

Both, the results of the case study and the assessment performed by the participants of the case are utilized to verify whether the hypothesis advocated in this research can be confirmed or rejected.

The criteria utilized to deploy the questions, adapted from Vernadat (1996), are consistency, completeness, scope, broadness, precision, depth, simplicity, objectivity, coherence and instrumentability. Pigosso (2012) also used those criteria in order to deploy the questions utilized to evaluate the application of a method by participants of a case study.

3. Fuzzy Front-end and Business Model

As mentioned on the activity 1.1 of the research method, this section presents concepts and characteristics of the fuzzy front-end. In addition, business models are presented, as well as its dimensions and the types of business model changes.

3.1 Fuzzy Front-end

The fuzzy front-end, a planning phase, is composed by activities undertaken before the development of technologies, products and/or services or new business (KOEN, *et al.*, 2001).

3.1.1 Characteristics

The main characteristics of the fuzzy front-end, according to Jetter (2003) and Koen *et al.* (2002), are:

- Uncertainty, imprecision and constant change of information;
- Information are processed from different functional areas;
- Necessity to transfer and store knowledge based on a common understanding;
- Holistic and systemic overview are required;
- The scope is broad and superficial;
- The nature of the work is experimental, chaotic, complex to plan and with creativity moments.

From these characteristics, one of the most mentioned on the literature is the uncertainty: market, technology, environment uncertainty or even on the resources allocation (JETTER, 2003). Uncertainty is the difference between the known information about a specific subject and the relevant information that should be known to support the decision making or the execution of an activity but it is not known yet (GALBRAITH, 1974).

The uncertainties and also the dynamism of the required and generated information during the fuzzy front-end hamper the adoption of a structured approach to manage this process (MURPHY; KUMAR, 1997). That is why the processes approach is not appropriate to study complex process like the fuzzy front-end. Some authors indicate the approach based on information processing, also known as

approach based on the uncertainty reduction (MOENAERT *et al.*, 1995), to be used on the fuzzy front-end management. This approach focuses on the analysis of the information being processed over the fuzzy front-end. Therefore, it is assumed that in the beginning of the process there is zero knowledge or maximum level of uncertainty about the information and in the end of the process there is complete knowledge about the information or minimum level of uncertainties. Yet, it can be noticed that the information has a primary role and the activities, a secondary one (OLIVEIRA *et al.*, 2011).

The information processing approach is more flexible and adapted to consider the iterative and complex characteristics from the fuzzy front-end (OLIVEIRA *et al.*, 2011).

Despite the relevance and influence of the fuzzy front-end on the performance and success of the development process (GRIFFIN, 1997; COOPER, R. G., 2001), mostly is it a small team or just one person who takes part of this process and make decisions (KOEN *et al.*, 2002). This fact may influence the efficacy of such decisions as the knowledge about certain functional areas can be missing, which may lead to inappropriate decisions.

Therefore, besides the lack of information, which causes uncertainties, the lack of knowledge is also a challenge to be faced when it comes to the creation of project proposals during the fuzzy front-end.

Moenaert *et al.* (1995) remarks the advantages of creating an innovation team, composed by employees of different functional areas who are able to find or have the knowledge on the required information. Then, information about market, product and technology but also about resources, costs and revenues could be known and utilized during the fuzzy front-end to assist the creation of more robust and complete project proposals, which could increase the chances of success on the approval of this proposals for development.

3.1.2 Conceptual Model

Oliveira *et al.* (2011), through a systematic literature review, performed a synthesis of the models utilized to define the activities and characteristics of the fuzzy front-end.

After that, a conceptual model with different elements was proposed, as shown in Figure 2.

Figure 2 – Conceptual model of the fuzzy front-end (Adapted from OLIVEIRA *et al.*, 2011)

The most important fuzzy front-end elements for the scope of this research, which are inputs, outputs and phases, are presented in accordance with the conceptual model of Oliveira *et al.* (2011).

Stages

The three main stages of the fuzzy front-end are: opportunity identification, concept generation and project definition. In spite of the linear sequence demonstrated on the conceptual model, the inputs of the fuzzy front-end can go straight to any of the three stages. This will depend on the characteristics and level of abstraction of the input. The deliverables of each stage are: opportunity, concept (of product, service, product-service combination, technology or business) and project proposal, respectively.

Inputs and Outputs

The inputs of the fuzzy front-end are strategies, innovations and ideas. As the ideas could have different abstraction levels, it represents the generalization of the terms thought, solution or even a concept in textual or graphical form. They can emerge unexpectedly or from the identification of an opportunity (CUNHA, 2011). The outputs of the fuzzy front-end are project proposals. These proposals can be of a

product, service, product or service combination, technology or business (OLIVEIRA *et al.*, 2011).

3.2 Business models

Shafer *et al.* (2005) defines a business model as a tool that represents the company's core logic and communicates the strategic orientation. According to Elbers (2010), it describes how a company creates, delivers and captures value based on its strategic choices. It consolidates customer needs and ability to pay, defines the manner a company delivers value to customers, attracts customers to pay for the offering, and converts those payments to profit by performing the proper design and operation of the value chain (TEECE, 2010).

A business model might become part of a business plan. However, it should not be considered a spread sheet or a computer model. A business model is a conceptual, rather than financial, model of a business. It embodied the organizational architecture of the business and articulates the information that support the creation of a value proposition for the customer and a viable structure of revenues and costs (TEECE, 2010).

The functions of a business model are to (CHESBROUGH; ROSENBLOOM, 2002):

- Create an offering based on technology;
- Identify a market segment;
- Specify the revenue mechanism;
- Define the value chain required to create and distribute the offering;
- Define complementary assets needed to support position in the chain;
- Estimate the cost structure and profit;
- Describe the position of the firm within the different actors of the value chain;
- Formulate the competitive strategy in order to gain and hold advantage.

Osterwalder (2004) made an intensive literature review about business model concepts, dimensions and their relationships. According to the author, business model decreases business logic complexity by providing a holistic overview of how a company can derive value from its resources and processes. He, in a posterior research, defined business model as a conceptual tool composed of

objects, concepts and their relationships that enable to express simplified description and representation of the business logic of a firm (OSTERWALDER et al., 2005). From business models, practices can be created in order to help companies to capture, understand, design, analyze and change their business logic (OSTERWALDER; PIGNEUR, 2010).

3.2.1 Dimensions

Osterwalder (2004) claims that the definition of the dimensions that compose a business model is one of the first steps while planning a business and enhancing the comprehension of its characteristics and relationships.

Research presented by Chesbrough (2006) and Osterwalder; Pigneur (2010), two of the studies that are most accepted by practitioners and theorists, not only conceptualize business model but also describe its dimensions. Dimensions are blocks that cover the main areas of a business models. Both studies reveals similarities and distinctions between the dimensions proposed. Most of their dimensions are the same, such as cost structure and value proposition. Some of their dimensions are named differently, but with the same meaning, e.g., market segment and customer segment. The main distinction between both studies remain in the fact that Chesbrough (2006) includes the competitive strategy as a business model dimension, while Osterwalder; Pigneur (2010) do not embrace any dimension related to strategy, as they affirm that strategy and business model are different entities although related.

This research follows the business model study of Osterwalder; Pigneur (2010) and does not consider strategy as a business model dimension. Strategy is a driver for the creation of business models. Therefore, a company's strategy may be formulated before its business model is created (BARQUET; OLIVEIRA; et al., 2013).

This is in accordance with Magretta (2002). For this author, business models describe how the parts of a business fit together. However, they don't rely on competition, which is a strategic issue. Therefore, the creation of a successful business model is not enough to ensure competitive advantage. Once implemented, the elements of business models are often transparent and therefore easy to be imitated. Thus, strategy and business model should be analyzed together in order to be protected from the competition (TEECE, 2010).

Osterwalder; Pigneur (2010) defined nine dimensions of business models: value proposition, customer segments, distribution channels, customer relationship, revenue streams, key resources, key activities, key partners and cost structure. These dimensions are described below on Table 2.

Table 2 - Description of the business model dimensions (OSTERWALDER; PIGNEUR, 2010)

Dimension	Description
Customer segments (CS)	Delimits the groups of people or organizations a company aims to reach and serve.
Value propositions (VP)	Describes the set of products and services that creates value for a specific customer segment.
Distribution channels (DC)	Define company's interface with its customers.
Customer relationships (CR)	Describes the types of relationships a company establishes and maintains with specific customer segments.
Revenue streams (RS)	Characterizes the revenue a company generates from each customer segment
Key resources (KR)	Define the assets required to offer and deliver value to the each customer segment
Key activities (KA)	Describes the processes and activities involved in offering and delivering value to the each customer segment
Key partners (PA)	Delimits the network of suppliers and partners that support the business model execution.
Cost structure (CS)	Describes the costs incurred to operate the business model

A firm's business model serves two purposes. First, it provides stability for the development of a company's activities as it enables the understanding of the business logic. This understanding can be reached through the definition of the content of each business model dimension and the design the complete business model. Second, it can be modified and allow changes in order to reach improvements (CAVALCANTE et al., 2011). Business model design and change are discussed following.

3.2.2 Business model design

The design of the business model is essential for both, a new business and an existing one. To design business models, it is required that tools (ZOTT; AMIT, 2010):

- Foster dialogue and promote common understanding;
- Emphasize the importance of taking into account the design of the system, instead of partial optimization of the business (for example, whether a specific business process should be outsourced or conducted in-house).

Canvas Business Model is a tool developed by means of an extensive investigation of business models and represents the point of view of a large group of academy and industry experts. The purpose of the tool is to assist the design of business models. Moreover, there is empirical evidence that support the performance of this model. It has been applied successfully by many organizations, such as IBM and Ericsson (OSTERWALDER; PIGNEUR, 2010). Figure 3 the Canvas Business Model with the nine dimensions. In addition, the creators of the canvas stated that the tool provides a shared language that facilitates the description of business models.

Thus, it is noticed that the Canvas Business Model attend the requirements of having a system point of view and foster a common understanding, both mentioned by Zott; Amit (2010).

Figure 3 - Canvas Business Model (OSTERWALDER; PIGNEUR, 2010)

As shown in Figure 4, the authors also provide a template to design a business model.

Figure 4 – Template for business model design

3.2.3 Business Model Change

Tools like the Canvas Business Model can be utilized to design and understand a business model. Nevertheless, a designed business model represents the logic of a business at a certain moment in time, presenting a static point of view. Nevertheless, most of the business faces constantly pressure to change and, in response to that, they need to change their business models. Examples of pressures to changes are (LINDER; CANTRELL, 2001):

- Maximize the returns in order to grow and profit;
- Enhance core skills to create new positions on the price/value curve;
- Cover new markets through product and service lines or by expanding the reach, e.g. from local to global.

Changes in the business model depend on the degree to which the core logic is modified. (LINDER; CANTRELL, 2001). On the one hand, companies can refine their current business models, on the other hand, they can create new ones (TEECE, 2010). Cavalcante et al. (2011) explore business model change. According to these authors, business model change encompasses both the improvement of a current business model and the creation of new ones.

Improve current business model

The purpose of changing a current business model is to improve the business. This can happen when the current business model is not effective, e.g. its products and/or services do not satisfy customers anymore or the business model

faces obsolescence. Therefore, in order to improve a current business model, companies should consider to explore opportunities for enlarging the existing business (CAVALCANTE et al., 2011).

This type of business model change requires rethinking the business and modifying the content of some business model dimensions. For instance, the customer segment is the same of the current model but new benefits are developed to improve the value proposition.

Examples of challenges of changing a current business model are uncertainty, lack of knowledge and skills and resistance. To cope with lack of knowledge and skills, Kodak took an important decision about changing its business model. The company, which was a producer of cameras and film, was forced to revise the current business with the advent of digital technology. Therefore, instead of trying to develop digital technology internally, Kodak decided to acquire the knowledge on digital imaging through joint ventures with other firms (CAVALCANTE et al., 2011). In that case, the company started providing a new value proposition (digital cameras) joint with new partners.

Creating a new business model

When managers recognize technological and/or market opportunities that are not consistent with the logic of the current business, they might decide on creating a new business model. Examples of factors that might lead to this decision are (CAVALCANTE et al., 2011):

- Identification of new opportunities that require new ways of doing business;
- the competitors are threatening to capture its market share by developing new ways of meeting customer's needs.

The creation of a new business model takes into account the materialization of a new idea or opportunity, which should be developed on a new venture or business unit. In this case, there are no knowledge prior to the creation of the new business model and essential processes related to customers, partners and competitors are just ideas or hypotheses. Thereby, lack of knowledge about technology, marketing and finance and difficulties in attracting sufficient financial

capital for the new venture are examples of facts that can lead to uncertainties. (CAVALCANTE et al., 2011).

Companies might face other challenges during the creation of a new business model. New products and services should be accepted by customers; technological and commercial competencies need to be developed and connected with offers that are already available on the market; business processes should be created and coordinate. These are example of such challenges (CAVALCANTE et al., 2011).

4. Product-Service System (PSS)

This section presents concept, classifications, characteristics, benefits, practical examples of PSS adoption, as presented on activity 1.2 of the research method.

4.1 Concept

Different research communities have been studied product and service bundle and using different terms to explain the same subject. Among these terms, three of them are more relevant in the literature: servitization (VANDERMERWE; RADA, 1988), service-dominant logic (VARGO; LUSCH, 2004) and product-service systems (PSS) (GOEDKOOOP *et al.*, 1999). Despite the difference on terms, the central concept is the same: to shift the focus of traditional businesses based on the development and sale of physical products to a new business orientation based on functionalities and benefits delivered through products and services aiming to satisfy specific customer needs (MONT, 2004; MANZINI; VEZZOLI, 2003; BAINES *et al.*, 2007).

Boehm and Thomas (2013) performed a systematic literature review and, by means of 265 articles, presented the state-of-the-art on PSS research. They also stated that the term Product-Service System is used by most authors and there are several other closely related expressions. In accordance with them, the term adopted in this study is PSS.

The term Product-Service System emerged in 1999, introduced in the literature by Goedkoop *et al.* (1999) through a study named “Product-Service Systems – Ecological and Economic Basics.” The authors defined PSS as a system of products, services, infrastructure, and networks that continually strive to be competitive, satisfy customer needs, and result in a lower environmental impact than traditional business models. A more current definition states that “A Product-Service System (PSS) is an integrated bundle of products and services which aims at creating customer utility and generating value” (BOEHM; THOMAS, 2013).

PSS is an approach that enables business innovation. The innovation is represented by a new interpretation on the product's role and new ways to co-

produce value by means of the participation of different stakeholders and partnership between them (MANZINI; VEZZOLI, 2003), considering a new manner to approach the value chain and its involved (MONT, 2000).

Therefore, exchange processes and relationships are essential in PSS (VARGO; LUSCH, 2004) as the locus of value creation shifts from the provider to the process of co-creation among different players (JACOB; ULAGA, 2008). What originates competitive advantage is the co-creation and co-production among PSS providers, customers and partners (LUSCH et al., 2007; GRÖNROOS, 2011; VARGO; LUSCH, 2004). The interaction between different players contributes to an improved value proposition since an integration of resources, knowledge and skills can be reached (KOWALKOWSKI, 2010).

4.2 Classification

Two different classifications for PSS are presented following.

4.2.1 Product, use and result-oriented

The most common and utilized classification is from Tukker (2004). This classification, which takes into account the financial and environmental perspectives, presents the most widely accepted and extensively used classification of PSS. This classification covers three types of PSS: product-oriented services (POS), use-oriented services (UOS), and result-oriented services (ROS), as illustrated in Figure 5.

Figure 5 – Types of PSS (Adapted from TUKKER, 2004)

Product-oriented services

It comprises the traditional product sales, when customer assumes ownership of the product. PSS provider offers and charges for associated services, to ensure product functionality and durability (maintenance, repair, reuse, recycling, training and consulting). In this case, the introduction of PSS can reduce the costs of the product during its use phase, guarantying a longer duration and proper functioning of the product. The two sub-types of the product-oriented service are:

- Services for products, like maintenance and repairs;
- Consulting and training, types of services that can assist clients on the better use of products.

Use-oriented services

In this type of PSS, the product's ownership belongs to the PSS provider and it is not transfer to the client after the commercialization. The provider sells product use or functions by leasing, sharing or renting. In this case, PSS can maximize the use phase of products by extending its lifecycle and reuse of product's parts or materials. The PSS provider will be motivated to develop products considering long-life materials and end-of-life strategies and offer services to keep its products in good condition for as long as possible as it bears the costs of their maintenance. The three sub-types of this type of PSS are:

- Product leasing, when clients pay a fixed price to use the product during a period of time;
- Product sharing or location, in case the product is used by more than one client. The provider charges based on the amount of time the product is used;
- Pooling, when the product is rented but used simultaneously by different clients.

Result-oriented services

The PSS provider sells a result or competence rather than products. Yet, a set of customized services is offered and, when the result is delivered through a product, the PSS provider maintains its ownership and the customer pays only for the results that the product delivers. The sub-types of result-oriented services are:

- Activities management, when the client outsource some activities to the provider;
- Services charged per unit, in that case the product is still the basis of the offer but the client pays by the results that the product deliver;
- Functional results, when the provider has freedom to decide how to attend the clients need and how to deliver it.

It can be observed that from the first to the third type, the importance of the product as a core competence of the PSS decrease and the client's needs have to be formulated in more abstract terms. The uncertainties and risks are higher for the PSS provider in the cases of higher level of services when compared to cases with higher levels of product. Still, the provider has more responsibility on the uncertainties and risks when the service level is higher (MEIER et al., 2010).

This typology is relevant to classify PSS in terms of product ownership and source of revenue, which are the most differentiators of the PSS approach compared to the traditional selling-buying structure. However, despite the fact that Tukker (2004) named the PSS types as PSS business models, they cannot be considered business models. It can be noticed that the types of PSS are differentiated according to the value proposition (by means of the amount of products and services levels) and do not take into account other business model dimensions.

Tan e McAloone (2006) affirms that, despite this typology demonstrates an spectrum of PSS variations related to the value proposed to clients, it is purely descriptive and do not cover other essential characteristics. For Baines *et al.* (2009), Tukker (2004) typology is relevant to present examples of how different PSS offers can work. However, the authors believe it has limited utilization for companies that intend to adopt PSS.

4.2.2 Function-, availability-, and result-oriented

Another typology of PSS was developed by the IPS² (Industrial Product-Service System) community. One of the main studies about IPS² had been written by Meier *et al.* (2010) aiming to set up the state of the art on IPS². The definition of IPS² was first published in a German publication by Meier, Uhlmann e Kortmann (2005) apud Meier *et al.* (2010). The authors stated that IPS² is characterized by an

integrated vision of the planning, development, offer and use of products and services, including software as a support component. As suggested by the “I” from IPS², the industrial meaning of this approach indicates that it is suitable for the business-to-business (B2B) environment (MEIER et al., 2010).

The types of IPS2 are: function-, availability-, and result-oriented use models (MEIER et al., 2010). On the function-oriented use model, machine functionality is guaranteed according to an agreed period of time, e.g. a maintenance contract. On the availability-oriented use model, not only the machine functionality is guaranteed but also part of the production process. Thus, the IPS2 provider is responsible for business processes of the customer and bears a part of the production risk. In a result-oriented business model the complete responsibility of the production process is transferred to the IPS2 provider. In that case, the customer pays for the parts produced.

It can be noticed that the description of this typology is superficial. And, despite (MEIER et al., 2010) affirm that this is a business model typology, they only discuss about customer relationship and processes outsourcing and do not address other business model dimensions.

4.3 General characteristics

Additionally to the PSS typology, Tukker (2004) also presents environmental and financial characteristics for PSS planning and development. Some of them are:

- Market value of PSS (tangible and intangible);
- Production costs of PSS (the traditional ones and of the risks to adopt this new approach);
- Investments and capital required to offer PSS;
- Ability to capture the value on the value chain (strategic position on the value chain and contribution to client fidelity and innovation speed).

Mont (2004) suggested some PSS characteristics and organized them according to four dimensions: products, services, infrastructure and network of players.

On the IPS² literature, the characteristics mentioned are: partners, provider, clients, environment and social issue, PSS use, interactions between system and user and lifecycle phases (MEIER et al., 2010).

Still, the characteristics mentioned by the different authors do not only focus on products and services but also on clients' interaction, relationship and responsibilities of the different players of the network and activities (MANZINI; VEZZOLI, 2003). For Baines *et al.* (2007), the main characteristics required to plan and develop PSS are:

- Shift from product to system thinking;
- Higher involvement and proximity between PSS provider and clients, since the planning phase;
- Higher responsibility of the provider on the entire lifecycle of the PSS, mainly during the use phase.

Thus, to adopt PSS, both provider and client need a new mindset. The provider should involve other players to assist on the PSS planning and development. Clients may be prepared for not having the property of the physical product anymore (TUKKER; TISCHNER, 2006).

4.4 Benefits

Benefits of adopting PSS, both for clients and providers are presented in the literature. Table 3 shows some of them according to Baines *et al.* (2007) and Tan (2010).

Table 3 - PSS advantages for customers and companies (Baines et al., 2007; Tan, 2010)

Customers	Companies
More customized offers. New functionalities and combinations of products and services to better suit customers' needs. Responsibility for monitoring and end-of-life transferred to the PSS provider. Higher value delivered to the customer by adding service elements.	New market opportunities and competitive advantages. Access to information about the product's performance during its use phase. Higher profit margins achieved by providing services instead of only products. Strengthening customer relationships to increase loyalty.

Schenkl et al. (2014) also present benefits for the society, which are reached mainly by means of the decrease of environmental impact.

4.5 Environment Issues

The environment benefits that may be reached by adopting PSS is related to the possibility of attend client's needs by means of service offer. This approach differs from the focus on the intensive use of material of the traditional buying and selling model (MONT, 2002).

Yet, since the provider could have the product property, he is obliged to take it back on end-of-life phase. This can be a driver to recover these products and their parts, by means of remanufacturing for instance, and then commercialize them again. By doing that, less waste is generated and less material and energy are utilized. Less resources are required to remanufacture compared to manufacture a new product (MONT, 2002).

Thus, a PSS offer could cause less environment impact because it closes the material cycle, leads to the reductions of consumption and increase of resource productivity both due to the use of the product in different lifecycles (MONT, 2002).

Inspite of the aforementioned facts, there are contradictions and incoherencies when it comes to the environment benefits of adopting PSS (TUKKER, 2004). There are no evidences that simply replacing product selling for service offer is enough to lead to more sustainable solutions (EVANS *et al.*, 2007).

Some factors can decrease the chances of reaching environment benefits though PSS, such as immaturity on PSS implementation or the type of relationship enterprises have between each other on the value chain. Keep the boundaries in respect to the roles of each organization in the system (provider produces, retail sells, user pays for the costs in the use phase of the product) limits the potential for environmental improvements (EVANS *et al.*, 2007).

Tukker (2004) believes that the majority of the PSS types lead to small environment improvements, with the exception of the type named result-oriented service. On the other hand, use-oriented service type, on leasing cases, can even increase the environment impact if the client has less careful attitude with the product as it is not his own property. The author states that the sub-types location, product sharing, pooling and functional result are the most promising considering the environment improvements point of view as they are more dematerialized offers.

According to Manzini e Vezzoli (2003), more studies need to be carried out to enable reaching more consistent conclusions about the environment issues of implementing PSS. It is a mistake to conclude that PSS adoption will result, automatically, in environment benefits (TUKKER, 2004).

Even though the literature presents possibilities of environment benefits reached by PSS adoption, in most of the cases companies decide to implement PSS because of the economic benefits that it can bring and the environment potential turns out not to be considered and measured (MONT, 2002).

4.6 Practical examples of PSS

Some practical examples of PSS are described in the literature. The selling of washing clothes services instead of washing machines selling, services of refrigeration instead of air conditioning systems and availability of car use instead of selling the car property are some of these examples (EVANS *et al.*, 2007).

A known case of PSS is the one developed by Rolls Royce, named Power by the Hour. The company makes contracts with flight operators where the cost of engine maintenance is fixed. These contracts, named Total Care contracts, are made for long periods of time and can reach until ten years. In this kind of contract, Rolls Royce keeps the ownership of the engine and the revenue streams of the company are based on services' offer and spare parts supplying (BAINES *et al.*, 2009). The way of doing business enables Rolls Royce to have direct access to information about product performance during the use phase of the product through remote monitoring. This information is used to improve the performance parameters of the products, increase engine efficiency and to decrease total costs and environment impacts caused by the product (BAINES *et al.*, 2007).

Enterprises that manufacture high added value products, like elevators, machine tools, printing machines and construction equipment are also realizing the opportunities and adopting PSS (BAINES *et al.*, 2009).

Baines *et al.* (2007) described some successful examples of PSS adoption carried out by Xerox and Electrolux. Xerox's printing machines are not sold anymore as its property remains with the provider, who supplies "solutions on document management". In that case, the provider supplies the equipment, the consumables,

product maintenance and monitoring. The client pays according to the number of copies he makes. Yet, in the end of the contract or when the machine reaches its the end-of-life strategy, the provider takes it back and decide upon the most appropriated end-of-life to be performed.

Beuren (2011) remarks about another PSS application examples concerning car sharing. The client does not have the ownership of the car and pays according to the period of time he utilizes it. Options of payment are per hour or per day, according to the client's needs. The cost of maintenance, insurance and parking relies on the PSS provider. In 2009, this kind of business started in Brazil though a company named Zazcar, which was inspired in cases like Zip car on USA, one of the biggest enterprises of car sharing in the world. Nowadays, Zazcar¹ owns around 60 cars of different models that are spread in 45 points of São Paulo, the largest city in Brazil.

Car sharing is gaining market share and customer acceptance mainly because of the increase of social awareness of sustainability at both societal and individual levels. Other examples of this type of PSS offering are Autolib, City Car Club, Greenwheels, Stadtmobil. Yet, many traditional car rental companies are now offering car sharing, such as Hertz on Demand, Enterprise Car Share, UHaul Car Share (LIUA et al., 2014).

¹ For more information, see www.zazcar.com.br

5. PSS business model

This section explore business models for PSS. It discusses definitions, business model utilized as reference on the PSS literature, the content of this business model, i.e. PSS characteristics. Finally, two methods that support the adoption of PSS business model are described. This section is stated on activity 1.3 of the research method.

5.1 Concepts

Different researches mention business models when they discuss PSS implementation (WISE; BAUMGARTNER, 1999; TUKKER, 2004; LAY et al., 2009; BOEHM; THOMAS, 2013; MEIER; BOSSLA, 2013). Some studies also pointed out the fact that business models are central to implementing PSS successfully (MONT et al., 2006; REIM et al., 2014).

In fact, one of the main challenges for companies wishing to adopt PSS is to identify the changes required in their businesses (MEIER; MASSBERG, 2004). These changes derive from the differences between PSS and the traditional way of developing and selling products (BARQUET; OLIVEIRA; et al., 2013).

Tan (2010) states that the business model concept is useful to characterize PSS, since its implementation often requires the redefinition or creation of new business models. (TUKKER; TISCHNER, 2006) also believe that it is important to conceptualize PSS in terms of business models to facilitate its adoption. Because the success of a company depends on its operations, strategy and networks, the business model may be redesigned to support the PSS offer (SCHUH et al., 2009). Matthyssens and Vandenbempt (2010) brought up an important point by questioning why and how the transition toward PSS affects companies and how they can deal with it in terms of their business models. Richter et al. (2009) highlighted the need of investigations which combine the viewpoint of PSS and business models, aiming to gain a better understanding of this context and to assist on PSS adoption.

Reim et al. (2014) performed a literature review on PSS and highlighted six studies that define business model within PSS context. These and other definitions

are presented on the Table 4 and the dimensions pointed out on the definitions are specified.

Table 4 - Business model definition within PSS context

Author	Definition of business model	Dimensions
(MEIER; MASSBERG, 2004)	"The use of the customer (result dimension) defines the market segments and the corresponding business models on the strategic level."	Customer segment
(RICHTER et al., 2009)	"Business models that are based on the dynamic bundles describe the design of the customer-supplier relationship in the form of performance schemes and responsibilities."	Customer relationship
(SCHUH et al., 2009)	The main aspect in the definition of a business model should be the capitalization and the benefit mechanisms of a company."	Revenue Stream
(SPRING; ARAUJO, 2009)	"Common themes in business model literature include a concern with network structure; a focus on how transactions are made; revenue streams and incentives; and how providers' capabilities are transferred or accessed through products, services, or combinations thereof."	Partnership, revenue stream, resources, value proposition
(MEIER et al., 2010)	"A business model can be described by a user model, architecture of value creation and turnover model and by describing the design of the customer-supplier relation."	Customer relationship, value proposition, partnership, processes and activities, revenue stream.
(GAO et al., 2011)	"A business model depicts the way in which the partners of a business collaborate with one another."	Network
(MEIER; BOSSLA, 2013)	"The business model characterizes the relationship between a provider and a customer as well as potential third value-adding parties over the entire life cycle of an IPS ² . It describes the value proposition, the risk distribution, revenues streams, and the property rights for all parties in the IPS ² network as well as its organizational implementation."	Customer relationship, Partnership, processes and activities, value proposition, revenues streams

A common fact that can be noticed in all the definitions aforementioned is that none of them takes into account the complete set of business dimensions when discussing about PSS business models. Therefore, an incomplete view of PSS business model is generated.

On the business model literature, Linder and Cantrell (2001) stated that there is a misunderstanding related to the business model concept as many studies discuss about business models when they only mean parts of a business model. An online community is not a business model on itself, but part of the customer relationship. Revenue sharing is not a business model in itself either, but a manner to explore partnerships in order to address customer and distribute the revenues (OSTERWALDER et al., 2005).

Thereby, this study defines PSS business model as a representation of the logic developed to create and deliver a value proposition by means of a bundle of product and services, i.e. a PSS offer. The value proposition should attend costumers' needs and the logic to create it should encompass the definition of other business model dimensions, named as customer relationship, processes and activities, actors, resources, revenue streams and cost structure.

5.2 Business model reference

A solution to cope with the incomplete view of PSS business models would be the utilization of a business model reference to be used in the context of PSS. Nevertheless, from different publications relating PSS and business model, most of them do not rely on any reference to approach business model for PSS. The few studies that utilize a reference are presented on Table 5.

Table 5 – Business model reference within PSS context

Title	Reference	Business model reference
Product service systems in the automobile industry: contribution to system innovation?	(WILLIAMS, 2007)	(TUKKER, 2004)
Industrial Product-Service Systems—IPS2	(MEIER et al., 2010)	(MEIER et al., 2010)
Understanding service uncertainties in industrial product–service system cost estimation	(ERKOYUNCU et al., 2011)	(TUKKER, 2004)
Business model elements for product-service system	(BARQUET et al., 2011)	(OSTERWALDER; PIGNEUR, 2010; TUKKER, 2004)
A Framework for designing Products Service Systems	(VASANTHA et al., 2011)	(TUKKER, 2004)
Business model design methodology for innovative product-service systems: A strategic and structured approach	(LEE et al., 2011)	(OSTERWALDER, 2004)

It can be observed that some of authors from PSS studies refers to Tukker (2004) when discussing about business models. As already mentioned (section 4.2), this cannot be viewed as a business model typology. This fact can be another argument that explains the incomplete view originated by research about PSS business models.

5.3 Content of PSS business models

The content of PSS business models refers to the characteristics utilized to design a PSS business model and the dimensions used to organize these characteristics.

Barquet and Oliveira et al. (2013), through a literature review, identified characteristics that should be considered when adopting a PSS business model and organized these characteristics according to the dimensions of Osterwalder and Pigneur (2010).

The characteristics identified by Barquet and Oliveira et al. (2013) were dispersed in different studies. The purpose of systematizing them was to organize and make available the content that should be considered when creating PSS business models.

Some examples of the characteristics are shown in the Table 6. A more detailed description of the them is available on Barquet and Oliveira et al. (2013).

Table 6 - PSS characteristics classified according to business model dimensions

Dimension	Characteristics	Reference
Value Proposition	Lower responsibility for product lifecycle; functional guarantee	(ISAKSSON et al., 2009)
	Customization	(TUKKER; TISCHNER, 2006)
	Trust, commitment and attraction	(GRÖNROOS, 2011)
Customer Segments	Of different target groups with distinct ideas about product ownership according to habits, behavior and values	(TUKKER; TISCHNER, 2006; MANZINI E VEZZOLI (2003)
Distribution Channels	“sell the idea” through marketing campaigns and highlights the advantages of PSS	(TUKKER; TISCHNER, 2006)
Customer Relationships	Creation of added value and its delivery through direct relations and intensified contacts with customers	(MONT, 2004)
	Long-term relationships	(WILLIAMS, 2006)
	Closer relationships with customers through increased operational links, information exchange, legal ties and the establishment of cooperative rules	(MATTHYSSENS; VANDENBEMPT, 2010)
Key Resources	Training of the retail and sales staff	(TUKKER; TISCHNER, 2006)
	Fundamental shift in the organizational culture and market engagement, which requires time and resources	(TAN; MCALOONE, 2006)
Key Activities	Focus on the key activities of the customers, rather than concentrating efforts on activities related to physical products	(TAN; MCALOONE, 2006)
Key Partners	Proposition of value through products and services embraces a complex network of suppliers and competencies.	(TAN, 2010)
Cost Structure	Financial and accounting practices need adaptations, since the time scale of financial flows changes considerably from an almost immediate return of capital to an extended usage period	(MONT, 2004)
Revenue Streams	Companies must create new revenue models based on performance-based pricing	(MATTHYSSENS; VANDENBEMPT, 2010)
	Augmenting companies' revenue through the enlargement of functions offered by the PSS provider	(MONT, 2000)

5.4 Methods to support PSS business model creation

Two methods were identified on the literature that aims at helping companies to create PSS business. These methods were selected for two reasons:

- They were already applied successfully in real cases;
- They present a systematic and well defined set of phases, steps and activities.

5.4.1 PSS Innovation Scan (TUKKER; HALEN, VAN, 2003)

PSS Innovation Scan is a method developed by Delft University and PricewaterhouseCoopers. The aim of this method is to initiate a fast process on a company wishing to adopt a PSS business. The method provides an overview about potential PSSs that a company could implement and thus allows the decision makers to decide which PSS offers should be developed.

Thereby by using this method, which the authors name as a manual, companies can learn quickly and easy about:

- Potential PSS to be implemented;
- How to describe and select a PSS offer;
- How to present the PSS offers to decision makers.

The PSS Innovation Scan targets all different kind of business organizations, such as SMEs and multinationals, regardless the type of customer or product. Benefits for product-driven and customer-driven organizations are highlighted. For the first group, which generally secures its turnover from products selling and may have a weak process of new business development, the method promises to offer considerable potential for changing the way these companies deliver value to its clients by stimulating ideas and opportunities for innovation. In the case of customer-driven organizations, the method provides opportunities to evaluate or review the current product-service offers. By doing this, companies can deepen knowledge and explore possibilities on how to create additional value in a systematic manner.

The authors suggest that the method should be carried out by a team in order to generate a dynamic interaction and to yield ideas and knowledge to be shared, exchanged, discussed and assessed.

This team should include members responsible for the company's innovation strategy and also from different departments, such as marketing, environment, research and development (R&D), manufacturing, business development and product and service design. An interdisciplinary approach is relevant when it comes to business innovations since information and knowledge from different areas of expertise are required. Yet, external facilitators may also support the team when the company does not have enough knowledge about PSS.

Figure 6 presents the steps of the method.

Figure 6 - Six steps of the PSS innovation scan

The time to apply all the steps of the method vary between 1,5 and 6 days. The amount of time depends on some variables, such as amount of information already available.

The authors suggest some tools or references of tools that can be utilized while applying the PSS Innovation Scan. These tools are classified according to each of the six steps of the method.

Although the method presents a systematic way to create PSS offers, some limitations can be identified. First, as mentioned by the authors of the method, the structure and the content of the method are general. Thus, it can be also used for product development and new business development. This fact shows that the method does not include enough PSS specific characteristics.

A second limitation of the method concerns the novelty of the product selected to be part of a new PSS. The analysis phase addresses the selection of a product for which the PSS Innovation Scan will be carried out. However, this selection is based on a company existing product and the method does not give possibility to start from a functionality that further will be offered by a specific product. By selecting an existent product, the chances of requiring a new business model also decreases and most of the times utilizing the method will imply in business model adaption and minor innovations.

The third limitation identified is linked with the business dimensions addressed by the method. The method just considers the dimensions market segment and value proposition for the creation of a PSS proposal. In this sense, important business model dimensions such as partnership, resources and cost structure are not mentioned. However, during step 5 – management presentation – the authors include the others dimensions of the business model that were not addressed by the method and there is no indication on how to get information about these dimensions.

5.4.2 Methodology for Product-Service System (MEEPS)(HALEN et al., 2005)

MEEPS is a methodology created to guide companies in the process of development and implementation of PSS. According with the authors, it can be utilized by every company, regardless of the size and industrial sector. The methodology can be applied by a multidisciplinary team of experts in a planning process.

Figure 7 shows the five phases of MEEPS.

Figure 7 – Five steps of MEEPS

Each of the five phases is composed by a set of steps and processes. First phase takes into account the whole business system and its main aim is to generate businesses alternatives based on PSS. Second phase considers market and value chain together with PSS ideas in order to create PSS innovation routes. On phase 3 the design of the most promising PSS ideas starts and on phase 4 the detailed design is performed. Phase 5 covers the decision about implementing PSS into an existing business model or starting a new venture. The involvement of partners is also highlighted in case of lack of competences to implement PSS.

This methodology provides a clear orientation to reach PSS implementation. However, despite the fact that it considers the business on the first phase and some business model dimensions on the second phase, it lacks the holistic view of business model on the development of the opportunities (phases 3 and 4). The focus is on detailing the PSS design that is one of the main business processes but not the only one. Therefore, there is a missing link between phases 3 and 4 and phase 5, when the PSS is implemented in the current or new business.

6. Creation of the first version of the Configurator of PSS Proposals

The section addresses phase 2 of the research method.

6.1 Context of the Configurator of PSS proposals utilization

This section embraces the deployment of elements from the literature review in order to set up the context in which the method proposed by this study, named Configurator of PSS proposals, should be utilized. In addition, the method is described. This section is in accordance with activity 2.1 of the research method.

The creation of a PSS proposal during the fuzzy front-end is highlighted and definitions of terms used in this research are covered. Next, the characteristics of the method are described, as presented in the activity 2.2 of the research method.

6.1.1 Creation of PSS proposals in the fuzzy front-end

As mentioned in section 3.1.2, proposals are formulated during the fuzzy front-end and is the main deliverable of this phase. Thus, in the last stage of fuzzy front-end, one or more proposals could be formulated and selected for development. These proposals can be for improving or creating technologies, products, services, PSS in current or new business.

Yet, there is no specific stage of the fuzzy front-end in which the proposals are created. Depending on the level and amount of information required and available, a proposal can be formulated anytime and stages of the fuzzy front-end can be even skipped. That is the case of proposals concerning the improvement of a current product. However, in the case of more complex proposals, such as the creation of a new business, more information is required, so that the fuzzy front-end can take longer.

In spite of products, services and technologies being part of PSS, the planning and development of PSS go beyond service and product development, encompassing partners and customer relationship, cost structure, revenue streams, etc. Therefore, this research considers that PSS proposals should be created together with the definition of the appropriated business models. This supports the decision of organizing the content of the PSS proposals according to business model dimensions.

Figure 8 shows the definition of proposals during the fuzzy front-end. The proposals selected can be developed on a current business model or in a new one.

Figure 8 – Context of the definition and development of proposals

6.1.2 Relevant terms

The relevant terms that should be understood for the ones that utilize the method, adapted from Tan (2010), are:

- PSS development: starts when a PSS proposal is approved to be developed. It is the phase that comes after the fuzzy front-end and it covers conceptual stage, detail design and production of the PSS offer.
- PSS provider: is the company responsible for creating the PSS proposal. The PSS provider can either be the one performing the activities related to plan, develop and deliver the PSS or the one that has control over the other actors performing such activities.
- PSS offer: are the options of product and service combinations that are offered and delivered to customers.

Another two relevant terms, suggested by the author of this study, are:

- PSS alternatives: they are created on the fuzzy front-end from strategies, ideas, opportunities and concepts and they comprise information about customer value proposition (CVP), i.e., the value proposition and customer segment.
- PSS proposals: they are deployed from the PSS alternatives and contain detailed information from the PSS business model. The PSS provider analyzes these proposals and selects the one(s) to be further developed.

6.2 Characteristics of the Configurator of PSS proposals

The Configurator aims at supporting companies to create of PSS proposals during the fuzzy front-end. It may be used by a team of employees from different expertise fields as the information required to create a PSS business model should come from different functional areas. In order to utilize the Configurator, the team should have knowledge and information, or the possibility to access them, regarding the current business model and PSS types. Thereby, a multifunctional team and the availability of such knowledge and information are the requirements to use the Configurator. Another requirement to use the method is the wish to adopt PSS or to improve an existing PSS business model.

The purpose of the method is to provide a step-by-step that can be followed by companies aiming to improve a current business through PSS or to start a new business by creating a PSS proposal during the fuzzy front-end. The PSS proposal, the end result of utilizing the Configurator, comprises the definition of the content of each business model dimension, such as: market segment, value proposition, processes and activities, etc.

The Configurator does not provide guide on how to select one or more PSS proposals to be further developed and on how to implement such proposals. The scope of the Configurator is limited to the fuzzy front-end, when such proposals are created.

Adapted from (TUKKER; HALEN, VAN, 2003), the time estimated for using the Configurator differs according to some variables, such as:

- The amount of knowledge already available about PSS concepts and types;
- The amount of information already available about the current business:

- The decision about adapting the current business or creating a new business.
The creation of the new business requires more effort, such as time, information and knowledge;
- The participation of facilitators, such as external consultants and experts on the field;
- Type and size of company and number of employees in the team.

6.3 Elements of the Configurator of PSS proposals

This section, addressed in activity 2.3 of the research method, presents the research topics covered by the Configurator of PSS proposals, developed based on the literature review of phase 1.

Table 7 presents the research topics and from which area they originated. In addition, the section they are described in this study is also shown.

Table 7 – Research topic utilized to deploy elements of the method

Section	Research Area	Research Topic
3.1	Fuzzy front-end	Analysis of strategies, ideas and opportunities; creation of proposals
3.2	Business model	Business model design; business model change; business model dimensions; customer value proposition (CVP)
4	PSS	PSS types and PSS characteristics

The elements of the method, classified in steps, inputs and outputs, were developed based on the research topics.

The Configurator comprises three steps:

- Analysis of the business context;
- Creation of PSS alternatives;
- Definition of PSS characteristics.

The steps and inputs and outputs are presented in Figure 9.

Figure 9 - The steps, inputs and outputs of the proposed method

Table 8 clarifies the acronyms utilized on Figure 9.

Table 8 –Meaning of acronyms of Figure 9

Acronym	Meaning
PA	Partners
MS	Market/ Customer Segment
KR	Key Resources
KA	Key Activities
VP	Value Proposition
CR	Customer Relationship
DC	Distribution Channel
RS	Revenue Streams
CS	Cost Structure

POS	Product-oriented services
UOS	Use-oriented services
ROS	Result-oriented services
CVP	Customer Value Proposition

Following, the three steps of the method are described and the inputs and outputs from each step presented.

6.3.1 Step 1: Analysis of the business context

Figure 10 presents the inputs and outputs of step 1.

Figure 10 - Inputs and outputs of Step 1

Some authors believe that companies wishing to adopt PSS must first understand their current business models (KUO et al., 2010; SAKAO et al., 2009; MATZEN, 2009). For this purpose, it is suggested to design the current business model by means of the tool Canvas business model (OSTERWALDER; PIGNEUR, 2010), presented on section 3.2.2.

Together with the business model design, strategies, ideas and opportunities should be analyzed as they are the trigger for starting the process of creating a PSS proposal.

This analysis should assist the decision of employing PSS in the current business or creating a new business for PSS. The first approach is in accordance with Tan (2010). The author claims that the PSS should be adapted to the current business and then the performance of the product-service offer can be compared to the previous product or service offer. By doing that, the analysis of potential barriers and benefits can be performed and actions of improvement suggested. In addition,

the PSS adoption occurs incrementally, reducing the impact and risks of the business change process.

Nonetheless, some companies decide to create new business to implement PSS rather than shifting from the current business to a new mindset (MONT, 2004). This case is comparable to spin-offs creation, which allows radical innovations to be developed (CHRISTENSEN, 1997). Inputs for creating a new business might come from the strategic planning in form of strategies, innovations and ideas, which are also inputs of the fuzzy front-end (OLIVEIRA *et al.*, 2011).

Therefore, after analyzing the current business and its opportunities and restrictions, the company needs to decide among two possibilities of business model changes:

- Adapt a current business by adopting PSS;
- Create a new business for PSS.

However, if this decision cannot be taken on step 1, different business opportunities can be carried out. Thus, a suggestion is to develop different alternatives for adopting PSS in the current business or in a new one. The next step explain how to create and analyze such alternatives.

6.3.2 Step 2: Creation of PSS alternatives

Figure 11 presents the inputs and outputs of step 2. The input “types of PSS” is highlighted on the figure as it does not come from the utilization of the method. They are proposed by Tukker (2004).

Figure 11 - Inputs and outputs of Step 2

In order to explore different possibilities of PSS businesses that a company can develop, this step involves the creation of PSS alternatives according to three variables: the different types of PSS, treated on section 4.2 Classification of PSS, the types of business model changes presented in the section 3.2.3 and the design of the current business model, in case the company decides to adapt it for PSS.

Despite the fact that Tukker (2004) PSS types cannot be considered a business model typology, they can be utilized as a first and more general classification of the business. Thus, product ownership and source of revenue, which is one of the most relevant characteristics of PSS, can be distinguished in each PSS alternative.

If the decision about adapting or creating a new business was already taken on step 1, the selection of the different types of PSS can be limited according to this decision. In case this decision was not taken, six different alternatives can be deployed from the variables “types of PSS” and “business model change”, as presented on Table 9. The variables mentioned are the main inputs of step 2.

Table 9 - Alternatives derived from types of PSS and business model change

Business model change X PSS type	POS (Product-Oriented Services)	UOS (Use-Oriented Services)	ROS (Result-Oriented Services)
Adaptation of current business through PSS	Alternative 1	Alternative 2	Alternative 3
Creation of new	Alternative 4	Alternative 5	Alternative 6

One to six alternatives can be developed. The development consists in the definition of the customer segment and the value proposition. (JOHNSON; CHRISTENSEN, 2008) defined it as customer value proposition (CVP). The authors affirm that the most relevant information to define a business proposal is the “way to create value for customers”. Therefore, it is not possible to create or improve a business model without first identifying a clear value proposition for a specific customer segment.

In the same direction, Tukker and Tischer (2006) suggest to take the necessity that the final user seeks for as a starting point of business definition. Thus, in order to start the development of an alternative, the dimensions value proposition and customer segment should be first analyzed and some questions answered, such as: Which is the market I want to reach? Do I have the value proposition defined? If yes, it will be delivered by means of which products and services? If no, which is the main benefit I want to offer to the market segment?

6.3.3 Step 3: Definition of PSS characteristics

Figure 12 shows inputs and outputs of step 3.

Figure 12 - Inputs and outputs of Step 3

The alternatives encompass customer segment and value proposition defined. It is in the step 3 that the alternatives are detailed and the content of the other business model dimensions should be completely develop. The definition of both the customers' segment and the value proposition offered to them should facilitate the creation of the content of the other dimensions.

The team can decide to detail one or more alternatives according to different criteria, which are the input of step 3 highlighted on Figure 12. The input "definition of criteria to select PSS alternatives" is not generated by the method and they should be defined for each case as it depends on the relevant variables of each company (e.g. technologic risks, knowledge about needs of the customer segment, etc.).

Examples of criteria that might be considered are: business model efficiency, influence on the current business and disruption of competitors. Taking these criteria into consideration, a checklist can be created to support the decision about which alternatives should be deployed to generate PSS proposals (JOHNSON; CHRISTENSEN, 2008):

- Can you design a business proposal in which all the dimensions, such as customer segment, value proposition, the key resources, the key processes, work together to operate the model in the most efficient way?
- Can you create a new business that will not be affected by the negative influences of your current business?
- After implementing the proposal, will the new business disrupt competitors?

PSS characteristics defined by Barquet and Oliveira et al. (2013) can be utilized in order to create the proposal.

7. Application of the Configurator of PSS proposal in a case study

This section depicts the execution of the case study and results gathered through the application of the Configurator of PSS proposals. This section refers to the phase 3 of the research method. The main goals of this application are:

- Generate a PSS proposal for the company under study;
- Collect feedback about the advantages and disadvantages of applying the Configurator in a company willing to adopt PSS;
- Identify improvements to be performed on the Configurator.

The company observed the requirements to use the Configurator as the participants of the case study were representatives of its engineering, manufacturing and sales departments with information and knowledge about the current business.

From the academia side, three participants collaborated on the execution of the case by conducting and stimulating discussions. One is the PhD candidate author of this research and the other two were a master student and an under graduation student. All of them were members of the Group of Integrated Engineering from the School of Engineering of São Carlos on University of São Paulo, Brazil.

7.1 Company profile

The company is a Brazilian machine tool manufacturer located in the state of São Paulo and is called Company A for confidential reasons. Its core business is the design and manufacture of pressure forming machines and machines to produce biodegradable plastic bags. Company A operates on the machine tool market for more than 50 years and it has more than 2,500 of its machines in operation in Brazilian and Latin American factories.

Company A was interested in applying the Configurator because it seeks new business possibilities and recognizes PSS as an opportunity for reaching competitive advantages. One of the reasons for that is the current environment of competition concerning the machine tool market. Companies are striving to improve machine performance, provide better maintenance and reduce the consumption of tangible resources (ZHU et al., 2011). Therefore, competitors are adopting PSS to differentiate themselves from the others. A relevant competitor of Company A,

located in the United States, which designs, manufactures and sells the same type of machines, are currently offering additional services, such as: monitoring, training and preventive maintenance. The competitor has also long term relationships with its customers and it has increased its market-share.

7.2 Execution of the case study

The Configurator was applied by means of two 6-hour workshops attended by the three aforementioned representatives of the company. In a first moment, a presentation was carried out in order to describe the objectives of the study, explaining the main concepts and advantages of PSS and presenting the Configurator of PSS proposals. The presentation included a description of successful cases of PSS implementation by manufacturing companies.

Although the company's representatives already know how a PSS operates, particularly because its main competitor already adopted it, they were unfamiliar with the terms "product-service system", "service-dominant logic" or "servitization".

Following, the application of the three steps of the Configurator performed during the workshop are explained.

7.2.1 Step 1: Analysis of the business context

First step addressed by the Configurator is the analysis of the current business model. For this purpose, a brainstorming section was held with the company's representatives and information was raised about the general characteristics of the Company A business. Some aspects of the current business were pointed out, such as the position of services as value offered to the clients, its importance on the revenue model of the company, the existing type of relationship with customer and the fact that they do not take any responsibility for the machines in their end-of-life. These aspects are discussed in following.

The company's main business unit manufactures thermoforming machines. The revenue model is mainly based on the sale of machines. Company A also supplies services such as maintenance and technical assistance. However, these services represent only 5% of the company's revenue, which covers only its operational costs. This fact demonstrates that the company does not exploit and prioritize services as value proposition to support reaching competitive advantage.

During the use phase of the machines, the relationship with clients is punctual as it happens only when a specific service is required by the client. Therefore, Company A does not have much source of information about the performance of its products and also about customer needs that are not being attended by the current offer.

With respect to the end-of-life of the machines, Company A states that currently it is not responsible for their disposal. The company's representatives couldn't answer what happens or how clients discard it.

Discussions about current market, products and industry also provided understanding for the academia participants and brought up information about the current business model to support the identification of PSS alternatives.

7.2.2. Step 2: Creation of PSS alternatives

Focusing on the current business of thermoforming machines, alternatives were analyzed for the adoption of different types of PSS. Three alternatives were exploited aiming to adapt the current business according to PSS specificities for the current value proposition and customer segment. The fourth alternative investigated the possibility of developing a new business considering a new product-service combination for a new customer segment.

The company decided to use two criteria for selecting the alternatives that should be detailed in order to generate PSS proposal(s):

- The efforts required to modify the current business (in case of adaptation of current business through PSS) or the effort to create a new one.
- Level of cultural change, as a fundamental shift is also required in the organizational culture when adopting PSS (TAN; MCALOONE, 2006; COOK et al., 2006).

The four PSS alternatives aforementioned are presented on Table 10.

Table 10 - PSS alternatives of Company A

Business model change X PSS type	POS (Product-Oriented Services)	UOS (Use-Oriented Services)	ROS (Result-Oriented Services)
Adaptation of current business through PSS	Alternative 1	Alternative 2	Alternative 3
Creation of new business	-	Alternative 4	-

The alternatives address the definition of the value to be offered and the specification of the customer segment, named as Customer Value Proposition (CVP). The four alternatives are described below.

Alternative 1: Product-oriented for the current business

The initial idea to apply the product-oriented PSS to the business of thermoforming machines was to integrate and improve the service element of the offer. In this sense, the machine continues to be sold but new services would be available for the customer during its use phase. The customer segment to be reached is the current customer of thermoforming machines. The Customer Value Proposition of alternative 1 is presented below:

CVP: Services available for thermoforming machines to current customer
--

The dimensions of the current business model requiring major modifications are: value proposition, resources, activities, customer relationships and cost structure, as presented following.

As mentioned earlier, the company already provides some services so it has some expertise on it. However, some new services should be created to increase the value offered and delivered to the customers.

As the focus of this alternative is the improvement of the service element, the dimension guiding the creation of the proposal is value proposition. Some benefits stemming from these actions are: increased revenue by supplying services, performance of the product monitored during its use phase, increased value delivered to and perceived by the client, and to effectively use the client's feedback about the products' performance.

New resources and activities would be also required. Examples are: the creation or improvement of service development process and its integration to the product development process. Another important aspect is the development of programs for employees covering trainings for improved services supply and development and also programs to teach about PSS concepts.

These resources and activities would cause new costs to be included in the cost structure dimension. For example, new costs related to structuring service development process and supplying the service.

Furthermore, by supplying these services new relationships with customers would be generated or the current relationships improved, mainly in the use phase of the product. This would require the definition of new ways to relate with the customers in order to increase the trust and information sharing.

The revenue streams won't change – the product is still being sold by the traditional manner. However, few modifications are required on the structure of the revenue streams dimension as a new inflow of cash should take place from services hired by the clients. The distribution channel for products won't change, but new possibilities of channels for service delivery might be considered.

No modifications would be demanded on customer segment, since it remains the same of the current business model. Also, no new partnerships intend to be developed.

Table 11 summarizes the classification the dimensions of the current business model that would require modifications in case of Alternative 1.

Table 11 - Modifications of alternative 1

Dimension	Major modifications	Minor modifications	No modifications
value proposition	X		
resources	X		
activities	X		
cost structure	X		
customer relationships	X		
revenue streams		X	
customer segment			X
distribution channel		X	
partnership			X

Alternative 2: Use-oriented PSS for an existing business

During the development of this alternative it was realized that major modifications would be required in all dimensions, except customer segment. The Customer Value Proposition of alternative 2 is:

CVP: Availability of thermoforming machines for the current customer
--

In respect to the value proposition dimension, the company would have to rethink the services it currently offers and to come with new services, when considering the alternative of implementing a use-oriented PSS. Therefore, new activities and resources would have to be established to ensure the proper supply of these services.

Another major modification on the value proposed to the customer concerns the offer of the machine functionality and guarantee of operation instead of its ownership. However, Company A was not convinced that this new value proposition would provide more benefits to customers than the simply purchasing of them. This means that Company A worries about not convincing its customer segment of the benefits of this offer due to the easy financing for purchasing machines.

Companies operating in the Brazilian market can obtain this financing from the Brazilian Development Bank (BNDES) through a program named Finame (Financing of machinery and equipment). This program allows customers to acquire loans for buying machines produced in Brazil and pay them back in up to 10 years. When the client acquires a machine using this financing, he also makes periodic payments for the right to use it like in a PSS offer. The difference lies in the fact that he owns the machine after paying off his loan, which is not the case of PSS. Such an incentive for purchasing new machines hampers companies to implement a use-oriented PSS on that market.

The implementation of this alternative would also lead to major modifications on cost structure and revenue streams dimensions. The offering of the machine functionality instead of its selling would require high initial capital investments since the company would earn money periodically and not at one time as it happens during a sale. This means the client would no longer pay for the acquisition of the machine but instead perform periodic payments for the right to use it. This fact leads to a relevant question made by the company members: how much time would be required to amortize the initial investment? In this sense, a financial partner would be required to support Company A on such investments. The company already has a financial partner that they could try to negotiate investing on this offer. Therefore, the modifications on the partnership dimension are considered minor.

In addition, the company believes that the supply of services associated with its products through regular fee instead of payments for services rendered could encourage the client to adopt a careless attitude about the use and conservation of the product. In this sense, higher costs and more resources would be spent on repair and maintenance services.

Concerning the dimension distribution channel, the selling of PSS offers would demand the creation of new sales area. A new mindset should be developed since employees from sales are used to sell product ownership. Yet, resources would have to be spent on training of the sales staff for offering PSS to the customer.

Another major modification concerns the customer relationship dimension. Currently, Company A enjoys a close relationship characterized by informality with most of its clients. Also, business agreements are signed directly with the client's top management. Thus, a modification regarding the formalization of the customer relationship would be required through contracts, which are essential for the proper operation of a PSS.

Table 12 synthesizes the modifications required for alternative 2.

Table 12 - Modifications required for of alternative 2

Dimension	Major modifications	Minor modifications	No modifications
value proposition	X		
resources	X		
activities	X		
cost structure	X		
customer relationships	X		
revenue streams	X		
customer segment			X
distribution channel	X		
partnership		X	

Alternative 3: Result-oriented PSS for an existing business

Most of the modifications pointed up in alternative 2 also apply to the third alternative. Thus, Company A will have to modify all the dimensions of the business model proposal, except for the customer segment dimension, which is same of the current business model. For alternative 3, the Customer Value Proposition is:

CVP: Availability of plastics bags units for the current customer

In both alternatives 2 and 3, the PSS provider keeps the ownership of the machine. Therefore, the facility of financing machines, the doubts concerning the time required to amortize the initial investment and the most effective manner to generate revenue also apply to the third alternative, as well as the modifications claimed on all the dimensions of the proposal. Also, as presented on the alternative 2, a financial partner would be required for alternative 3.

An issue specific to result-oriented PSS that has been mentioned by many studies about PSS is how to define the price of this type of supply, given the complexity of pricing intangible elements as services. The company has doubts about how to price the “availability of plastics bags units”, which would be the result provided to the customer.

Table 13 synthesizes the modifications required for alternative 3.

Table 13 - Modifications required for of alternative 3

Dimension	Major modifications	Minor modifications	No modifications
value proposition	X		
resources	X		
activities	X		
cost structure	X		
customer relationships	X		
revenue streams	X		
customer segment			X
distribution channel	X		
partnership		X	

Alternative 4: Use-oriented PSS for a new business

Alternative 4 involves the commercialization of a new type of machine that produces aluminum packaging. The company already has a specific market that demand this machines, which comprises small enterprises and/or start ups. However, Company A does not hold the technology required to develop this kind of machine. Hence, they plan to outsource the development and buy machines from a supplier located in China and then lease them under Company’s A quality seal and warranty.

For both customers and Company A, the use-oriented PSS is a more advantageous alternative in this case than the product or result-oriented options. As these machines would have to be imported, financing through BNDES Fname is not available. In this sense, more clients can be attracted in acquiring the PSS offer since they would have to pay at once the full price of the machine to acquire its property. The value proposed for the clients includes lower initial investment and lower operational costs, since the PSS provider – Company A - takes responsibility for maintenance and technical support.

It can be noticed that this alternative includes not only new value propositions but also a new customer segment. Since the product should be developed and produced by a outsourced company, just the service element of the PSS offer might

lead to modification as Company A needs to be prepared to supply services for this new machine. Therefore, considering the element product and the element service, minor modifications are required in the value proposition dimension. Despite the fact that the customer segment is new to the company, Company A already knows and understand the needs of this market. Customer Value Proposition of alternative 4 addresses:

CVP: Availability of aluminum packaging machines to new and small companies

Modifications would be required for resources dimension. Company A would face high initial investment in order to purchase machines and train or acquire new staff. However, the creation of a new business unit implies fewer cultural barriers for the part of employees. In addition, no product and manufacturing technology need to be developed in-house.

Since a new costumer segment is addressed for a use oriented offer, a new customer relationship is required. Differently from the current customers of the previous alternatives, the new customers would not have resistance on signing formal contracts.

The same modifications reported on revenue streams and cost structure dimensions of alternatives 2 and 3 would succeed for alternative 4.

Since product development and manufacturing would take place in the outsourced company, these processes would not be included in the ones required to run the Company A business. However, new processes and activities, such as a new or improved service development process and a new distribution process would be required. In addition, importing schemes should be clarified.

For the dimension partnership, a financial partner would be also necessary for alternative 4. In addition, a partnership with the manufacturer company should be formalized since the company contracted would have an essential role on the value chain of the PSS. Company A does not have knowhow and experience on such kind of strategic partnerships.

Table 14 presents the classification of the modifications for each dimension of the alternative 4.

Table 14 - Modifications addressed on alternative 4

Dimension	Major modifications	Minor modifications	No modifications
value proposition		X	
resources		X	
activities	X		
cost structure	X		
customer relationships		X	
revenue streams	X		
customer segment		X	
distribution channel	X		
partnership	X		

Selection of alternatives according to the criteria

After describing the four alternatives, they were analyzed to identify the most attractive for detailing and thus create a PSS proposal. This analysis, performed jointly with the company, considered the amount of effort required to modify the current business (alternatives 1, 2 and 3) and to implement a new business (alternative 4) and also the cultural barriers related to the implementation of each of these businesses.

Therefore, when it comes to the amount of effort, it can be noticed that the ones with more major modifications required are alternatives 2 and 3. Both of them present minor modifications on partnership dimension, no modifications in the customer segment dimension and major modifications on all the other dimensions. According to the analysis carried out jointly with the company members, alternative 1 and alternative 4 would need less effort to be further implemented.

For the second criteria, alternative 1 presents more barriers related to the changes on the organizational culture. The redefinition of a business that is currently profitable leads to doubts and resistance about changing it. Several authors argue that one of the major barriers faced by companies wishing to adopt PSS is the change in culture from product to service orientation (TAN, 2010; MARTINEZ et al., 2010; GOEDKOOP et al., 1999; MANZINI; VEZZOLI, 2003).

Taking into consideration the two criteria predefined by Company A, alternative 4 was the one selected to be detailed and deployed as a PSS proposal.

7.2.3 Step 3: Definition of PSS characteristics

The discussion with company's members focused on detailing alternative 4 in order to originate a PSS proposal. The detailing was carried by discussing with the participants of the workshop. The main PSS characteristics are shown on the bullets

followed by a descriptive text of the content of each business dimension. Customer Value Proposition is presented again as reminder.

CVP: Availability of aluminum packaging machines to new and small companies

Customer Segments

- Small and new companies;
- Price resistance.

The company seeks to reach small companies or companies that are entering the market, which do not have enough capital to purchase new machines and might find difficulties on making heavy investments. Through market research, the company found out that clients might have resistance to acquire the offer because of price conditions.

Value Proposition

- Service customization;
- Product new to the market;
- Performance;
- Quality;
- Brand;
- Lower initial investment.

As already mentioned, the value proposition is offered by means of the use oriented PSS. The service options of the PSS offered could be customized according to each client's needs, considering, for instance, the frequency in which the machine is used and type and variety of services that clients want to acquire. Services already provided by Company A could also be included on the service package. They are: delivery, planned maintenance and technical assistance when the client requires it.

The machine is a differentiation of the PSS offer since it is a new product not only for Company A, but also for the Brazilian market. Considering the newness and the complexity of the machine, new services include training courses on how to operate. Thereby, in addition of learning about the operation of the machine, clients' would benefit from its improved performance.

In addition of more quality provided and the strong brand of Company A, the company can also offer a lower initial investment option for the customer segment, considering the fact that the client would not purchase the machine but would pay for its use, which spreads these costs over the time the machine is used. Also, as the PSS provider is responsible for the machine during its entire lifecycle, the client's expenses with maintenance and technical assistance services are reduced.

Customer Relationships

- Long-term relationships;
- Co-development of solutions;
- Communication and information sharing.

Company A aims to establish long-term relationships through formal agreements, seeking close relationships. Closer relationships might facilitate the involvement of customers in the service development activities and thus the co-development of solutions. In this case, the PSS provider could support the development of solutions at the client's facilities. The greater the proximity between the PSS provider and the client, the better the communication and information sharing, making it easier for the PSS provider to participate in the client's processes and to improve the performance of the PSS offer.

As owners of the machine, the PSS provider is responsible for it during the use and end-of-life (EoL) phases. Thereby, the information gathered through embedded sensors on the machine might put the provider in contact with the customer in order to perform services, e.g. corrective maintenance.

Key Resources

- New relationships and processes;
- Financial resources, human resources and software.

The key intangible resources considered by the company in this new offer are mostly new relationships and processes. The relationships include the one with clients, explained in "customer relationships" and the one with the machine provider that will be addressed on "partnerships". The processes required to run the PSS offer will be described on key processes and activities.

The key tangible resources are financial resources, human resources and software. The financial resources involve the investment required to acquire this new offer, i.e., the resources required to purchase the machines from China.

It is also required to involve qualified staff to offer services to support the use of the machines and to provide technical, mechanical, electrical and electronic maintenance services. In addition, training for sales staff should be considered, as well as the definition of staff and of people directly responsible for managing contracts.

The company will consider the use of specific software programs to monitor the machine during its use phase and advice when it is time to perform services and take the machine out of operation.

Key Processes and Activities

- New processes for partners' management, clients' management, performance measurement, process of product and service development, and distribution channel;
- Few changes on the technology development;
- No changes on manufacturing.

With respect to partners' management, the increase in the number of partners needed for the development of a PSS offer demonstrates the importance of managing this network. Risks and profits will have to be shared with partners on a contract basis. The fact that the company aims at create closer relationships with its clients requires a differentiated management of the activities conducted with these clients. New forms of communication with clients will be required on a regular basis.

Suitable performance indicators should be created to measure the results of this new offer. These indicators must be able to measure client satisfaction with the PSS, e.g. the services provided during the use phase. The product lifecycle cost should also be used as an internal performance measure of client satisfaction in order to measure financial issues.

Ways to integrate process of product development and service development must be outlined, since the product development will be carried out in the outsourced manufacturing company. A possibility is to create a virtual co-development between

Company A and the manufacturer. In this sense, both companies can collaborate in the product development activities and ensure that relevant requirements are taken into consideration. For instance, the machine must have sensors to enable the remote monitoring during the use phase.

New distribution channels should be created to reach the customer segment. In addition to its already existing sales office, Company A is considering new sales channels for the realization of marketing activities and sales, qualified to demonstrate to clients the benefits of the PSS offer. In addition, the company intends to use its website as a tool to enable constant communication with the client. The type of distribution channel is direct to client, with no retailers involved.

Few changes are required in the on process of technology development, which are related to the knowledge required to manage the software embed on it, and no changes on the manufacturing process as this process will be outsourced.

Key Partners

- Partner for manufacturing;
- Partner for contract management;
- Information technology (IT) supplier.

One of the most relevant elements for PSS-oriented business is the partnerships required to develop and deliver the offer. Upon examining the value proposition and customer segment, the machine tool manufacturer identified several actors required to create this offer. First, Company A can be pointed out as the actor responsible for this network. Despite its role as OEM, Company A is not the original manufacturer of this specific offer.

Second, a partner for contract management is also demanded. Due to the new types of agreements signed with partners and clients, it will be necessary to have a law office in charge of contract management.

Finally, information technology (IT) supplier will be necessary to create architecture for product monitoring aspects of both hardware and software.

Company A is dependent of all the partners mentioned to execute its activities and take decisions, which demonstrates the high complexity of partners' interaction.

Revenue Streams

- Monthly payment of a fixed rate;
- Fixed contracts.

The total revenue would be generated based on the use of the machine through the monthly payment of a fixed rate, which would cover both the product and services that would be available throughout the machine's lifecycle.

The acquisition of the machines 'use should be performed by fixed contracts. However, these contracts could cover customized product-service combination according to the client' needs.

Cost Structure

- Profits shared with partners;
- Substantial initial investment;
- Costs involved in the use and end-of-life phases of the PSS.

Some of the costs involved in this PSS differ from the usual ones pertaining to product sales. The increased number of partners means that profits will be shared with them. Moreover, unlike the sale of a product, the entire revenue will not be realized at the moment the machine is delivered to the client and the company will have to make a substantial initial investment on the acquisition of the machines. And, since the company retains ownership of the machines, it will have to bear the costs involved in the use phase of the PSS (maintenance services, upgrades, replacement parts and shipping of same) and on the end of life and/or disposal costs (reverse logistics and end of life alternatives, such as reuse, remanufacturing and recycling).

7.3 Insights from the Configurator application

Advantages and disadvantages of using the Configurator are described following.

7.3.1 Advantages of the Configurator

The application of the Configurator occurred in the presence of the company's board members, who agreed on the possibility of implementing the end result of the Configurator – the PSS proposal - on the near future. This fact suggests that the Configurator has potential to assist the company in the definition of PSS proposals that could be further implemented. Additionally, the Configurator supported Company A on:

- The understanding of the current business model and the exploration about how this business could operate within different PSS alternatives;
- The identification of efforts related to the different PSS alternatives;
- The creation of a proposal according to PSS requirements;
- The generation of new business ideas and opportunities as a result of the knowledge acquired using the Configurator.

7.3.2 Disadvantages of the Configurator

Some disadvantages of the Configurator were pointed out during the application by members of Company A and after the application, by means of discussions between the researchers that participated on the case study. These disadvantages were systematized and are listed below:

Disadvantage I: to take a decision about business model change (create a new business or adapt the current one) considering only information about the current business model and the analysis of strategies, concepts, ideas and opportunities. It would be more flexible whether such decision could be taken anytime during the application of the method. Therefore, does not make sense to limit the decision about business model change to step 1.

- Disadvantage II: refers to the utilization of PSS types (on step 2) as a first manner to classify the PSS alternatives. Members of the Company A experienced difficulties on deciding about which PSS type fits better a specific Customer Value Proposition (CVP) without developing more the content of the proposal. In addition, the characteristics concerning product ownership and source of revenue, which are the main ones that differentiates the PSS

types, could be described later on, when developing the dimension customer relationship or revenue streams on step 3, for instance.

- Disadvantage III: the need to take a decision (on the beginning of step 3) of selecting an alternative after having developed only the Customer Value Proposition (CVP). If the content of other dimensions have already been created, they would have more knowledge and information to take such decision.
- Disadvantage IV: concerns the difficulty to use the method without having a better knowledge about different characteristics that can be included on a PSS proposal and about the meaning of the business model dimensions. Step 3 of the method mentions some PSS characteristics, but they were considered too generic and abstract to be utilized to create PSS proposals. Yet, the company faced difficulties to decide which PSS characteristics should fit in which business model dimension.

Figure 13 presents the method with the four aforementioned disadvantages in red.

Figure 13 – Representation of the method with the disadvantages

8. Creation of the second version of the Configurator of PSS Proposals

After applying the Configurator of PSS proposals in a case study, disadvantages of the method were pointed out by the academic team and by Company's A representatives. For each of the four disadvantages pointed out in the section 7.3.2, actions of improvement were outlined. Table 15 presents a summary of both disadvantages and the actions of improvement.

Table 15 - Disadvantages and actions of improvement on the Configurator

Disadvantages	Action of improvement
(I) Decision about business model change as output of step 1	Removal this output
(II) Utilization of PSS types to classify the PSS proposals	Removal of step 2
(III) Decision to select an alternative based only on the CVP	Removal of step 3
(IV) Difficulty to use the method without deep knowledge about different characteristics that can be included on the PSS proposal and about the meaning	Removal of step 3

of the business model dimensions.	Inclusion of new content
	Creation of new steps

The actions of improvements proposed are described in following. This section presents the execution of the phase 4 of the research method.

8.1 Removal and creation of steps

To minimize the aforementioned disadvantages, the first modification performed in the method was to exclude the step 2 “Creation of PSS alternatives”. Two elements of this step, which are the input “PSS types” and the input “business model change”, were criticized. By removing step 2, the creation of PSS alternatives, which address the definition of a Customer Value Proposition (CVP), was also discouraged. The selection of alternatives to be deployed as PSS proposals restricted the possibilities of developing a set of different proposals that could lead to successful business models. Therefore, step 3 was also removed.

In order to create new steps for the method, a literature review was carried out. By executing the same search about authors exploring PSS business model performed on Section 5 (see Table 5), it was realized that most of the current research utilizes business model dimensions from (OSTERWALDER; PIGNEUR, 2010), as presented on Table 16. It differs from what was identified on the literature until 2012, where most of the studies used the typology of Tukker (2004) as types of PSS business models. This is also another reason to explain the exclusion of “PSS types” and the utilization of business model dimensions as a manner to organize the content of the method.

Table 16 - Business model reference for PSS

Title	Author	Business model reference
Employing the business model concept to support the adoption of product-service systems (PSS)	(BARQUET; OLIVEIRA; et al., 2013)	(OSTERWALDER; PIGNEUR, 2010)
Product Service Systems as a driver for business model innovation: lessons learned from the manufacturing industry	(VELAMURI et al., 2013)	(OSTERWALDER et al., 2005; ZOTT; AMIT, 2010; CHESBROUGH, 2010)
Developing PSS Concepts from Traditional Product Sales Situation: The Use of Business Model Canvas	(WALLIN et al., 2013)	(OSTERWALDER; PIGNEUR, 2010)
Guidelines for the definition of innovative industrial product-service systems (PSS) business models for remanufacturing	(GUIDAT et al., 2014)	(OSTERWALDER; PIGNEUR, 2010)

Association of Product-Service Systems Design Concepts with Business Models and their Evaluation Method	(WON et al., 2014)	(OSTERWALDER; PIGNEUR, 2010)
Integrative re-use systems as innovative business models for devising sustainable product service-systems	(GELBMANN; HAMMERL, 2014)	(OSTERWALDER; PIGNEUR, 2010)
Product Service Systems (PSS) business models and tactics e a systematic literature review	(REIM et al., 2014)	(TUKKER, 2004; OSTERWALDER; PIGNEUR, 2010; TEECE, 2010)
Extended Product Business Model Development in Four Manufacturing Case Studies	(WIESNER et al., 2014)	(OSTERWALDER; PIGNEUR, 2010; TEECE, 2010)

Business models dimensions adapted from Osterwalder; Pigneur (2010) and deployed in steps are:

- Value Proposition: deals the combinations of products and services that will be offered to the client and the benefits delivered through them.
- Customer Segment: comprises the information about the market that should be attracted by the value proposition. Therefore, information about current and potential clients should be considered.
- Customer Relationship: presents the different options of relating with clients on the different phases of the PSS lifecycle;
- Processes and Activities: encompasses the processes and activities of the PSS network;
- Partnership: covers the actors that should perform some of the processes of the PSS network;
- Distribution Channel: addresses the manner the PSS offer should be delivered to the customer;
- Resources: covers the different assets required to run the business, such as knowledge, technology, competence and human resources;
- Cost Structure: encompasses the different elements of the cost structure;
- Revenue streams: presents possibilities of how to earn money from different types of value proposition.

8.2 Addition of content on each step

To assist in the definition and organization of the content of each step,i.e., each business model dimension, a literature review is executed about methods and

tools that support creation of PSS taking into account different business models dimensions or at least parts of it. The methods and tools identified are summarized and analyzed.

After that, systematic literature reviews were carried out in order to identify the content of the method. This action of improvement aims at reduce the disadvantage IV and provide more knowledge about different characteristics that could be taken into account to create a PSS proposal.

8.2.1 Methods and tools

Three methods and tools are presented on this section.

Morphologic matrix for PSS strategies (TAN; MCALOONE, 2006)

The authors identified PSS strategies applied for companies and grouped them in characteristics that covers different variations. Similar to a morphologic matrix, the characteristics presents different variations. The selection of different blend of variations leads to a set of PSS solutions.

The matrix can be visualized on Table 17.

Table 17 – Characteristics of strategies and possible variations

Strategic characteristics	Variations			
Benefit is oriented towards	ownership of the physical product	use of the product	results of the of the product	consumption of the product
Transfer of ownership	after sale	after installation	returns to the provider at end of life	is never transferred – owned by the provider throughout its life
Responsibility during use	customer has full responsibility	provider is responsible for installing	provider installs, maintains and takes back the product	provider has full responsibility for the use of the product

The authors' intentions were two: to create a morphology of PSS characteristics by mapping them in a great amount of empirical studies and to identify patterns of PSS solutions.

Some factors should be analyzed in order to guide the creation of successful PSS offers. Thereby, before starting the definition of the variations of each characteristic on a specific case, it is important to analyze: knowledge of the

stakeholders, client's values and necessities and technological possibilities of the company.

The morphologic matrix was built based on empirical cases and do not took into account information and knowledge available on the literature. More research is required to create a more complete version of the matrix (TAN, 2010).

Between 2012 and 2013, the research group that developed this morphologic matrix also created a tool named PSS Configurator. The purpose of this tool is to inspire the planning and design of PSS offers. They present a range of alternatives, e.g. update online inspections, repair, take back systems that should be selected in order to configure a PSS offer. The PSS configurator was developed by mapping approximately 60 product and service identified in companies (FINKEN et al., 2013).

The PSS configurator encompasses alternatives for creating PSS offer, i.e., the value proposition. However, by analyzing the PSS configurator, alternatives concerning the distribution channel dimension is also identified, such as call center, sales office, e-commerce. Nevertheless, the tool does not covers alternatives for the other business model dimensions.

Framework for PSS business models (LEE et al., 2011)

The authors built up a framework to create business models, which is composed by templates and a method. There are two types of templates: strategy template and protocols template. The strategy template guides the decisions about the company logic and the manner it operates and competes on the market. The protocols provide a set of patterns elements that need to be taken into consideration to implement the business model on the operational level.

The information of both templates is structured according to the dimensions of business models proposed by Osterwalder (2004): customer segment, client relationship, distribution channel, revenue streams, cost structure, resources, activities configuration and partnership network.

To facilitate the understanding about the templates and their use, an example is demonstrated for one of the dimensions, the customer segment. The elements described on the strategy template are: diversification, segment extension, new

product development and market entrance. The elements of the protocols template are: B2B, B2C, B2G, local, regional, international, global and niche.

Table 18 presents the elements of customer segment.

Table 18 – Example of elements from templates strategy and protocol

Dimension	Type of template	Elements					
Customer segment	strategy template	diversification	segment extension	new product development	market entrance		
	protocols template	B2B	B2C	B2G	local	regional	International...

Each dimension addressed by the framework presents a diversity of elements of the strategy template and of the protocols template. Therefore, the authors stated that the variety of combinations between elements from the different templates and dimensions can generate a range of business models.

The second component of the framework is a method designed to create business models, which utilizes as input ideas of products and services and delivers business models as output.

The method encompasses five steps: identification of the product and service elements; creation of the business model concept by means of the strategy and protocols templates; identification of stakeholders and the relationship between them; identification of the value the business model can generate and; implementation of the business model.

Lee et al. (2011) suggest the identification of the relationships between the elements of the templates as a future research. Still, the research does not explain or gives advices on how to select the elements of the templates and the authors just take into account ideas of products and services as input for the business model creation without examining the possibility of developing PSS as a new business. This framework was developed through the knowledge gathered from real cases and does not include elements from the literature.

Morphology of PSS for innovative business models (MEIER; MASSBERG, 2004)

This study mentions some business model dimensions when discussing about features such as operation, maintenance, operating site, financing, and payment options. In addition, possible specifications of each feature are presented. Feature maintenance, for instance, concerns the responsibility of providing product

maintenance. The specifications related to this feature are: client, PSS provider and contracted service provider. Therefore, similar to the studies of Lee et al. (2011) and Tan; McAloone (2006), the combination of specifications from different features leads to different configurations of business models.

Table 19 presents the illustration of the aforementioned example.

Table 19 – Example of a feature and possible specifications

Feature	Specifications		
Maintenance	client	PSS provider	contracted service provider

Meier; Massberg (2004) address partially the dimensions and characteristics required to plan and develop PSS. In addition, despite the fact that they use the term business model; they do not take into account dimensions that are essential to create a business model, such as cost structure and client relationship.

Ontology of Business Models for Industrial Product-Service Systems (RESE et al., 2013)

This study provides a framework to analyze business models for PSS based on different characteristics of business models and their variations, which they name as attributes of business models characteristics. The authors affirm that this ontology provides means for designing, characterizing, classifying and comparing PSS business models (RESE et al., 2012).

Table 20 presents examples of one characteristic and attributes of the ontology.

Table 20 – Examples of characteristics and attributes

Characteristics	Attributes					
provider's life cycle activities	specification, procurement and installation	maintenance	upgrading	continuous improvement	manufacturing resources	operation

Consideration of the methods and tools

These studies present some similarities, despite the fact that they use different terms. First, they aim at characterizing PSS business models through a set of combinations between different attributes. Second, all of them utilizes, completely or partially, business models dimensions to organize the attributes. Third, each attribute encompasses different possibilities to characterize it, i.e. options.

This study name the content of the Configurator of PSS proposals as attribute and options. The correspondence between the terms utilized on this research and the ones aforementioned can be visualized on Table 21.

Table 21 – Correspondence between terms used on different research

Attribute	Options	References
Strategic characteristics	Variations	(TAN; MCALOONE, 2006)
Dimension	Elements	(LEE et al., 2011)
Feature	Specifications	(MEIER; MASSBERG, 2004)
Characteristics	Attributes	(RESE et al., 2012)

8.2.2 Development of the content

In order to create a more complete and robust method and reach a complete collection of attributes, systematic literature reviews were performed. The execution of the SLRs is explained in the activity 4.2 of the phase 4 on research method (section 2.2). Since two SLRs are executed, two results are introduced, one for product project attributes and another for PSS attributes. Each of them encompasses:

- Identify the attributes and their options;
- Define which attributes are embraced by which dimensions;
- Include the dimensions, attributes and options on a database. This database is named PSS configuration database.

Identification of the attributes

In order to identity the attributes that could characterize product and PSS projects, an investigation on the literature of product development project and PSS was performed and the existing typologies for both cases were studied. The protocol utilized to perform each SLR is available on Appendix 1.

The selection of typologies for the attributes identification stems on the typologies definition. Typologies, also called system of projects classification (CRAWFORD *et al.*, 2004), are consisted by attributes that enables projects characterization (ROSENØ, 2005; DANNEELS, 2002; SHENHAR, 2001a; SHENHAR; DVIR, 2007).

The studies selected on the RBS are the ones that discuss about attributes that enables projects characterization and, with such attributes, different options should be presented.

Table 22 clarifies the meaning of attributes and options.

Table 22 – Clarification of the terms attributes and options

Attributes	Options				
Attribute 1	1A	1B	1C	1D	1E
Attribute 2	2A	2B	2C	2D	2E
Attribute 3	3A	3B	3C	3D	3E
Attribute 4	4A	4B	4C	4D	4E

Attributes from typology of product development projects

A great amount of typologies for product projects were found on the literature. The attributes identified on these typologies were analyzed and classified according to the business models dimensions presented in section 8.1.

Dimension customer segment

Typologies of product development projects discuss about how new is the customers' segment to the company and the level of uncertainty of conditions and trends of these customers'. Reasons that make the client attracted or not to the value proposition and its receptivity for new offers are also explored.

Table 23 exhibit the attributes identified on literature about typologies of product development projects that encompass customer segment dimension.

Table 23 – Attributes of customer segment identified on typologies of product development projects

Attributes	Options				References
elements that increase perceived value to client	new technology	new attributes/ direct benefit	new attributes/ indirect benefit	improvement on existing attributes	(LEE; CONNOR, 2003)
resistance to acquire the offer	new knowledge	behavior change	price		(LEE; CONNOR, 2003)
newness of the market segment	market unknown with no needs identified yet	market known with needs partially identified	market well known with needs identified		(HART <i>et al.</i> , 1999)
market's receptivity for new products/ market's rhythms	clients are not open for novelty	clients can be open for novelty after some discussion	clients are open for novelty		(DACKO <i>et al.</i> , 2008)
level of uncertainty of	conditions and trends are	conditions and trends are	conditions and trends		(RAINEY, 2005)

market conditions and trends	unknown	partially known	are known		
market novelty level to the company	market unknown	market known			(CHEN et al., 2005) (RAINEY, 2005) (LEE; CONNOR, 2003)

Dimension Value Proposition

The attributes covered by this dimension mention products and services. For products, attributes related to environmental aspects, innovation and complexity, regarding internal and external structure, are depicted. Product scope and architecture are also presented.

In relation to services, environmental aspects, innovation and diversity are discussed.

Table 24 shows the attributes of the dimension Value Proposition.

Table 24 - Attributes of value proposition identified on typologies of product projects

Attributes	Options							Reference
type of environmental aspects into product concepts	lifetime	material composition	recycled parts or components/ recyclability	parts or components recyclable	energy source	energy consumption	no environmental aspects considered	(SOUSA E WALLACE, 2006),
allocation of environment experts	allocated on corporative level	allocated on product development		allocated on other departments (e.g. marketing or production process)		there is no environment experts		(KIVIMAA, 2008)
environmental criteria on products	common between projects			developed according to each case				(KIVIMAA, 2008)
complexity of the internal structure of the product/ Internal integrity	small amount and small variety of components with low interaction	small amount and small variety of components with many interaction	high amount and high variety of components with low interaction	high amount and high variety of components with many interaction	small amount and high variety of components with low interaction	small amount and high variety of components with many interaction	high amount and small variety of components with low interaction	(CHAPMAN; HYLAND, 2004) (BARCLAY; DANN, 2000) (BARCLAY, 2002) (WHEELWRIGHT; CLARK, 1992)
type of product scope	component	Assembly		sub-system		system		(SHENHAR, 1998, 2001a; SHENHAR <i>et al.</i> , 1995;
type of product architecture	platform		derivative					(TATIKONDA, 1999)
complexity of the user interface/	product/service relatively easy to use, client needs manuals to learn		product/service complex to use, client needs training and support		product/service easy to use, client can do it alone			(CHAPMAN; HYLAND, 2004) (BARCLAY, 2002)

External integrity								(BARCLAY; DANN, 2000) (CLARK; FUJIMOTO, 1991)
level of change on product	improvement	derivative	addition on product family		next generation	totally new		(WHEELWRIGHT; CLARK, 1992)
ways to communicate product value	product differentiation	product diversification	product identity	brand creation	corporate identity	corporate culture		(TRUEMAN, 1998)
product tactical decisions	product styling	aesthetics	quality	price	brand	advertisement	promotion	(TRUEMAN, 1998)
level of product novelty to the world	low	high						(BARCLAY; DANN, 2000) (HART <i>et al.</i> , 1999) (GRIFFIN; PAGE, 1996)
level of product novelty to the company	low	high						(GRIFFIN; PAGE, 1996) (BARCLAY; DANN, 2000) (LEE; CONNOR, 2003) (HART <i>et al.</i> , 1999)
level of innovation on product	incremental	really new	radical					(GARCIA; CALANTONE, 2002)
level of novelty on services for the company	low	medium	high					(MENOR <i>et al.</i> , 2002) (BRETANI, 2001)
level of novelty on services for	low	medium	high					(MENOR <i>et al.</i> , 2002)

the client								
level of novelty on services	new to the market		new to the company					(AVLONITIS <i>et al.</i> , 2001)
type of service offer	services oriented to products		services oriented to clients process					(KUJALA <i>et al.</i> , 2010).
environmental aspect on services	service brings no improvement on ecoefficiency of client business process		service brings incremental improvement on ecoefficiency of client business process		service brings radical improvement on ecoefficiency of client business process			(BARTOLOMEO <i>et al.</i> , 2003)
level of variety of services	little options and mostly common types of services		little options but distinct types of services		many options and mostly common types of services		many options with distinct and common types of services	(BULLINGER <i>et al.</i> , 2003)

Dimension Processes and activities

Attributes related to project management were identified, such as type of project management style, project size, type of project manager, level of dependency between projects and project complexity.

Typologies for the production process, which includes attributes related to novelty and complexity on this process, are also depicted.

Table 25 presents the attributes mentioned.

Table 25 – Attributes of processes and activities identified on typologies of product development projects

Attributes	Options					Reference
type of project management style	client oriented	process oriented	contract oriented			(TWIGG, 1998)
project size	little amount of functions to be performed and low level of work	little amount of functions to be performed and high level of work	high amount of functions to be performed and low level of work	high amount of functions to be performed and high level of work		(LAKEMOND <i>et al.</i> , 2001)
type of project manager	project coordinator	supervised project coordinator	autonomous project manager	functional and supervised project coordinator	functional and supervised project manager	(LECHLER; DVIR, 2010)
level of definition of responsibilities and roles on project management	responsibilities and roles not defined	responsibilities and roles partially defined		responsibilities and roles fully defined		(AVLONITIS <i>et al.</i> , 2001)
level of cross-functional involvement	low	medium	high			(AVLONITIS <i>et al.</i> , 2001)
level of dependency between projects	no dependency	projects share resources	dependency on deliverables	totally dependent		(DAHLGREN; SÖDERLUND, 2010)
multi project strategy	new design	design transfer		design modification		(NOBEOKA; CUSUMANO, 1995) (NOBEOKA; CUSUMANO, 1993)
complexity of project actors interaction	low	medium	high			(ARTTO <i>et al.</i> , 2008)
project complexity	long period and much resources	short period and much resources	short period and less resources	long period and less resources		(BARCLAY; DANN, 2000) (LAKEMOND <i>et al.</i> , 2001)
level of novelty on production process	incremental change	improvement of one line	next generation process	really new process		(WHEELWRIGHT; CLARK, 1992) (TATIKONDA; ROSENTHAL, 2000)
level of complexity on production process	low	medium	high			(CHAPMAN; HYLAND, 2004).

Dimension Partnership

Attributes related to the level of contact between the company and its customers', frequency of communication with the different actors of the value chain and level of dependency the company has from the partners concerning taking decisions and executing activities are included on this dimension.

Table 26 exhibits the attributes of the partnership dimension.

Table 26 - Attributes of partnership identified on typologies of product development projects

Attributes	Options				Reference
level of clients contribution during the development	no contribution	contributes in specific activities		contributes all long the project	(O'HERN; RINDFLEISCH, 2008)
level of contact with client	Low	medium	high		(BULLINGER <i>et al.</i> , 2003). (MATHIEU,2001)
actors responsibility level on the development	no responsibility	responsible for specific activities		full responsibility	(WYNSTRA; PIERICK, 2000)
development risk	Low	high			(WYNSTRA; PIERICK, 2000)
frequency of communication with actors	sparse communication	communication in specifics moments		daily communication	(WYNSTRA; PIERICK, 2000)
orientation of actors communication	one-way		double track		(WYNSTRA; PIERICK, 2000)
actor responsible for development	Client	supplier	OEM		(TWIGG, 2002)
actors with responsibilities on the development	Client	supplier	OEM		(TWIGG, 2002)
level of firm's dependency of actors	no dependency	dependency to take decisions	dependency to execute activities	dependency on decisions and activities	(TANGPONG <i>et al.</i> , 2008)
type of approach to involve actors	systematic integration	ad hoc integration		no type of integration	(LAKEMOND <i>et al.</i> , 2006)
way of actors control	centralized	descentralized			(HONG <i>et al.</i> , 2009)

Dimension Resources

Among the researches that discuss about resources on product development projects, some of them propose typologies for knowledge management knowledge transfer and competence, such as acquisition of client competence, structure of

knowledge management activities and level of knowledge transfer inside the company.

Attributes related to technology, e.g. technology complexity, technology innovation and technology transfer and insertion are explored too.

The attributes of the resource dimension are listed on Table 27.

Table 27 - Attributes of resources identified on typologies of product development projects

Attributes	Options					References
structure of knowledge management activities	central role of a knowledge manager, who has a team	decentralized role/ based on each project (role of each development team)		knowledge management cells functionally allocated	no formal role for knowledge manager or team	(SÖDERQUIST, 2006)
level of efficiency on the technology transfer between firms	easy and fast transfer	medium	difficult and slow transfer			(LEIPONEN, 2006)
level of knowledge transfer inside the company	no knowledge transfer	knowledge transfer when required		permanent knowledge transfer		(LEIPONEN, 2006)
sources of organizational learning	functional learning	cross-functional learning	learning based on clients relationship	learning based on other companies relationship		(LEENDERS; VOERMANS, 2007)
novelty on technology capability	low/ competence exists on firm	high/ competence new on firm				(DANNEELS, 2002) (ULRICH; EPPINGER, 2011),
type of technology competence	Platform	complete project derivative	partial project derivative	tropicalization	nacionalization	(CONSONI; QUADROS, 2006)
level of technology capability	offer leads to low improvement of firms capability		offer leads to medium improvement of firms capability		offer leads to high improvement of firms capability	(VERYZER, 1998)
level on client competence	existent and developed competence (known client)			new competence to the firm (unknown client)		(DANNEELS, 2002)
type of acquisition of client competence	by marketing channel (market research)	by distribution channel	by managing client business process	by communication channel (information exchange)		(DANNEELS, 2002)
level of product capability	low amount of benefits perceived by the client		benefits perceived by the client are as expected		high amount of benefits perceived by	(VERYZER, 1998) (MOSEY,

					the client	2005)
level of knowledge on the final offer	known and delivered offer	known and not yet delivered	totally new offer			(ULRICH; EPPINGER, 2011)
level of capability for product innovation	potential competence (knowledge built based on external sources)			perceived competence (knowledge built based on know-how)		(BRANZEI; VERTINSKY, 2006)
level of technology insertion on product	Platform	system	equipment	components		(KERR <i>et al.</i> , 2008)
type of borders for technology insertion	across sectors	across products	across projects	across firms		(KERR <i>et al.</i> , 2008)
level of interaction between firm that transfer and firm that receive technology	no interaction	interaction only when transfer happens	permanent interaction			(STOCK; TATIKONDA, 2000)
level of technology novelty	technology is known	technology is partially known		technology is unknown		(STOCK; TATIKONDA, 2000) (GARCIA; CALANTONE, 2002) (ROSENØ, 2005) (DAHLGREN; SÖDERLUND, 2010)
technological readiness to launch new products	Passive	active				(DACKO <i>et al.</i> , 2008)
level of technology uncertainty	no technological change required	low level of technological change required	medium level of technological change required	high level of technological change required		(RAINEY, 2005) (SHENHAR, 1998, 2001a; SHENHAR <i>et al.</i> , 1995) (CHEN <i>et al.</i> , 2005)
technology complexity	low variety of technologies required		medium variety of technologies required		high variety of technologies required	(CHAPMAN; HYLAND, 2004)

It can be observed that not all the dimensions appeared in this section, such as cost structure and revenue streams, since no attributes related to these dimensions were identified on the literature about product projects typology.

Attributes of PSS

A diversity of attributes of PSS was found through the SLR, despite the fact that they are fewer than the items of product development project. In the same manner chosen to organize product project items, PSS attributes were classified in accordance with business model dimensions.

Dimension Customer Segment

Among the PSS references investigated, just Lee *et al.* (2011) mention typologies for customer segment, based on Osterwalder (2004).

Thereby, this is the only attribute of this dimension, as shown in Table 28.

Table 28 - Attributes of customer segment identified from typologies of PSS

Attributes	Options							Reference
Market range	B2B	B2C	B2G	local	regional	national	international	Osterwalder (2004)

Dimension Value Proposition

Among PSS typologies, the most cited is the one from Tukker (2004) (YOON *et al.*, 2012; TAN; MCALOONE, 2006; GEUM; PARK, 2010; GEUM; PARK, 2011; MEIER *et al.*, 2010; ROY, RAJKUMAR, 2011; DATTA; ROY, 2011; HAO; XIAO-MIN, 2010). However, the author does not mention which attributes were utilized to create this typology. It is observed that the main differentiator between the types is the orientation of the offer, which depicts product ownership and source of revenue.

Level of tangibility, type of technology interface and level of customization in the product-service bundle are examples of attributes discussed on the PSS literature.

Attributes related to services were also identified in the PSS literature. The authors discuss about service innovation, service position on the business, service orientation and types of service.

Table 29 presents the attributes of dimension Value Proposition.

Table 29 - Attributes of value proposition identified from typologies of PSS

Attributes	Options									References
level of tangibility of product-service bundle	product stands service			half product half service			service stands product			(GAO <i>et al.</i> , 2011)
types of product-service orientation	product oriented			use oriented			result oriented			(TUKKER, 2004) (COOK <i>et al.</i> , 2006) (TAN; MCALOONE, 2006)
Service position of business / project	nonexistent			operational			strategic			(MATHIEU, 2001)
type of technology interface on product-service integration	technology as a direct enabler	technology as an indirect enabler	technology as a mediator (servitization mediator)	technology as a mediator (produtization mediator)	technology as a facilitator (service facilitator)		technology as a facilitator (product facilitator)		(GEUM <i>et al.</i> , 2011).	
level of customization on product-service bundle	no customization/ standard			just some parts/modules/ser vices can be customized	customized products	customized services	customized products/ services	customize d solutions	(MATHIEU, 2001)	
service orientation	product oriented			process oriented	tasks/labor oriented	technology oriented		infrastructure oriented	(WU; GAO, 2010)	
types of innovation on product-service bundle	improvement on bundle				new bundle		improvement on product- service development process			(YOON <i>et al.</i> , 2012)
type of service	Planning	consulting	planned overhaul	logistics	diagnosis plus recommendations	optimization/ improvement	service technician on call	delivery	training	(KORTMANN, 2007 apud MEIER <i>et al.</i> , 2010)
nature of service provision	service to client process				service to product					(MATHIEU, 2001)

Dimension Customer Relationship

The attributes from typologies about customer relationship embraces responsibility of product, product ownership, interactions with the customer and types of contracts. Table 30 exhibits the attributes concerning the customer relationship dimension.

Table 30 – Attributes of customer relationship identified from typologies of PSS

Attributes	Options					References
client behavior regarding product ownership	wants product ownership		may give up the ownership depending on benefits		do not care on having product ownership	(TAN; MCALOON E, 2006) (TUKKER, 2004)
option of product ownership	client's ownership	client's ownership until end of life, when firm tack it back		firm's ownership	client finance product has its ownership at the end of funding	(TAN; MCALOON E, 2006) (TUKKER, 2004)
responsibility of product	client has the responsibility during usage and end of life phase		client has the responsibility during usage		firm has the responsibility during usage phase	(TAN; MCALOON E, 2006) (MEIER <i>et al.</i> , 2010)
	firm has the responsibility during usage phase and end of life phase		firm manages client production process		firm provides services when client require	
level of involvement of provider on client business processes	provider do not manage processe s or execute activities for clients	provider do not manage processes but execute activities for clients		provider manage processes but do not execute activities for clients	provider do not manage processes and do not execute activities for clients	(ERKOYU NCU <i>et al.</i> , 2011)
level of contact/relationship with client	no communication, trust and information sharing between client and provider		low intensity of communication, trust and information sharing between client and provider		high intensity of communication, trust and information sharing between client and provider	(BULLING ER <i>et al.</i> , 2003) (COOK, <i>et al.</i> , 1999)
type of commercial relationship	transactional			relationship based		(OSTERW ALD, 2004)
types of contract	based on frequency of client contact	based on type, complexity and/or urgency of client request		based on duration of client production cycle	simultaneous contracts of the same PSS	MEIER <i>et al.</i> , 2010)
	based on the quantity of product-service use (resource)		based on the period of product-service use (time)	based on availability	based on the quantity of product-service use (resource)	

Dimension Processes and activities

Baines *et al.* (2009) e Lee *et al.* (2011), based on Osterwalder (2004), investigate the processes and activities required to run PSS, such as product and service development, manufacturing, logistics, sales. Types of indicators to measure the different aspects of the PSS offer are also explored.

Table 31 presents the attributes mentioned.

Table 31 – Attributes of processes and activities identified on typologies of PSS

Attributes	Options										References
processes and activities required	technology development	acquisition	logistics	manufacturing	marketing and distribution	client management	product and service development	partners management	quality management		(BAINES et al., 2009) (OSTERWALDER, 2004)
types of performance measure (external/client)	availability of provider when client requires	client satisfaction	response time to meet client	reliability of client on provider	service availability	capacity to provide maintenance	occurrence of product failure	occurrence of service failure	rate of product devolution		(BAINES et al., 2009)
types of performance measure (internal)	product conformity	service delivery conformity	product lifecycle cost	response capacity	service delivery time	repair time	costs of product failure	time of supplier development	achievement of planned activities	time-to-market	(BAINES et al., 2009)
type of uncertainty	commercial uncertainty		uncertainty of employees capacity to sell the offer		uncertainty of employees capacity to develop the offer		uncertainty of employees capacity to supply services		project uncertainty		(ERKOYUNCU et al., 2011)

Dimension Distribution Channel

Types of distribution channel for PSS and types of risks regarding supply and demand of services are addressed on the PSS typologies. These two attributes are covered by the dimension Distribution Channel, as show on Table 32.

Table 32- Attributes of distribution channel identified on typologies of PSS

Attributes	Options						References
demand uncertainties	low	medium	high				(ERKOYUNCU <i>et al.</i> , 2011)
supply uncertainties	low	medium	high				(ERKOYUNCU <i>et al.</i> , 2011)
type of distribution channel	shared channel	service partnerships	call center	sales office	service teams	e-commerce	(OSTERWALDER, 2004)

Dimension Partnership

Different types of actors and types of role that these actors can perform are addressed by different studies. The attributes are shown on Table 33.

Table 33 – Attributes of partnership identified from typologies of PSS

Attributes	Options											References
role of actors	manage clients activities during use phase of product				manage clients activities during use and post use phase of product			manage clients activities of the post use phase of product		focus only on IT activities		(ANTTONEN, 2010)
Type of actors (network related)	competitor	legislation institutions	society	government	OEM	knowledge institution	collaboration networks	external service networks	financial institution	communication companies	partner for contract management	(GAO et al., 2011) (MEIER <i>et al.</i> , 2010) (OSTERWALDER, 2004)
Type of actors (process related)	administrator	parts and products supplier	service supplier	IT supplier	consultant	distributor	client	technology supplier	customer's supplier	customer's customers (end users)	logistic company	(MEIER <i>et al.</i> , 2010) (OSTERWALDER, 2004)

Dimension Resources

Types of resources are classified in intangible and tangible resources required to develop PSS offers.

Table 34 exhibits the the attribute of this dimension.

Table 34– Attribute of resource identified on typologies from PSS

Attributes	Options						References
type of tangible resource	equipment	infrastructure	software	material	financial	human resources	(RADDATS; EASINGWOOD , 2010) (COOK et al., 1999) (OSTERWALDER, 2004)
type of intangible resource	partnership	intellectual (brand patents)	technology	knowledge	skills	experience	

Dimension Cost Structure

Cost orientation and types of cost elements such as incremental costs, price and recurrent costs, are discussed on the literature.

Table 35 presents the attributes of cost structure dimension.

Table 35 – Attributes of cost structure identified from typologies of PSS

Attributes	Options				References
cost structure drive	cost-driven		value-driven		(OSTERWALDER; PIGNEUR, 2010)
cost structure orientation	activity oriented	project oriented	resource oriented		(OSTERWALDER, 2004)
cost element	recurrent cost	non recurrent cost	overhead	deductible	(MEIER <i>et al.</i> , 2010) (DAUSCH; HSU, 2005)
	occult cost	price	compensation	incremental cost	

Dimension Revenue streams

PSS typologies address types and sources of revenue streams for PSS.

These attributes can be visualized on Table 36.

Table 36 - Attribute of revenue streams identified from typologies of PSS

Attributes	Options								Reference
types of revenue	service offer	product selling (ownership transfer)	selling product use (without ownership transfer)	selling offer result	fixed contracts	management of client business process	product-service customization	selling consulting and training service	(OSTERWALDER, 2004) (TAN; MCALOONE, 2006) (COSTER, 2008)
source of revenue	fixed contracts	product selling	product use	product result	management of clients processes	PSS customization	services offer		(MEIER <i>et al.</i> , 2010) (TAN; MCALOONE, 2006) (COSTER, 2008)

Considerations about the attributes identified

Some statements should be set up regarding the product development project and PSS typologies. On the one hand, the product project development attributes fit into the following dimensions: customer segment, value proposition, network and resources. On the other hand, PSS attributes were organized into customer segment, value proposition, customer relationship, network, resources, cost structure and revenue streams. The dimensions utilized to organize the attributes from both typologies are shown in Table 37.

Table 37 – Dimensions covered by attributes of PSS and product project

Dimensions	Product project attributes	PSS attributes
Customer Segment	X	X
Value Proposition	X	X
Customer Relationship		X
Processes and activities	X	X
Distribution Channel		X
Partnership	X	X
Resources	X	X
Cost Structure		X
Revenue streams		X

It is observed that not all the dimensions suggested for the classification were utilized for product development projects. Some dimensions, such as customer relationship, cost structure and revenue streams were not used since none of the attributes of product development project fits into those dimensions.

Regarding PSS attributes, the attributes fit into all the dimensions of business model. This fact is in agreement with some studies that suggested the use of business model dimensions to organize PSS attributes (TAN; MCALOONE, 2006; TAN, 2010) and also supports the statement of the present study, which utilizes business models dimensions to organize the content of PSS proposals.

Some attributes of product and service combination, such as “Environmental aspect of PSS” and “PSS innovation” were identified on the product development projects literature. However, the items of PSS do not cover essential attributes of products, such as product innovation and complexity, which still is one of the main components of a PSS,. In addition, few attributes related to services, another main component of a PSS offer, were found on PSS literature.

It can be noticed that more attributes were identified on the literature of product development projects compared with the PSS literature. It stems from the fact that the PSS literature is newer and has fewer researches available when compared to the product literature.

Taking into account the statements highlighted, the findings of product project and PSS attributes can be considered complementary and, together, should compose a more complete frame about the content that should be included in PSS proposals.

Integration of attributes

In order to create a database embracing the attributes of PSS and product project typologies, three tasks were performed:

- Put together the attributes identified on PSS and product development project typologies covered by the same dimension;
- Analyze the content originated by this integration;
- Eliminate or combine attributes that are similar, to avoid repetitions.

During the analyses of the attributes originated from the two systematic literature reviews, no repetitions were found. Therefore, all the attributes of product and PSS originated the first version of a database, named PSS configuration database. The database covers 9 dimensions and 100 attributes.

8.2.3 First round of experts evaluation

The PSS configuration database should be investigated in order to evaluate whether the attributes and options of the database are relevant to support the creation of PSS proposals and whether important attributes and/or options are missing.

To perform this evaluation, experts were consulted and interviewed. The material used to conduct the interviews is the PSS configuration database itself since it is the object that should be assessed by the experts. After the evaluations, the suggestions of the experts were analyzed, selected and systematized, originating the second version of the PSS configuration database.

The profile of the two experts who evaluated the database can be visualized on Table 38.

Table 38 – Profile of the experts

Evaluator	Graduation	Topics of research
A	Mechanical Engineer with master and doctorate degrees on Production Engineering.	Innovation and Development of Products and Services
B	Environment Engineer with master and doctorate degrees on Production Engineering.	Ecodesign and Development of Products and Services

The evaluation of the attributes occurred in three steps. First, interviews with both experts were performed in order to explain the objective of the present work and the purpose of the evaluation. After that, the experts received the database and beside each attribute and options, they had a free space where they should give a grade according to the importance of each attribute and their options. The grades are a continuum from 1 (not relevant) to 5 (relevant).

Second step addressed the evaluation itself, done individually by each of the experts. The analysis of the material containing the attributes grades and comments was carried out on the third step. Comments gave by the experts included:

- Exclusion, integration and creation of attributes;
- Addition of services attributes on the database;

Exclusion, integration and creation of attributes

The attributes that should be excluded from the database were the ones with grades equal or under 3 by at least one of the experts.

Table 39 presents attributes excluded from the database. The experts believe the information required to select options of those attributes will be available after the project starts, in other words, after the approval of this proposal for development and not during the creation of the proposal.

Table 39 – Attributes excluded from the database (information available later)

Dimension	Attribute
Value Proposition	complexity of the internal structure of the product/ internal integrity
Value Proposition	type of product scope
Value Proposition	type of product architecture
Value Proposition	considering environmental aspect on services
Value Proposition	service position on business/project
Customer relationship	frequency of client contact

Partnership	frequency of communication with actors
Processes and activities	level of definition of responsibilities and roles on project management
Resources	level of technology insertion on product
Resources	type of technology competence

Table 40 shows attributes that were excluded from the database because they are considered in a higher level of decision and do not concern a specific proposal or project but the whole company.

Table 40- Attributes excluded from the database (not proposal related)

Dimension	Attribute
Value Proposition	environmental criteria on product
Resources	level of efficiency on the technology transfer between firms
Resources	level of interaction between firm that transfer and firm that receive technology
Resources	level of capability for product innovation
Resources	sources of organizational learning
Resources	type of borders for technology insertion
Resources	novelty on technology capability
Processes and activities	allocation of environment experts
Processes and activities	structure of knowledge management activities
Cost Structure	cost structure orientation

Table 41 lists attributes excluded from the database because the options they encompass were considered not relevant for a PSS proposal. For instance, the attribute level of variety of services presents as options: little options and mostly common types of services, little options but distinct types of services, many options and mostly common types of services and many options with distinct and common types of services.

Table 41 – Attributes excluded from the database (options not relevant)

Dimension	Attribute excluded
Value Proposition	service orientation
Value Proposition	level of variety of services
Value Proposition	elements that increase perceived value to client
Value Proposition	level of tangibility on product-service bundle
Partnership	way of actors control
Partnership	orientation of actors communication
Processes and activities	complexity of project actors interaction
Processes and activities	project size
Processes and activities	level of cross-functional involvement
Processes and activities	multi project strategy
Resources	technology complexity
Resources	technological readiness to launch new products
Resources	level of technology novelty

The experts also indicated some attributes with similar meaning that could be jointed and pointed cases when one attribute could be split into two or more new

attributes. In some cases, the joint or new attributes were reallocated on another dimension. Table 42 presents all the mentioned modifications

Table 42 – Attributes created from mixing or derivation of other attributes and their respective dimensions before and after the evaluation

Dimension on 1 st version of the database	Dimension on 2 nd version of the database	Attribute removed or modified	Joint or new attributes
Customer Segment	Customer Segment	market novelty level to the company	level of uncertainty of market conditions and trends
Customer Segment	Customer Segment	newness of the market segment	level of uncertainty of market conditions and trends
Value proposition	Value proposition	level of product novelty to the world	novelty of products for whom?
Value proposition	Value proposition	level of product novelty to the company	novelty of products for whom?
Value proposition	Value proposition	level of novelty on services for the company for the market	novelty of services for whom?
Value proposition	Value proposition	level of novelty on services for the company	novelty of services for whom?
Value proposition	Value proposition	level of novelty on services for the client	novelty of services for whom?
Value proposition	Value proposition	level of novelty on services	novelty of services for whom?
Value proposition	Value proposition	ways to communicate product value	benefits for the customer
Value proposition	Value proposition	product tactical decisions	benefits for the customer
Processes and activities	Processes and activities	processes and activities required	the options of this attribute become attributes (see table x)
Distribution Channel	Processes and activities	demand uncertainties	type of uncertainty
Distribution Channel	Processes and activities	supply uncertainties	type of uncertainty
Processes and activities	Processes and activities	level of technology uncertainty	type of uncertainty
Partnership	Processes and activities	development risk	type of risk
Processes and activities	Processes and activities	type of project management style	type of project management approach
Processes and activities	Processes and activities	level of novelty on production process	production process configuration
Processes and activities	Processes and activities	level of complexity on production process	production process configuration

Yet, the experts suggested the creation of some attributes in order to increase the completeness of the database. The attributes created are shown in Table 43.

Table 43 – Attributes created and their respective dimensions

Dimension	Attribute
Processes and	type of risk

activities	
Processes and activities	type of project management approach
Processes and activities	distribution channel configuration
Processes and activities	quality control configuration
Processes and activities	performance measurement configuration
Processes and activities	process of product and service development configuration
Processes and activities	marketing activities configuration
Processes and activities	partners management configuration
Processes and activities	acquisition process configuration
Processes and activities	production process configuration
Processes and activities	clients management configuration
Processes and activities	process of technology development configuration
Customer relationship	level of involvement of client on provider business processes
Revenue streams	percentage of revenue expected from service offer
Revenue streams	percentage of revenue expected from product selling (ownership transfer)
Revenue streams	percentage of revenue expected from selling product use (without ownership transfer)
Revenue streams	percentage of revenue expected from selling offer result

After the modifications presented on this section, a second version of the PSS configuration database was created, which covers 8 dimensions and 59 attributes.

8.2.4 Literature reviews on service and PSS attributes

Another limitation of the Configurator highlighted by the experts was the fact that the literature from service projects typologies was not consulted. Systematic literature reviews were carried out on the product and PSS literature, but not on the service literature. In addition, another improvement performed on the database concerns the research of more PSS attributes on the latest literature.

Systematic literature review for service projects

A systematic literature review for service projects was underwent by performing the same steps carried out to execute the systematic literature review (SLR) for product projects and PSS. The protocol for this SLR can be found in Appendix 2.

The attributes identified on the SLR and can be visualized in the Table 44. These attributes were identified and classified according to the business model dimensions value proposition (VP), customer relationship (CR), processes and activities (PA), resources (RE), partners (PT), revenue streams (RS). No attributes were found for the dimensions customer segment and cost structure.

Table 44 – Attributes identified on service project typologies

D	Attributes	Options						References
V P	level of service newness	Low		moderate		high		(AVLONITI S et al., 2001)
	novelty of services for whom?	new to the market			new to the company			(AVLONITI S et al., 2001)
	type of service innovation	additions to existing service	improvements and revisions to existing services		new-to-the-world services	Repositioning	cost reductions	(BOOZ ALLEN; HAMILTON , 1982) (KHAN; KHAN, 2009)
	ways to communicate service value	perceived ease of use	perceived price fairness		risk averseness	satisfaction with existing service		(LEE, 2012)
	options of innovations in services	conceptual innovations (call centers)	client interface innovations (introduction of account management systems in professional organizations)		service delivery system (home shopping services, e-commerce)	technological options (use of it or gps by supermarkets, banks)		(HERTOG, 2000)
C R	level of contact/relationship with client	Low		moderate		high		(GEBAUER et al., 2010) (BULLINGER et al., 2003) (CHOWDHURY; MILES, 2006)
R E	sources of innovation for the offer	services supplier	customers	competitors	consultants	OEM	technology supplier	(CHANG et al., 2012)
	type of intangible resources	Skills	information	knowledge		experience		(BU; GUO, 2011)
P T	type of actors	customers	supplier	competitors		knowledge institutions		(BU; GUO, 2011)
	level of involvement of client on provider business processes	Low	moderate	high				(GEBAUER et al., 2010) (CARBONELL, 2012)
	level of service customization	Low	moderate	high				(WONG, 2007)

P A	cross-functional involvement	Low	moderate	high				(AVLONITIS et al., 2001)
	level of formality of the development process	Low	moderate	high				(GEBAUER et al., 2010)
	level of technology novelty	Low	moderate	high				(AVLONITIS et al., 2001)
	degree of automation of service delivery process	process mostly automated, manual work on every bill	mix of automated and manual process	highly automated process, some manual work		fully automated process		(PONSIGNON et al., 2011)
	types of service delivery system	service shop		service factory		professional service		(PONSIGNON et al., 2011)
R S	types of revenue	new technologies		new products and services		ancillary revenues		(ROTHKOPF; WALD, 2011)

In order to integrate the findings of service literature on the database, two activities were carried out. First, an analysis of the service attributes was performed in order to identify the ones with the same level of granularity of the ones on the database. In addition, attributes similar to the ones that were excluded on the evaluation of experts (section 8.2.3) were not included in the database. That was the case of the attributes “level of formality of the development process” and “cross-functional involvement”. The attribute “level of service customization” was also not inserted in the database, since an attribute named “level of customization on product-service bundle” already exists and depicts both product and service customization.

Table 45 presents the attributes selected to be included on the PSS configuration database.

Table 45 – Attributes from service project typologies included on the PSS configuration database.

D	Attributes	Options				
VP	type of service innovation	additions to existing service	improvements and revisions to existing services	new-to-the-world services	repositioning	cost reductions
	options of innovations in services	conceptual innovations (call centers)	client interface innovations (introduction of account management systems in professional organizations)		service delivery innovations (home shopping services, e-commerce)	technological options (use of IT or GPS by supermarkets, banks or transport service providers)

	ways to communicate service value	perceived ease of use	perceived price fairness	risk averseness		satisfaction with existing service	
RE	sources of innovation for the offer	services suppliers	customers	competitors	consultants	OEM	technology supplier
PA	types of service delivery system	service shop		service factory		professional service	
	degree of automation of service delivery process	process mostly automated, manual work on every bill		mix of automated and manual process		highly automated process, some manual work	

Identification of more PSS attributes in the newest literature

As already mentioned, in comparison to the product project literature the PSS literature is newer and thus the amount of attributes identified for PSS was fewer compared to the ones for product. As the combination of products and services is one of the most important elements of the PSS proposal, it was decided to look for more attributes in the literature available after the systematic literature review on PSS, which was executed on the first semester of 2012. The main sources of this search were the investigation of the papers published in the 2013 and 2014 CIRP Conference on Industrial Product Service Systems, one of the most relevant conferences about PSS.

As performed for the attributes from the service literature, two activities were carried out in order to integrate the findings of latest PSS literature on the database. First, an analysis of the attributes identified was performed in order to identify the ones with the same level of granularity of the ones in the de database. In addition, attributes similar to the ones that were excluded of the evaluation of experts (section 8.2.3) did not enter in the database.

Three new attributes were selected to be included on the PSS configuration database, as shown on Table 46.

Table 46 - Attributes included on the PSS configuration database

D	Attribute	Options				Reference
VP	novelty of product-service combination	new combinations of existing products with existing services	new services for existing	new products for existing	combinations of new products with new services	(WIESNER et al., 2013)

				products	services		
	attractiveness factors to acquire the offer	reduced risk		reduced cost	product functionality		(WALLIN et al., 2013)
PT	types of sharing with actors	risk sharing	cost sharing	data sharing	revenue sharing	resources sharing/pooling (e.g. facilities)	(MOUGAARD et al., 2012)

New options for the attribute types of services (value proposition dimension) were identified. Therefore, these attribute originated two attributes (type of services on product and other type of services) as presented on Table 47.

Table 47 – Modification on attributes and options of the PSS configuration database

Attribute	Options						Reference
type of services on product	otimization/improvement	planned overhaul	diagnosis plus recommendations	on-site inspections	installatio n	mainte- nance	(MEIER et al., 2010) (MOUGAARD et al., 2013) (MOUGAARD et al., 2012) (PARIDA et al., 2014)
	repair	upgra- de	remote operation	remote monito- ring	service techni- cians on call	spare parts supply	
other type of services	planning	consul- ting	training	logistics	financing	delivery	
	system operation on behalf of the customer	support customer to operate the system		product/ system tack back	product/ system disposal	remanufac- turing and/or recondition- ning	

Finally, new options were added to existing attributes, as shown in Table 48.

Table 48 – Options included on attributes of the PSS configuration database

	Attribute	Option						Reference
VP	types of product-service orientation	property of physical product	use of the product	availability of the product	result of the use of the product	consumption of product		(TUKKER, 2004) (COOK et al., 2006) (LIER et al., 2013)
RS	options of revenue	transfer of partnership	based on per-use	based on units consumed	taking responsibility of the use	based on result of the use (performance based)	based on availability	(TAN; MCALOONE, 2006) (COSTER, 2008) (MOUGAARD et al., 2012) (RESE et al., 2012).
RS	sources revenue	selling services	product selling (ownership transfer)	selling product use (without ownership transfer)	selling result	management of client business process	product-service customization	(TAN; MCALOONE, 2006) (COSTER, 2008) (ROTHKOPF; WALD, 2011) (WALLIN et al., 2013)
		selling consulting and training service		selling new technologies	selling of licenses	selling spare parts selling		
	options of distribution channel	shared channel	online (internet)/ e-commerce	call center	sales office	sales agent	service partnerships	(MOUGAARD et al., 2013)
		service teams			own service stations			
PA	type of risk	technology complexity risk	risk due to environmental laws creation and changes		development risk	financial risk	market risk	(WYNSTRA; PIERICK, 2000) (RESE et al., 2012).

The attributes from the latest literature on PSS and the attributes of service projects are included on the third version of the PSS configuration database.

8.2.5 Second round of experts evaluation

After reaching a range of attributes on the third version of the PSS configuration database, experts were consulted in order to:

- Assess the relevance of the attributes and options to create PSS proposals;
- Support on defining an order for the steps of the method.

Expert 1 is graduated in Industrial Engineering on Technical University of Berlin, with MBA (Master of Business Administration) on Entrepreneurship and Strategic Management. Expert 1 is doctor for the Institute for Machine Tools and Factory Management, on Technical University of Berlin. He has been working for more than 2 years with consultancy on Operations Strategy.

Expert 2 is graduated in Business and Marketing on Université de Haute-Alsace Mulhouse-Colmar. He had been working for more than 3 years as Key Account Manager in a OEM that provides solutions and services in optronics, avionics and electronics. Currently, expert 2 is PhD candidate on the Institute for Machine Tools and Factory Management, on Technical University of Berlin. The profile of the experts can be visualized on the Table 49.

Table 49 - Profile of the experts

Evaluator	Graduation	Topics of research
1	Industrial Engineer with MBA and doctorate	Product-Service Systems and remanufacturing
2	Business and Marketing	Product-Service Systems and remanufacturing

During one month, weekly meetings were carried out with the two experts to discuss about the content (attributes and options) and order of the steps taking into account the content.

Assessment of attributes and options

As performed in the first round, the experts graded the attributes and options using a continuum from 1 (not relevant) to 5 (relevant) and made comments possible modifications on the attributes.

Attributes with grades under 3 were removed from the database. They are presented on Table 50.

Table 50 – Attributes removed from the PSS configuration database

	Attributes	Options				
VP	options of innovations in services	conceptual innovations (call centers)	client interface innovations (introduction of account management systems in professional organizations)	service delivery innovations (home shopping services, e-commerce)	technological options (use of IT or GPS by supermarkets, banks or transport service providers)	
	novelty of products for whom?	new for the market	new for the firm	new for the client		
	level of change on product	improvement	derivative	addition on product family	next generation	totally new
	complexity of the user interface/ external integrity	product/service easy to use, client can do it alone	product/service relatively easy to use, client needs manuals to learn		product/service complex to use, client needs training and support	
	types of innovation on product-service bundle	improvement on bundle	new bundle	improvement on product-service development process		
CS	market's receptivity for new products/ market's rhythms	clients are not open for novelty	clients can be open for novelty after some discussion		clients are open for novelty	
CR	level of involvement of provider on client business processes	provider do not manage processes or execute activities for clients	provider do not manage processes but execute activities for clients	provider manage processes but do not execute activities for clients	provider do not manage processes and do not execute activities for clients	
PA	actor responsible for development	client	supplier	OEM	provider	
	types of service delivery system	service shop	service factory	professional service		
	degree of automation of service delivery process	process mostly automated, manual work on every bill		mix of automated and manual process	highly automated process, some manual work	

The experts also suggested modifications in some attributes, as shown in Table 51. Yet, some attributes had modifications or inclusions of options, such as: benefits for the customer, type of environmental and cost element.

Table 51– Modification of attributes of the PSS configuration database

D	attribute removed or modified	joint or new attributes
VP	novelty of services for whom?	type of service innovation
	ways to communicate service value	benefits for the customer
	attractiveness factors to acquire the offer	benefits for the customer
CS	market range	types of clients
CR	level of involvement of client on provider business processes	level of customer involvement on the development of PSS

The fourth and last version of the PSS configuration database, which takes into account the modifications aforementioned, possess 8 dimensions and 57 attributes.

Order of the steps

The experts also assisted on the definition of an order for the steps within the method. During this activity, the author of this study and the two experts analyzed the attributes of each dimension and defined a sequence for the steps according to the information required on each business model dimension.

Table 52 presents the order suggested to apply the method and the correspondence between the steps and business model dimensions

Table 52– Number, title of steps and business model dimension corresponding

Step number	Step title	Business model dimension
1	Understand your business model	---
2	Configure Customer Segment	Customer Segment
3	Configure Value Proposition	Value Proposition
4	Configure Customer Relationship	Customer Relationship
5	Configure Business Processes and Actors of the Network	Processes and Activities, Partnership and Distribution channel
6	Configure Resources	Resources
7	Configure Revenue streams	Revenue streams
8	Configure Cost Structure	Cost Structure

Step 1 keeps the idea of analyzing the business context through understanding of the current business model (step created on the first version of the method) but without requiring the decision on creating a new business or improving the current one.

Steps 2 to 8 present as main activity the configuration of the information required on each of the business model dimensions. Since the attributes possess different options that should be selected, the selection of one or more options of each attribute leads to the configuration of different PSS proposals.

It is important to mention that an adaption from Osterwalder; Pigneur (2010) was carried out. The dimensions “Partnership”, “Distribution channel” and “Processes and activities” are considered jointly. On this study, these three dimensions are encompassed by the dimension “Business processes and actors of the network” as they are considered complementary. For example, when deciding the processes and activities that should be carried out in house or outsourced, it is necessary to decide which actors are going to perform the processes and activities. Yet, distribution is one of the business processes and since the dimension “Distribution channel encompasses only one attribute (distribution channel options), it was decided to place it in the dimension “Processes and activities”.

Figure 14 presents the steps of the method and their sequence.

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
Understand Current business model	C O N F I G U R E						
	Customer segment	Value proposition	Customer relation ship	Business Process and actors	Resources	Revenue Streams	Cost structure

Figure 14 – Steps of the Configurator of PSS proposals

8.2.6 Deployment of attributes in tasks

The development of the content of the method resulted the forth version of the PSS configuration database.

Out of the development of the method’s content, a forth version of the PSS configuration database resulted. The database comprises attributes and options that should be utilized to create PSS proposals. In order to increase the usability of the attributes and facilitate the use of the method, tasks were created based on the attributes of the database.

Types of tasks

Two different tasks are created using the attributes.

- Task type 1: selection of previously defined options of attributes;
- Task type 2: definition of information based on specific actions proposed.

The first type of task concerns the selection of options of the attributes according to the company strategic orientation. For instance, the dimension customer segment presents the attribute “market range”. Therefore, one option for the market range the company wants to reach should be selected. The options are international, national, regional, local. Additional options can be created when required.

Only the selection of options is not enough to create a proposal. Predefined options cannot be utilized to define all the relevant information of a PSS proposal and specific and descriptive information might be required, e.g. needs of a specific customer segment.

Therefore, a second type of task was defined where specific actions are proposed. For instance, concerning the example given for the attribute “market range”, an action is: Detail the geographical reach of the market (city, country, etc.). Detailing, describing, specifying are examples of actions of the second type of task.

Development of tasks

For each step, a set of tasks are derived from the attributes of the PSS configuration database. The following tables show the name and types of tasks deployed. Some of the tasks type 2 were created in order to provide a more complete PSS proposal.

For step 1, the tasks developed were based on the first version of the method “Analyze business context”.

Tasks of step 1 “understand your business model” are presented on Table 53.

Table 53 – tasks of step 1

Attribute	Name of the task	Task type 1	Task type 2
-----	Diagnosis of the current business	-----	Organize a brainstorming or a discussion session with representatives of different functional areas in order to perform a diagnosis of the current

			business.
-----	Design of current business model	-----	Design your current business model utilizing the information raised on the brainstorming or a discussion session.
-----	Improvement on current business model	-----	By performing a cross analysis between your designed business model and the diagnosis, you should be able to identify improvements on each of the dimensions of the business model.

Tasks of step 2 “configure customer segment” are shown on Table 54.

Table 54 - Tasks of step 2

Attribute	Name of the task	Task type 1	Task type 2
-----	Customer segment of the improved or new business	-----	Specify who your customer segment is. You can classify them according to behavior, culture, demography
Level of uncertainty of conditions and trends	Market conditions and trends	Select one option considering the level of uncertainty of conditions and trends of the customer segment you want to reach	Describe actions to increase the knowledge and decrease the level of uncertainty of conditions and trends in the market
Resistances to acquire PSS offer	Resistances to acquire PSS offer	Select one or more options to point out the resistances of the customer segment to acquire the offer	Describe actions to be taken to reduce the resistance
Market range	Market range	Select one option for the market range you want to reach	Detail the geographical reach of the market range (city, country, etc.)
Types of clients	Types of clients	Select one or more options for type of clients considering the customer segment you want to reach	-----
Types of clients	Profile of customer segment	-----	Describe the profile of the new customer segment: behavior, preferences, needs, perceptions, attitudes and values

Table 55 presents the tasks of step 3 “configure value proposition”.

Table 55 – Tasks of step 3

Attribute	Name of the task	Task type 1	Task type 2
-----	Value proposition of the improved or new business	-----	Describe the main value proposition you want to offer to your customer
Benefits for the customer	Benefits for the customer	Select one or more options of benefits your customer should recognize through the PSS offer	Describe how you plan to reach the benefits selected
Types of services on product	Types of services	Select one or more options of types of services that you want to offer to your customer	Detail service(s) selected
Other types of services	Types of services	Select one or more options of types of services that you want to	Detail service(s) selected

		offer to your customer	
Types of product-service orientation	PSS orientation	Select one option for types of product-service orientation	
-----	Product of the PSS offer	-----	What is the product that should compose the PSS offer? Which are its attributes?
Level of innovation on the product	Product of the PSS offer	Select one option for level of innovation on the product element of the PSS offer	Detail type of innovation
Level of innovation on services	Service Innovation	Select one option of level of innovation on the service element of the PSS offer	Detail type of innovation for each service
Novelty of product-service integration	PSS offer innovation	Select one option of novelty of product-service integration according to the product and service elements of the PSS offer	-----
Environmental aspect of the offer	Environmental aspect of the PSS offer	Select one or more options of environmental aspect of the PSS offer	Detail how you intend to reach the reduction selected
Level of customization on the PSS offer	Customization of the PSS offer	Select one option for the level of customization on the PSS offer you wish to provide to your customer	Describe what you wish to customize

Tasks of step 4 “configure customer relationship” can be visualized on Table 56.

Table 56 – Tasks of step 4

Attribute	Name of the task	Task type 1	Task type 2
-----	Customer relationship of the current business	-----	Describe the current relationship you have with your customer.
Type of commercial relationship	Commercial relationship	Select one option for the type of commercial relationship you plan to accomplish with your customer	List the point of contacts you plan to have with your customer
Level of contact/relationship	Customer contact	Select one option of the level of contact/relationship you plan to have with the customer	Describe how you plan to communicate with customers
Level of customer involvement	Customer involvement	Select one option concerning the level of involvement that your customer might have during the development of the PSS	Specify which activities you want to have participation of the customer and the type of participation
Product responsibility	Product responsibility	Select options concerning who should have the responsibility for product on the different lifecycles	If an actor of the network has product responsibility, specify who this actor is
Product ownership	Product ownership	Select options concerning who should own the product on the different lifecycles	If an actor of the network has product ownership, specify

			who this actor is
Types of contract	Types of contract	Select one or more options for the types of contract you wish to arrange with your customer	Describe how you plan to arrange contracts with your customer

Table 57 addresses the tasks of step 5 “configure business process and network of actors”.

Table 57 – Tasks of step 5

Attribute	Name of the task	Task type 1	Task type 2
-----	Business processes and actors of the improved or new business	-----	<p>List the processes required to run your current PSS business model and specify which ones are performed in-house and which ones are outsourced.</p> <p>List the actors that execute the outsourced processes of your current business model.</p>
Type of processes Type of actors	Business processes and actors of the improved or new business	Select the type of processes that should be part of the improved/new network and which actor should perform them:	<p>Specify who the key actors you selected are. E.g.: industrial area, name of companies, etc.</p> <p>Point out the level of change in each process (no change; adaptation or creation) that might be required on the improvement of your business model. In addition, describe what should be changed. If you are creating a new business model, you don't need to point out level of change as all the processes will be created new.</p>
Actors supporting the business	types of actors (business related)	Select one or more types of actors (business related) that you wish to involve in the PSS network in order to support the development of the business:	Specify who the key actors you selected are. E.g.: industrial area, name of companies, etc. and their roles in the network.
Types of sharing with actors	Sharing with actors	Select one or more types of sharing with actors that you wish to implement in your PSS network in order to modify the current network or to create a new one	Select option for each type of actor of the PSS network.
Level of dependency from actors	Dependency from actors	Select one or more options according to the level of dependency you might have with the actors of the PSS network you are modifying or creating	Select option for each type of actor of the PSS network and specify dependencies.
Types of approaches to involve actors	Actor involvement	Select one or more types of approaches to involve actors of the PSS	Select option for each type or group of actor of the PSS network and specify how you plan to implement

		network you are modifying or creating	the approach selected.
Types of performance measure	Performance measure	Select one or more types of performance measure you wish to utilize	Detail the types of performance measure: create a title, the goal and specify the unit of measure for each type selected.
Types of distribution channel	Distribution channel	Select one or more types of distribution channel you plan to utilize to deliver the PSS offer to your customer	Detail the types of distribution channel you selected.
Type of project management approach	project management approach	Select one option of type of project management approach you wish to utilized on the implementation of your PSS proposal	
Type of project manager	Project manager	Select one type of project manager that should lead the implementation of the PSS proposal	Specify the competences of the type of project manager you selected.
Level of dependency	Dependency between projects	Select one option for level of dependency of this PSS proposal with other projects or businesses	Specify the project and dependencies.
Project complexity	Project complexity	Select one option of project complexity you might face when implementing the PSS proposal within a business model	Describe the organizational tasks and interaction that can be already defined.
Types of uncertainties	Uncertainties	Select one or more types of uncertainties you might face by creating or improving the PSS business model	Describe actions to reduce uncertainties selected.
Types of risks	Risks	Select one or more types of risks that you might face by creating or improving the PSS business model	Describe actions to reduce risks selected.

Table 58 covers the tasks of step 6 “configure resources”.

Table 58 – Tasks of step 6

Attribute	Name of the task	Task type 1	Task type 2
-----------	------------------	-------------	-------------

	Resources of the current business		Describe the resources required to run your current business model
Type of technology interface	Technology interface	Select one type of technology interface you will require for product-service integration	Describe the role of the technology in the product and service integration
Level of technology capability	Technology capability	Select one option of level of technology capability you reach by developing the PSS offer	Exemplify capabilities that can be required during the development of the PSS offer
Types of acquisition on client competence:	Acquisition of client competence	Select one or more types of acquisition on client competence	Detail how this channel should be developed or improved
Sources of knowledge	Sources of knowledge	Select one or more options of which actors should be sources of knowledge required for the implementation of the PSS business model	Specify the type of knowledge that should be obtained by the ones selected
Types of resources	Types of resources	Select one or more types of resources you will need to run the PSS business model	Specify the resources selected

The tasks of step 7 “configure revenue streams” are described on Table 59.

Table 59 – Tasks of step 7

Attribute	Name of the task	Task type 1	Task type 2
	Revenue streams of current business		Describe your current revenue streams
Types of revenue	Types of revenue	Select one or more types of revenue you plan to have through the PSS business model	Describe options selected
Sources of revenue	Sources of revenue	Select one or more sources of revenue you plan to have through the PSS business model	Specify the approximate percentage of revenue for options selected

Finally, tasks of step 8 “configure cost structure” are available on Table 60.

Table 60 – Tasks of step 8

Attribute	Name of the task	Task type 1	Task type 2
	Cost structure of current business		Describe your current cost structure and list the most important costs of the current business model
			Define the most important cost in terms of percentage of sales of the current PSS offer
Cost drive	Cost drive	Select one option of cost drive for PSS business model	
Cost elements	Cost elements	Select one or more options of cost elements (variable costs and	Define a percentage of each cost in terms of percentage of sales of

		fixed costs) for the PSS business model	the PSS offer
--	--	---	---------------

8.2.7 Inclusion of help in the method

In order to assist the execution of tasks, some elements were developed and added to the method. These elements, named help, includes examples of real cases, relations, hints and methods and tools.

The symbols that represent the help are shown on Table 61:

Table 61 – Symbols to represent the help

Example of real cases
Relations between tasks
Hints
Methods and tools

Examples of real cases

Examples of companies that adopted PSS were identified by means of literature review. Keywords such as “case study” and “implementation” together with PSS and their synonyms were inserted in Scopus and Google scholar. In addition, a book named “PSS case book” was also consulted as it explore examples of PSS within companies (MOUGAARD et al., 2012).

Examples of companies that adopted PSS are shown as a motivation factor and to exemplify the information those companies would provide as if they were utilizing the method. The examples also illustrate the level of granularity of the information expected from the ones performing the tasks and ideas they can use on their proposals.

Table 62 presents the examples utilized and the steps they are placed in.

Table 62 – Correspondence between step, task and examples of real cases.

Step	Task	Examples of real cases
------	------	------------------------

1	Design of current business model	To assist you on how to do that, an example is illustrated. It shows you the design of a PSS business model from a machine tool manufacturer. You can see that you just need general information of the business to perform this task (BARQUET; OLIVEIRA; et al., 2013).
2	Customer segment of the improved or new business	Volvo Aero presents as customer the segment of OEMs of commercial aircraft engines. BASF Automotive Refinish presents Refinishing workshops of the automotive industry as customers. (MOUGAARD et al., 2012).
3	Value proposition of the improved or new business	MAN Truck & Bus UK Ltd defined as value proposition transport solutions through guaranteed cost per km (MOUGAARD et al., 2012). A coffee vending machine manufacturer considers its value proposition hot and good taste coffee (BARQUET; GUIDAT; et al., 2013).
3	Benefits for the customer	The benefits for the healthcare business unit of Siemens include reduced risk, increased machine uptime and increased profitability. Brand is also another factor that attracts Siemens clients (VELAMURI et al., 2013).
3	Types of services	PayXUse, developed by the Italian appliances manufacturer, named Ariston, provides to clients access to washing machines as main value proposition. Type of services offered includes delivery of a washing machine, maintenance, upgrade and end-of-life collection (product tack back) (CESCHIN, 2013).
3	PSS orientation	RiverSimple aims to offer cars based on their use (i.e. the customer pays per mile driven) (TAN, 2010).
3	Environmental aspect of the PSS offer	MAN Truck & Bus UK Ltd sells transportation solutions with the newest technology, which support the customer on decreasing the fuel consumption (reduced energy consumption) (MOUGAARD et al., 2012).
4	Product responsibility	Evergreen leases a modular carpet system (carpet functionality and services such as, color, design, and aesthetics) and has the responsibility to maintain and dispose the carpet. Therefore, the company has the responsibility during usage phase and end of life phase (CESCHIN, 2013).
4	Types of contract	Contracts based on the period of product-service use are utilized for Wetrok, a European leader in cleaning systems, which offers monthly fee-based service plans available 24/7 (VELAMURI et al., 2013).
5	Business processes and actors of the improved or new business	An example of adaptations on the distribution channel is presented by MAN Truck & Bus UK Ltd. A sales-force initiative, named MAN DIRECT, was created and instead of performing sales and services provision, they provide only services (MOUGAARD et al., 2012).
5	Actors supporting the business	The business unit of laundry systems of Electrolux works with a financial institution that provides leasing and loans to Electrolux customers (VELAMURI et al., 2013)
5	Sharing with actors	Volvo Aero shares risks, costs and revenues with its customers throughout the product lifecycle. (MOUGAARD et al., 2012).
5	Risks	An example of market risk: the competitor launch a similar PSS offer you are developing or plan to develop to the same customer segment you aim at reaching (WYNSTRA; PIERICK, 2000).
5	Risks	An example of action to reduce the financial risk is to include minimum period of time when establishing a contract with your customer. That is the case of the company Steelcase, which rents workspace settings on a time basis for a minimum of three hours (TAN, 2010).
6	Technology interface	An example of technology as a direct enabler can be seen at Dell customization. Product and service element are not technology-

		embedded but the integration of them is performed by the technology. The information technology relates customer and company during the direct sales process (GEUM et al., 2011).
6	Acquisition of client competence	Sales organization of MAN Truck & Bus UK Ltd utilizes an information system named “E-Workshop” to collect data (e.g. maintenance reports) from their clients, the dealers. Therefore, type of acquisition is by distribution channel. (MOUGAARD et al., 2012).
6	Resources	MAN Truck & Bus UK Ltd provided courses to the sales department in order to increase the skills of the employees on business strategies. Initially, their main role and expertise was selling products and the company wanted to develop skills on service provision. (MOUGAARD et al., 2012).
6	Resources	Electrolux utilizes software to collect operating statistics such as running time and energy use in order to improve the PSS design and better achieve customer’s needs (VELAMURI et al., 2013).
7	Types of revenue	Wetrok, an European leader in cleaning systems, offers monthly fee-based service plans through which customers have access to a 24/7 repair service network. Therefore, the company revenue is based on availability (VELAMURI et al., 2013).
7	Types of revenue	A coffee vending machine manufacturer rents its machines and charges per cup of coffee consumed, meaning units consumed (BARQUET; GUIDAT; et al., 2013).
7	Sources of revenue	MAN Truck & Bus UK Ltd split the service revenue in % of total company revenue: 2% fleet management; 5% wholly owned service; 5% rental; 10% repair and maintenance contracts and 15% spare parts (MOUGAARD et al., 2012).
8	Cost drive	The main business costs of a machine tool manufacturer concerns the customized services supplied during the use phase of the machine in order to increase the value perceived by the clients. The company follows the value-driven approach (BARQUET; GUIDAT; et al., 2013).
8	Cost elements	MAN Truck & Bus UK Ltd utilized the TCO tool for estimating the cost of the lifecycle of a truck. 45% of the cost is the fuel, 29% the driver, 10% a new truck, 10% administrative costs and 6% repair and maintenance (MOUGAARD et al., 2012).

Hints of practices

Hints of practices to assist in the utilization of the method were developed. They aim at increasing the comprehensiveness and integrity of the tasks.

Table 63 shows the hints and the steps they are placed in.

Table 63 - Correspondence between step, task and hints of practices.

Step	Task	Hints of practices
1	All tasks	In case you plan to create a new business model for PSS, you can skip step 1.
2	Customer segment of the current business	You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current customer segment.
2	Profile of customer segment	If you are improving a PSS business model and decide to keep the current customer segment, you can skip this task
3	Value proposition of the current business	You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current value proposition.

4	Customer relationship of the current business	You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current customer relationship.
5	Business processes and actor of the current business	You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current network.
5	Project complexity	You can start the description of the organizational tasks and interaction by defining the roles and responsibilities of the ones involved on this project/business.
6	Resources of the current business	You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the resources required on the current business model.
6	Resources	Checklist to support you to define tangible resources: Do we need to hire managers and assistants? How many? Do we need to hire people for support functions? How many? Which and how many facilities are required? Which and how much material is required? Which and how many equipment are required? Which software is required? How much money I need as investment?
6	Resources	Checklist to support you to define intangible resources: Which technology is required? Which product technology is required? Which and how many partners are required?
7	Revenue streams of current business	You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current revenue streams.
8	Cost structure of current business	You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current cost structure.

Methods and tools

Methods and tools help to generate necessary information for the PSS proposal. They were identified through literature review. Keywords such as “method” and “tools” together with PSS and their synonyms were inserted in Scopus and Google scholar. Yet, the book “PSS tool case” was also consulted since it introduces methods and tools for PSS (FINKEN et al., 2013) and it could not be found by literature review. The methods and tools selected to be placed in the method were the ones that generate the information required for the tasks.

Methods and tools utilized can be visualized in Table 64.

Table 64 - Correspondence between step, task and methods and tools

Step	Task	Methods and tools
1	Diagnosis of the current business.	You can use a generic approach such as SWOT in order to identify improvements on your current business (HALEN et al., 2005)
1	Design of current	You can utilize the tool canvas business model to design your current

	business model	business model.
2	Profile of customer segment	If you want help on the definition of customers 'needs, you might check the tool user activity cycle (FINKEN et al., 2013), as well as the tool PSS configuration based on support vector machine (LONG et al., 2013).
3	Value proposition of the improved or new business	If you need support on the definition of your value proposition, check the tool ontological representation of PSS. It can assist you on the definition through the representation of the relations between values, functions and structures (KIM et al., 2009).
3	Value proposition of the improved or new business	In case you are in doubt about which value proposition you should offer, you can have a look on the tool value strategy canvas. It can assist you on the visualization of the value proposition taking into account the needs of your customer segment. Though this visualization it will be easier to compare different value propositions and decide upon them (FINKEN ET AL., 2013).
3	Product of the PSS offer	Different product characteristics are preferable when selecting or designing the product element of the PSS offer, such as durability, longevity and modularization. A high durability and longevity allow products to be used for longer period and by more customers. Modularity and standardization will tend to reduce time and cost of assembly and further disassembly of the product (MONT et al., 2006).
3	PSS offer innovation	In case you need ideas to select product and/or service for your PSS offer, you might also utilize the tool offering diagram, which aims to highlight how products are used to provide specific services (LIM et al., 2012).
3	PSS offer innovation	Though the tool PSS configurator, you can have a look on PSS offers and get inspired to create your own product and service combination (FINKEN et al., 2013).
4	Commercial relationship	The tool service blueprint shows you the points of contact with clients, which can help on the definition of improvements on the relationship with them (FINKEN et al., 2013).
4	Types of contract	In order to define the type of contract, you can have a look on types of contracts for PSS and on the method of defining the optimal contract parameters (BINGCHUN et al., 2009)..
5	Business processes and actor of the current business	You can design your current PSS network using a modeling tool in order to visualize the current processes and actors of the PSS business model. An example is IDEF0, a tool that provides an accurate representation of the physical connections between various components of a system (MORELLI, 2006).
5	Business processes and actors of the improved or new business	To support you on defining of the processes and activities of your network, you can use the tool user activity cycle (FINKEN et al., 2013).
5	Business processes and actors of the improved or new business	In case you need to perform changes or even create a new process for service development, you might check the tool service blueprint (FINKEN et al., 2013).
5	Business processes and actors of the improved or new business	The tool ecosystem map can help you to define the actors of your network by providing an overview of the flow of information, capital, products and services between the different actors (FINKEN et al., 2013). Many different tools are available to support you on the mapping and visualization of the actors that might be involved in your PSS network, such as the map of interaction (MORELLI, 2006) and the Relation-based Model and the Ontology-based Model (LIM et al., 2012).
5	Types of uncertainties	Check the approach of Rodrigues et al. (2014) that integrates real options and scenarios method along with performance indicators in order to reduce uncertainties during the development of a specific PSS offer.

6	Technology interface	Aiming to help you on defining the type of technology interface, the technology roadmap developed by Geum et al. (2011) shows you the relationship of product, service and technology on the PSS offer and highlights the role of technology on product and service integration.
6	Types of resources	The model named service triangle can support you on the visualization of tangible resources, intangible resources and actors. Another possibility is to use the tool system map to visualize actors, facilitates, material, information, and financial flow among them (LIM et al., 2012).
7	Types of revenue	To assist you on deciding types of revenue, you might have a look on different types of revenue streams for manufacturing firms providing PSS offers (COSTER, 2011).
7	Sources of revenue	If you are in doubt about which services might lead you to more revenues, you should check the simulation tool for prioritizing PSS offers, which provides a service model that shows you the highest income for the provider and the best service for customers. The model uses as criteria the average profit per day, utilization ratio and acceptance ratio (ALFIAN et al., 2014).
8	Cost elements	Considering Design for X on the PSS development, particularly design for remanufacturing, can lead to reduction of variable costs, such as material costs (raw material) on current businesses (FINKEN et al., 2013).
8	Cost elements	The tool total cost of ownership (TCO) provides a financial estimate aiming to assist you to determine the costs elements of the offer on the different lifecycle phases (COSTER, 2008).
8	Cost elements	The tool value strategy canvas can show you the different costs you have according to the value proposition (FINKEN et al., 2013).
8	Cost elements	Yet, you might check the framework for estimating the cost of in-service provision in order to estimate the cost factors service for a PSS offer (HUANG et al., 2011).

Relations

Relations between tasks from different steps were highlighted in order to show the influences they have on each other. Therefore, they aim to support in the definition of a more coherent PSS proposal. Two types of relations were developed. One type is based on information available on the literature, as presented on Table 65.

Table 65 - Correspondence between steps and tasks related

Step	Task	Step	Task	Reference
3	PSS orientation	7	types of revenue	(TUKKER, 2004)
3	PSS orientation	4	Product ownership	(TUKKER, 2004)
4	level of contact/relationship	6	Acquisition of client competence	(BAINES <i>et al.</i> , 2007)
5	sharing with actors	4	customer involvement	(MEIER <i>et al.</i> , 2010) (OSTERWALDER, 2004)
5	dependency with actors	4	customer involvement	
5	actor involvement	4	customer involvement	

The other type of relation was created to increase the coherence of the method. These relations are demonstrated on Table 66.

Table 66 – Relations developed for the method

Step	Task
1	Utilize the improvements identified as input for the first task of steps 2 to 8.
5	It is recommended that you perform the tasks 5.9 to 5.14 after performing all the tasks of this guideline. The tasks mentioned capture the initial effort of the further implementation of the PSS proposal on the current or new business model.
6	You will notice that this step has a strong relationship with step 5 and step 9 . Therefore, remember to revise the performed tasks of such steps to ensure coherent decisions among them.

Figure 15 represents the method after including the content, named tasks and help, on each of the eight steps.

Figure 15 – Steps and the content of the Configurator of PSS proposals

The Configurator of PSS proposals is available in Appendix 3.

8.3 Considerations about the second version of the method

This section presented the improvements carried out on the method. Regarding the structure of the method, the steps were modified. From the three steps of the first version of the Configurator, only step 1 was kept but also improved. Seven steps were created and each of them embraces business model dimensions. The content of the Configurator covers attributes and options, inspired on different methods and tools registered on the literature that aim at creating PSS business models. However, systematic literature reviews were carried out in order to reach a more complete range of attributes. Experts assessed the relevance of this range of attributes for creating PSS proposals.

After more literature research and another consulting with experts, a final version of a database named PSS configuration database was introduced. From

each of the attributes of this database, tasks were deployed (see section 8.2.6. In addition, different elements, named help, were included on the method to support in utilizing it. Finally, together with experts, an order was suggested to arrange the steps.

As presented on the first version of the method, the input for starting using the method, i.e. for step 1, is the analysis of strategies, ideas and opportunities and information about the current business model. The main output, i.e. the result of applying the method is one or more PSS proposals.

Figure 16 represents the second version of the Configurator of PSS proposals.

Figure 16 - Representation of the second version of the Configurator of PSS proposals

9. Test of the Configurator of PSS proposals

This section depicts the execution of a case study within the context of a research project, to test whether the Configurator assists the creation of PSS proposals. This section refers to the phase 5 of the research method. Other goals of this application are:

- Generate a PSS proposal for the project under study;
- Evaluate the utilization of the Configurator.

9.1 Profile of the research project

The Collaborative Research Center (CRC) 1026 “Sustainable Manufacturing – Shaping Global Value Creation” is a multi-disciplinary research project funded by the German Research Foundation DFG. It consists of seventeen main projects in the fields of manufacturing, design, economics, environmental engineering and mathematics and covers research institutes from Berlin, Germany. The goal of the project is to demonstrate how sustainable manufacturing can be superior compared to the traditional paradigms of management and technology and in ensuring economic growth, proper quality of the environment and adequate quality of life (SFB 1016).

9.1.1 Profile of the researchers

The profile of the researchers of the mentioned project involved in the application of the Configurator is presented on Table 67.

Table 67 – Profile of the researchers participating on the case study

Researcher	Role on the research project	Research field	Topics of research
A	Virtual Product Creation in Sustainable Value Creation Networks	Product development	Sustainable product development
B	Integration Shop	Manufacturing and assembly	Value creation networks
C	Intellectual Capital and Knowledge Management	Knowledge management	Tangible and intangible resources
D	Multi-perspective modeling of sustainable	Modeling	Process modelling

The researchers attended the first requirement regarding the involvement of participants from different fields (product development, knowledge management, process modeling, manufacturing, and engineering) to apply the Configurator. In that case, no information and knowledge about the current business, which is the second requirement, was available since this case encompasses the creation of a new business.

9.1.2 Result of the research project: PSS concept

One of the results of this project is the development of sustainable products and services. To support the development, a methodology was developed. It assists design engineers in sustainable trade-off decisions by providing suggestions for the improvement and evaluation of sustainability. Therefore, the products developed using this methodology can (SFB 1016):

- Be developed more environmentally friendly through the use of renewable resources;
- Increase social value in the use phase by early ergonomic considerations and;
- Be adapted quicker to specific living conditions worldwide with a proper modular design structure.

To generate sustainable products, first strategies, ideas, concepts and opportunities need to be analyzed and developed in proposals. For this case, a PSS concept was created. The product element is a bicycle and the service elements encompass maintenance, repair, tack back on EoL and product recover (remanufacturing, recycle, etc.). The research team believes the use of the PSS approach might increase the sustainability aspects of its future business model as the selling of use instead of the product property is stated as a more sustainable option.

The type of bicycle is named pedelec (pedal electric cycling). According to EU regulations Directive 2002/24/EC, pedelecs are “cycles with pedal assistance which are equipped with an auxiliary electric motor having a maximum continuous rated power of 0.25 kW, of which the output is progressively reduced and finally cut

off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling” (OFFICIAL JOURNAL OF THE EUROPEAN COMMUNITIES, 2002)

Pedelecs are also referred to as e-bicycles or electric bicycles. However, the main difference between e-bicycles and electric bicycles to pedelecs is that pedelecs only work if the driver is pedaling. That fact that a pedelec has an auxiliary electric motor makes it attractive to people that would not cycle a regular bicycle without power assistance (BLONDEL et al., 2011).

A research shows that a reduction in greenhouse gas emissions up to below 0.4tCO₂/cap is reached if the infrastructure of the cities is adapted for pedestrians, cyclists and efficient public transit. Cars are related to environmental, public health and social concern. They lead to the increase of air pollution, noise-induced stress and climate change, injuries from traffic accidents and social exclusion. Therefore, the development of different types of bicycles is considered a sustainable alternative for urban mobility (CREUTZIG et al., 2012).

Figure 17 present a drawing from the first ideas of the PSS concept.

Figure 17 - Drawing from the first ideas of the PSS concept

While the development of the PSS concept, the research team thought about the creation of a start up to convert this concept into a commercial offer. Nonetheless, doubts emerged, such as:

- Which partners would we need?
- How would the customer charged for using the Pedelec?

To support the clarification of these questions, the utilization of the Configurator of PSS proposals was considered helpful for the creation of a business proposal for this concept.

9.2 Application of the method

The application of the method was conducted by the author of this study that acted as a mediator during the meetings with the research group. The Configurator was applied by means of four 3-hour meetings attended by the four aforementioned representatives of the research project and the mediator.

A projector was utilized to show the method during the meetings. The mediator wrote down the results of each task in a word document. After the meetings, the results were organized by the mediator.

Following, specific parts of the application is presented in order to highlight the discussions that took place, doubts and statements made by the research team as well as to demonstrate how the method was utilized. For this purpose, some figures of the method and partial results of tasks are presented. The complete PSS proposal of the Pedelec is shown on Appendix 4.

9.2.1 Introduction to the method

In a first moment, the research team read the introduction part of the method in order to understand the Configurator and gets to know its goal and structure. They were familiar with both PSS and business model concept, a fact that facilitated the discussions and utilization of the Configurator. However, the meaning of a PSS proposal and a PSS business model were not clear for them.

In Figure 18 these two concepts are highlighted.

CONFIGURATOR OF PSS PROPOSALS

Goal
The Configurator of PSS proposals is a method that aims to guide you during the creation of PSS proposals.

What is PSS?
PSS stands for product-service system and represents a new business orientation that provide value to customers through the combination of products and services.
[\(read more about PSS\)](#)

What is a PSS proposal?
A PSS proposal describes a future PSS business that your company might develop. This development can occur in your current business or a new business should be created to offer a PSS to your market. Thereby, PSS proposals should be analyzed and further selected to be implemented as a new business or an improvements of a current one.

What is a business model?
A business model describes the company's core logic and communicate the strategic orientation. The content of a business model is divided in "dimensions", such as the value proposition offered to your customer, the relationship between your organization with the customer to support this offer, the processes and resources required to run the business, etc. A business model might become part of a business plan. However, it should not be considered a spreadsheet or a computer model. A business model is a conceptual, rather than financial, model of a business.
[\(read more about business model\)](#)

What is a PSS business model?
PSS business model represents the logic developed to create and deliver a value proposition by means of a bundle of product and services, i.e. a PSS offer. The value proposition should attend costumers' needs and the logic to create it should encompass the definition of other business model dimensions, named as customer relationship, processes and activities, actors, resources, revenue streams and cost structure.

Figure 18 – Introduction part of the method

The instructions, which are placed in the final part of the introduction, were read by the research team. Figure 19 **Erro! Fonte de referência não encontrada.** presents the instructions.

Instructions of use

If you are improving a PSS business model (proposal type 2), you should undergo all the steps and tasks presented in this guideline. The general information gathered to design the current business model (step 1) can be detailed on the further steps. In this sense, you will develop knowledge about the current business model and thus decide which elements you would like to change in order to reach an improved version of the current PSS business model.

In case you aim at creating a new business model (proposal type 1), you can skip both step 1 and task 1 of the steps 2 to 8.

The steps and tasks were set in such an order to facilitate the use of the guideline. However, you don't need to follow the sequential way of the activities.

Now, let's start!

- 1st. Find a white space! It can be a white page, a whiteboard or document on your computer.
- 2nd. For each step, you should first read all the content provided.
- 3rd. Write down the title of the step and the task you are working on.
- 4th. Write down the tasks: describe and detailed the actions accomplished and the options you selected on the different attributes.
- 5th. After finalizing a task, mark the checkbox and go to the next one.
- 6th. After undergoing all the steps, review this document in order to identify which tasks possess empty checkboxes, which means you still need to execute them.

Figure 19 - Instructions on how to use the method

Two of the six instructions were carried out differently from what is stated in the method. For the fourth stage of the instructions, it was decided not only to write down the selected options in a white document but to keep all the options and mark the options selected. An example is shown for the task 3.5 "PSS orientation", where the option "availability of the product" was selected.

Select one option for types of product-service orientation:

property of physical product	use of the product	result of the use of the product	availability of the product	consumption of product
------------------------------	--------------------	----------------------------------	-----------------------------	------------------------

In addition, instead of leaving the unfinished tasks with an empty checkbox as suggested in the sixth stage of the instructions, an exclamation mark was used for

the tasks partially or not executed. The team stated that this mark would remember them to come back to the tasks later on. Moreover, the empty checkbox could lead to misunderstanding because they could think the task was not even read yet.

Following, an example of the use of the exclamation mark is demonstrated for the task 8.3 “cost elements”. This task requests to “define a percentage of each cost elements (variable costs and fixed costs) in terms of percentage of sales of the PSS offer”. As not all the costs elements were defined, this task was not completely accomplished. This explains why the sentence “to be defined” is stated right after the request.

Define a percentage of each cost elements (variable costs and fixed costs) in terms of percentage of sales of the PSS offer. Example: The material cost may only account for 55% of sales. To be defined.
---	--

Step 1 and first task of all the further steps were not performed since the case covers the creation of a new business.

9.2.2 Step 2: Configure Customer Segment

Step 2 was easily performed by the participants. The relevant information about the customer segments was available mostly because the participants are also part of the segment to be reached.

In order to understand how they could explain which is the customer segment (task 2.2), i.e. the level of granularity they could use, the example of Volvo Aero, market on Figure 20, was considered useful.

Step 2. Configure customer segment

This step encompasses the definition of the customer segment, which should be performed considering the market and the client you aim to reach. Perform the tasks taking into account the new PSS business model you wish to create or the new customer segment you want to reach with your current PSS business model. If you are creating a new business model or aim at reaching a new customer segment, you can skip task 2.1.

Task 2.1 Customer segment of the current business

☐ Describe the profile of the current customers' segment: behavior, preferences, needs, perceptions, attitudes and values. Customers' characteristics in conjunction with their understanding and preferences shall show you if they might be attracted for PSS offers.

You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current customer segment.

☐ By analysing the profile of your current customer segment, you should decide whether you wish to keep the same customer segment of your current business model or select a new one. Take into account such decision, when performing the next tasks.

Task 2.2 Customer segment of the improved or new business

☐ Specify who your customer segment is. You can classify them according to behavior, culture, demography.

Volvo Aero presents as customer the segment of OEMs of commercial aircraft engines. BASF Automotive Refinish presents Refinishing workshops of the automotive industry as customers.

Task 2.3 Market conditions and trends

☐ Select one option considering [the level of uncertainty of conditions and trends](#) of the customer segment you want to reach:

☐ conditions and trends are unknown
☐ conditions and trends are partially known
☐ conditions and trends are known

Figure 20 – Part of the step 2 of the method

9.2.3 Step 3: Configure Value Proposition

As the concept of the PSS was already created, most of the tasks from step 3 were carried out smoothly.

The team pointed out a relation between task 3.3, which request to establish the benefits of the PSS offer, and task 2.4 and task 2.7. Task 2.4 addresses the definition of actions to reduce resistances customers might have on acquire the offer and task 2.7 requests the detailing of the profile of customer segment concerning their needs. For the team, the benefits should include actions to reduce the resistances and address each customer need.

To present the relations between the three tasks, a table was developed. The benefits are shown in the first column and the resistances they support minimizing are in the third column. The forth column exhibits the customer needs addressed by the benefit and the fifth column presents what was already defined in the PSS concept before the creation of the proposal.

Table 68 exhibits part of the result of the task 3.3.

Table 68 - Benefits recognized through the PSS offer and the needs attend by them

Benefit	How to reach the benefit	Customer segment	Needs attended	Already considered on the concept?
Perceived easy of use	help to self help (detailed on task 5.2)	---	---	Yes
Availability	Ensure return system (user returns the bike on the spots)	Meets needs of Customer segment 1 and 2	Require transportation in different times of the day, want to be sure about the availability of the transport	No
Convenience	The customer does not own the bike	Face the resistance (behavior change) of Customer segment 1	Concerns about theft, storage and maintenance	Yes

Another interesting point that emerged during the execution of step 3 was a discussion about the level of innovation of the product. The team was in doubt about which is the level on innovation of the Pedelec. In this sense, in order to decide upon the options of task 3.6, the definitions of the options for level of product innovation was consulted by clicking the hyperlink, as demonstrated in Figure 21. The understanding about the differences between the options facilitated the team to

realize that this Pedelec is an incremental innovation since it presents improvements compared to the Pedelecs available in the market.

Task 3.6 Product of the PSS offer

☐ What is the product that should compose the PSS offer? Which are its characteristics?

Different product characteristics are preferable when selecting or designing the product element of the PSS offer, such as **durability, longevity and modularization**. A high durability and longevity allow products to be used for longer period and by more customers. Modularity and standardization reduce time and cost of product assembly and disassembly.

☐ Select one option for **level of innovation on the product** element of the PSS offer:

[incremental](#) [really new](#) [radical](#)

☐ Detail type of innovation. For instance, if you selected "incremental", detail the improvements that should be performed on the current technology.

Task 3.7 Service Innovation

☐ Select one option of **level of innovation on the service** element of the PSS offer:

[services new-to-the-world](#) [services new to you](#) [services modifications](#) [repositioning](#)

☐ Select option for each **type of service** selected on the task 3.4 and detail type of innovation. For instance, if you selected "service modification", explain the modification you plan to carry out on the existing service.

Figure 21 – Part of the step 3 of the method

After reading the definitions of the options, the hyperlink was utilized to return to task 3.6, as represented in Figure 22.

Attribute: Level of innovation on product

(GRIFFIN; PAGE, 1996); (BARCLAY; DANN, 2000); (HART; TZOKAS; SAREN, 1999); (GARCIA; CALANTONE, 2002).

Option 1: Radical innovations

Radical innovations embody a new technology that results in a new market infrastructure. It does not address a recognized demand but create one previously unrecognized by the consumer. This new demand cultivates new industries with new competitors, firms, distribution channels and new marketing activities.

Option 2: Really new product

Really new product will result in a market discontinuity or a technological discontinuity but will not incorporate both.

Option 3: Incremental innovations

Incremental innovations can be defined as products that provide new features, benefits, or improvements to the existing technology in the existing market.

[<back to the task 3.6>](#)

Figure 22 – Part of the description of options and attributes placed in the method

9.3.3 Step 4: Configure Customer Relationship

As the PSS concept was developed taking into account a high level of customer interaction, e.g. through the service multiperspective user interface described in the task 3.4 “types of services”, the tasks of this step was executed with confidence.

For the conclusion of task 4.6 (product ownership), results from the task 3.5 were consulted in order to guarantee coherence between the results of both tasks.

Figure 23 shows the utilization of the hyperlink in order to consult task 3.5.

Task 4.6 Product ownership

☐ Select options concerning who should [own the product](#) on the different lifecycles:

Product ownership X actor	customer	you	an actor of the PSS network
usage phase			
end of life phase			

☐ If an actor of the network has product ownership, specify who this actor is.

The option selected here has a strong relationship with the [task 3.5 PSS orientation](#)

Task 4.7 Types of contract

☐ Select one or more options for the [types of contract](#) you wish to arrange with your customer:

based on frequency of client contact	based on type, complexity and/or urgency of client request	based on duration of client production cycle	simultaneous contracts of the same product-service (pooling)
based on the quantity of product-service use	based on the period of product-service use	based on availability	

☐ Describe how you plan to arrange contracts with your customer.

Figure 23 – Part of step 4 of the method

Since the PSS orientation chosen was “product availability (without ownership)”, the decision about keeping product ownership during the use phase was coherent to the results of task 3.5. The team also decided to keep product ownership in the end-of-life phase as they are planning different recovering alternatives for the parts of the Pedelec (remanufacturing, reuse, etc.).

After consulting task 3.5, the team returned to task 4.6, as presented in Figure 24.

Task 3.5 PSS orientation

☐ Select one option for [types of product-service orientation](#):

property of physical product	use of the product (without the property)	result of the use of the product (without the property)	availability of the product (without the property)	consumption of product (without the property)
------------------------------	---	---	--	---

RiverSimple aims to offer cars based on their use (i.e. the customer pays per mile driven).

The option selected here has a strong relationship with the [task 4.6 product ownership](#) and [task 7.2 types of revenue](#).

Task 3.6 Product of the PSS offer

☐ What is the product that should compose the PSS offer? Which are its characteristics?

Different product characteristics are preferable when selecting or designing the product element of the PSS offer, such as **durability, longevity and modularization**. A high durability and longevity allow products to be used for longer period and by more customers. Modularity and standardization reduce time and cost of product assembly and disassembly.

☐ Select one option for [level of innovation on the product](#) element of the PSS offer:

incremental	really new	radical
-----------------------------	----------------------------	-------------------------

☐ Detail type of innovation. For instance, if you selected “incremental”, detail the improvements that should be performed on the current technology.

Figure 24 – Consulting step 3.5 of the method

9.3.4 Step 5: Configure Business Processes and Network of Partners

The execution of step 5 was one of the most challenging. A discussion about the processes that should be carried out in-house and outsourced as well as how the processes should work took place. The mediator suggested to the team the use of the tool PSS board in order to assist the execution of the tasks. However, the team didn’t follow the suggestion.

The research team executed the task 5.7 concerning the development of measure performance for the business. However, the researchers mentioned the lack of options for types of indicators to measure social and environmental aspects of the business. They pointed out the fact that the types of indicators of task 5.7 address only the measure of economic aspects. Thereby, they utilized the exclamation mark on this task in order to remember that it is not concluded yet.

Tasks 5.9 to 5.14 were not executed as it was suggested to perform them at last, as shown in Figure 25.

Task 5.9 Project management approach

☐ It is recommended that you perform the tasks 5.9 to 5.14 after performing all the tasks of this guideline. The tasks mentioned capture the initial effort of the further implementation of the PSS proposal on the current or new business model.

☐ Select one option of [type of project management approach](#) you wish to utilize on the implementation of your PSS proposal:

[traditional management](#) [agile management](#)

Task 5.10 Project manager

☐ Select one [type of project manager](#) that should lead the implementation of the PSS proposal:

[project coordinator](#) [supervised project coordinator](#) [autonomous project manager](#) [functional and supervised project coordinator](#) [functional and supervised project manager](#)

☐ Specify the competences of the type of project manager you selected.

Task 5.11 Dependency between projects

☐ Select one option for [level of dependency](#) of this PSS proposal with other projects or businesses:

[no dependency](#) [projects share resources](#) [dependency on deliverables](#) [totally dependent](#)

☐ Specify the project and dependencies.

Figure 25 – Part of the step 5 of the method

9.3.5 Step 6: Configure Resources

This step was reported by the team as one of the most relevant for the Pedelec case as they haven't thought about each of the resources they will need in order to start the business. Thereby, since this is a proposal for a new business, almost all types of resources covered by task 6.6 needed to be considered.

The checklists presented on this task supported the team to take into consideration the different types of resources; even the ones that are not defined yet, e.g. the amount of sensors to monitor the Pedelec during the use phase.

The checklists are highlighted in Figure 26

Task 6.6 Resources

☐ Select one or more [types of resources](#) you will need to run the PSS business model:

Types of tangible resource		
financial	material	human resources
infrastructure	equipment	software

Types of intangible resource		
intellectual (brand patents)	partnership	technology
skills	experience	knowledge

☐ Specify the resources selected.

Checklist to support you to define tangible resources: Do we need to hire managers and assistants? How many? Do we need to hire people for support functions? How many? Which and how many facilities are required? Which and how much material is required? Which and how many equipment are required? Which software is required? How much money I need as investment?

Checklist to support you to define intangible resources: Which technology is required? (See [task 6.2 type of technology interface](#)). Which product technology is required? (See [task 3.6 product element of the PSS offer](#)). Which and how many partners are required? (See [task 5.2](#) and [task 5.3 types of actors](#))

The model named [service triangle](#) can support you on the visualization of tangible resources, intangible resources and actors. Another possibility is to use the tool [system map](#) to visualize actors, infrastructure, material, information, and time.

MAN Truck & Bus UK Ltd provided courses to the sales department in order to increase the skills of the employees on business strategies. Initially, their main role and expertise was selling products and the company wanted to develop skills on service provision.

Electrolux utilizes software to collect operating statistics such as running time and energy use in order to improve the PSS design and better achieve customer's needs.

Figure 26 – Part of the step 6 of the method

Table 69 exhibits partial results of task 6.6. In addition of detailing the types of resources, the result covers the purpose of the resource and unit of measure.

Table 69 – Partial results of task 6.6

Item	Type of tangible resources	Purpose	Unit
Initial investment	Financial	To start the business	To be defined
Employees required	Human Resources	Execute manufacturing, assembly, services and support functions	4
Facility required	Infrastructure	Execute manufacturing and assembly, services and storage	500 m ²
Monthly electricity consumption	Infrastructure	For manufacturing, assembly and services activities	550 kW
Special equipment for ergonomic adaptation of material supply	Equipment	For assembly workplace	2

9.3.6 Step 7: Configure Revenue Streams

The task 7.2 was executed with the support of the examples highlighted on Figure 27. The team recognized that the Pedelec case is similar to the example of Wetrok, which provides unlimited access to services for a monthly fee. In the Pedelec case, the fee will be annual. But they also decided to charge according to the time the customer uses the PSS offer (option “based on peruse”).

Figure 27 shows the examples studied in order to support the execution of task 7.2.

Task 7.2 Types of revenue

☐ Select one or more [types of revenue](#) you plan to have through the PSS business model:

based on fixed contracts	based on availability	based on units consumed
transfer of partnership	based on per use	based on result of the use (performance based)

☐ Describe options selected:

Wetrot, an European leader in cleaning systems, offers monthly fee-based service plans through which customers have access to a 24/7 repair service network. Therefore, the company revenue is based on availability.

A coffee vending machine manufacturer rents its machines and charges per cup of coffee consumed, meaning units consumed.

Figure 27 – Part of step 7 of the method

For the task 7.2, the team pointed out a relation with the task 4.7 types of contract. They mentioned that even the options of the two tasks are very similar and should be related to each other.

9.3.7 Step 8: Configure Cost Structure

The task 8.3 was one of the most difficult to be executed. First, the team tried to identify and classify the costs elements through the tool TCO (Total Cost of Ownership), following the example of MAN Truck & Bus UK Ltd, as shown in Figure 28.

Task 8.3 Cost elements

☐ Select one or more options of [cost elements](#) (variable costs and fixed costs) for the PSS business model:

Variable costs

material costs	direct labor costs (production area)	variable manufacturing costs (direct variable costs such as energy)	variable transport costs (packaging and outbound freight)
----------------	--------------------------------------	---	---

Fixed costs

direct fix manufacturing costs (maintenance/ repair building, external services and depreciation)	indirect fix manufacturing costs (indirect personnel as well as IT costs and external services)	material overhead costs (such as raw material purchase)	fixed logistics costs (logistics and/or distribution center and logistics management)
---	---	---	---

☐ Define a percentage of each cost in terms of percentage of sales of the PSS offer. Example: The material cost may only account for 55% of sales.

The option selected here has a strong relationship with the [task 6.6 types of resource](#). You should check the resources you require to define the costs you might have.

The tool [total cost of ownership \(TCO\)](#) provides a financial estimate aiming to assist you to determine the costs elements of the offer on the different lifecycle phases.

MAN Truck & Bus UK Ltd utilized the TCO tool for estimating the cost of the lifecycle of a truck. 45% of the cost is the fuel, 29% the driver, 10% a new truck, 10% administrative costs and 6% repair and maintenance.

Figure 28 – Part of task 8 of the method

The types of costs that they wish to utilize were: energy, consumables, raw material, equipment, labor, capital, overhead, services, fees and licenses. Nevertheless, information was still missing to estimate the percentage from most of these types of costs. Therefore, they decided to classify the costs according to the options presented for variable and fixed costs and thus mark the costs that still need to be defined.

Table 70 shows partial results of the task 8.3

Table 70 – Partial results of task 8.3

Item	Type of cost	Subtype of cost	Cost estimation in €
Labor cost per hour	Variable costs	Direct labor costs	21
Electricity cost per kwh	Variable costs	Variable manufacturing costs	0,25
Consumables per month	Variable costs	Material costs	1.000
Packaging and outbound freight	Variable costs	Variable transport costs	To be defined
Facility cost per m2/month	Fixed costs	Direct fix manufacturing costs	10
Maintenance/ repair	Fixed costs	Direct fix manufacturing costs	To be defined
External services	Fixed costs	Direct fix manufacturing costs	To be defined
IT costs	Fixed costs	Direct fix manufacturing costs	To be defined

9.3.8 Tasks 5.9 to 5.14

As mentioned in the section 9.3.4, tasks 5.9 to 5.14 should be performed at last. However, the team agreed only with leaving the execution of tasks 5.13 (uncertainties) and 5.14 (risks) in the end. The definition of risks and uncertainties provided not only a manner to estimate them for the further implementation of the proposal in a business model, but also to qualitatively measure the status of the proposal, i.e. how ready the proposal is and which information need to be acquired to continue developing it. Thus, it might facilitate the definition of the next actions required to complete the proposal in order to reduce the risks and uncertainties to further implement it.

9.3 Considerations about the application

After creating the proposal, some insights emerged from the application. First, none of the methods and tools covered by the help element was utilized. The limited use might be related to the amount of time required to learn and apply a specific method or tool. Despite the fact that the Configurator encompasses definitions of such methods and tools, in most cases this definition was not enough to apply them. Thereby, it would be also necessary to consult the source and more time would be demanded.

Different from the methods and tools, the relations and the examples covered by the help element facilitated the use of the method and the creation of the proposal as they were frequently utilized during the application. Additionally, the team pointed out other relations between tasks that were not covered by the method. These relations should be analyzed and assessed in order to decide whether they should be included in the method.

Moreover, results not requested by the tasks were generated during the application, which enriched the proposal. That is the case of task 3.3, which request the definition of the benefits to acquire the offer and the description of how these benefits could be reached. In addition of the request, relations were developed concerning each benefit and which customer segment and needs the benefit would reach. In this sense, new tasks could be created in order to increase the completeness of the method.

It is important to mention that this study shows the current status of the PSS proposal for the Pedelec case, which is not ready. As represented by the exclamation marks, some tasks still need to be concluded. However, by applying the method, the research team got aware about which information and knowledge they should acquire in order to complete the proposal.

9.4 Evaluation of the method

The participants of the case assessed the method and the PSS proposal generated through it by filling in an evaluation questionnaire, available on Appendix 5.

Table 71 presents the criteria used to deploy the questions and the elements being evaluated. The elements are: the method itself, steps, tasks, help, attributes and the end result of the method, namely the PSS proposal.

Table 71 - Evaluation criteria utilized, questions and elements evaluated

Evaluation criteria	Question	Element evaluated
Utility	1) How do you evaluate the Configurator as a guide for the creation of the business proposal?	All elements
	2) How do you assess the knowledge you acquired through the process of creating the business proposal (e.g. through the method and the meeting with the business case research group)?	All elements

	3) How do you evaluate the utility of the help (examples of cases, relations, methods and tools and hints) on the process of creating the business proposal?	Help
Consistency	4) How do you evaluate the order of the steps regarding its consistence?	Steps
	5) How do you assess the division of information into business model dimensions in order to classify the attributes?	Steps
Completeness	6) How do you assess the completeness of the tasks suggested to create a business proposal?	Tasks
Scope	7) How do you evaluate the results generated through the application of the method, i.e. the business proposal?	PSS proposal
Broadness	8) How do evaluate the applicability of the Configurator for different situations, such as different industries or size of business	Method
Precision	9) How do you evaluate the description of the tasks in order to be understood by people from different functional areas and different types of businesses?	Tasks
Depth	10) How do you assess the depth of the attributes and options?	Attributes
Simplicity	11) How do you evaluate the description of the tasks concerning its simplicity and comprehensiveness?	Tasks
Clarity	12) How do you assess the clarity of the instructions to use the Configurator?	Method
	13) How do you assess the clarity of the description of the steps?	Steps
	14) How do you assess the clarity of the description of the attributes (available on the hyperlinks)?	Attributes
Objectivity	15) How do you evaluate the objectiveness of the tasks?	Tasks
Coherence	16) How do you evaluate the coherence between the tasks and their help (examples of cases, relations, methods and tools and hints)?	Tasks/Help
Instrumentability	17) How do you assess the Configurator regarding its assistance on improving an already existent PSS business model?	Method
	18) How do you assess the Configurator regarding its assistance on creating a PSS business model?	Method

In addition of the 18 questions, one more question of the evaluation questionnaire requests the participants to write their opinion about the method and the proposal. Table 72 shows question 19:

Table 72 – Question 19 of the evaluation questionnaire

19. Please, point out the weak and strong points of the method and the business proposal:		
	Configurator of PSS proposals	PSS proposal
Weak points		
Strong points		

Next, the evaluation performed by two of the four researchers that participated in the case study, presented in Table 67, are exhibited. Unfortunately, the participant A and B didn't sent their evaluations.

9.4.1 Evaluation from Knowledge Management Researcher

The evaluation carried out by participant C is shown in Figure 29. The grades are represented by the vertical axis vertical, which vary from 1 (unsatisfactory) to 4 (very satisfactory). Participant C evaluated all the elements as very satisfactory (grade 4) and satisfactory (grade 3).

Figure 29 – Evaluation of the method and the proposal by Participant C

On the one hand, participant C pointed out that the method required too much time, especially when performing the tasks in detail. On the other hand, the requirement of a team with different expertise was highlighted as positive aspect of the method by the participant. He also reported that the method is easy to be used and effective. The PSS proposal generated for the Pedelec case was considered challenging to be evaluated as the research team is not a real company and the creation of a startup is still being evaluated. However, the results collected and presented in the proposal as well as the flexibility to conclude tasks when possible were strong points for participant C.

Table 73 presents the strong and weak points of both the method and the proposal according to participant C.

Table 73 – Weak and strong points according to participant C

	Configurator of PSS proposals	PSS proposal
Weak points	time-consuming if done in-depth	fictive, therefore hard to assess
Strong points	easy, effective, multifunctional team	flexibility and results

9.4.2 Evaluation from Process Modelling Researcher

The evaluation performed by participant D is shown in Figure 30. Fourteen of the eighteen questions had as grades very satisfactory (4) and satisfactory (3). However, four elements were evaluated as “need improvements” (grade 2). They correspond to: utility of the method (question 1), completeness of tasks (question 6), results of the method (question 7) and description of attributes and options (question 14).

Figure 30 - Evaluation of the method and the proposal by Participant D

Participant D missed an interface to further tasks, such as to write a business plan. However, this is out of the scope of the current version of the method. She also mentioned a lack of an explicit result of the PSS proposal. She believes a condensed report generated out of the tasks and summarizing the results would be helpful. That was the reason that the grade 2 was given to the elements: utility of the method (question 1) and results of the method (question 7).

However, she believes that the proposal provided awareness about points in which the research team has to concentrate and acquire more knowledge and information in order to reach a future successful business model. She also highlighted that the proposal was able to cover the results from different projects of the Collaborative Research Center (CRC) 1026 “Sustainable Manufacturing – Shaping Global Value Creation” that worked on the PSS concept, which contributed to create a common and systematic overview between the researchers.

As a strong point of the method, participant D mentions the Configurator is “a structured method to think about main facts in a business proposal and to help especially non-experts to think about their idea and to identify gaps in knowledge”.

Table 74 presents the strong and weak points of both the method and the proposal according to the opinion of participant D.

Table 74 - Weak and strong points according to participant D

	Configurator of PSS proposals	PSS proposal
Weak points	no interfaces to further tasks like writing a business plan	no explicit result at the end
Strong points	structured method to think about main facts in a business proposal helps especially non-experts	awareness about points in which the team have to concentrate on; integration of results out of several sub-projects of the CRC

10. Final Considerations

10.1 Results obtained

Despite the emergence of new approaches, such as PSS, which help companies innovate and compete in the market, there were no methods and tools that help to structure PSS proposals on the fuzzy front-end for potential PSS business models.

The goal of this research was achieved and a method, named Configurator of PSS proposals was developed. The elements of the method, i.e. steps, inputs and outputs, were identified in the literature of PSS, fuzzy front-end and business model.

The first version of the method was applied in a case study within a machine tool manufacturer. As the main purpose of this case study was to improve the method, some insights were registered covering advantages and disadvantages of the method. On the one hand, the method provided to the company a starting point to deal with PSS by generating alternatives and PSS proposals that may lead to a successful PSS implementation in the future. The creation of PSS proposals may increase the knowledge and understanding about the opportunities and challenges to develop PSS business models and then provide more consistency concerning the decisions made during the fuzzy front-end. Additionally, the Configurator supported:

- The understanding of the current business model and the exploration about how this business model could operate within different PSS alternatives;
- The creation of a proposal according to PSS requirements;
- The generation of new business ideas and opportunities as a result of the knowledge acquired using the Configurator.

On the other hand, disadvantages of the method were pointed out and led to actions of improving the Configurator. For instance, it was difficult to use the method without deep knowledge about different characteristics that can be included in a PSS proposal and about the meaning of the business model dimensions. The actions of improvement proposed to minimize the disadvantages were developed by means of systematic literature reviews and experts evaluation. As result a second version of the Configurator of PSS proposals was presented.

Through systematic literature reviews, a range of attributes of PSS, product and service projects, which were dispersed on different studies, were identified and systematized. Two rounds of experts' evaluation provided insights about which attributes of PSS are relevant to create PSS proposals. Inclusion, exclusion and enhancement of attributes and options led to a consolidated database named PSS configuration database.

The second version of the Configurator of PSS proposals presented new steps and improved inputs and outputs. Yet, new elements were included on the method, named tasks and help. The tasks were deployed from the attributes of the PSS configuration database. The help includes information about other methods and tools, description of cases from companies that apply PSS, relation between configurator tasks and hints on how to use the configurator. The second version was applied in a case study with the purpose to test the hypothesis of this study, which states that the Configurator supports the creation of PSS proposals.. The case presents the configuration of a business proposal for a bicycle sharing system. After the utilization of the method, the following benefits were pointed out:

- Increase of knowledge about different possibilities for the content of a PSS business model;
- Gathering of important information and knowledge for a PSS business that could be spread in different departments or with people from different areas.

According to the evaluation performed by the participants of the case study, the method assists the creation of PSS proposals. However, only two of the four participants answered the questionnaire and provided their opinion about the utilization of the method.

10.2 Contributions and limitation of the research

This study proposes a definition for PSS proposals and for PSS business model. PSS proposals are not explored currently on the literature and PSS business model does not present a common definition.

The research addresses the adoption of PSS through a perspective based on business model dimensions. This perspective differs from existent studies on PSS adoption, which normally focus on the PSS attributes related to one or few business

model dimensions, e.g., customer relationships, cost management or partnerships. Thus, this study brings a contribution to foster PSS adoption considering all the business dimensions. Also, these attributes, which were dispersed on the literature, were identified, organized and assessed by experts, originating a complete database of business model attributes. Through the analysis of these attributes, tasks were developed and a new and original method was created, named the Configurator of PSS proposals, which is the main contribution of this study. This method allows:

- To characterize, differentiate, compare and describe PSS proposals;
- To stimulate the emergence of new ideas and opportunities for new PSS oriented business;
- To provide a shared knowledge about PSS in the organization and between different areas of expertise and encourage the constitution of multifunctional teams during the fuzzy front-end;
- To create a document that can be utilized to present the PSS proposal to stakeholders.

Another contribution is the creation of the PSS proposal in two different case studies. These applications present how the Configurator can be utilized in order to identify opportunities for PSS adoption. Moreover, the method presents different paths, one for companies that wish to improve a PSS business model and one for the case of creating a new one, which can be considered a differential compared to another methods that support business model creation.

10.3 Limitations

The method does not address calculations of cost elements or revenue and, therefore, does not support the financial comparison between different proposals and the final decision about implementing or not such proposals.

The evaluation of the method by only two members of the research project was a limitation of the research methodology that could not be avoided due to the availability of the participants.

The lack of application of the second version of the Configurator in a real company can be highlighted as another limitation. Despite the application of the method in a research project context, other benefits could be reached by utilizing the

Configurator in a real case, e.g. test whether the improved Configurator can generate better results compared to the first version. Future studies could try to cope with such limitation, as presented below.

It was noted during the application that many tasks of the Configurator might be defined only during the development of a new PSS offer, especially in cases of radical innovations. Therefore, the complete description of a detailed business model results from the complete development of the PSS. However, for defining a PSS proposal in the fuzzy front-end, the method covered a comprehensive “checklist” of all possible attributes that might be required for the decision making process of selecting a proposal during the portfolio management, before the development phase begins, even if some tasks were not defined in this phase. If the team believes that the knowledge and information gathered up to that moment is enough for decision making, this is enough to begin the development phase. In this case, the Configurator might be applied also during the development to define a final version of the business model.

10.4 Future research

As already mentioned, the application of the Configurator of PSS proposals in a real case is suggested. However, a third version of the method could be generated taking into account the suggestions provided by the research team that participated in the case study. These suggestions include:

- The incorporation of new tasks and new relations between them;
- The development of a template or a condensed report to demonstrate the end result of the method, i.e. the PSS proposal;
- Increase the scope of the method and develop tasks for the creation of a business case.

A possibility of future study should consider the identification of more attributes regarding the environmental and social aspect of PSS to be included on the PSS proposals. The inclusion of such aspects might facilitate the creation of PSS proposal that include sustainability attributes.

Additionally, the revision of attributes, excluded in both evaluations with experts, might be an alternative to enrich the method with new tasks. Within the

knowledge and experience gained from case studies it might be realized that excluded attributes are relevant to be included on an improved version of the method.

Yet, a complementary financial model that supports calculations such as return of investments and economic feasibility of PSS proposals might be created and utilized in the steps 7 (Configure Revenue Streams) and 8 (Configure Cost Structure). A combination of information, knowledge and numbers (generated via financial model) might facilitate the decision of which proposals implement.

The utilization of the method by a team of different companies is another opportunity to analyze how the Configurator could work in the context of a network of companies or in an innovation system. It is assumed that more information and knowledge would be brought into discussion during the creation of the PSS proposal and the end result would fit better the requirements of the variety of companies that work together to develop a PSS.

Creativity methods for generating ideas could be used together with the Configurator in case the inputs for the method (strategies, ideas, opportunities, concepts) are not completely defined or radical innovations are planned. In such cases, little knowledge will be available to develop the proposal and the creativity methods might support the generation of more information.

Research on the evaluation of the success of these proposals could be an interesting point to be further developed. Identification of external and internal influence factors could help this evaluation.

The method shall be implemented via website to facilitate its use, e.g. the use of the hyperlinks, and to organize better the contents in different pages, e.g. the description of the methods and tools. This action might foster the adoption of PSS by means of increasing the acknowledgment and the utilization of the Configurator.

Finally, the application of the Configurator could be performed for a radical innovations to test if the assumption that the method can be utilized not only in the fuzzy front-end, but also in the development phase, is correct.

References

- ALFIAN, G.; RHEE, J.; YOON, B. A simulation tool for prioritizing product-service system (PSS) models in a carsharing service. **Computers & Industrial Engineering**, v. 70, p. 59–73, 2014.
- ANTTONEN, M. Greening from the Front to the Back Door? A Typology of Chemical and Resource Management Services. **Business Strategy and the Environment**, v. 215, n. January 2009, p. 199–215, 2010.
- ARTTO, K.; MARTINSUO, M.; DIETRICH, P.; KUJALA, J. Project strategy : strategy types and their contents in innovation projects. **International Journal of Managing Projects in Business**, v. 1, n. 1, p. 49–70, 2008.
- AVLONITIS, G. J.; PAPASTATHOPOULOU, P. G.; GOUNARIS, S. P. An empirically-based typology of product innovativeness for new financial services: Success and failure scenarios. **The Journal of Product Innovation Management**, v. 18, p. 324–342, 2001.
- BAINES, T.; LIGHTFOOT, H.; PEPPARD, J.; et al. Towards an operations strategy for product-centric servitization. **International Journal of Operations & Production Management**, v. 29, n. 5, p. 494–519, 2009.
- BAINES, T. S.; LIGHTFOOT, H. W.; EVANS, S.; et al. State-of-the-art in product-service systems. **Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture**, v. 221, n. 10, p. 1543–1552, 2007.
- BARCLAY, I. Organisational factors for success in new product development. **IEE Proceedings Science, Measurement and Technology**, v. 149, n. 2, p. 105–112, 2002.
- BARCLAY, I.; DANN, Z. New-product-development performance evaluation : a product-complexity-based methodology. **IEE Proceedings Science, Measurement and Technology**, v. 147, n. 2, p. 41–55, 2000.
- BARQUET, A. P. B.; CUNHA, V. P.; OLIVEIRA, M. G.; ROZENFELD, H. Business model elements for product-service system. **Functional Thinking for Value Creation**. p.332–337, 2011.
- BARQUET, A. P. B.; GUIDAT, T.; ALMEIDA, M. J.; SELIGER, G.; ROZENFELD, H. Service-oriented business models used by Brazilian manufacturing companies. The 13th International Research Symposium on Service Excellence in Management. **Proceeding...** p.10p., 2013.
- BARQUET, A. P. B.; OLIVEIRA, M. G. DE; AMIGO, C. R.; CUNHA, V. P.; ROZENFELD, H. Employing the business model concept to support the adoption of product–service systems (PSS). **Industrial Marketing Management**, v. 42, n. 5, p. 693–704, 2013.

BARTOLOMEO, M.; MASO, D.; JONG, P.; et al. Eco-efficient producer services—what are they, how do they benefit customers and the environment and how likely are they to develop and be extensively utilised? **Journal of Cleaner Production**, v. 11, p. 829–837, 2003.

BEUREN, F. H. **Principais Fatores Críticos de Sucesso para Sistemas Produto-Serviço (Master in Industrial Engineering)**, 2011. Universidade Federal de Santa Catarina.

BINGCHUN, L.; JIAN, L.; ZHENZHEN, H. Saving-sharing contract of product service system based on effort factor. The 16th International Conference on Industrial Engineering and Engineering Management. **Proceedings...** p.1393 – 1397, 2009.

BIOLCHINI, J. C. DE A.; MIAN, P. G.; NATALI, A. C. C.; CONTE, T. U.; TRAVASSOS, G. H. Scientific research ontology to support systematic review in software engineering. **Advanced Engineering Informatics**, v. 21, n. 2, p. 133–151, 2007.

BLONDEL, B.; MISPELON, C.; FERGUSON, J. Cycle more Often 2 cool down the planet! Quantifying CO2 savings of Cycling. **European Cyclists' Federation ASBL**, p. 16, 2011.

BOEHM, M.; THOMAS, O. Looking beyond the rim of one's teacup: a multidisciplinary literature review of Product-Service Systems in Information Systems, Business Management, and Engineering & Design. **Journal of Cleaner Production**, v. 51, p. 245–260, 2013.

BOOZ ALLEN; HAMILTON, I. **New products management for the 1980's**. New York: Booz Allen & Hamilton, 1982.

BRANZEI, O.; VERTINSKY, I. Strategic pathways to product innovation capabilities in SMEs. **Journal of Business Venturing**, v. 21, p. 75–105, 2006.

BRETANI, U. DE. Innovative versus incremental new business services: Different keys for achieving success. **Journal of Product Innovation Management**, v. 18, p. 169–187, 2001.

BULLINGER, H.-J.; FÄHNRIK, K.-P.; MEIREN, T. Service engineering—methodical development of new service products. **International Journal of Production Economics**, v. 85, n. 3, p. 275–287, 2003.

CARBONELL, P. Performance effects of involving lead users and close customers in new service development. **Journal of Services Marketing**, v. 26, n. 7, p. 497–509, 2012.

CAVALCANTE, S.; KESTING, P.; ULHØI, J. Business model dynamics and innovation: (re)establishing the missing linkages. **Management Decision**, v. 49, n. 8, p. 1327–1342, 2011.

CESCHIN, F. Critical factors for implementing and diffusing sustainable product-Service systems: insights from innovation studies and companies' experiences. **Journal of Cleaner Production**, v. 45, n. 74-88, 2013.

CHANG, Y.-C.; LINTON, J. D.; CHEN, M.-N. Service regime: An empirical analysis of innovation patterns in service firms. **Technological Forecasting and Social Change**, v. 79, n. 9, p. 1569–1582, 2012.

CHAPMAN, R.; HYLAND, P. Complexity and learning behaviors in product innovation. **Technovation**, v. 24, n. 7, p. 553–561, 2004.

CHEN, J.; REILLY, R. R.; LYNN, G. S. The Impacts of Speed-to-Market on New Product Success: The Moderating Effects of Uncertainty. **IEEE Transactions on Engineering Management**, v. 52, n. 2, p. 199–212, 2005.

CHESBROUGH, H. **Open Business Models: How to Thrive in the New Innovation Landscape**. Harvard Business School Press, 2006.

CHESBROUGH, H. Business Model Innovation: Opportunities and Barriers. **Long Range Planning**, v. 43, n. 2-3, p. 354–363, 2010.

CHESBROUGH, H.; ROSENBLOOM, R. S. The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. **Industrial and Corporate Change**, v. 11, n. 3, p. 529–555, 2002.

CHOWDHURY, S.; MILES, G. Customer-induced uncertainty in predicting organizational design: Empirical evidence challenging the service versus manufacturing dichotomy. **Journal of Business Research**, v. 59, p. 121–129, 2006.

CHRISTENSEN, C. M. **The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail**. Harvard Business School Press, 1997.

CLARK, K. B.; FUJIMOTO, T. **Product development performance: strategy, organization and management in the world auto industry**. Boston, Mass.: Harvard Business School Press., 1991.

CONFORTO, E. C.; CAPALDO, D.; SILVA, S. L. DA. Roteiro para revisão bibliográfica sistemática: aplicação no desenvolvimento de produtos e gerenciamento de projetos. 8 Congresso Brasileiro de Gestão de Desenvolvimento de Produto (CBGDP). **Proceedings.....** p.1–12, 2011. Porto Alegre, RS.

CONSONI, F.; QUADROS, R. From adaptation to complete vehicle design: a case study of product development capabilities in a carmaker in Brazil. **Int. J. Technology Management**, v. 36, n. 1/2/3, p. 91–107, 2006.

COOK, D. J.; MULROW, C. D.; HAYNES, R. B. Systematic reviews: synthesis of best evidence for clinical decisions. **Annals of internal medicine**, v. 126, n. 5, p. 376–80, 1997.

COOK, D. P.; GOH, C.-H.; CHUNG, C. H. SERVICE TYPOLOGIES: A STATE OF THE ART SURVEY. **Production and Operations Management**, v. 8, n. 3, p. 318–338, 1999.

COOK, M. B.; BHAMRA, T. A.; LEMON, M. The transfer and application of Product Service Systems: from academia to UK manufacturing firms. **Journal of Cleaner Production**, v. 14, n. 17, p. 1455–1465, 2006.

COOPER, R. G. **Winning at New Products: Accelerating the Process from Idea to Launch**. 3rd ed. Cambridge, Mass.: Perseus, 2001.

COSTER, R. DE. Differences in Forecasting Approaches Between Product Firms and Product- Service Systems (PSS). The 6th International Conference on Manufacturing Research (ICMR08). **Proceedings.....** p.539–547, 2008.

COSTER, R. DE. A collaborative approach to forecasting product–service systems (PSS). **The International Journal of Advanced Manufacturing Technology**, v. 52, n. 9-12, p. 1251–1260, 2011.

CRAWFORD, C. M.; BENEDETTO, C. A. **New Products Management**. 8th ed. ed. New York: McGraw-Hill/Irwin, 2006.

CRAWFORD, L.; HOBBS, J. B.; TURNER, J. R. Project Categorization Systems and their use in Organizations: An Empirical Study. The PMI Research Conference. **Proceedings.....** p.1–16, 2004.

CREUTZIG, F.; MUHLHOFF, R.; ROMER, J. Decarbonizing urban transport in European cities: four cases show possibly high co-benefits. **ENVIRONMENTAL RESEARCH LETTERS**, v. 7, 2012.

CUNHA, V. P. **Análise da gestão de ideias de produtos para apoiar o planejamento da inovação**, 2011. (Master in Industrial Engineering) Escola de Engenharia de São Carlos da Universidade de São Paulo.

DACKO, S. G.; LIU, B. S.; SUDHARSHAN, D.; FURRER, O. Dynamic capabilities to match multiple product generations and market rhythm. **European Journal of Innovation Management**, v. 11, n. 4, p. 441–471, 2008.

DAHLGREN, J.; SÖDERLUND, J. Modes and mechanisms of control in Multi-Project Organisations: the R & D case Jörgen Dahlgren. **Int. J. Technology Management**, v. 50, n. 1, p. 1–22, 2010.

DANNEELS, E. The dynamics of product innovation and firm competences. **Strategic Management Journal**, v. 23, n. 12, p. 1095–1121, 2002.

DATTA, P. P.; ROY, R. Operations strategy for the effective delivery of integrated industrial product-service offerings: Two exploratory defence industry case studies. **International Journal of Operations & Production Management**, v. 31, n. 5, p. 579–603, 2011.

DAUSCH, M.; HSU, C. Engineering Service Products: The Case of Mass-Customizing Service Agreements for Heavy Equipment Industry. **International Journal of Services Technology and Management**, p. 1–25, 2005.

DUL, J.; HAK, T. **Case Study Methodology in Business Research**. 1st ed. ed. Burlington: Elsevier, 2008.

EISENHARDT, K. Building Theories from Case Study Research. **Academy of Management Review**, v. 14, n. 4, p. 532–550, 1989.

ELBERS, B. F. **Designing innovative business models: A methodology for structured business model innovation Management**, 2010. Universidade Tecnológica de Eindhoven.

ERKOYUNCU, J. A.; ROY, R.; SHEHAB, E.; CHERUVU, K. Understanding service uncertainties in industrial product – service system cost estimation. **The International Journal of Advanced Manufacturing Technology**, v. 52, n. 9-12, p. 1223–1238, 2011.

EVANS, S.; PARTIDÁRIO, P. J.; LAMBERT, J. Industrialization as a key element of sustainable product-service solutions. **International Journal of Production Research**, v. 45, n. 18-19, p. 4225–4246, 2007.

FINKEN, K. H.; MCALOONE, T. C.; AVLONITIS, V.; et al. **PSS Tool Book: A workbook in the PROTEUS Series**. Technical University of Denmark, 2013.

GALBRAITH, J. R. Organization Design: An Information Processing View. **Interfaces**, v. 4, p. 28–36, 1974.

GAO, J.; YAO, Y.; ZHU, V. C. Y.; SUN, L.; LIN, L. Service-oriented manufacturing: a new product pattern and manufacturing paradigm. **Journal of Intelligent Manufacturing**, v. 22, p. 435–446, 2011.

GARCIA, R.; CALANTONE, R. A critical look at technological innovation typology and innovativeness terminology: a literature review. **Journal of Product Innovation Management**, v. 19, p. 110–132, 2002.

GEBAUER, H.; FISCHER, T.; FLEISCH, E. Exploring the interrelationship among patterns of service strategy changes and organizational design elements. **Journal of Service Management**, v. 21, n. 1, p. 103–129, 2010.

GELBMANN, U.; HAMMERL, B. Integrative re-use systems as innovative business models for devising sustainable product service-systems. **Journal of Cleaner Production**, v. In Press, 2014.

GEUM, Y.; LEE, S.; KANG, D.; PARK, Y. Technology roadmapping for technology-based product – service integration: A case study. **Journal of Engineering and Technology Management**, v. 28, n. 3, p. 128–146, 2011.

GEUM, Y.; PARK, Y. Development of Technology Roadmap for Product-Service System (TRPSS). IEEE International Conference on Industrial Engineering and Engineering Management (IEEM). **Proceedings**..... p.410–414, 2010.

GEUM, Y.; PARK, Y. Designing the sustainable product-service integration: a product-service blueprint approach. **Journal of Cleaner Production**, v. 19, n. 14, p. 1601–1614, 2011.

GILL, J.; JOHNSON, P. **Research methods for managers**. 3rd ed. ed. London: SAGE Publications Ltd, 2002.

GOEDKOOOP, M. J.; HALEN, C. J. G. VAN; RIELE, H. R. M. TE; ROMMENS, P. J. M. **Product Service systems , Ecological and Economic Basics**. Holanda, 1999.

GRIFFIN, A. Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices. **Journal of Product Innovation Management**, v. 14, p. 429–458, 1997.

GRIFFIN, A.; PAGE, A. L. PDMA success measurement project: recommended measures for product development success and failure. , v. 13, p. 478–496, 1996.

GRÖNROOS, C. A service perspective on business relationships: The value creation, interaction and marketing interface. **Industrial Marketing Management**, v. 40, n. 2, p. 240–247, 2011.

GUIDAT, T.; BARQUET, A. P.; WIDERA, H.; ROZENFELD, H.; SELIGER, G. Guidelines for the definition of innovative industrial product-service systems (PSS) business models for remanufacturing. The 6th CIRP Conference on Industrial Product-Service Systems. **Proceedings**..... p.193–198, 2014.

HALEN, C. VAN; VEZZOLI, C.; WIMMER, R. **Methodology for Product Service System Innovation: How to Develop Clean, Clever and Competitive Strategies in Companies**. 2005.

HAO, L. I.; XIAO-MIN, L. I. Study on the Service Model of Product Service Provider. International Conference on System Science, Engineering Design and Manufacturing Informatization. **Proceedings**..... p.42–44, 2010.

HART, S.; TZOKAS, N.; SAREN, M. The effectiveness of market information in enhancing new product success rates. **European Journal of Innovation Management**, v. 2, n. 1, p. 20–35, 1999.

HERTOG, P. DEN. KNOWLEDGE-INTENSIVE BUSINESS SERVICES INNOVATION, CO-PRODUCERS OF INNOVATION. **International Journal of Innovation Management**, v. 4, n. 4, p. 491–528, 2000.

HONG, Y.; PEARSON, J. N.; CARR, A. S. A typology of coordination strategy in multi-organizational product development. **International Journal of Operations & Production Management**, v. 29, n. 10, p. 1000–1024, 2009.

HUANG, X.; NEWNES, L.; PARRY, G. An Analysis of Industrial Practice for Estimating the In-Service Costs of a Product Service System. The 16th Design for Manufacturing and the Life Cycle Conference. **Proceedings.....** p.605–615, 2011.

ISAKSSON, O.; LARSSON, T. C.; RÖNNBÄCK, Ö. Development of Product-Service Systems: Challenges and Opportunities for the Manufacturing Firm. **Journal of Engineering Design**, v. 20, n. 4, p. 21, 2009.

JACOB, F.; ULAGA, W. The transition from product to service in business markets: An agenda for academic inquiry. **Industrial Marketing Management**, v. 37, n. 3, p. 247–253, 2008.

JETTER, A. J. M. Educating the guess: strategies, concepts and tools for the fuzzy front end of product development. Portland International Conference on Management of Engineering and Technology Technology Management for Reshaping the World. **Proceedings.....** p.261–273, 2003. Portland State Univ.

JOHANSSON, C.; HICKS, B.; LARSSON, A. C.; BERTONI, M. Knowledge Maturity as a Means to Product-Service Systems Development. **Project Management Journal**, v. 42, n. 2, p. 32–50, 2011.

JOHNSON, M. W.; CHRISTENSEN, C. M. Reinventing Your Business Model. **Harvard business review**, p. 1–12, 2008.

KARLSSON, C. **Researching in Operations Management**. New York: Routledge, 2009.

KERR, C. I. V; PHAAL, R.; PROBERT, D. R. Technology insertion in the defense industry: A primer. **Proceedings of the Institution of Mechanical Engineers , Part B: Journal of Engineering Manufacture**, v. 222, p. 1009–1023, 2008.

KHAN, M.; KHAN, M. A. How technological innovations extend services outreach to customers: The changing shape of hospitality services taxonomy. **International Journal of Contemporary Hospitality Management**, v. 21, n. 5, p. 509–522, 2009.

KIM, Y. S.; WANG, E.; PARK, M. W. Value – Function – Structure Modeling in an Ontological Representation of Product-Service Systems. ICED 09, the 17th International Conference on Engineering Design. **Proceedings.....** p.359–370, 2009.

KIVIMAA, P. Integrating Environment for Innovation: Experiences From Product Development in Paper and Packaging. **Organization & Environment**, v. 21, n. 1, p. 56–75, 2008.

KOEN, P. A.; AJAMIAN, G. M.; BOYCE, S.; et al. Fuzzy Front End: Effective Methods, Tools, and Techniques. **The PDMA ToolBook for New Product Development**. p.5–35, 2002.

KOEN, P.; AJAMIAN, G.; BURKART, R.; et al. Providing clarity and a common language to the “fuzzy front end.” **Research-Technology Management**, v. 44, n. 2, p. 46–55, 2001. Industrial Research Institute, Inc.

KOWALKOWSKI, C. What does a service-dominant logic really mean for manufacturing firms? **CIRP Journal of Manufacturing Science and Technology**, v. 3, n. 4, p. 285–292, 2010.

KRUCKEN, L.; MERONI, A. Building stakeholder networks to develop and deliver product-service-systems: practical experiences on elaborating pro-active materials for communication. **Journal of Cleaner Production**, v. 14, p. 1502–1508, 2006.

KUJALA, S.; ARTTO, K.; AALTONEN, P.; TURKULAINEN, V. Business models in project-based firms – Towards a typology of solution-specific business models. **International Journal of Project Management**, v. 28, n. 2, p. 96–106, 2010. Elsevier Ltd and IPMA.

KUO, T. C. Simulation of purchase or rental decision-making based on product service system. **The International Journal of Advanced Manufacturing Technology**, v. 52, n. 9-12, p. 1239–1249, 2010.

KUO, T. C.; MA, H.-Y.; HUANG, S. H.; HU, A. H.; HUANG, C. S. Barrier analysis for product service system using interpretive structural model. **The International Journal of Advanced Manufacturing Technology**, v. 49, n. 1-4, p. 407–417, 2010.

LAKEMON, N.; BERGGREN, C.; WEELE, A. VAN. Coordinating supplier involvement in product development projects: a differentiated coordination typology. **R&D Management**, v. 36, n. 1, p. 55–66, 2006.

LAKEMON, N.; ECHELTEL, F. VAN; WYNSTRA, F. A Configuration Typology for Involving Purchasing Specialists. **Journal of Supply Chain Management**, v. Module 3, p. 11–20, 2001.

LANCASTER, G. **Research methods in management: a concise introduction to research in management and business consultancy**. 1st ed. ed. Oxford: Elsevier Butterworth-Heinemann, 2005.

LAY, G.; SCHROETER, M.; BIEGE, S. Service-based business concepts: a typology for business-to-business markets. **European Management Journal**, v. 27, n. 6, p. 442–455, 2009.

LECHLER, T. G.; DVIR, D. An Alternative Taxonomy of Project Management Structures: Linking Project Management Structures and Project Success. **IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT**, v. 57, n. 2, p. 198–210, 2010.

LEE, B. C. Y. The determinants of consumer attitude toward service innovation – the evidence of ETC system in Taiwan. **Journal of Services Marketing**, v. 26, n. 1, p. 9–19, 2012.

LEE, J. H.; SHIN, D. I.; HONG, Y. S. Business Model Design Methodology for Innovative Product-Service Systems: A Strategic and Structured approach. Annual SRII Global Conference. **Proceedings**..... p.663–673, 2011.

LEE, Y.; CONNOR, G. C. O. The Impact of Communication Strategy on Launching New Products: The Moderating Role of Product Innovativeness. **Journal of Product Innovation Management**, v. 20, p. 4–21, 2003.

LEENDERS, M.; VOERMANS, C. Beating the odds in the innovation arena: The role of market and technology signals classification and noise. **Industrial Marketing Management**, v. 36, n. 4, p. 420–429, 2007.

LEIPONEN, A. Managing Knowledge for Innovation: The Case of Business-to-Business Services. **Journal of Product Innovation Management**, v. 23, p. 238–258, 2006.

LEVY, Y.; ELLIS, T. J. A Systems Approach to Conduct an Effective Literature Review in Support of Information Systems Research. **Informing Science Journal**, v. 9, p. 181–212, 2006.

LIER, S.; WÖRSDÖRFER, D.; GESING, J. Business Models and Product Service Systems for Transformable, Modular Plants in the Chemical Process Industry. The 5th CIRP Conference on Industrial Product Service Systems. **Proceedings**..... , 2013.

LIM, C.-H.; KIM, K.-J.; HONG, Y.-S.; PARK, K. PSS Board: a structured tool for product-service system process visualization. **Journal of Cleaner Production**, v. 37, p. 42–53, 2012.

LIN, K.; SHIH, L.; LU, S.; LIN, Y. Strategy selection for product service systems using case-based reasoning. **African Journal of Business Management**, v. 4, n. 6, p. 987–994, 2010.

LINDER, J.; CANTRELL, S. **Changing Business Models: Surveying the Landscape**. 2001.

LIUA, A.; WUESTB, T.; WEIC, W.; LUA, S. Application of Prospect Theory on Car Sharing Product Service System. The 6th CIRP Conference on Industrial Product-Service Systems. **Proceedings**... p.350–355, 2014.

LONG, H. J.; WANG, L. Y.; SHEN, J.; WU, M. X.; JIANG, Z. B. Product service system configuration based on support vector machine considering customer perception. **International Journal of Production Research**, v. 51, n. 18, p. 5450–5468, 2013.

LUSCH, R. F.; VARGO, S. L.; O'BRIEN, M. Competing through service: Insights from service-dominant logic. **Journal of Retailing**, v. 83, n. 1, p. 5–18, 2007.

MAGRETTA, J. Why Business Models Matter. **Harvard Business Review**, p. 8, 2002.

MANZINI, E.; VEZZOLI, C. A strategic design approach to develop sustainable product service systems: examples taken from the “environmentally friendly innovation” Italian prize. **Journal of Cleaner Production**, v. 11, n. 8, p. 851–857, 2003.

MARTINEZ, V.; BASTL, M.; KINGSTON, J.; EVANS, S. Challenges in transforming manufacturing organisations into product-service providers. **Journal of Manufacturing Technology Management**, v. 21, n. 4, p. 449–469, 2010.

MATHIEU, V. Service strategies within the manufacturing sector : benefits , costs and partnership. **International Journal of Service Industry Management**, v. 12, n. 5, p. 451–475, 2001.

MATTHYSSENS, P.; VANDENBEMPT, K. Service addition as business market strategy: identification of transition trajectories. **Journal of Service Management**, v. 21, n. 5, p. 693–714, 2010.

MATZEN, D. **A systematic approach to service oriented product development** (Doctorate in Management Engineering), 2009. Technical University of Denmark.

MEIER, H.; BOSSLA, M. Design and Engineering of Dynamic Business Models for Industrial Product-Service Systems. The 4th CIRP Conference on Industrial Product Service Systems. **Proceedings....** p.179–184, 2013.

MEIER, H.; MASSBERG, W. Life Cycle-Based Service Design for Innovative Business Models. **CIRP Annals - Manufacturing Technology**, v. 53, n. 1, p. 393–396, 2004.

MEIER, H.; ROY, R.; SELIGER, G. Industrial Product-Service Systems - IPS². **CIRP Annals Manufacturing Technology**, v. 59, n. 2, p. 607–627, 2010.

MENOR, L. J.; TATIKONDA, M. V; SAMPSON, S. E. New service development : areas for exploitation and exploration. **Journal of Operations Management**, v. 20, p. 135–157, 2002.

MEURIS, D.; HERZOG, M.; BENDER, B.; SADEK, T. IT Support in the Fuzzy Front End of Industrial Product Service Design. The 6th CIRP Conference on Industrial Product-Service Systems. **Proceedings...** p.379–384, 2014.

MOENAERT, R. K.; MEYER, A. DE; SOUDER, W. E.; DESCHOOLMEESTER, D. R&D/marketing communication during the fuzzy front-end. **IEEE Transactions on Engineering Management**, v. 42, n. 3, p. 243–258, 1995.

MONT, O. **Product-Service Systems Final Report** The International Institute of Industrial Environmental. 2000.

MONT, O. Clarifying the concept of product – service system. **Journal of Cleaner Production**, v. 10, p. 237–245, 2002.

MONT, O. **Product-Service Systems : Panacea or Myth ?**, 2004. Lund University.

MONT, O.; DALHAMMAR, C.; JACOBSSON, N. A new business model for baby prams based on leasing and product remanufacturing. **Journal of Cleaner Production**, v. 14, n. 17, p. 1509–1518, 2006.

MORELLI, N. Developing new product service systems (PSS): methodologies and operational tools. **Journal of Cleaner Production**, v. 14, n. 17, p. 1495–1501, 2006.

MOSEY, S. Understanding new-to-market product development in SMEs. **International Journal of Operations & Production Management**, v. 25, n. 2, p. 114–130, 2005.

MOUGAARD, K.; NEUGEBAUER, L. M.; ANDERSEN, J. A. B.; et al. **PSS Case Book: A workbook in the PROTEUS series**. Technical University of Denmark (DTU), 2012.

MOUGAARD, K.; NEUGEBAUER, L. M.; GARCIA I MATEU, A.; et al. **Maritime Branch Analysis: A workbook in the PROTEUS series**. PROTEUS Wo ed. Technical University of Denmark (DTU), 2013.

MURPHY, S. A.; KUMAR, V. The front end of new product development : a Canadian survey. **R&D Management**, v. 27, n. 1, p. 5–15, 1997.

NEMOTO, Y.; AKASAKA, F.; SHIMOMURA, Y. Product-Service Integration for Sustainable Solutions. In: H. Meier (Ed.); The 5th CIRP International Conference on Industrial Product-Service Systems. **Proceedings...** , Lecture Notes in Production Engineering.. p.41–52, 2013. Berlin, Heidelberg: Springer Berlin Heidelberg.

NOBEOKA, K.; CUSUMANO, M. A. **Multi-Project Management: Strategy and Organization in Automobile Product Development**. 1993.

NOBEOKA, K.; CUSUMANO, M. A. Multiproject Strategy , Design Transfer , and Project Performance: A Survey of Automobile Development Projects in the US and Japan. **IEEE Transactions on Engineering Management**, v. 42, n. 4, p. 397–409, 1995.

O'HERN, M.; RINDFLEISCH, A. **Customer Co-Creation: A Typology and Research Agenda**. 2008.

OFFICIAL JOURNAL OF THE EUROPEAN COMMUNITIES. DIRECTIVE 2002/24/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. ,2002.

OLIVEIRA, M. G.; PHAAL, R.; PROBERT, D.; AND, V. P. .; ROZENFELD, H. A starting point for addressing product innovativeness in the Fuzzy Front-End. **Int. J. Technology Intelligence and Planning**, v. 7, n. 4, p. 309–326, 2011.

OSTERWALDER, A. **The Business Model Ontology - a proposition in a design science approach**, 2004. (Doctorate in Information Management) Universidade de Lausanne, Switzerland.

OSTERWALDER, A.; PIGNEUR, Y. **Business Model Generation**. Amsterdam: Self Published, 2010.

OSTERWALDER, A.; PIGNEUR, Y.; TUCCI, C. L. Clarifying Business Models: Origins, Present and Future of The Concept. **Communications of the Association for Information Systems**, v. 15, p. 1–40, 2005.

PARIDA, V.; SJÖDIN, D. R.; WINCENT, J.; KOHTAMÄKI, M. A Survey Study of the Transitioning towards High-Value Industrial Product-Services. The 6th CIRP Conference on Industrial Product-Service Systems. **Proceedings...** p.176–180, 2014.

PIGOSSO, D. C. A. **Ecodesign Maturity Model: a framework to support companies in the selection and implementation of ecodesign practices**. (Doctorate in Industrial Engineering), 2012. UNIVERSITY OF SÃO PAULO.

PONSIGNON, F.; SMART, P. A.; MAULL, R. S. Service delivery system design: characteristics and contingencies. **International Journal of Operations & Production Management**, v. 31, n. 3, p. 324–349, 2011.

RADDATS, C.; EASINGWOOD, C. Industrial Marketing Management Services growth options for B2B product-centric businesses. **Industrial Marketing Management**, v. 39, n. 8, p. 1334–1345, 2010.

RAINEY, D. **Product innovation: leading change through integrated product development**. Cambridge: Cambridge University Press, 2005.

REIM, W.; PARID, V.; ÖRTQVIST, D. Product Service Systems (PSS) business models and tactics e a systematic literature review. **Journal of Cleaner Production**, v. In Press, 2014.

RESE, M.; MEIER, H.; GESING, J.; BOSSLA, M. Ontology of Business Models for Industrial Product-Service. The 4th CIRP Conference on Industrial Product Service Systems. **Proceedings...** p.191–196, 2012.

RICHTER, A.; SADEK, T.; STEVEN, M.; WELP, E. G. Use-Oriented Business Models and Flexibility in Industrial Product-Service Systems. The 1st CIRP Industrial Product-Service Systems (IPS2) Conference. **Proceedings...** p.186–192, 2009. Cranfield University.

RODRIGUES, K. F. DE C.; NAPPI, V.; ROZENFELD, H. A proposal to support the value proposition in product oriented service business model of product service systems. The 6th CIRP Conference on Industrial Product-Service Systems. **Proceedings...** p.211–216, 2014.

ROSENØ, A. **A Four-Dimensional Product Innovativeness Typology: Introducing Seven New Product Project Types for the Study of Innovation Management.** 2005.

ROTHKOPF, M.; WALD, A. Innovation in Commoditized Services: a Study in the Passenger Airline Industry. **International Journal of Innovation Management**, v. 15, n. 04, p. 731–753, 2011.

ROY, R. Operations strategy for the effective delivery of integrated industrial product-service offerings Two exploratory defence industry case studies. **International Journal of Operations & Production Management**, v. 31, n. 5, p. 579–603, 2011.

SAKAO, T.; SANDSTRÖM, G. Ö.; MATZEN, D. Framing research for service orientation of manufacturers through PSS approaches. **Journal of Manufacturing Technology Management**, v. 20, n. 5, p. 754–778, 2009.

SCHENKL, S. A.; RÖSCH, C.; MÖRTL, M. Literature study on factors influencing the market acceptance of PSS. Proceedings of the 6th CIRP Conference on Industrial Product-Service Systems. **Proceedings...** p.98–103, 2014.

SCHUH, G.; SCHITTNY, B.; GAUS, F. Differentiation through industrial product-service-systems in the tooling industry. POMS 20th Annual Conference. **Proceedings...** p.1–26, 2009. Orlando, Florida U.S.A.

SFB 1016. <http://www.sustainable-manufacturing.net/>. .

SHAFER, S.; SMITH, H.; LINDER, J. The power of business models. **Business Horizons**, v. 48, n. 3, p. 199–207, 2005.

SHENHAR, A. J. From Theory to Practice: Toward a Typology of Project-Management Styles. **IEEE Transactions on Engineering Management**, v. 45, n. 1, p. 33–48, 1998.

SHENHAR, A. J. Contingent management in temporary , dynamic organizations : The comparative analysis of projects. **Journal of High Technology Management Research**, v. 12, p. 239–271, 2001.

SHENHAR, A. J.; DVIR, D. **Reinventing project management: the diamond approach to successful growth and innovation.** Boston: Harvard Business Press, 2007.

SHENHAR, A. J.; DVIR, D.; SHULMAN, Y. A two-dimensional taxonomy of products and innovations. **J. Eng. Technol. Management**, v. 12, p. 175–200, 1995.

SÖDERQUIST, K. E. Organising Knowledge Management and Dissemination in New Product Development: Lessons from 12 Global Corporations. **Long Range Planning**, v. 39, p. 497–523, 2006.

SOUSA, I.; WALLACE, D. Product classification to support approximate life-cycle assessment of design concepts. **Technological Forecasting and Social Change**, v. 73, n. 3, p. 228–249, 2006.

SPERRY, R.; JETTER, A. Theoretical Framework for Managing the Front End of Innovation under Uncertainty. PICMET 2009 - Technology Management in the Age of Fundamental Change. **Proceedings...** p.2021–2028, 2009.

SPRING, M.; ARAUJO, L. Service, services and products: rethinking operations strategy. **International Journal of Operations & Production Management**, v. 29, n. 5, p. 444–467, 2009.

STOCK, G. N.; TATIKONDA, M. V. A typology of project-level technology transfer processes. **Journal of Operations Management**, v. 18, p. 719–737, 2000.

TAN, A. R. **Service-oriented product development strategies** (Doctorate in Management Engineering), 2010. Technical University of Denmark (DTU).

TAN, A. R.; MCALOONE, T. C. Characteristics of Strategies in Product-Service-System Development. The 8th International Design Conference. **Proceedings...** p.1–8, 2006. Dubrovnik, Croatia.

TANGPONG, C.; MICHALISIN, M. D.; J.MELCHER, A. Toward a Typology of Buyer – Supplier Relationships : A Study of the Computer Industry. **Decision Sciences**, v. 39, n. 3, p. 571–593, 2008.

TATIKONDA, M. V; ROSENTHAL, S. R. Technology Novelty , Project Complexity , and Product Development Project Execution Success: A Deeper Look at Task Uncertainty in Product Innovation. **IEEE Transactions on Engineering Management**, v. 47, n. 1, p. 74–87, 2000.

TATIKONDA, M. V. An empirical study of platform and derivative product development projects, 1999..pdf. **Journal of Product Innovation Management**, v. 16, p. 3–26, 1999.

TEECE, D. J. Business Models, Business Strategy and Innovation. **Long Range Planning**, v. 43, n. 2-3, p. 172–194, 2010. Elsevier Ltd.

TISCHNER, U.; VERKUIJL, M.; TUKKER, A. Product Service Systems: best practice document. SusProNet. **Proceedings...** p.133, 2002.

TRUEMAN, M. Managing innovation by design – how a new design typology may facilitate the product development process in industrial companies and provide a competitive advantage. **European Journal of Innovation Management**, v. 1, n. 1, p. 44–56, 1998.

TUKKER, A. Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet. **Business Strategy and the Environment**, v. 13, n. 4, p. 246–260, 2004.

TUKKER, A.; TISCHER, U. **New Business for Old Europe - Product-Service Development, Competitiveness and Sustainability**. UK: Greenleaf Publishing Ltd, 2006.

TUKKER, A.; TISCHNER, U. Product-services as a research field: past, present and future. Reflections from a decade of research. **Journal of Cleaner Production**, v. 14, p. 1552–1556, 2006.

TUKKER, A.; VAN HALEN, C. **Innovation Scan for Product Service Systems**: Open your eyes to the power of your company to create value! Manual, Netherlands, 2003.

TWIGG, D. Managing product development within a design chain. **International Journal of Operations & Production Management**, v. 18, n. 5, p. 508–524, 1998.

TWIGG, D. Managing the design/manufacturing interface across firms. **Integrated Manufacturing Systems**, v. 13, n. 4, p. 212–221, 2002.

ULRICH, K. T.; EPPINGER, S. D. **Product design and development**. Massachusetts, United States: Mc. Graw Hill, 2011.

VANDERMERWE, S.; RADA, J. Servitization of business: Adding value by adding services. **European Management Journal**, v. 6, n. 4, p. 314–324, 1988.

VARGO, S. L.; LUSCH, R. F. Evolving to a New Dominant Logic. **Journal of Marketing**, v. 68, p. 1–17, 2004.

VASANTHA, G. V. A.; HUSSAIN, R.; ROY, R.; TIWARI, A.; EVANS, S. A Framework for designing Product- Service Systems. The 18th International Conference on Engineering Design. **Proceedings...** p.67–76, 2011.

VELAMURI, V. K.; BANSEMIR, B.; MÖSLEIN, A.-K. N. K. M. Product Service Systems as a driver for Business Model Innovation: Lessons learned from the manufacturing industry. **International Journal of Innovation Management**, v. 17, n. 1, p. 25, 2013.

VERNADAT, F. **Enterprise Modeling and Integration: Principles and Applications**. Springer, 1996.

VERYZER, R. W. Discontinuous innovation and the new product development process. **Journal of Product Innovation Management**, v. 15, p. 304–321, 1998.

VOSS, C.; TSIKRIKTSIS, N.; FROHLICH, M. Case research in operations management. **International Journal of Operations & Production Management**, v. 22, n. 2, p. 195–219, 2002.

WAGNER, L.; BAUREIS, D.; WARSCHAT, J. How to develop Product-Service Systems in the Fuzzy Front End of Innovation. **Int. J. of Technology Intelligence and Planning**, v. 8, n. 4, p. 333 – 357, 2012.

WALLIN, J.; CHIRUMALLA, K.; THOMPSON, A. Developing PSS Concepts from Traditional Product Sales Situation: The Use of Business Model Canvas. The 5th CIRP Conference on Industrial Product Service Systems. **Proceedings...** , 2013.

WHEELWRIGHT, S. C.; CLARK, K. B. Creating Project Plans to Focus Product Development. **Harvard Business Review**, p. 1–16, 1992.

WIESNER, S.; PADROCK, P.; THOBEN, K.-D. Extended Product Business Model Development in Four Manufacturing Case Studies. The 6th CIRP Conference on Industrial Product-Service Systems. **Proceedings...** p.110–115, 2014.

WIESNER, S.; WINKLER, M.; ESCHENBÄCHER, J.; THOBEN, K.-D. STRATEGIES FOR EXTENDED PRODUCT BUSINESS MODELS IN MANUFACTURING SERVICE ECOSYSTEMS. The 5th CIRP Conference on Industrial Product Service Systems. **Proceedings...** , 2013.

WILLIAMS, A. Product-service systems in the automotive industry: the case of micro-factory retailing. **Journal of Cleaner Production**, v. 14, n. 2, p. 172–184, 2006.

WILLIAMS, A. Product service systems in the automobile industry: contribution to system innovation? **Journal of Cleaner Production**, v. 15, p. 1093–1103, 2007.

WISE, R.; BAUMGARTNER, P. Go downstream: The New Profit Imperative in Manufacturing. **Harvard Business Review**, p. 133–141, 1999.

WON, J. H.; KIM, Y. S.; LEE, J. H.; HONG, Y. S. Association of Product-Service Systems Design Concepts with Business Models and their Evaluation Method. International ICE Conference on Engineering, Technology and Innovation (ICE). **Proceedings...** p.1 – 9, 2014.

WONG, R. **Patterns of innovation in service industries**, 2007. Thesis (S.M.)-Massachusetts Institute of Technology.

WU, Y.; GAO, J. A Study on the Model and Characteristics of Product-Based Service Supply Chain. International Conference on Logistics Systems and Intelligent Management. **Proceedings...** p.1127–1131, 2010.

WYNSTRA, F.; PIERICK, E. Managing supplier involvement in new product development: a portfolio approach. **European Journal of Purchasing & Supply Management**, v. 6, p. 49–57, 2000.

YOON, B.; KIM, S.; RHEE, J. An evaluation method for designing a new product-service system. **Expert Systems With Applications**, v. 39, n. 3, p. 3100–3108, 2012. Elsevier Ltd.

ZHU, Q. Q.; JIANG, P. Y.; HUANG, G. Q.; QU, T. Implementing an industrial product-service system for CNC machine tool. **The International Journal of Advanced Manufacturing Technology**, v. 52, n. 9-12, p. 1133–1147, 2011.

ZOTT, C.; AMIT, R. Business Model Design: An Activity System Perspective. **Long Range Planning**, v. 43, p. 216–226, 2010.

Appendix 1 – SLR Protocol

Protocol of the SLR for product projects typology

1. Definition of problem and rationale

It is assumed that attributes of product project, obtained by typologies of product project, can assist the creation of PSS proposals.

2. Definition of goals

The goal of SLR is to identify the attributes used to develop typologies of product projects. More specifically, the goal of this cycle is to identify the strings that should be used to achieve the goal of SLR.

3. Selection of primary sources:

3.1. Data base

The criteria for defining sources are their availability on indexed electronic database. The bases used were Web of Science, Scopus, Science Direct, Elsevier, Emerald, IEE Explore, Compendex, Proquest, Wiley e Scirus.

3.2. Criteria to exclude sources (journals and proceedings)

CIP-1) be indexed to one of the bases selected for the SLR.

CIP-2) have free access or be signed by University of Sao Paulo.

CIP-3) present full papers in English.

4. Creation of strings and search

The process of creating the strings was iterative, in cycles of development, testing and refinement. The steps carried out in each iteration were:

- Step 1: transcription of the keywords of the articles selected in the preliminary search;
- Step 2: Selection of relevant terms for this research within these keywords;
- Step 3: Search for synonyms for relevant terms;
- Step 4: Definition of the constraints, expressions that guarantee the right orientation of the searches;

- Step 5: Preparation of strings taking into account the relevant terms and constraints;
- Step 6: Test the string in each database;
- Step 7: Refinement of relevant terms, constraints and strings.

The relevant term is typology. Constraints are "product development" and project. The search was performed by title, keywords and abstract. Table 75 shows the number of search performed, the strings and the database in which the search was conducted.

Table 75 – Elaboration of strings

ID	String	Database
Search 1	(typology AND project)	Web of Science
Search 2	((("type of project" OR "project type" OR "project typology" OR "project classification" OR "project taxonomy" OR typology OR classification OR taxonomy) AND ("product development" OR "new product development")))	Web of Science
Search 3 (refined)	((typology) AND (project) AND ("product development"))	Web of Science, Scopus, Science Direct/Elsevier, Emerald, IEE Explore, Compendex, Proquest, Wiley, Scirus.

Three iterations for the preparation of the strings were performed. The final strings are shown on search 3 (refined).

5. Defining the criteria for inclusion of articles

The only inclusion criteria was:

- CI1 - Presence of typologies and / or features and / or attributes of product project

Exclusion criteria were:

- EC1 - Absence of typologies and / or features and / or attributes of the product project
- EC2 - Presence of typologies and / or features and / or attributes of projects that were not for product development.

6. Steps performed (Search and filters)

- Definition of strings (three iterations were performed).
- Cross the results in order to eliminate duplicates.

- Exporting of the results of search 1, 2 and 3 for the filter spreadsheet and application of filters 1, 2 and 3.
- Application of Filter 1: read the title, keywords and summary of the article. Application of the criteria for inclusion and exclusion of articles and decision of A (approved), R (rejected) and I (unavailable).
- Application of Filter 2: partial reading of the article, including introduction, results and conclusion. Application of the criteria for inclusion and exclusion of articles and decision of A (approved), R (rejected) and I (unavailable).
- Application of Filter 3: full reading of the articles. Application of qualification standards for articles and decision of A (approved), R (rejected) and I (unavailable).
- Extraction of data for the spreadsheet by means of in-depth reading of the selected articles.
- Cataloguing Articles: articles were cataloged and stored in software for managing references named Mendeley.

Protocol of the SLR for PSS typologies

1. Definition of problem and rationale

It is assumed that attributes PSS, obtained by typologies of PSS, can assist the creation of PSS proposals.

2. Definition of goals

The goal of SLR is to identify the attributes used to develop typologies of PSS. More specifically, the goal of this cycle is to identify the strings that should be used to achieve the goal of SLR.

3.1. Data base

The criteria for defining sources are their availability on indexed electronic database. The bases used were Web of Science, Scopus, Science Direct, IEE Explore.

3.2. Criteria to exclude sources (journals and proceedings)

CIP-1) be indexed to one of the bases selected for the SLR.

CIP-2) have free access or be signed by University of Berlin.

CIP-3) present full papers in English.

4. Creation of strings and search

The process of creating the strings was iterative, in cycles of development, testing and refinement. The steps carried out in each iteration were:

- Step 1: transcription of the keywords of the articles selected in the preliminary search;
- Step 2: Selection of relevant terms for this research within these keywords;
- Step 3: Search for synonyms for relevant terms;
- Step 4: Definition of the constraints, expressions that guarantee the right orientation of the searches;
- Step 5: Preparation of strings taking into account the relevant terms and constraints;
- Step 6: Test the string in each database;
- Step 7: Refinement of relevant terms, constraints and strings.

The terms considered relevant are: *typology*, *classification*, *taxonomy*, *characteristic*. The constraints are: "*product service system*", *servitization*, "*functional product*", "*functional sales*", "*Integrated Product Service Engineering*" or "*Integrated Product Service Offering*". They were adopted from Beuren (2011).

The search was performed by title, keywords and abstract.

Table 76 shows the number of search performed, the strings and the database in which the search was conducted.

Table 76 - Elaboration of strings

ID	String	Database
Search 1	typology or classification or taxonomy and "product service system" or servitization or "functional product" or "functional sales" or "Integrated Product Service Engineering" or "Integrated Product Service Offering"	ISI, Scopus, Science Direct, IEE Explore.
Search 2 (refined)	characteristic and "product service system" or servitization or "functional product" or "functional sales" or "Integrated Product Service Engineering" or "Integrated Product Service Offering"	Web of Science, Scopus, Science Direct/Elsevier, Emerald, IEE Explore, Compendex, Proquest, Wiley, Scirus.

Three iterations for the preparation of the strings were performed. The final strings are shown on search 2 (refined).

5. Defining the criteria for inclusion of articles

The only inclusion criterion was:

- CI1 - Presence of typologies and / or features and / or attributes of PSS

Exclusion criteria were:

- EC1 - Absence of typologies and / or features and / or attributes of the PSS
- EC2 - Presence of typologies and / or features and / or attributes that were not for PSS.

6. Steps performed (Search and filters)

- Definition of strings (three iterations were performed).
- Cross the results in order to eliminate duplicates.
- Exporting of the results of search 1 and 2 for the filter spreadsheet and application of filters 1, 2 and 3.

- Application of Filter 1: read the title, keywords and summary of the article. Application of the criteria for inclusion and exclusion of articles and decision of A (approved), R (rejected) and I (unavailable).
- Application of Filter 2: partial reading of the article, including introduction, results and conclusion. Application of the criteria for inclusion and exclusion of articles and decision of A (approved), R (rejected) and I (unavailable).
- Application of Filter 3: full reading of the articles. Application of qualification standards for articles and decision of A (approved), R (rejected) and I (unavailable).
- Extraction of data for the spreadsheet by means of in-depth reading of the selected articles.
- Cataloguing Articles: articles were cataloged and stored in software for managing references named Mendeley.

Appendix 2 – SLR Protocol

Protocol of the SLR for service projects typology

1. Definition of problem and rationale

It is assumed that attributes of service project, obtained by typologies of service project, can assist the creation of PSS proposals.

2. Definition of goals

The goal of SLR is to identify the attributes used to develop typologies of service projects. More specifically, the goal of this cycle is to identify the strings that should be used to achieve the goal of SLR.

3. Selection of primary sources:

3.1. Data base

The criteria for defining sources are their availability on indexed electronic database. The bases used were Web of Science and Scopus.

3.2. Criteria to exclude sources (journals and proceedings)

CIP-1) be indexed to one of the bases selected for the SLR.

CIP-2) have free access or be signed by University of Sao Paulo.

CIP-3) present full papers in English.

4. Creation of strings and search

The process of creating the strings was iterative, in cycles of development, testing and refinement. The steps carried out in each iteration were:

- Step 1: transcription of the keywords of the articles selected in the preliminary search;
- Step 2: Selection of relevant terms for this research within these keywords;
- Step 3: Search for synonyms for relevant terms;
- Step 4: Definition of the constraints, expressions that guarantee the right orientation of the searches;
- Step 5: Preparation of strings taking into account the relevant terms and constraints;

- Step 6: Test the string in each database;
- Step 7: Refinement of relevant terms, constraints and strings.

The search was performed by title, keywords and abstract.

Table 77 shows the number of search performed, the strings and the database in which the search was conducted.

Table 77 - Elaboration of strings

ID	String	Database
Search 1	(TITLE-ABS-KEY("service development") AND TITLE-ABS-KEY(typology OR classification OR taxonomy OR characteristic)) AND (EXCLUDE(SUBJAREA, "MEDI") OR EXCLUDE(SUBJAREA, "MEDI") OR EXCLUDE(SUBJAREA, "SOCI") OR EXCLUDE(SUBJAREA, "PSYC") OR EXCLUDE(SUBJAREA, "NURS") OR EXCLUDE(SUBJAREA, "HEAL") OR EXCLUDE(SUBJAREA, "MATH") OR EXCLUDE(SUBJAREA, "BIOC") OR EXCLUDE(SUBJAREA, "NEUR") OR EXCLUDE(SUBJAREA, "ARTS") OR EXCLUDE(SUBJAREA, "EART") OR EXCLUDE(SUBJAREA, "DENT") OR EXCLUDE(SUBJAREA, "PHAR") OR EXCLUDE(SUBJAREA, "PHYS"))	Scopus
Search 2	TITLE(service) AND TITLE(design OR innovation OR TYPE OR new OR engineering) AND (EXCLUDE(SUBJAREA, "COMP") OR EXCLUDE(SUBJAREA, "MEDI") OR EXCLUDE(SUBJAREA, "SOCI") OR EXCLUDE(SUBJAREA, "MATH") OR EXCLUDE(SUBJAREA, "ENER") OR EXCLUDE(SUBJAREA, "CENG") OR EXCLUDE(SUBJAREA, "NURS") OR EXCLUDE(SUBJAREA, "MATE") OR EXCLUDE(SUBJAREA, "BIOC") OR EXCLUDE(SUBJAREA, "EART") OR EXCLUDE(SUBJAREA, "ECON") OR EXCLUDE(SUBJAREA, "HEAL") OR EXCLUDE(SUBJAREA, "PSYC") OR EXCLUDE(SUBJAREA, "PHAR") OR EXCLUDE(SUBJAREA, "PHYS") OR EXCLUDE(SUBJAREA, "AGRI") OR EXCLUDE(SUBJAREA, "CHEM") OR EXCLUDE(SUBJAREA, "ARTS") OR EXCLUDE(SUBJAREA, "NEUR") OR EXCLUDE(SUBJAREA, "DENT") OR EXCLUDE(SUBJAREA, "VETE") OR EXCLUDE(SUBJAREA, "IMMU") OR EXCLUDE(SUBJAREA, "Undefined")) AND (EXCLUDE(DOCTYPE, "cp") OR EXCLUDE(DOCTYPE, "re") OR EXCLUDE(DOCTYPE, "no") OR EXCLUDE(DOCTYPE, "sh")) AND	Scopus

```

(EXCLUDE(DOCTYPE, "ed") OR
EXCLUDE(DOCTYPE, "cr") OR
EXCLUDE(DOCTYPE, "bk") OR
EXCLUDE(DOCTYPE, "er") OR
EXCLUDE(DOCTYPE, "le") OR
EXCLUDE(DOCTYPE, "rp") OR
EXCLUDE(DOCTYPE, "bz") OR
EXCLUDE(DOCTYPE, "Undefined")) AND
(EXCLUDE(EXACTKEYWORD,
"Telecommunication services") OR
EXCLUDE(EXACTKEYWORD, "Mathematical
models") OR EXCLUDE(EXACTKEYWORD,
"Telecommunication services") OR
EXCLUDE(EXACTKEYWORD, "Mathematical
models") OR EXCLUDE(EXACTKEYWORD,
"Internet") OR EXCLUDE(EXACTKEYWORD,
"Computer simulation") OR
EXCLUDE(EXACTKEYWORD, "Network
protocols") OR EXCLUDE(EXACTKEYWORD,
"TELECOMMUNICATION SYSTEMS") OR
EXCLUDE(EXACTKEYWORD, "Web services")
OR EXCLUDE(EXACTKEYWORD, "DIGITAL
COMMUNICATION SYSTEMS") OR
EXCLUDE(EXACTKEYWORD, "Europe") OR
EXCLUDE(EXACTKEYWORD, "Standards") OR
EXCLUDE(EXACTKEYWORD,
"Telecommunication networks") OR
EXCLUDE(EXACTKEYWORD,
"Telecommunication traffic") OR
EXCLUDE(EXACTKEYWORD, "Computer
software") OR EXCLUDE(EXACTKEYWORD,
"Mobile telecommunication systems") OR
EXCLUDE(EXACTKEYWORD, "Internet") OR
EXCLUDE(EXACTKEYWORD, "Computer
simulation") OR EXCLUDE(EXACTKEYWORD,
"Network protocols") OR
EXCLUDE(EXACTKEYWORD,
"TELECOMMUNICATION SYSTEMS") OR
EXCLUDE(EXACTKEYWORD, "Web services")
OR EXCLUDE(EXACTKEYWORD, "DIGITAL
COMMUNICATION SYSTEMS")) AND (LIMIT-
TO(LANGUAGE, "English")) AND
(EXCLUDE(EXACTKEYWORD, "Information
technology") OR EXCLUDE(EXACTKEYWORD,
"Article") OR EXCLUDE(EXACTKEYWORD,
"Sales") OR EXCLUDE(EXACTKEYWORD,
"United States") OR
EXCLUDE(EXACTKEYWORD, "Performance")
OR EXCLUDE(EXACTKEYWORD, "Societies and
institutions") OR EXCLUDE(EXACTKEYWORD,
"Taiwan") OR EXCLUDE(EXACTKEYWORD,
"Information services") OR
EXCLUDE(EXACTKEYWORD, "Quality
assurance") OR EXCLUDE(EXACTKEYWORD,
"Research") OR EXCLUDE(EXACTKEYWORD,
"Construction industry") OR
EXCLUDE(EXACTKEYWORD, "Decision
making") OR EXCLUDE(EXACTKEYWORD,
"Empirical analysis")) AND

```

	(EXCLUDE(PUBYEAR, 1989) OR EXCLUDE(PUBYEAR, 1988) OR EXCLUDE(PUBYEAR, 1987) OR EXCLUDE(PUBYEAR, 1986) OR EXCLUDE(PUBYEAR, 1985) OR EXCLUDE(PUBYEAR, 1984) OR EXCLUDE(PUBYEAR, 1981) OR EXCLUDE(PUBYEAR, 1978) OR EXCLUDE(PUBYEAR, 1972) OR EXCLUDE(PUBYEAR, 1971) OR EXCLUDE(PUBYEAR, 1970) OR EXCLUDE(PUBYEAR, 1965) OR EXCLUDE(PUBYEAR, 1964) OR EXCLUDE(PUBYEAR, 1961) OR EXCLUDE(PUBYEAR, 1959) OR EXCLUDE(PUBYEAR, 1953) OR EXCLUDE(PUBYEAR, 1950)) AND (LIMIT- TO(LANGUAGE, "English")) AND (LIMIT- TO(SRCTYPE, "j"))	
Search 3 (refined)	(TITLE(service) AND TITLE(innovation OR design OR new OR engineering) AND TITLE-ABS- KEY(typology OR classification OR taxonomy OR characteristic)) AND DOCTYPE(ar) AND PUBYEAR > 1989 AND (EXCLUDE(EXACTKEYWORD, "Article") OR EXCLUDE(EXACTKEYWORD, "Human") OR EXCLUDE(EXACTKEYWORD, "Humans") OR EXCLUDE(EXACTKEYWORD, "Female") OR EXCLUDE(EXACTKEYWORD, "Male") OR EXCLUDE(EXACTKEYWORD, "Adult") OR EXCLUDE(EXACTKEYWORD, "Adolescent") OR EXCLUDE(EXACTKEYWORD, "United States") OR EXCLUDE(EXACTKEYWORD, "Aged") OR EXCLUDE(EXACTKEYWORD, "Health service") OR EXCLUDE(EXACTKEYWORD, "Middle Aged") OR EXCLUDE(EXACTKEYWORD, "Major clinical study") OR EXCLUDE(EXACTKEYWORD, "Priority journal") OR EXCLUDE(EXACTKEYWORD, "New Zealand") OR EXCLUDE(EXACTKEYWORD, "Mental health service") OR EXCLUDE(EXACTKEYWORD, "Telecommunication services") OR EXCLUDE(EXACTKEYWORD, "Web services") OR EXCLUDE(EXACTKEYWORD, "Economics") OR EXCLUDE(EXACTKEYWORD, "Health care planning") OR EXCLUDE(EXACTKEYWORD, "Statistics") OR EXCLUDE(EXACTKEYWORD, "Child") OR EXCLUDE(EXACTKEYWORD, "Controlled study") OR EXCLUDE(EXACTKEYWORD, "United Kingdom") OR EXCLUDE(EXACTKEYWORD, "Questionnaire") OR EXCLUDE(EXACTKEYWORD, "Questionnaires") OR EXCLUDE(EXACTKEYWORD, "Computer simulation") OR EXCLUDE(EXACTKEYWORD, "Health care delivery") OR EXCLUDE(EXACTKEYWORD, "Utilization review")) AND (EXCLUDE(EXACTKEYWORD, "Mathematical models") OR	Web of Science, Scopus

```

EXCLUDE(EXACTKEYWORD, "Computer
software") OR EXCLUDE(EXACTKEYWORD,
"Internet") OR EXCLUDE(EXACTKEYWORD,
"Network protocols") OR
EXCLUDE(EXACTKEYWORD, "Distributed
computer systems") OR
EXCLUDE(EXACTKEYWORD, "Europe") OR
EXCLUDE(EXACTKEYWORD, "Algorithms") OR
EXCLUDE(EXACTKEYWORD, "Bandwidth") OR
EXCLUDE(EXACTKEYWORD, "Communication")
OR EXCLUDE(EXACTKEYWORD, "Computer
networks") OR EXCLUDE(EXACTKEYWORD,
"Eurasia") OR EXCLUDE(EXACTKEYWORD,
"Mathematical programming") OR
EXCLUDE(EXACTKEYWORD, "Mobile
telecommunication systems")) AND
(EXCLUDE(EXACTKEYWORD, "Electronic
commerce") OR EXCLUDE(EXACTKEYWORD,
"Forestry") OR EXCLUDE(EXACTKEYWORD,
"Geographic information systems") OR
EXCLUDE(EXACTKEYWORD, "Italy"))

```

Three iterations for the preparation of the strings were performed. The final strings are shown on search 3 (refined).

5. Defining the criteria for inclusion of articles

The only inclusion criterion was:

- CI1 - Presence of typologies and / or features and / or attributes of service project

Exclusion criteria were:

- EC1 - Absence of typologies and / or features and / or attributes of the service project
- EC2 - Presence of typologies and / or features and / or attributes of projects that were not for service development.

6. Steps performed (Search and filters)

- Definition of strings (three iterations were performed).
- Cross the results in order to eliminate duplicates.
- Exporting of the results of search 1, 2 and 3 for the filter spreadsheet and application of filters 1, 2 and 3.
- Application of Filter 1: read the title, keywords and summary of the article. Application of the criteria for inclusion and exclusion of articles and decision of A (approved), R (rejected) and I (unavailable).

- Application of Filter 2: partial reading of the article, including introduction, results and conclusion. Application of the criteria for inclusion and exclusion of articles and decision of A (approved), R (rejected) and I (unavailable).
- Application of Filter 3: full reading of the articles. Application of qualification standards for articles and decision of A (approved), R (rejected) and I (unavailable).
- Extraction of data for the spreadsheet by means of in-depth reading of the selected articles.
- Cataloguing Articles: articles were cataloged and stored in software for managing references named Mendeley.

Appendix 3 – Configurator of PSS proposals

CONFIGURATOR OF PSS PROPOSALS

Goal

The Configurator of PSS proposals is a method that aims to guide you during the creation of PSS proposals.

What is PSS?

PSS stands for product-service system and represents a new business orientation that provide value to customers through the combination of products and services.

([read more about PSS](#))

What is a PSS proposal?

A PSS proposal describes a future PSS business that your company might develop. This development can occur in your current business or a new business should be created to offer a PSS to your market. Thereby, PSS proposals should be analyzed and further selected to be implemented as a new business or an improvements of a current one.

What is a business model?

A business model describes the company's core logic and communicate the strategic orientation. The content of a business model is divided in “dimensions”, such as the value proposition offered to your customer, the relationship between your organization with the customer to support this offer, the processes and resources required to run the business, etc. A business model might become part of a business plan. However, it should not be considered a spreadsheet or a computer model. A business model is a conceptual, rather than financial, model of a business.

([read more about business model](#))

What is a PSS business model?

PSS business model represents the logic developed to create and deliver a value proposition by means of a bundle of product and services, i.e. a PSS offer. The value proposition should attend costumers' needs and the logic to create it should encompass the definition of other business model dimensions, named as customer

relationship, processes and activities, actors, resources, revenue streams and cost structure.

Types of PSS proposals

Two types of PSS proposals can be created through the use of this guideline and each of them will further generate different business models:

- Proposal type 1: a new PSS business model;
- Proposal type 2: an improved PSS business model.

The first type covers the cases of opening a new business unit or even a new company an already existing PSS business model.

Benefits of use

The main benefit of using this guideline is to create PSS proposals. In addition, there are further benefits, e.g.:

- Comparison of different PSS proposals during the selection of which one should be implemented;
- Increase of knowledge about different possibilities for the content of a PSS business model;
- Gathering of important information and knowledge for a PSS business that could be spread in different departments;
- Create a document that can be utilized to present the PSS proposal to stakeholders or business directors.

Structure and content of this guideline

This guideline is structured in eight steps:

Step 1. Understand the current business model
Step 2. Configure Customer Segment
Step 3. Configure Value Proposition
Step 4. Configure Customer Relationship
Step 5. Configure Network
Step 6. Configure Resources
Step 7. Configure Revenue Streams
Step 8. Configure Cost Structure

Step 1 requires understand the current business model, which is essential in case you want to improve an existent PSS business model. Steps 2 to step 8 invite you to configure the PSS proposal by executing a set of tasks related to each dimension of the business model.

Types of PSS tasks in this guideline

The two types of tasks encompassed by each step are:

- Task type 1: selection of previously defined options of attributes;
- Task type 2: definition of attributes based on specific actions proposed in this guideline.

Task type 1: selection of previously defined options of attributes

A comprehensive research on important PSS attributes for each business model dimension was carried out. These attributes, which present different options, can be used as a checklist as they help you to have a holistic view about a possible PSS business model. Through these attributes and options, part of the content of your PSS proposal is defined.

For instance, the step 2 “Configure customer segment” possesses the task 2.5 which cover the attribute “market range”. Therefore, you should select one option for the market range you want to reach. The options are: international, national, regional, local. In order to create your PSS proposal, you should select the option that fits into your strategic orientation. However, one cannot affirm that all the possible and existent options are placed on this guideline. Thereby you can create and use additional ones in your proposal where required.

If you click on the hyperlinks, the description and the references utilized to create the categories and options are visualized. They are represented as shown in the following. Once you have finished a task, mark the empty checkbox. This will assist you to identify the tasks you have or haven’t perform.

☐

Attribute:

Option 1	Option 2	Option 3
----------	----------	----------

Task type 2: definition of attributes by based on specific actions proposed in this guideline.

In the research carried out to define possible PSS attributes, some of them does not fit in type 1 as they require descriptive and specific information and no predefined

option could be utilized. In order to keep flexibility, this guideline invites you to execute specific actions (task type 2).

For instance, concerning the example given (task 2.5 “market range”), an action is: Detail the geographical reach of the market (city, country, etc.). Detailing, describing, specifying are examples of actions you are required to perform. They are presented in a gray line containing an empty checkbox. Therefore, you should mark the checkbox after accomplishing the action for you to keep track of the tasks already executed.

☐	Action
--------------------------	--------

In case you don't have information to perform a specific task, you might skip it and go to the next one. Later on, you can check the tasks that you still need to perform in order to finalize your PSS proposal by visualizing the ones that present empty checkboxes.

Help

The guideline also presents further help. These help includes examples of real cases, relations, hints and methods and tools. You are going to find examples of companies that adopted PSS, hint of practices to assist you in the utilization of the guidelines, as well of methods and tools that can help you on generating necessary information for your PSS proposal. Relations between tasks from different steps might show you the influences they have on each other. Therefore, they aim at supporting you in defining a more coherent PSS proposal. The symbols that represent them are shown below:

Example of real cases
Relations between category of options
Hints
Methods and tools

Instructions of use

If you are improving a PSS business model (proposal type 2), you should undergo all the steps and tasks presented in this guideline. The general information gathered to design the current business model (step 1) can be detailed on the further steps. In this sense, you will develop knowledge about the current business model and thus decide which elements you would like to change in order to reach an improved version of the current PSS business model.

In case you aim at creating a new business model (proposal type 1), you can skip both step 1 and task 1 of the steps 2 to 8.

The steps and tasks were set in such an order to facilitate the use of the guideline. However, you don't need to follow the sequential way of the activities.

Now, let's start!

- 1st. Find a white space! It can be a white page, a whiteboard or document on your computer.
- 2nd. For each step, you should first read all the content provided.
- 3rd. Write down the title of the step and the task you are working on.
- 4th. Write down the tasks: describe and detailed the actions accomplished and the options you selected on the different attributes.
- 5th. After finalizing a task, mark the checkbox and go to the next one.
- 6th. After undergoing all the steps, review this document in order to identify which tasks possess empty checkboxes, which means you still need to execute them.

Step 1. Understand the current business model

In case you plan to create a new business model for PSS, you can skip step 1.

Task 1.1 Diagnosis of the current business

Organize a brainstorming or a discussion session with representatives of different functional areas in order to perform a diagnosis of the current business.

You can use a generic approach such as [SWOT](#) in order to identify improvements on your current business.

Task 1.2 Design of current business model

Design your current business model utilizing the information raised on the brainstorming or a discussion session.

You can utilize the tool [canvas business model](#) to design your current business model.

To assist you on how to do that, an example is illustrated that shows the design of a PSS business model from a machine tool manufacturer. You can see that you just need general information of the business to perform this task.

Task 1.3 Improvement on current business model

By performing a cross analysis between your designed business model and the diagnosis, you can identify improvements on each of the dimensions of the business model.

Utilize the improvements identified as input for the first task of each step.

Step 2. Configure customer segment

This step encompasses the definition of the customer segment, which should be performed considering the market and the client you aim to reach. Perform the tasks taking into account the new PSS business model you wish to create or the new customer segment you want to reach with your current PSS business model. If you are creating a new business model or aim at reaching a new customer segment, you can skip task 2.1.

Task 2.1 Customer segment of the current business

☐	Describe the profile of the current customers' segment: behavior, preferences, needs, perceptions, attitudes and values. Customers' characteristics in conjunction with their understanding and preferences shall show you if they might be attracted for PSS offers.
You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current customer segment.
☐	By analysing the profile of your current customer segment, you should decide whether you wish to keep the same customer segment of your current business model or select a new one. Take into account such decision, when performing the next tasks.

Task 2.2 Customer segment of the improved or new business

☐	Specify who your customer segment is. You can classify them according to behavior, culture, demography.
Volvo Aero presents as customer the segment of OEMs of commercial aircraft engines. BASF Automotive Refinish presents Refinishing workshops of the automotive industry as customers.

Task 2.3 Market conditions and trends

☐	Select one option considering the level of uncertainty of conditions and trends of the customer segment you want to reach:			
<table border="1"><tr><td>conditions and trends are unknown</td><td>conditions and trends are partially known</td><td>conditions and trends are known</td></tr></table>		conditions and trends are unknown	conditions and trends are partially known	conditions and trends are known
conditions and trends are unknown	conditions and trends are partially known	conditions and trends are known		
☐	Describe actions to increase the knowledge and decrease the level of uncertainty of conditions and trends in the market.			

Task 2.4 Resistances to acquire PSS offer

☐	Select one or more options to point out the resistances of the customer segment to acquire the offer:			
<table border="1"><tr><td>new knowledge</td><td>behavior change</td><td>price</td></tr></table>		new knowledge	behavior change	price
new knowledge	behavior change	price		
☐	Describe actions to be taken to reduce the resistance.			

Task 2.5 Market range

☐ Select one option for the [market range](#) you want to reach:

local	regional	national	international
-------	----------	----------	---------------

☐ Detail the geographical reach of the market range (city, country, etc.)

Task 2.6 Types of clients

☐ Select one or more options for [type of clients](#) considering the customer segment you want to reach:

B2C - "Business to Consumer" (private customers)	B2B - "Business to Business" (private organizations customers)	B2G - "Business to Government" (governmental organizations)
---	--	--

Task 2.7 Profile of customer segment

If you are improving a PSS business model and decide to keep the current customer segment, you can skip this task, since you already described the profile of the current customer on task 2.1.

☐ Describe the profile of the new customer segment: behavior, preferences, needs, perceptions, attitudes and values.

If you want help on the definition of customers 'needs, you might check the tool [user activity cycle](#).

Step 3. Configure Value Proposition

This step involves the definition of the value proposition by means of the characterization of the service and product elements and the combination of them, which generates the PSS offer.

Execute the following tasks in order to configure your improved or new value proposition. If you want to create a new business model or aim at providing a new value proposition on your current business model, you can skip task 3.1.

Task 3.1 Value proposition of the current business

☐	Describe the value proposition of the current business model.
☐	Taking into account the current PSS offer, answer the question: Which tangible product compose the offer?
☐	Taking into account the current PSS offer, answer the question: Which service(s) compose the offer?
You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current value proposition.

Task 3.2 Value proposition of the improved or new business

☐	Describe the main value proposition you want to offer to your customer.
You can also have a look on some examples in order to get inspired for defining your main value proposition: MAN Truck & Bus UK Ltd defined as value proposition transport solutions through guaranteed cost per km. A coffee vending machine manufacturer considers its value proposition hot and good taste coffee.
If you need support on the definition of your value proposition, check the tool ontological representation of PSS . It can assist you on the definition through the representation of the relations between values, functions and structures.
In case you are in doubt about which value proposition you should offer, you can have a look on the tools value strategy canvas and PSS configuration based on support vector machine . Both of them assist you on the visualization of the value proposition taking into account the needs of your customer segment. Though this visualization it will be easier to compare different value propositions and decide upon them.

Task 3.3 Benefits for the customer

☐

Select one or more options of [benefits](#) your customer should recognize through the PSS offer:

reduced risk	risk averseness	reduced cost	reduced environmental impacts
perceived ease of use	perceived price fairness	aesthetics	product differentiation
customization	brand	functionality	quality

☐

Describe how you plan to reach the benefits selected.

The benefits for the healthcare business unit of Siemens include reduced risk, increased machine uptime and increased profitability. Brand is also another factor that attracts Siemens clients. In that case, some options such as increase machine uptime and profitability, which are not placed on the options of this guideline, are presented.

Task 3.4 Types of services

☐

Select one or more options of types of services that you want to offer to your customer:

[Types of services on product](#)

installation	maintenance	repair	upgrade
remote monitoring	remote operation	optimization/ improvement	service technicians on call
on-site inspections	spare parts supply	diagnosis plus recommendations	planned overhaul

[Other types of services](#)

training	consulting	planning	logistics
financing	delivery	product/ system disposal	
product/ system tack back		remufacturing and/or reconditioning	

☐

Detail service(s) selected. For instance, in case you select maintenance, you can specify if it will be a corrective maintenance or a preventive maintenance with fix intervals.

☐

Describe how the services selected assist on providing the **benefits** (task 3.3) for the customer.

PayXUse, developed by the Italian appliances manufacturer, named Ariston, provides to clients access to washing machines as main value proposition. Type of services offered includes delivery of a washing machine, maintenance, upgrade and end-of-life collection (product tack back).

Task 3.5 PSS orientation

☐

Select one option for [types of product-service orientation](#):

property of physical product	use of the product (without the property)	result of the use of the product (without the property)	availability of the product (without the property)	consumption of product (without the property)
------------------------------	---	---	--	---

RiverSimple aims to offer cars based on their use (i.e. the customer pays per mile driven).

The option selected here has a strong relationship with the [task 4.6 product ownership](#) and [task 7.2 types of revenue](#).

Task 3.6 Product of the PSS offer

What is the product that should compose the PSS offer? Which are its characteristics?

Different product characteristics are preferable when selecting or designing the product element of the PSS offer, such as **durability, longevity and modularization**. A high durability and longevity allow products to be used for longer period and by more customers. Modularity and standardization reduce time and cost of product assembly and disassembly.

Select one option for [level of innovation on the product](#) element of the PSS offer:

[incremental](#)

[really new](#)

[radical](#)

Detail type of innovation. For instance, if you selected “incremental”, detail the improvements that should be performed on the current technology.

Task 3.7 Service Innovation

Select one option of [level of innovation on the service](#) element of the PSS offer:

[services new-to-the-world](#)

[services new to you](#)

[services modifications](#)

[repositioning](#)

Select option for each **type of service** selected on the task 3.4 and detail type of innovation. For instance, if you selected “service modification”, explain the modification you plan to carry out on the existing service.

Task 3.8 PSS offer innovation

Select one option of [novelty of product-service integration](#) according to the product and service elements of the PSS offer:

combinations of existing products with existing services

combinations of new services for existing products

combinations of new products for existing services

combinations of new products with new services

In case you need ideas to select product and/or service for your PSS offer, you might also utilize the tool [offering diagram](#), which support to define the functionalities of the PSS offer. After understanding the functionalities it will be easier to define through which products and services you are going to deliver them.

Though the tool [PSS configurator](#), you can have a look on PSS offers and get inspired to create your own product and service combination.

Task 3.9 Environmental aspect of the PSS offer

Select one or more options of [environmental aspect of the PSS offer](#):

reduced energy consumption

reduced emission consumption

reduced material consumption

no reduction

Detail how you intend to reach the reduction selected.

MAN Truck & Bus UK Ltd sells transportation solutions with the newest technology, which support the customer on decreasing the fuel consumption (reduced energy consumption).

Task 3.10 Customization of the PSS offer

Select one option for the [level of customization on the PSS offer](#) you wish to provide to your customer:

no customization/ standard	just some parts/modules/services can be customized	customized products
customized services	customized products/ services	customized solutions

Describe what you wish to customize.

Step 4. Configure Customer Relationship

This step assists you to describe how you can interact with your customer in different moments of the PSS life cycle. Accomplish the tasks considering the new customer relationship you aim at creating or the modification on the current one. If you are creating a new business model or aim at creating a new customer relationship, you can skip task 4.1.

Task 4.1 Customer relationship of the current business

Describe the current relationship you have with your customer.

You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current customer relationship.

Task 4.2 Commercial relationship

Select one option for the [type of commercial relationship](#) you plan to accomplish with your customer:

[transactional](#)

[relationship based](#)

List the point of contacts you plan to have with your customer.

The tool [service blueprint](#) shows you the points of contact with clients, which can help on the definition of improvements on the relationship with them.

Task 4.3 Customer contact

Select one option of the [level of contact/relationship with the customer](#) you plan to have:

no communication, trust and information sharing

low intensity of communication, trust and information sharing

high intensity of communication, trust and information sharing

Describe how you plan to communicate with customers.

Task 4.4 Customer involvement

Select one option concerning the [level of involvement of the customer](#) during the development of the PSS:

customer does not interact or influence development

customer interacts during some selected activities of the development

customer interacts during all the development

Specify which activities you want to have participation of the customer and the type of participation.

Task 4.5 Product responsibility

Select options concerning who should have the [responsibility for product](#) on the different lifecycles:

Responsibility for product X actor	customer	you	an actor of the PSS network
usage phase			
end of life phase

If an actor of the network has product responsibility, specify who this actor is.

Evergreen leases a modular carpet system (carpet functionality and services such as, color, design, and aesthetics) and has the responsibility to maintain and dispose the carpet. Therefore, the company has the responsibility during usage phase and end of life phase.

Task 4.6 Product ownership

Select options concerning who should [own the product](#) on the different lifecycles:

Product ownership X actor	customer	you	an actor of the PSS network
usage phase			
end of life phase

If an actor of the network has product ownership, specify who this actor is.

The option selected here has a strong relationship with the [task 3.5 PSS orientation](#)

Task 4.7 Types of contract

Select one or more options for the [types of contract](#) you wish to arrange with your customer:

based on frequency of client contact	based on type, complexity and/or urgency of client request	based on duration of client production cycle	simultaneous contracts of the same product-service (pooling)
based on the quantity of product-service use	based on the period of product-service use	based on availability

Describe how you plan to arrange contracts with your customer.

Contracts based on the period of product-service use are utilized for Wetrok, a European leader in cleaning systems, which offers monthly fee-based service plans available 24/7.

In order to define the type of contract, you can have a look on [types of contracts for PSS](#).

Step 5. Configure Business Process and Network of Actors

This step aims at assisting you in the definition of the PSS network of actors and the business process they are responsible. Perform the tasks taking into account the new network you are creating or the modification of the current one. If you are creating a new business model or aim at developing a new network, you can skip task 5.1.

Task 5.1 Business processes and actor of the current business

☐ List the processes required to run your current PSS business model and specify which ones are performed in-house and which ones are outsourced.

☐ List the actors that execute the outsourced processes of your current business model.

You can design your current PSS network using a modeling tool in order to visualize the current processes and actors of the PSS business model. An example is [IDEFO](#), a tool that provides an accurate representation of the physical connections between various components of a system.

You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current network.

Task 5.2 Business processes and actors of the improved or new business

☐ Select the [type of processes](#) that should be part of the improved/new network and which [type of actor](#) should perform them:

Type of process X actor	you	OEM	service supplier	IT supplier	logistic operator	distributor	parts and products supplier	technology supplier	customer's suppliers	customer's customers (end users)
distribution channel										
production										
quality control										
performance measurement										
clients management										
marketing										
acquisition										
product and service development										
technology development										

☐ Specify who the key actors you selected are. E.g.: industrial area, name of companies, etc.

☐ Detail the processes that will be carried out in-house.

☐ According to the, point out the [level of change](#) in each process (no change; adaptation or creation) that might be required on the improvement of your business model. In addition, describe what should be changed. If you are creating a new business model, you don't need

	to point out level of change as all the processes will be created new.
An example of adaptations on the distribution channel is presented by MAN Truck & Bus UK Ltd. A sales-force initiative, named MAN DIRECT, was created and instead of performing sales and services provision, they provide only services.
To support you on defining of the processes and activities of your network, you can use the tool user activity cycle and the PSS board .
In case you need to perform changes or even create a new process for service development, you might check the tool service blueprint .
The tool ecosystem map can help you to define the actors of your network by providing an overview of the flow of information, capital, products and services between the different actors. The tool map of interaction also to support you on the mapping and visualization of the actors that might be involved in your PSS network.

Task 5.3 Actors supporting the business

☐ Select one or more [types of actors \(business related\)](#) that you wish to involve in the PSS network in order to support the development of the business:

competitor	legislation institutions	society	government	financial institutions
knowledge institutions	partner for contract management	consultant	communication companies	

☐ Specify who the key actors you selected are. E.g.: industrial area, name of companies, etc. and their roles in the network.

The business unit of laundry systems of Electrolux works with a financial institution that provides leasing and loans to Electrolux customers.

Task 5.4 Sharing with actors

☐ Select one or more [types of sharing with actors](#) that you wish to implement in your PSS network in order to modify the current network or to create a new one:

risk sharing	cost sharing	data sharing	revenue sharing	resources sharing/pooling (e.g. facilities)
--------------	--------------	--------------	-----------------	---

☐ Select option for each type of actor of the PSS network.

If the customers' is involved on development activities, select option for them too (see [task 4.4 Customer involvement](#))

Volvo Aero shares risks, costs and revenues with its customers through out the product lifecycle.

Task 5.5 Dependency with actors

- ☐ Select one or more options according to the [level of dependency](#) you might have with the actors of the PSS network you are modifying or creating:

no dependency	dependency to take decisions	dependency to execute activities	dependency on decisions and activities
---------------	------------------------------	----------------------------------	--

- ☐ Select option for each type of actor of the PSS network and specify dependencies.

- If the customers' is involved on development activities, select option for them too (see [task 4.4 Customer involvement](#))

Task 5.6 Actor involvement

- ☐ Select one or more [types of approaches to involve actors](#) of the PSS network you are modifying or creating:

systematic integration	ad hoc integration	no integration
--	------------------------------------	--------------------------------

- ☐ Select option for each type or group of actor of the PSS network and specify how you plan to implement the approach selected.

- If the customers' is involved on development activities, select option for them too (see [task 4.4 Customer involvement](#))

Task 5.7 Performance measure

- ☐ Select one or more types of performance measure you wish to utilize:

[Types of performance measure \(external/client\)](#)

availability of provider when client requires	client satisfaction	response time	customer reliability
service availability	occurrence of product failure	occurrence of service failure	rate of devolution

[Types of performance measure \(internal\)](#)

product conformity	costs of product failure	product lifecycle cost	response capacity
achievement of planned activities	time-to-market	service delivery conformity	

- ☐ Detail the types of performance measure: create a title, the goal and specify the unit of measure for each type selected.

Task 5.8 Distribution channel

- ☐ Select one or more [types of distribution channel](#) you plan to utilize to deliver the PSS offer to your customer:

shared channel	online (internet)/ e-commerce	sales office
own service stations	service partnerships	call center

Detail the types of distribution channel you selected.

Task 5.9 Project management approach

It is recommended that you perform the tasks 5.9 to 5.14 after performing all the tasks of this guideline. The tasks mentioned capture the initial effort of the further implementation of the PSS proposal on the current or new business model.

Select one option of [type of project management approach](#) you wish to utilized on the implementation of your PSS proposal:

[traditional management](#)

[agile management](#)

Task 5.10 Project manager

Select one [type of project manager](#) that should lead the implementation of the PSS proposal:

[project coordinator](#)

[supervised project coordinator](#)

[autonomous project manager](#)

[functional and supervised project coordinator](#)

[functional and supervised project manager](#)

Specify the competences of the type of project manager you selected.

Task 5.11 Dependency between projects

Select one option for [level of dependency](#) of this PSS proposal with other projects or businesses:

[no dependency](#)

[projects share resources](#)

[dependency on deliverables](#)

[totally dependent](#)

Specify the project and dependencies.

Task 5.12 Project complexity

Select one option of [project complexity](#) you might face when implementing the PSS proposal within a business model:

[high demand from the project team regarding organizational tasks and interaction](#)

[low demand from the project team regarding organizational tasks and interaction](#)

[no demand from the project team regarding organizational tasks and interaction](#)

Describe the organizational tasks and interaction that can be already defined.

You can start by defining the roles and responsibilities of the ones involved on this project/business.

Task 5.13 Uncertainties

☐

Select one or more [types of uncertainties](#) you might face by creating or improving the PSS business model:

commercial uncertainty	uncertainty of employees capacity to sell the offer	uncertainty of employees capacity to develop the offer	uncertainty of employees capacity to supply services	project/business uncertainty
------------------------	---	--	--	------------------------------

☐

Describe actions to reduce uncertainties selected.

Check the approach that **integrates real options and scenarios method along with performance indicators** in order to reduce uncertainties during the development of a specific PSS offer.

Task 5.14 Risks

☐

Select one or more [types of risks](#) that you might face by creating or improving the PSS business model:

technology complexity risk	risk due to environmental laws creation and changes	development risk	market risk	financial risk
----------------------------	---	------------------	-------------	----------------

☐

Describe actions to reduce risks selected.

An example of market risk: the competitor launch a similar PSS offer you are developing or plan to develop to the same customer segment you aim at reaching.

An example of action to reduce the financial risk is to include minimum period of time when establishing a contract with your customer. That is the case of the company Steelcase, which rents workspace settings on a time basis for a minimum of three hours.

Step 6. Configure Resources

This step aims to support you on defining the resources required to develop and commercialize the PSS offer. Execute the tasks taking into account the additional resources you might need in order to improve the current business model or the resources required to create a new one.

If you are creating a new business model or will not consider the resources of your current business model when improving it, you can skip task 6.1.

You will notice that this step has a strong relationship with [step 5](#) and [step 8](#). Therefore, remember to revise the performed tasks of such steps to ensure coherent decisions among them.

Task 6.1 Resources of the current business

Describe the resources required to run your current business model.

You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the resources required on the current business model.

Task 6.2 Technology interface

Select one [type of technology interface](#) you will require for product-service integration:

technology as a direct enabler	technology as an indirect enabler	technology as a mediator (servitization mediator)
technology as a mediator (productization mediator)	technology as a facilitator (service facilitator)	technology as a facilitator (product facilitator)

Describe the role of the technology in the product and service integration.

An example of **technology as a direct enabler** can be seen at Dell customization. Product and service element are not technology-embedded but the integration of them is performed by the technology. The information technology relates customer and company during the direct sales process.

Aiming to help you on defining the type of technology interface, the [product-service integrated roadmap](#) show you the relationship of product, service and technology on the PSS offer and highlights the role of technology on product and service integration.

Task 6.3 Technology capability

Select one option of [level of technology capability](#) you reach by developing the PSS offer:

offer leads to no capability improvement	offer leads to low capability improvement	offer leads to high capability improvement
--	---	--

Exemplify capabilities that can be required during the development of the PSS offer.

Task 6.4 Acquisition of client competence

Select one or more [types of acquisition on client competence](#):

by marketing channel (market research)	by distribution channel	by managing client business process	by communication channel (information exchange)
---	-------------------------	--	---

Detail how this channel should be developed or improved.

Take into account the [task 4.4 level of contact/relationship](#) when executing this task.

Sales organization of MAN Truck & Bus UK Ltd utilizes an information system named “E-Workshop” to collect data (e.g. maintenance reports) from their clients, the dealers. Therefore, type of acquisition is by **distribution channel**.

Task 6.5 Sources of knowledge

Select one or more options of which actors should be [sources of knowledge](#) required for the implementation of the PSS business model:

services suppliers	customer	competitors	consultants	OEM	technology supplier	internal departments	knowledge institution
-----------------------	----------	-------------	-------------	-----	------------------------	-------------------------	--------------------------

Specify the type of knowledge that should be obtained by the ones selected.

Task 6.6 Resources

Select one or more [types of resources](#) you will need to run the PSS business model:

Types of tangible resource

financial	material	human resources
infrastructure	equipment	software

Types of intangible resource

intellectual (brand patents)	partnership	technology
skills	experience	knowledge

Specify the resources selected.

Checklist to support you to define tangible resources: Do we need to hire managers and assistants? How many? Do we need to hire people for support functions? How many? Which and how many facilities are required? Which and how much material is required? Which and how many equipment are required? Which software is required? How much money I need as investment?

Checklist to support you to define intangible resources: Which technology is required? (See [task 6.2 type of technology interface](#)). Which product technology is required? (See [task 3.6 product element of the PSS offer](#)). Which and how many partners are required? (See [task 5.2](#)

	and task 5.3 types of actors).
The model named service triangle can support you on the visualization of tangible resources, intangible resources and actors. Another possibility is to use the tool system map to visualize actors, infrastructure, material, information, and time.
MAN Truck & Bus UK Ltd provided courses to the sales department in order to increase the skills of the employees on business strategies. Initially, their main role and expertise was selling products and the company wanted to develop skills on service provision.
Electrolux utilizes software to collect operating statistics such as running time and energy use in order to improve the PSS design and better achieve customer's needs.

Step 7. Configure Revenue Streams

Revenue streams can be defined as the result from value propositions successfully offered to customers.

Perform the tasks taking into account modifications you want to execute on the revenue streams of your current business model or the new revenue streams you wish to create. If you are creating a new business model or aim at creating a new revenue stream, you can skip task 7.1.

Task 7.1 Revenue streams of current business

☐	Describe your current revenue streams.
You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current revenue streams.

Task 7.2 Types of revenue

☐ Select one or more [types of revenue](#) you plan to have through the PSS business model:

based on fixed contracts	based on availability	based on units consumed
transfer of partnership	based on per use	based on result of the use (performance based)

☐	Describe options selected.
Wetrol, an European leader in cleaning systems, offers monthly fee-based service plans through which customers have access to a 24/7 repair service network. Therefore, the company revenue is based on availability.
A coffee vending machine manufacturer rents its machines and charges per cup of coffee consumed, meaning units consumed.

Task 7.3 Sources of revenue

☐ Select one or more [sources of revenue](#) you plan to have through the PSS business model:

selling services	product selling (ownership transfer)	selling product use (without ownership transfer)	selling result	selling spare parts
product-service customization	managing client business process	selling new technologies	selling consulting and training service	selling licenses

☐	Specify the approximate percentage of revenue for options selected.
--------------------------	---

MAN Truck & Bus UK Ltd split the service revenue in % of total company revenue: 2% fleet management; 5% wholly owned service; 5% rental; 10% repair and maintenance contracts and 15% spare parts.

If you are in doubt about which services might lead you to more revenues, you should check the [simulation tool for prioritizing PSS offers](#), which provides a service model that shows you the highest income for the provider and the best service for customers. The model uses as criteria the average profit per day, utilization ratio and acceptance ratio.

Step 8. Configure Cost Structure

This step aims to support you on defining the cost associated with the PSS offer. Accomplish the tasks taking into account the modifications on the cost structure you might need in order to improve the current business model or the new cost structure required for your current or new business model. If you are creating a new business model or aim at creating a new cost structure, you can skip task 8.1.

Task 8.1 Cost structure of current business

☐ Describe your current cost structure and list the most important costs of the current business model.

☐ Define the most important cost in terms of percentage of sales of the current PSS offer.

You can have a look on the next tasks if you want to have some insights about which attributes you can utilize in order to perform a more detailed description of the current cost structure.

Task 8.2 Cost drive

☐ Select one option of [cost drive](#) for PSS business model:

☐ cost-driven ☐ value-driven

Check if the drive you selected is compatible with the options you selected on the [task 3.3 benefits of the PSS offer](#).

The main business costs of a machine tool manufacturer concerns the customized services supplied during the use phase of the machine in order to increase the value perceived by the clients. The company follows the value-driven approach.

Task 8.3 Cost elements

☐ Select one or more options of [cost elements](#) (variable costs and fixed costs) for the PSS business model:

Variable costs

material costs	direct labor costs (production area)	variable manufacturing costs (direct variable costs such as energy)	variable transport costs (packaging and outbound freight)
----------------	--------------------------------------	---	---

Fixed costs

direct fix manufacturing costs (maintenance/ repair building, external services and depreciation)	indirect fix manufacturing costs (indirect personnel as well as IT costs and external services)	material overhead costs (such as raw material purchase)	fixed logistics costs (logistics and/or distribution center and logistics management)
---	---	---	---

Define a percentage of each cost in terms of percentage of sales of the PSS offer. Example: The material cost may only account for 55% of sales.
The option selected here has a strong relationship with the task 6.6 types of resource . You should check the resources you require to define the costs you might have.
The tool total cost of ownership (TCO) provides a financial estimate aiming to assist you to determine the costs elements of the offer on the different lifecycle phases.
MAN Truck & Bus UK Ltd utilized the TCO tool for estimating the cost of the lifecycle of a truck. 45% of the cost is the fuel, 29% the driver, 10% a new truck, 10% administrative costs and 6% repair and maintenance.
Considering Design for X on the PSS development, particularly design for remanufacturing, can lead to reduction of variable costs, such as material costs (raw material) on current businesses.
The tool value strategy canvas can show you the different costs you have according to the value proposition.
You might check the framework for estimating the cost of in-service provision in order to estimate the cost factors service for a PSS offer.

Definitions

What is PSS?

The term Product-Service System emerged in 1999, introduced in the literature by Goedkoop *et al.* (1999) through a study named “Product-Service Systems – Ecological and Economic Basics.” The authors defined PSS as a system of products, services, infrastructure, and networks that continually strive to be competitive, satisfy customer needs, and result in a lower environmental impact than traditional business models. A more current definition states that “A Product-Service System (PSS) is an integrated bundle of products and services which aims at creating customer utility and generating value” (BOEHM; THOMAS, 2013).

PSS is an approach that enables business innovation. The innovation is represented by a new interpretation on the product’s role and new ways to co-produce value by means of the participation of different stakeholders and partnership between them (MANZINI; VEZZOLI, 2003), considering a new manner to approach the value chain and its involved (MONT, 2000).

[<back to the topic “What is PSS?”>](#)

What is a business model?

According to Elbers (2010), it describes how a company creates, delivers and captures value based on its strategic choices. It consolidates customer needs and ability to pay, defines the manner a company delivers value to customers, attracts customers to pay for the offering, and converts those payments to profit by performing the proper design and operation of the value chain (TEECE, 2010).

A business model might become part of a business plan. However, it should not be considered a spread sheet or a computer model. A business model is a conceptual, rather than financial, model of a business. It embodied the organizational architecture of the business and articulates the information that support the creation of a value proposition for the customer and a viable structure of revenues and costs (TEECE, 2010).

The functions of a business model are to (CHESBROUGH; ROSENBLOOM, 2002):

- Create a offering based on technology;

- Identify a market segment;
- Specify the revenue mechanism;
- Define the value chain required to create and distribute the offering;
- Define complementary assets needed to support position in the chain;
- Estimate the cost structure and profit;
- Describe the position of the firm within the different actors of the value chain;
- Formulate the competitive strategy in order to gain and hold advantage.

<[back to the topic "What is business model?"](#)>

Description and reference of attributes and options

Here you can read definitions of some the attributes and options and also get to know the references utilized to create them.

Attribute: Uncertainty of conditions and trends

(RAINEY, 2005) (LEE; CONNOR, 2003) (CHEN; REILLY; LYNN, 2005).

[<back to the task 2.3>](#)

Attribute: Resistance to acquire the offer

Refers to the factors that lead to client's negative impression and might hampers their attraction to the PSS offer (LEE; CONNOR, 2003).

[<back to the task 2.4>](#)

Attribute: Market range of the business

Defines the geographical reach of the market (OSTERWALDER, 2004).

[<back to the task 2.5>](#)

Attribute: Type of clients

(OSTERWALDER, 2004)

[<back to the task 2.6>](#)

Attribute: Benefits to acquire the offer

Indicates the benefits clients can perceive by adopting the offered PSS (WALLIN; CHIRUMALLA; THOMPSON, 2013) (LEE, 2012) (TRUEMAN, 1998) (LEE; CONNOR, 2003).

[<back to the task 3.3>](#)

Attribute: Type of services on product

Comprises a range of services that can be offered jointly with the product (MEIER; ROY; SELIGER, 2010); (MOUGAARD et al., 2013); (MOUGAARD et al., 2012).

[<back to the task 3.4>](#)

Attribute: Other type of service

comprises a range of services that can be offered during the PSS lifecycle (MEIER; ROY; SELIGER, 2010); (MOUGAARD et al., 2013); (MOUGAARD et al., 2012).

<[back to the task 3.4](#)>

Attribute: Types of product-service orientation

Presents options on how the client acquires the offer (TUKKER, 2004); (COOK; BHAMRA; LEMON, 2006); (LIER; WÖRSDÖRFER; GESING, 2013).

<[back to the task 3.5](#)>

Attribute: Level of innovation on product

(GRIFFIN; PAGE, 1996); (BARCLAY; DANN, 2000); (HART; TZOKAS; SAREN, 1999); (GARCIA; CALANTONE, 2002).

Option 1: Radical innovations

Radical innovations embody a new technology that results in a new market infrastructure. It does not address a recognized demand but create one previously unrecognized by the consumer. This new demand cultivates new industries with new competitors, firms, distribution channels and new marketing activities.

Option 2: Really new product

Really new product will result in a market discontinuity or a technological discontinuity but will not incorporate both.

Option 3: Incremental innovations

Incremental innovations can be defined as products that provide new features, benefits, or improvements to the existing technology in the existing market.

<[back to the task 3.6](#)>

Attribute: Type of service innovation

(BOOZ ALLEN; HAMILTON, 1982); (KHAN; KHAN, 2009) (MENOR; TATIKONDA; SAMPSON, 2002) (AVLONITIS; PAPASTATHOPOULOU; GOUNARIS, 2001).

Option 1: Services new-to-the-world

Services that are new to you and to the market

Option 2: Services new to you

Services new to you but not to the market

Option 3: Services modifications

Improvements on a existing service

Option 4: Repositioning

Repositioning of a existing service

<[back to the task 3.7](#)>

Attribute: Novelty of product-service combination

Refers to the combination between new and existing elements (WIESNER et al., 2013).

<[back to the task 3.8](#)>

Attribute: Environmental aspect of the PSS offer

Present possibilities of delivering an offer that includes the reduction of emission, material and/or energy as a benefit for the customer (BARTOLOMEO et al., 2003).

<[back to the task 3.9](#)>

Attribute: Level of customization on product-service combination

Presents options regarding the development of the offer, which can be according to specific clients' requirements (customized) or standardized offers and not differentiate by clients' needs (no customized). (MOUGAARD et al., 2013); (MATHIEU, 2001a).

<[back to the task 3.10](#)>

Attribute: Type of commercial relationship

(OSTERWALDER, 2004).

Option 1: Transactional

Point of contact between client and you is limited by the moment of selling-buying, short term relationship.

Option 2: Relationship based

Variety of points of contacts with the clients during the lifecycle of the PSS, long term relationships.

[<back to the task 4.2>](#)

Attribute: Level of contact/relationship with client

Describes the contact between you and the client (COOK; GOH; CHUNG, 1999); (GEBAUER; FISCHER; FLEISCH, 2010); (BULLINGER; FÄHNRIK; MEIREN, 2003); (MATHIEU, 2001b); (CHOWDHURY; MILES, 2006).

[<back to the task 4.3>](#)

Attribute: Level of involvement of client on PSS development

Indicates the level of interaction and influence of the client on the development of the offer (GEBAUER; FISCHER; FLEISCH, 2010); (CARBONELL, 2012); Adapted from (COOK; GOH; CHUNG, 1999).

[<back to the task 4.4>](#)

Attribute: Responsibility of product

Indicates who is the responsible for the product according to its lifecycle phase (TAN; MCALOONE, 2006); (MEIER; ROY; SELIGER, 2010).

[<back to the task 4.5>](#)

Attribute: Ownership of product

Indicates who has the ownership of the product according to its lifecycle phase (TAN; MCALOONE, 2006); (TUKKER, 2004).

[<back to the task 4.6>](#)

Attribute: Types of contract

Presents the type of contract established between you and the client (MEIER; ROY; SELIGER, 2010).

[<back to the task 4.7>](#)

Attribute: Type of processes

Presents some of the processes that might be part of your value chain (MEIER; ROY; SELIGER, 2010); (OSTERWALDER, 2004); (MOUGAARD et al., 2012).

[<back to the task 5.2>](#)

Attribute: Type of actors (process related)

Presents some of the actors that might be part of your value chain, which are the ones that should work on the development of the PSS offer according to their competences (MEIER; ROY; SELIGER, 2010); (OSTERWALDER, 2004); (MOUGAARD et al., 2012).

<[back to the task 5.2](#)>

Attribute: Level of change on processes

(BAINES et al., 2008).

<[back to the task 5.2](#)>

Attribute: Type of actors (business related)

Presents some of the actors that might be part of your value chain, which are the ones that should support the business/ project development according to their competences (MEIER; ROY; SELIGER, 2010); (OSTERWALDER, 2004); (MOUGAARD et al., 2012).

<[back to the task 5.3](#)>

Attribute: Type of sharing with actors

Refers to what you share with the different actors of the PSS network (MOUGAARD et al., 2012).

<[back to the task 5.4](#)>

Attribute: Level of firm's dependency of their actors

(TANGPONG; MICHALISIN; J.MELCHER, 2008).

<[back to the task 5.5](#)>

Attribute: Type of approach to involve actors

Refers to the manner you plan to integrate the different actors of your PSS network (LAKEMOND et al., 2006).

Option 1: Systematic

Sistemática, quando o trabalho ocorre de forma integrada, com troca de informação intensa e frequência determinada.

The work between you and actors occurs in an integrated and systematic manner, with intense exchange of information and predefined frequency.

Option 2: Ad hoc

You and actors work together randomly, just when specific problems occur.

Option 3: No integration

Actors are more independent and there is little support from your company during the process. Actor's activities have few dependences of your activities.

<[back to the task 5.6](#)>

Attribute: Types of performance measure (external/client)

Presents indicators that measure the PSS business in relation to their implementation, time, cost and scope. The external indicators should be used to measure the achievement of the customer requirements (BAINES et al., 2008).

<[back to the task 5.7](#)>

Attribute: Types of performance measure (internal)

Presents indicators that measure the PSS business in relation to their implementation, time, cost and scope. Internal indicators should be utilized to measure all the aspects of the project/ business (BAINES et al., 2008).

<[back to the task 5.7](#)>

Attribute: Options of distribution channel

Defines through what sales channel the PSS is sold and distributed (OSTERWALDER, 2004); (MOUGAARD et al., 2013).

<[back to the task 5.8](#)>

Attribute: Type of project management approach

Refers to the approach chosen to manage the project (PROJECT MANAGEMENT INSTITUTE, 2008).

Option 1: Traditional management

Application of knowledge, techniques and tools on the project activities in order to achieve its requirements.

Option 2: Agile management

Set of principles that aims to simplify project management process by being more flexible and iterative and obtain better performance and increased value to clients.

<[back to the task 5.9](#)>

Attribute: Type of project manager

Refers to the level of authority the project manager has to influence design decisions (LECHLER; DVIR, 2010).

Option 1: Project coordinator

This role is also indicated by the low values of the functional responsibilities these PMs have and that they are recruited from positions with very low functional responsibilities.

Option 2: Supervised project coordinator

The authority and responsibility structure is similar to the structure of project coordinator with one exception; these projects are coordinated and supported by a steering committee consisting of senior managers.

Option 3: autonomous project manager

Exhibit considerable higher levels of project authority and responsibility and also a higher level of personnel authority. PMs are in a position to implement their projects relatively independent from the functional organization.

Option 4: Functional and supervised project coordinator

Projects are implemented by functional managers who have simultaneously to accomplish tasks within the functional organization. PM supported by steering committees.

Option 5: Functional and supervised project manager

Projects are implemented by functional managers who have simultaneously to accomplish tasks within the functional organization. PMs are not directly supported by a steering committee; rather they are more autonomous to implement their projects.

<[back to the task 5.10](#)>

Attribute: Level of dependency

Indicates to which extent the success of this business/ project is a condition for the results of other businesses/ projects (DAHLGREN; SÖDERLUND, 2010).

<[back to the task 5.11](#)>

Attribute: Project complexity

Depicts the level of project/ business complexity. Complex projects requires a substantial demand from the project team (time and resources) and high quantity and magnitude of organizational tasks (BARCLAY; DANN, 2000); (LAKEMOND; ECHELTELT; WYNSTRA, 2001).

<[back to the task 5.12](#)>

Attribute: Types of uncertainties

(ERKOYUNCU et al., 2011); (WYNSTRA; PIERICK, 2000).

<[back to the task 5.13](#)>

Attribute: Types of risk

(WYNSTRA; PIERICK, 2000); (LIER; WÖRSDÖRFER; GESING, 2013).

<[back to the task 5.14](#)>

Attribute: Type of technology interface on product-service integration

Presents the different virtual points in which products and services are integrated to meet the needs of the customers. Technology interface creates the interaction between the products and services (GEUM et al., 2010); (GEUM et al., 2011).

Option 1: Direct integration enabler

Technology directly enables the integration of products and services, directly infused in the process of integration. Even the individual product or service is not technology-embedded; the integration can be realized by the technology. Dell customization

Option 2: Indirect integration enabler

Technology indirectly enables the integration of products and services by being applied to the products and services and providing the means for integration.

Option 3: Servitization mediator

Technology mediates the product originated integration, particularly the technology-based servitization, firstly applied to the product and then the technology-embedded product is servitized to gain the competitive advantages. Mostly happens in high-tech products. Xerox control system.

Option 4: Productization mediator

Technology mediates the service-originated integration, firstly applied to the service and the service is productized to provide the more valuable information. Technology firstly applied to the banking system. Then, the automated banking system is evolved toward the productization, ATM.

Option 5: Service facilitator

Technology and products are independently applied to the services, facilitating the product–service integration. Mostly happens in technology-based maintenance service. Maintenance service of water-purifier

Option 6: Product facilitator

Technology facilitates the integration of products and services, especially the integration toward the product. Contents-making or create-a book service.

<[back to the task 6.2](#)>

Attribute: Level of technology capability

Presents different levels at which the development of the offer leads to expansion of your capabilities (MOSEY, 2005); (VERYZER, 1998).

<[back to the task 6.3](#)>

Attribute: Type of acquisition of client competence

Composed by market elements, such as: knowledge on clients' needs, their preferences and sales procedures and information acquired through the information exchange between you and them (DANNEELS, 2002).

<[back to the task 6.4](#)>

Attribute: Sources of knowledge

Refers to the actors that provide information to support the creation of the PSS offer (CHANG; LINTON; CHEN, 2012).

[<back to the task 6.5>](#)

Attribute: Type resource

(OSTERWALDER, 2004); (RADDATS; EASINGWOOD, 2010); (COOK; GOH; CHUNG, 1999); (MOUGAARD et al., 2012).

[<back to the task 6.6>](#)

Attribute: Types of revenue

Presents possibilities of how to structure your revenue streams. Adapted from (OSTERWALDER, 2004); (TAN; MCALOONE, 2006); (COSTER, 2008); (MOUGAARD et al., 2012) (LIER; WÖRSDÖRFER; GESING, 2013).

[<back to the task 7.2>](#)

Attribute: Sources of revenue

Shows options of how to generate cash from the offer. Adapted from (OSTERWALDER, 2004); (TAN; MCALOONE, 2006); (COSTER, 2008); (ROTHKOPF; WALD, 2011); (LIER; WÖRSDÖRFER; GESING, 2013); (WALLIN; CHIRUMALLA; THOMPSON, 2013).

[<back to the task 7.3>](#)

Attribute: Cost structure drive

Shows options of how to generally distinguish between companies approach towards their cost (OSTERWALDER; PIGNEUR, 2010).

Option 1: Cost-driven

Aims at creating and maintaining the leanest possible cost structure, using low price offers, maximum automation, and outsourcing.

Option 2: Value-driven

Aims at creating and maintaining premium offers and a high degree of customized service.

[<back to the task 8.2>](#)

Attribute: Cost elements

Comprises the variable and fixed costs of your project/business. In case of changes on the current business, these costs can be worked in order to be reduced. In new

business creation, you should specify each of them (OSTERWALDER; PIGNEUR, 2010).

<[back to the task 8.3](#)>

Description of method and tools

SWOT (strengths, weaknesses, opportunities and threats)

Goal: identify the key internal and external factors considered relevant on achieving a specific goal determined on the strategic planning.

Description:

SWOT is a planning method used to identify and evaluate the internal and external factors that are in favor or not to achieve specific goals. The four factors to be analysed are:

- Strengths: a resource or capacity of an organization that can be utilized to achieve specific goals;
- Weaknesses: a limitation that might hinder achievement of goals;
- Opportunities: a favourable situation in the market;
- Threats: an adverse situation in the market.

Reference: (TUKKER; HALEN, VAN, 2003).

[<back to the task 1.1>](#)

Canvas business model

Goal: assist the design of business models.

Description:

Canvas Business Model is a tool developed by means of an extensive investigation of business models and represents the point of view of a large group of academy and industry experts. It has been applied successfully by many organizations, such as IBM and Ericsson. Canvas Business Model present nine dimensions, as described in the table:

Dimension	Description
Customer segments (CS)	Delimits the groups of people or organizations a company aims to reach and serve.
Value propositions (VP)	Describes the set of products and services that creates value for a specific customer segment.
Distribution channels (DC)	Define company's interface with its customers.
Customer relationships (CR)	Describes the types of relationships a company establishes and maintains with specific customer segments.
Revenue streams (RS)	Characterizes the revenue a company generates from each customer segment

Key resources (KR)	Define the assets required to offer and deliver value to the each customer segment
Key activities (KA)	Describes the processes and activities involved in offering and delivering value to the each customer segment
Key partners (PA)	Delimits the network of suppliers and partners that support the business model execution.
Cost structure (CS)	Describes the costs incurred to operate the business model

In addition, the creators of the canvas stated that the tool provides a shared language that facilitates the description of business models. The following figure represents the relations between the nine dimensions:

Reference: (OSTERWALDER; PIGNEUR, 2010).

<[back to the task 1.2](#)>

User Activity Cycle (UAC)

Goal: identify processes and activities, needs of the customer, position in the PSS network and revenue captured.

Description:

This method consists of three phases:

- PRE: describes all user activities and associated needs, prior to using the PSS;
- DURING, details the activities that are carried out by the user during use;
- POST: describes the activities that the user incurs after the PSS has fulfilled its purpose.

Taking these three phases into consideration, the mapping of the actors involved in each activity allows the identification of how and where your company is positioned and how much of the revenue you are capturing from the customer.

Reference: (FINKEN et al., 2013).

<[back to the task 2.7](#)>

[<back to the task 5.2>](#)

Ontological representation of PSS

Goal: support the path from the customer needs to the definition of PSS offers.

Description:

The authors state PSS consists of three types of elements: products, services and their relations. Yet, PSS can be specified by the following attributes: value, function, behaviour, structure.

Value is the most abstract element, and is deduced from the needs of the customer.

Function is the realization of the value. Behavior is the realization of the function.

Structure is the realization of a behavior using physical components and it is a more detailed/less abstract level. Therefore, through the decomposition of the knowledge, PSS elements and attributes are defined and related.

Reference: (KIM; WANG; PARK, 2009)

[<back to the task 3.2>](#)

Value Strategy Canvas

Goal: support the visualization and comparison of PSS offers.

Description:

PSS offers can be visualized in respect to two variables: customers' needs and costs. By means of comparison, it can support the prioritisation and selection of PSS offers that should be further developed.

Reference: (FINKEN et al., 2013).

[<back to the task 3.2>](#)

[<back to the task 8.3>](#)

PSS configuration based on support vector machine

Goal: translate customer needs into a specific PSS offers.

Description:

First, customer needs are classified in functional needs and perception needs.

Functional needs can be represented objectively and obtained through experience.

Perception needs are subjective and deal with feelings customers have by experiencing PSS offers. Examples of words used to express perception needs are: reliable, powerful function, secure and high efficiency.

The representative descriptions of perception needs are extracted by means of factor analysis. Based on it, a multiclass support vector machine model is developed for configuring a specific PSS offer that meets both functional and perceptions needs.

Reference: (LONG et al., 2013).

[<back to the task 3.2>](#)

Offering diagram

Goal: define functionalities of the PSS offer.

Description:

Starting from opportunities and ideas, the tool can be used to define what the PSS is going to offer. Thereby, the functionalities that characterize the PSS offer should be defined by answering the question: “How could the core function be delivered?”.

The complementar functionalities should be classified in:

- Basic functionalities: should guarantee the deliver of the core function of the PSS offer;
- Added-value functionalities: additional functionalities that should be deliver together with the core function. It is suggested to evaluate them considering the benefits perceived compared to the cost.

The figure hereafter represents how the core functions and the complementar functionalities can be designed and related.

Reference: (HALEN; VEZZOLI; WIMMER, 2005).

[<back to the task 3.8>](#)

PSS configurator

Goal: inspire the plan and design of PSS offers.

Description:

This tool is similar to a catalogue of PSS offerings that can be combined in many possibilities. Some offerings complement each other, others may be counterproductive in case of combination. This tool uses the knowledge that has emerged from the relations found between the offerings, to present combinations of offerings that are likely to suit your company situation and priorities. Examples of offerings are: product manuals, upgrade, delivery, training.

Reference: (FINKEN et al., 2013).

[<back to the task 3.8>](#)

Service blueprint

Goal: map the path of a specific service and the activities to develop and deliver it.

Description:

This tool created for service conceptualisation is also applicable for PSS conceptualisation. Traditionally, the Service Blueprint is divided into:

- Frontstage: comprises all the activities the user sees and interacts with;
- Backstage: covers the activities the user does not see but are necessary for the development and delivery of the service.

The result of using the tool is the development of a systematic representation of services of the PSS offer. In addition, the mapping of the frontstage enables the identification of the touchpoints, i.e. all the moments the customer has contact with the service provider, between the customer and the service provider. Thereby, the definition of the channels (phone call, website, etc.) and the background processes that enable the interaction (IT systems, internal activities, etc.) are facilitated.

Reference: (FINKEN et al., 2013).

[<back to the task 4.2>](#)

[<back to the task 5.2>](#)

Types of contracts for PSS

Goal: explores types of contracts to facilitate the PSS adoption.

Description:

The framework encompasses three types of contracts and compare the incentives provided by them. The contracts, which are established between one manufacturer and one retailer, are named wholesale price (WP), franchise fee (FF) and retail price maintenance (RPM) contract.

With the WP contract, the retailer buys products at a WP and commercialize them to consumers without any relation or obligation to the manufacturer. This type of contract is easier to implement and has extensive application. The FF contract is a two-part pricing scheme. it specifies a wholesale price for each unit of the product and an additional fixed franchise fee between the contractors. With the RPM contract, the manufacturer is the core actor of the network and specifies a retail price and a cost-plus payment from the retailer.

The FF contract is more flexible than the RPM, as it only fixes the wholesale price for the retailer. Therefore, the retailer can choose the preferred service level and the retail price. On the other hand, on the RPM contract, the retail price is specified for the retailer. Thus, it has an indirect control over the retailer's service level.

Within a PSS business, some statements were highlighted, which depend on the power structure of the supply chain and cost types:

- the wholesale price (WP) contract is dominated by the other two contracts;
- The retail price maintenance contract (RPM) generates higher profit for the manufacturer and higher satisfaction for the customer;
- The franchise fee (FF) contract generates higher profit for the retailer and stimulates the retailer to provide more services to the customer.

Reference: (XIE et al., 2014).

[<back to the task 4.7>](#)

IDEF0 (Integration definition for function modelling)

Goal: allows the representation of the business processes required for a PSS offer.

Description:

This tool is helpful to support the design of the business processes for PSS since it provides an accurate representation of logical, time and physical connections between various components of a system.

The system is modelled as a series of boxes, each of them representing a function of the system. An arrow entering the left side of a box means inputs, which are transformed by the function to generate outputs, represented by arrows leaving a box on the right side. An arrow entering the box on the top are named “controls”. The controls specify conditions required for the function to generate the outputs. Each of those boxes can be decomposed in sub-boxes. There is also the possibility of recomposing the system overview, by referring to the boxes in the highest level, as presented in the figure below:

Reference: (MORELLI, 2006).

[<back to the task 5.1>](#)

Ecosystem map

Goal: map actors and the interactions between them.

Through the identification of the actors of a PSS network and their interactions, important aspects can be identified in order to improve the PSS business, e.g. addition of new services by including a new actor on the network.

Reference: (FINKEN et al., 2013).

[<back to the task 5.2>](#)

PSS Board

Goal: allows the visualization of processes and actors of the PSS network.

Description:

The tool is represented as a matrix. In one hand, the rows list four components: products, services, infrastructure and actors. On the other hand, the processes of PSS are placed in the columns. Thus, on the intersecting cells, the components involved in attend the customers, i.e. assist customers in getting a job done, can be visualized.

Step	Description
Define	Define product(s) and related plan
Locate	Locate or gather product and needed input
Prepare	Prepare things (e.g. knowledge or required equipment for product use)
Confirm	Confirm requirements and criteria to proceed with the job execution
Execute	Carry out the job
Monitor	Monitor or verify the conditions and result of job execution with products
Resolve	Resolve the problems of product or users caused by job execution
Modify	Make modifications or adjustments
Conclude	Conclude the process and prepare the next job execution

Following table presents some of the components and steps of the PSS board for a car sharing scheme.

Partners					
Infrastructure	An informatic system	Parking spaces			
Services	Support the reservation			Assist self-rental	
Product		Parked			The customer is transported
Customer activities			ID card	Unlock	Drive
	Define	Locate	Prepare	Confirm	Execute

Reference: (LIM et al., 2012).

[<back to the task 5.2>](#)

Map of interaction

(MORELLI, 2006)

Goal: allows the visualization of the actors involved on the PSS network.

Description:

This tool enables the representation of which actors participate on the PSS network and the direct and indirect relationships between them. Flow of material and information can also be visualized between the different actors.

Reference: (MORELLI, 2006)

[<back to the task 5.2>](#)

Approach to manage uncertainty and flexibility on PSS offers

Goal: management of uncertainties related to definition of PSS offers

Description:

The approach covers the application of scenarios with real options considering the most suitable financial performance indicators. As a result, three scenarios are presented: optimistic, moderate and pessimistic, each one showing three possible real options: to expand, to abandon and to defer the incorporation of services.

Reference: (RODRIGUES; NAPPI; ROZENFELD, 2014).

[<back to the task 5.13>](#)

Product-Service Integrated Roadmap

Goal: allows the strategic planning of PSS from the perspective of the technology

Description:

The suggested roadmap consists of five layers: market, service, technology, product, and R&D. The main focus lies in the relationship between product, technology and service layers. Different from the traditional roadmap, the service layer is at the same level of the product layer since both should be handled with the same importance. In addition, the interaction of the product and the service layer is triggered by the technology layer, which highlights the role of technology on the product–service integration.

The roadmap has the word “integrated” as the layers should work simultaneously and collaborate with each other in order to reach the goal of providing integrated products and services. The following figure represents the integrated roadmap.

Reference: (GEUM et al., 2011).

<[back to the task 6.2](#)>

Service triangle

Goal: enable the representation of the resources and actors involved on services provision.

Description:

This tool supports the visualization of three elements: tangible resources (e.g., equipments), intangible resources (e.g., relationships) and actors involved on the development and deliver of a specific service. Therefore, several triangles can be created with these elements and the service as nodes of the triangles.

Reference: (LIM et al., 2012).

<[back to the task 6.6](#)>

System map

Goal: enable the representation of the resources required, activities performed and actors involved on the PSS offer.

Description:

Actors of the PSS network, their roles, e.g. activities performed by them, are represented in a map along with the resources required for the development of a specific PSS offer, such as the infrastructure, time and flows of information and material.

Reference: (HALEN; VEZZOLI; WIMMER, 2005).

[<back to the task 6.6>](#)

Simulation tool for prioritizing PSS offers

Goal: assist the selection of services within PSS offers.

Description:

This tool enables measuring service models in order to help the selection of the best service model before implementing it. Three criteria are utilized to evaluate the performance of possible service models: profits per day, acceptance ratio and utilization ratio. Profits per day and utilization ratio measure the profitability. On the other hand, acceptance ratio is important to measure customer satisfaction.

According to these criteria, the highest income for the provider and the best service for customers are presented.

Reference: (ALFIAN; RHEE; YOON, 2014).

[<back to the task 7.3>](#)

Design for X

Goal: increase profitability and value to customers.

Description:

Design for X is an approach to be utilized on PSS development, where the “X” element stands for a range of design considerations, e.g. manufacturing, assembly, service. Four of the Design for X approaches addresses aspects that assist to reach profitability and increased value to customers within PSS offers, as shown following:

Design for X	Cost savings	Improved customer value	Other benefits
Design for Remanufacture	Reduced raw material and production cost Reduced expenses for maintaining spare part Reduced costs for recovering of obsolete and used products	Reduced maintenance costs	Valuable feedback on product failures Access to developing markets (due to lower pricing alternatives)
Design for Reliability	Reduced costs related to product failures (service, spare parts and replacements)	Reduced losses due to increased up-time Reduced risk of failures	
Design for Disassembly	Reduced time for service and maintenance	Reduced maintenance duration	Improved potential for remanufacturing Improved material recyclability
Design for	Reduced cost for	Reduced maintenance	Reduced risk of

Maintenance	service and maintenance	and service duration	malfunction
--------------------	-------------------------	----------------------	-------------

Reference: (FINKEN et al., 2013).

<[back to the task 8.3](#)>

Framework for estimating the cost of in-service provision

Goal: estimate the costs of PSS offers based on costs factors.

Description:

The framework addresses cost factors, such as distance from the service provider to customer, number of call outs for after-sales service, machine failure rate, number of years a machine is in service, in order to estimate the costs of PSS offers.

Relationships are generated between these factors and, based on them, statements performed. Examples of statements are:

- Demand for after-sales service does not increase when there is convenient and economical transportation links between the service provider and the customer;
- There is not strong correlation between the distance from the service provider to customer companies and the number of call outs for after-sales service.

Reference: (HUANG; NEWNES; PARRY, 2011).

<[back to the task 8.3](#)>

TCO (total cost of ownership)

Goal: calculate TCO for PSS processes and activities.

Description:

The scope of the processes and activities required for PSS is identified by means of the application of total cost of ownership (TCO), a tool that takes into consideration the direct and indirect costs of the PSS offer. The processes and activities are: acquisition, instalation, operation, maintenance, upgrade and disposal. The main cost elements considered for each process and activity comprise: capital investment; manufacturing activities; logistics activities and customer lifecycle support.

A better understanding of the economic value from the PSS provider perspective and an overview of the costs related to a PSS offer for a specific customer are examples of benefits reached through the utilization of this tool.

Reference: (COSTER, 2008) (FINKEN et al., 2013).

[<back to the task 8.3>](#)

References

- ALFIAN, G.; RHEE, J.; YOON, B. A simulation tool for prioritizing product-service system (PSS) models in a carsharing service. **Computers & Industrial Engineering**, v. 70, p. 59–73, 2014.
- AVLONITIS, G. J.; PAPASTATHOPOULOU, P. G.; GOUNARIS, S. P. An empirically-based typology of product innovativeness for new financial services: Success and failure scenarios. **The Journal of Product Innovation Management**, v. 18, p. 324–342, 2001.
- BAINES, T. et al. Towards an operations strategy for product-centric servitization. **International Journal of Operations & Production Management**, 2008.
- BARCLAY, I.; DANN, Z. New-product-development performance evaluation : a product-complexity-based methodology. **IEEE Proceedings Science, Measurement and Technology**, v. 147, n. 2, p. 41–55, 2000.
- BARTOLOMEO, M. et al. Eco-efficient producer services—what are they, how do they benefit customers and the environment and how likely are they to develop and be extensively utilised? **Journal of Cleaner Production**, v. 11, p. 829–837, 2003.
- BOEHM, M.; THOMAS, O. Looking beyond the rim of one's teacup: a multidisciplinary literature review of Product-Service Systems in Information Systems, Business Management, and Engineering & Design. **Journal of Cleaner Production**, v. 51, p. 245–260, 2013.
- BOOZ ALLEN; HAMILTON, I. **New products management for the 1980's**. New York: Booz Allen & Hamilton, 1982.
- BULLINGER, H.-J.; FÄHNRIK, K.-P.; MEIREN, T. Service engineering—methodical development of new service products. **International Journal of Production Economics**, v. 85, n. 3, p. 275–287, 11 set. 2003.
- CARBONELL, P. Performance effects of involving lead users and close customers in new service development. **Journal of Services Marketing**, v. 26, n. 7, p. 497–509, 2012.
- CHANG, Y.-C.; LINTON, J. D.; CHEN, M.-N. Service regime: An empirical analysis of innovation patterns in service firms. **Technological Forecasting and Social Change**, v. 79, n. 9, p. 1569–1582, nov. 2012.
- CHEN, J.; REILLY, R. R.; LYNN, G. S. The Impacts of Speed-to-Market on New Product Success : The Moderating Effects of Uncertainty. **IEEE Transactions on Engineering Management**, v. 52, n. 2, p. 199–212, 2005.
- CHESBROUGH, H.; ROSENBLOOM, R. S. The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. **Industrial and Corporate Change**, v. 11, n. 3, p. 529–555, 2002.

CHOWDHURY, S.; MILES, G. Customer-induced uncertainty in predicting organizational design: Empirical evidence challenging the service versus manufacturing dichotomy. **Journal of Business Research**, v. 59, p. 121–129, jan. 2006.

COOK, D. P.; GOH, C.-H.; CHUNG, C. H. SERVICE TYPOLOGIES : A STATE OF THE ART SURVEY. **Production and Operations Management**, v. 8, n. 3, p. 318–338, 1999.

COOK, M. B.; BHAMRA, T. A.; LEMON, M. The transfer and application of Product Service Systems: from academia to UK manufacturing firms. **Journal of Cleaner Production**, v. 14, n. 17, p. 1455–1465, jan. 2006.

COSTER, R. DE. **Differences in Forecasting Approaches Between Product Firms and Product- Service Systems (PSS)** Proceedings of the 6th International Conference on Manufacturing Research (ICMR08), 2008

DAHLGREN, J.; SÖDERLUND, J. Modes and mechanisms of control in Multi-Project Organisations : the R & D case Jörgen Dahlgren. **Int. J. Technology Management**, v. 50, n. 1, p. 1–22, 2010.

DANNEELS, E. The dynamics of product innovation and firm competences. **Strategic Management Journal**, v. 23, n. 12, p. 1095–1121, dez. 2002.

ELBERS, B. F. **Designing innovative business models: A methodology for structured business model innovation**. [s.l.] Universidade Tecnológica de Eindhoven, 2010.

ERKOYUNCU, J. A. et al. Understanding service uncertainties in industrial product – service system cost estimation. **The International Journal of Advanced Manufacturing Technology**, v. 52, n. 9-12, p. 1223–1238, 2011.

FINKEN, K. H. et al. **PSS Tool Book: A workbook in the PROTEUS Series**. [s.l.] Technical University of Denmark, 2013. p. 73

GARCIA, R.; CALANTONE, R. A critical look at technological innovation typology and innovativeness terminology : a literature review. **Journal of Product Innovation Management**, v. 19, p. 110–132, 2002.

GEBAUER, H.; FISCHER, T.; FLEISCH, E. Exploring the interrelationship among patterns of service strategy changes and organizational design elements. **Journal of Service Management**, v. 21, n. 1, p. 103–129, 2010.

GEUM, Y. et al. **Technology Interfaces in Product-Service Integration : Concept and Typology**. Proceedings of Technology Management for Global Economic Growth (PICMET). 2010

GEUM, Y. et al. Technology roadmapping for technology-based product – service integration : A case study. **Journal of Engineering and Technology Management**, v. 28, n. 3, p. 128–146, 2011.

GOEDKOOP, M. J. et al. **Product Service systems , Ecological and Economic BasicsEconomic Affairs**. Holanda: [s.n.].

GRIFFIN, A.; PAGE, A. L. PDMA success measurement project: recommended measures for product development success and failure. v. 13, p. 478–496, 1996.

HALEN, C. VAN; VEZZOLI, C.; WIMMER, R. **Methodology for Product Service System Innovation: How to Develop Clean, Clever and Competitive Strategies in Companies**. [s.l: s.n.]. p. 216

HART, S.; TZOKAS, N.; SAREN, M. The effectiveness of market information in enhancing new product success rates. **European Journal of Innovation Management**, v. 2, n. 1, p. 20–35, 1999.

HUANG, X.; NEWNES, L.; PARRY, G. **An Analysis of Industrial Practice for Estimating the In-Service Costs of a Product Service System**. Proceedings of the 16th Design for Manufacturing and the Life Cycle Conference. 2011

KHAN, M.; KHAN, M. A. How technological innovations extend services outreach to customers: The changing shape of hospitality services taxonomy. **International Journal of Contemporary Hospitality Management**, v. 21, n. 5, p. 509–522, 2009.

KIM, Y. S.; WANG, E.; PARK, M. W. **Value – Function – Structure Modeling in an Ontological Representation of Product-Service Systems**. Proceedings of ICED 09, the 17th International Conference on Engineering Design.2009

LAKEMOND, N.; BERGGREN, C.; WEELE, A. Coordinating supplier involvement in product development projects: a differentiated coordination typology. **R and D Management**, v. 36, n. 1, p. 55–66, jan. 2006.

LAKEMOND, N.; ECHELT, F. VAN; WYNSTRA, F. A Configuration Typology for Involving Purchasing Specialists. **Journal of Supply Chain Management**, v. Module 3, p. 11–20, 2001.

LECHLER, T. G.; DVIR, D. An Alternative Taxonomy of Project Management Structures : Linking Project Management Structures and Project Success. **IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT**, v. 57, n. 2, p. 198–210, 2010.

LEE, B. C. Y. The determinants of consumer attitude toward service innovation – the evidence of ETC system in Taiwan. **Journal of Services Marketing**, v. 26, n. 1, p. 9–19, 2012.

LEE, Y.; CONNOR, G. C. O. The Impact of Communication Strategy on Launching New Products: The Moderating Role of Product Innovativeness. **Journal of Product Innovation Management**, v. 20, p. 4–21, 2003.

LIER, S.; WÖRSDÖRFER, D.; GESING, J. **Business Models and Product Service Systems for Transformable, Modular Plants in the Chemical Process**

Industry Proceeding of the 5th CIRP Conference on Industrial Product Service Systems. **Anais...**2013

LIM, C.-H. et al. PSS Board: a structured tool for product service system process visualization. **Journal of Cleaner Production**, v. 37, p. 42–53, 2012.

LONG, H. J. et al. Product service system configuration based on support vector machine considering customer perception. **International Journal of Production Research**, v. 51, n. 18, p. 5450–5468, 2013.

MANZINI, E.; VEZZOLI, C. A strategic design approach to develop sustainable product service systems: examples taken from the “environmentally friendly innovation” Italian prize. **Journal of Cleaner Production**, v. 11, n. 8, p. 851–857, dez. 2003.

MATHIEU, V. Service strategies within the manufacturing sector : benefits , costs and partnership. **International Journal of Service Industry Management**, v. 12, n. 5, p. 451–475, 2001a.

MATHIEU, V. Product services : from a service supporting the product to a service supporting the client. **Journal of Business & Industrial Marketing**, v. 16, n. 1, p. 39–58, 2001b.

MEIER, H.; ROY, R.; SELIGER, G. Industrial Product-Service Systems - IPS². **CIRP Annals Manufacturing Technology**, v. 59, n. 2, p. 607–627, 2010.

MENOR, L. J.; TATIKONDA, M. V; SAMPSON, S. E. New service development : areas for exploitation and exploration. **Journal of Operations Management**, v. 20, p. 135–157, 2002.

MONT, O. **Product-Service Systems Final Report** The International Institute of Industrial Environmental. [s.l.: s.n.].

MORELLI, N. Developing new product service systems (PSS): methodologies and operational tools. **Journal of Cleaner Production**, v. 14, n. 17, p. 1495–1501, jan. 2006.

MOSEY, S. Understanding new-to-market product development in SMEs. **International Journal of Operations & Production Management**, v. 25, n. 2, p. 114–130, 2005.

MOUGAARD, K. et al. **PSS Case Book: A workbook in the PROTEUS series**. [s.l.] Technical University of Denmark (DTU), 2012. p. 36

MOUGAARD, K. et al. **Maritime Branch Analysis: A workbook in the PROTEUS series**. PROTEUS Wo ed. [s.l.] Technical University of Denmark (DTU), 2013. p. 87

OSTERWALDER, A. **The Business Model Ontology - a proposition in a design science approach**. [s.l.] (Doutorado em Gestão da Informação) Universidade de Lausanne, Switzerland., 2004.

OSTERWALDER, A.; PIGNEUR, Y. **Business Model Generation**. Amsterdam: Self Published, 2010. p. 278

PROJECT MANAGEMENT INSTITUTE. **A Guide to the Project Management Body of Knowledge (PMBOK Guide)**. 4th ed. ed. [s.l: s.n.]. p. 459

RADDATS, C.; EASINGWOOD, C. Industrial Marketing Management Services growth options for B2B product-centric businesses. **Industrial Marketing Management**, v. 39, n. 8, p. 1334–1345, 2010.

RAINEY, D. **Product innovation: leading change through integrated product development**. Cambridge: Cambridge University Press, 2005. p. 625

RODRIGUES, K. F. DE C.; NAPPI, V.; ROZENFELD, H. **A proposal to support the value proposition in product oriented service business model of product service systems**. Proceedings of the 6th CIRP Conference on Industrial Product-Service Systems. 2014

ROTHKOPF, M.; WALD, A. Innovation in Commoditized Services: a Study in the Passenger Airline Industry. **International Journal of Innovation Management**, v. 15, n. 04, p. 731–753, ago. 2011.

TAN, A. R.; MCALOONE, T. C. **Characteristics of Strategies in Product-Service-System Development**. Proceedings of the 8th International Design Conference. **Anais...**Dubrovnik, Croatia: 2006

TANGPONG, C.; MICHALISIN, M. D.; J.MELCHER, A. Toward a Typology of Buyer – Supplier Relationships : A Study of the Computer Industry. **Decision Sciences**, v. 39, n. 3, p. 571–593, 2008.

TEECE, D. J. Business Models, Business Strategy and Innovation. **Long Range Planning**, v. 43, n. 2-3, p. 172–194, abr. 2010.

TRUEMAN, M. Managing innovation by design – how a new design typology may facilitate the product development process in industrial companies and provide a competitive advantage. **European Journal of Innovation Management**, v. 1, n. 1, p. 44–56, 1998.

TUKKER, A. Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet. **Business Strategy and the Environment**, v. 13, n. 4, p. 246–260, jul. 2004.

VERYZER, R. W. Discontinuous innovation and the new product development process. **Journal of Product Innovation Management**, v. 15, p. 304–321, 1998.

WALLIN, J.; CHIRUMALLA, K.; THOMPSON, A. **Developing PSS Concepts from Traditional Product Sales Situation: The Use of Business Model Canvas**. Proceeding of the 5th CIRP Conference on Industrial Product Service Systems. 2013

WIESNER, S. et al. **Strategies for Extended Product Business Models in Manufacturing Service Ecosystems**. Proceeding of the 5th CIRP Conference on Industrial Product Service Systems. 2013

WYNSTRA, F.; PIERICK, E. Managing supplier involvement in new product development : a portfolio approach. **European Journal of Purchasing & Supply Management**, v. 6, p. 49–57, 2000.

XIE, W. et al. Contract design for cooperative product service system with information asymmetry. **International Journal of Production Research**, v. 52, n. 6, p. 1658–1680, 2014.

Appendix 4 – PSS proposal for the Pedelec case

This document presents a PSS proposal for the concept of a sustainable pedal electric cycle (Pedelec) developed by a research team of the SFB CRC 1026 "Sustainable Manufacturing – Shaping Global Value Creation".

The proposal was elaborated following the method "Configurator of PSS proposals". This method is composed by eight steps and each step presents tasks that should be performed in order to create a specific business proposal.

The tasks concluded by the team are shown through a marked checkbox. An example is given for the task 3.2 "value proposition of the improved or new business", which request: "describe the main value proposition you want to offer to your customer". The result of this task is show right after the request. In this case, the result of the task, i.e. the main value proposition, is "sustainable alternative to urban mobility for early-industrialized countries".

Describe the main value proposition you want to offer to your customer. Sustainable alternative to urban mobility for early-industrialized countries.
---	--

However, there are some tasks that could not be executed considering the current level of abstraction of the Pedelec case. Therefore, the tasks not finalized are exhibit with an exclamation mark. This mark aims to remember the research team that information need to be acquired and decisions are yet to be taken in order to conclude the task.

Following, the example of the task 8.3 "cost elements" is presented. This task requests to "define a percentage of each cost elements (variable costs and fixed costs) in terms of percentage of sales of the PSS offer". As not all the costs elements defined, this task was not accomplished. This explains why the sentence "to be defined" is stated right after the request.

Define a percentage of each cost elements (variable costs and fixed costs) in terms of percentage of sales of the PSS offer. Example: The material cost may only account for 55% of sales. To be defined.
---	--

Some tasks offer a variety of options that should be selected according to the Pedelec case. The options selected for this case are marked in orange. An example

is shown for the task 3.5 “PSS orientation”, where the option “availability of the product” was selected.

Select one option for types of product-service orientation:

property of physical product	use of the product	result of the use of the product	availability of the product	consumption of product
---------------------------------	--------------------	-------------------------------------	--------------------------------	---------------------------

The tasks not required for the Pedelec case are stated as “does not apply”. The entire Step 1 “Understand the current business model” was removed from this document as it does not fit the Pedelec case. A new business model is being created and no current business model exists.

Next pages presents the current status of the PSS proposal for the Pedelec, starting from the step 2. Configure Customer Segment.

Step 2. Configure Customer Segment

Task 2.1 Customer segment of the current business

Does not apply.

Task 2.2 Customer segment of the improved or new business

☒	<p>Specify who your customer segments are. You can classify them according to behavior, culture, demography.</p> <p>Individuals requiring transportation (recreational, transportation of goods, people and commuting).</p> <p>From these individuals, two customer segments are composed, according to demography characteristics:</p> <ul style="list-style-type: none">• Customer segment 1: students (academics);• Customer segment 2: professors and employees.
-------------------------------------	---

Task 2.3 Market conditions and trends

☒	Select one option considering the level of uncertainty of conditions and trends of the customer segments you want to reach:
-------------------------------------	---

conditions and trends are unknown	conditions and trends are partially known	conditions and trends are known
-----------------------------------	---	---------------------------------

☒	<p>Describe actions to increase the knowledge and decrease the level of uncertainty of conditions and trends in the market.</p> <p>Does not apply as the customer segment is known.</p>
-------------------------------------	---

Task 2.4 Resistances to acquire PSS offer

☒	Select one or more options to point out the resistances of the customer segment to acquire the offer:
-------------------------------------	---

new knowledge	behavior change	price
---------------	-----------------	-------

- Customer segment 1: students (academics): use their own bicycles. Change behavior is related to product ownership;
- Customer segment 2: professors and employees: use cars. Change behavior related to comfort aspects.

☒	<p>Describe actions to be taken to reduce the resistance.</p> <p>Actions to be taken to reduce the resistance: to be defined on step 3, task 3.3.</p>
-------------------------------------	---

Task 2.5 Market range

☒	Select one option for the market range you want to reach:
-------------------------------------	---

local	regional	national	international
-------	----------	----------	---------------

☒	<p>Detail the geographical reach of the market range (city, country, etc.)</p> <p>PTZ (Produktionstechnisches Zentrum), Berlin, Germany</p>
-------------------------------------	---

Task 2.6 Types of clients

Select one or more options for type of clients considering the customer segment you want to reach:

B2C - "Business to Consumer" (private customers)	B2B - "Business to Business" (private organizations customers)	B2G - "Business to Government" (governmental organizations)
---	--	--

Task 2.7 Profile of customer segment

Describe the profile of the new customer segment: behavior, preferences, needs, perceptions, attitudes and values.

Customer segment 1: students (academics)

- Low income
- Require transportation in different times of the day
- Want to be in different places fast

Customer segment 2: professors and employees

- Want to be sure about the availability of the transport
- Want to be sure about the reliability of the transport
- Like to be punctual
- Want to transport bags, boxes
- Want to transport kids
- Like comfort
- Don't want to get wet when it is raining

Step 3. Configure Value Proposition

Task 3.1 Value proposition of the current business

Does not apply.

Task 3.2 Value proposition of the improved or new business

☒	Describe the main value proposition you want to offer to your customer. Sustainable alternative to urban mobility for early-industrialized countries.
-------------------------------------	--

Task 3.3 Benefits for the customer

☒ Select one or more options of benefits your customer should recognize through the PSS offer:

reduced risk	risk averseness	reduced cost	reduced environmental impacts
perceived ease of use	perceived price fairness	aesthetics	product differentiation
customization	brand	functionality	quality

Additional options of benefits: availability, convenience, time effective, agility, safety, contribute to sustainability aspects, increase health, share experiences with other users, community identity, transport goods and people, comfort

☒	Describe how you plan to reach the benefits selected. Results of this activity in the following table.
-------------------------------------	---

Benefit	How to reach the benefit	Customer segment	Needs attended	Already included on the concept?
Perceived ease of use	help to self-help (detailed on task 5.2)	---	---	Yes
Availability	Ensure return system (user returns the bike on the spots)	Meets needs of Customer segment 1 and 2	Require transportation in different times of the day, want to be sure about the availability of the transport	No
Convenience	The customer does not own the bike	Face the resistance (behavior change) of Customer segment 1	Concerns about theft, storage and maintenance	Yes
Convenience	Charging of mobile phone	---	---	Yes
Reduced cost	Not defined	Meets needs of Customer segment 1	Low income	No
Time effective, Agility	Variants of engine performance (or high performance battery?) (detailed on task 5.2)	Meets needs of Customer segment 1 and 2	Like to be punctual, want to be in different places fast	Yes

Quality and safety (long lasting, durable materials)	Strong frame	Meets needs of Customer segment 2	Want to be sure about the reliability of the transport	No
Contribute to sustainability aspects (reduced environmental impacts)	Show the customer what he reached using a Pedelec instead a car (trees saved, CO2 not emitted, money saved)	---	---	No
	Different ways of energy supply and recovery			Yes
Increase health	Show the customer how many calories he burned, the distance he cycled	---	---	No
Share experiences with other users	IT systems	---	---	Yes
Community identity (make part of a group)	Advertising displays on the bike: Logo Fraunhofer, TU Berlin	---	---	No
Transport goods and people	Strong frame, modularity aspects	Meets needs of Customer segment 2	Want to transport kids, bags, boxes, Space that fits kid sit or storage area	Yes
Comfort	Ergonomic aspects of the sit	Face the resistance (behavior change) of Customer segment 2	Like comfort	Yes
Comfort	Cover to protect the cyclist	Meets needs of Customer segment 2	Don't want to get wet when it is raining	No

Task 3.4 Types of services

Select one or more options of types of services that you want to offer to your customer:

Types of services on product

installation	maintenance	repair	upgrade
remote monitoring	remote operation	optimization/ improvement	service technicians on call
on-site inspections	spare parts supply	diagnosis plus recommendations	planned overhaul

Other types of services

training	consulting	planning	logistics
financing	delivery	product/ system disposal	
product/ system tack back		remanufacturing and/or reconditioning	

Additional option of type of services: multiperspective user interface

<p>Detail service(s) selected. For instance, in case you select maintenance, you can specify if it will be a corrective maintenance or a preventive maintenance with fix intervals. Option of service: Multiperspective user interface. Goal is to:</p> <ul style="list-style-type: none"> • measure health conditions/utilization for sports; • enable the customer to perform maintenance (help to self-help); • monitor energy consumption; • access internet and communicate to users of other Pedelecs; • allow smartphones to be charged. <p>Other types of services still need to be detailed.</p>
---	--

<p>Describe how the services selected assist on providing the benefits (task 3.3) for the customer. Table following present the results of this activity. In addition, it shows the services already considered in the product concept, i.e. before the creation of this proposal</p>
---	---

Type of service	Already included in the concept?	Relation to benefits
Installation	No	Convenience, quality and safety
Maintenance	Yes	Quality and safety
Repair	Yes	Quality and safety
Upgrade (sensors, software)	No	Quality and safety
Remote monitoring	Yes	Availability of bikes on the community
Service technicians on call	No	Availability of bikes on the community
Logistics	No	Convenience
Delivery	No	Convenience
Product take back	Yes	Convenience, contribute to sustainability aspects
Reconditioning and disposal	Yes	Contribute to sustainability aspects
Multiperspective user interface	Yes	Convenience, share experiences with other users, contribute to sustainability aspects

Task 3.5 PSS orientation

Select one option for types of product-service orientation:

property of physical product	use of the product	result of the use of the product	availability of the product	consumption of product
------------------------------	--------------------	----------------------------------	-----------------------------	------------------------

Task 3.6 Product of the PSS offer

☒	What is the product that should compose the PSS offer? Pedelec
	Which are its characteristics? The product presents four main characteristics that should guide the PSS development phase: reduced energy consumption, increased user interface and ergonomic and modularization aspects.

Next figure presents a CAD model of the Pedelec.

☒	Select one option for level of innovation on the product element of the PSS offer:
<div style="border: 1px dashed black; padding: 2px;"> incremental really new radical </div>	
☒	Detail type of innovation. For instance, if you selected “incremental”, detail the improvements that should be performed on the current technology.
	Improvements compared to the Pedelects available on the market encompass: ergonomic aspects, high strength frame, high performance battery, additional charging options (e.g. solar panels)

Task 3.7 Service Innovation

☒	Select one option of level of innovation on the service element of the PSS offer:
<div style="border: 1px dashed black; padding: 2px;"> services new-to-the-world services new to you services modifications repositioning </div>	
☒	Select option for each type of service selected on the task 3.4 and detail type of innovation. For instance, if you selected “service modification”, explain the modification you plan to carry out on the existing service.
	Level of innovation on services: all services (defined on task 3.4) are new to my company but not the market.

Task 3.8 PSS offer innovation

Select one option of novelty of product-service integration according to the product and service elements of the PSS offer:

combinations of existing products with existing services	combinations of new services for existing products	combinations of new products for existing services	combinations of new products with new services
--	--	--	--

Task 3.9 Environmental aspect of the PSS offer

Select one or more options of environmental aspect of the PSS offer:

reduced energy consumption	reduced emission consumption	reduced material consumption	no reduction
----------------------------	------------------------------	------------------------------	--------------

Detail how you intend to reach the reduction selected.
Results from this task in the following table.

Type of environmental aspect	How to reach?
Reduced energy consumption	By applying end-of-life strategies (reutilization of value embedded on the used products) By creating charging options: <ul style="list-style-type: none"> via solar panels at home through mobile solar charging station via solar panels on the ride while mounted on the rack via "charging while standing" (the pedals can be connected to a generator); By developing a high performance battery
Reduced material consumption	By applying end-of-life strategies (reutilization of value embedded on the used products) By utilizing material as lightweight as possible By selecting material according to results from LCSA (lifecycle sustainable assessment)

Task 3.10 Customization of the PSS offer

Select one option for the level of customization on the PSS offer you wish to provide to your customer:

no customization/standard	just some parts/modules/services can be customized	customized products
customized services	customized products/ services	customized solutions

Describe what you wish to customize.
Customization possible through modularization aspects: different rack variants that enable to put child, storage for luggage or solar panel. Customer should be able to put or remove them and exchange from one Pedelec to another.

Step 4. Configure Customer Relationship

Task 4.1 Customer relationship of the current business

Does not apply.

Task 4.2 Commercial relationship

Select one option for the type of commercial relationship you plan to accomplish with your customer:

transactional

relationship based

List the point of contacts you plan to have with your customer.

Point of contacts with your customer: request/book the bike through a smartphone, download apps, report problems and make suggestions via company website, self-repair of Pedelects (help to self-help) on workplace for assembly.

Task 4.3 Customer contact

Select one option of the level of contact/relationship with the customer you plan to have:

no communication, trust and information sharing

low intensity of communication, trust and information sharing

high intensity of communication, trust and information sharing

Describe how you plan to communicate with customers.

Most of the information will be automatically collected via sensors on the Pedelect. For instance, travelling distance, report of positive or negative experiences.

Task 4.4 Customer involvement

Select one option concerning the level of involvement of the customer during the development of the PSS:

customer does not interact or influence development

customer interacts during some selected activities of the development

customer interacts during all the development

Specify which activities you want to have participation of the customer and the type of participation.

Customer interacts during some selected activities of the development, to test product usability and functionality when prototype is ready. In addition, customers should test the workplace for assembly in order to evaluate the ease of use of the self-repair.

Task 4.5 Product responsibility

Select options concerning who should have the responsibility for product on the different lifecycles:

Responsibility for product X actor	customer	my company	an actor of the PSS network
usage phase			
end of life phase			

Task 4.6 Product ownership

Select options concerning who should own the product on the different lifecycles:

Product ownership X actor	customer	my company	an actor of the PSS network
usage phase			
end of life phase			

Task 4.7 Types of contract

Select one or more options for the types of contract you wish to arrange with your customer:

based on frequency of client contact	based on type, complexity and/or urgency of client request	based on duration of client production cycle	simultaneous contracts of the same product-service (pooling)
based on the quantity of product-service use	based on the period of product-service use	based on availability

Describe how you plan to arrange contracts with your customer.
Two types of contract will be arranged with customers:

- Based on availability: customer pays an annual fee to have the possibility to use the Pedelects;
- Based on the period of use: additionally, customer pays from the moment he books a bike until the moment he puts it back in a dock station.

Step 5. Configure Business Process and Network of Actors

Task 5.1 Business processes and actor of the current business

Does not apply.

Task 5.2 Business processes and actors of the improved or new business

Select the type of processes that should be part of the improved/new network and which type of actor should perform them:

Type of process X actor	My company	OEM	service supplier	IT supplier	parts and products supplier	Other (communication company)
distribution channel						
manufacturing and assembly						
quality control						
performance measurement						
clients management						
marketing acquisition						
product and service development						
technology development						

!	<p>Specify who the key actors you selected are. E.g.: industrial area, name of companies, etc. Most of the processes should be performed in-house.</p> <p>The three key actors required to support the execution of the outsourced processes are:</p> <ul style="list-style-type: none"> IT supplier responsible for the development of the IT system that will collect and process the information gathered both through the sensors on Pedelec and from the smartphones of the customers. A communication company responsible for the marketing activities. Parts supplier for acquisition of parts to produce the Pedelec. <p>Key actors were not selected yet.</p>
---	---

!	<p>Detail the processes that will be carried out in-house.</p> <p>The processes are described in the following table. Not concluded yet.</p>
---	--

Type of process	Description
Product and service development	<p>A specific methodology, named IT-based support assistant, is being utilized. This methodology enables the development team to choose sequential and parallel combinations of design methods from a database depending on different criteria, such as design target and type of product. Output expected from this process: engineering drawings, bills of material and design requirements (material, shape, geometry, number and type of parts/components).</p> <p>LCSA (lifecycle sustainable assessment) supports decisions during the PSS development, e.g. the selection of material to be used on the development and manufacturing of the Pedelec. Materials already considered for the frame are: steel, aluminium, titanium and bamboo.</p>
Manufacturing	A methodology for sustainable manufacturing will be tested for the manufacturing

and assembly	<p>of the Pedelec. It addresses options (e.g. qualification level and available infrastructure) and criteria (e.g. cost, functionality and material) to be selected according to the different surroundings (e.g. countries) with distinct infrastructure and availability of materials. In addition, an adaptive software for instructions and adaptive work arrangement should support the assembly of the Pedelec within these different surroundings. Therefore, a reconfigurable workplace for assembly will be created.</p> <p>Functions of the reconfigurable assembly workplace:</p> <ul style="list-style-type: none"> • Visual recognition for tracking of movement patterns of hands and evaluate work sequences with a newly developed software tool; • Planning of work places taking into consideration time measurement, design of work instructions, training and qualification; • Support in work processes through the design of work instructions step-by-step and continuous improvement.
Logistic	Trucks required for redistributing and relocating the Pedelecs from full stations to empty docking stations.
Distribution	By means of e-commerce. Pedelecs available on docking stations within a 10 km ratio around the community;
Repair and maintenance	<p>The same workshops used for assemble the Pedelecs (reconfigurable workplace) will be available close to the docking stations for clients that wish to maintain the Pedelecs they are using. For this purpose, customized repair kits will be available on the repair workshops.</p> <p>As an incentive to perform the self-repair, the customers receive free time to use Pedelecs.</p>
Recovering of parts	Parts of the used Pedelecs should be categorized, according to remaining value and the most favorite option from the hierarchy of waste (e.g. landfilling, energy recovery, recycling, reuse/remanufacturing, minimization and prevention).

Following figure represents the general layout for the assembly line of the frames from the Pedelecs.

Task 5.3 Actors supporting the business

Select one or more types of actors (business related) that you wish to involve in the PSS network in order to support the development of the business:

competitor	legislation institutions	society	government	financial institutions
knowledge institutions	partner for contract management	consultant	communication companies

Specify who the key actors you selected are. E.g. industrial area, name of companies, etc. and their roles in the network.

The knowledge institution is Technical University of Berlin.

Financial institutions not selected yet.

Task 5.4 Sharing with actors

Select one or more types of sharing with actors that you wish to implement in your PSS network in order to modify the current network or to create a new one:

risk sharing	cost sharing	data sharing	revenue sharing	resources sharing/pooling (e.g. facilities)
--------------	--------------	--------------	-----------------	---

Select option for each type of actor of the PSS network.

The option selected for each type of actor is presented on the table placed after task 5.6.

Task 5.5 Dependency with actors

Select one or more options according to the level of dependency you might have with the actors of the PSS network you are modifying or creating:

no dependency	dependency to take decisions	dependency to execute activities	dependency on decisions and activities
---------------	------------------------------	----------------------------------	--

Select option for each type of actor of the PSS network and specify dependencies.

The option selected for each type of actor is presented on the table placed after task 5.6.

Task 5.6 Actor involvement

Select one or more types of approaches to involve actors of the PSS network you are modifying or creating:

systematic integration	ad hoc integration	no integration
------------------------	--------------------	----------------

Select option for each type or group of actor of the PSS network and specify how you plan to implement the approach selected.

The option selected for each type of actor is presented on the table following.

Actor performing or supporting the business	Task 5.4 Sharing with actors	Task 5.5 Dependency with actors	Task 5.6 Actor involvement
Financial Institutions	Cost	dependency to execute activities	no integration
Communication Companies	data (one direction requirement)	no dependency	ad hoc integration
IT Supplier	data (input required,	dependency on	systematic

	bilateral), revenue	decisions and activities	integration
Parts Supplier	data (one direction requirement)	dependency to execute activities	ad hoc integration
Customer	data (input required, bilateral)	dependency on decisions and activities	systematic integration

Task 5.7 Performance measure

Select one or more types of performance measure you wish to utilize:

Types of performance measure (external/client)

availability of provider when client requires	client satisfaction	response time	customer reliability
service availability	occurrence of product failure	occurrence of service failure	rate of devolution

	Detail the types of performance measure: create a title, the goal and specify the unit of measure for each type selected. Indicators presented on the following table. Indicators to measure the social and environmental aspects of this business still need to be defined.
--	--

Title (element)	Goal (factor)	Measure
Availability of provider when customer required/ Response time	Time taken to contact customer	Minutes/month
Service availability	Time taken to provide services	Minutes/month
Client satisfaction	Number of complains (services, products, software)	Numbers/month
Product failure	Number of product failures/defects	Numbers/month
Service failure	Number of complains after providing services	Numbers/month

Types of performance measure (internal)

product conformity	costs of product failure	product lifecycle cost	response capacity
achievement of planned activities	time-to-market	service delivery conformity	

	Detail the types of performance measure: create a title, the goal and specify the unit of measure for each type selected. Indicators presented on the following table. Indicators to measure the social and environmental aspects of this business still need to be defined.
--	--

Title (element)	Goal (factor)	Measure
Response capacity	Time taken to contact customer	Minutes/month
Achievement of planed activities	Number of activities delayed	Numbers/month
Cost of product failure	Cost of repair and corrective maintenance	Euros/month
Cost of product lifecycle	Cost of maintaining PSS	Euros/month
Conformity of product	Number of product failures/defects	Numbers/month
Conformity of service delivery	Number of complains after providing services	Numbers/month

Task 5.8 Distribution channel

Select one or more types of distribution channel you plan to utilize to deliver the PSS offer to your customer:

shared channel	online (internet)/ e-commerce	sales office
own service stations	service partnerships	call center

Detail the types of distribution channel you selected.
PSS offer should be acquired online through the company website.

Task 5.9 Project management approach

Select one option of type of project management approach you wish to utilized on the implementation of your PSS proposal:

traditional management	agile management
------------------------	------------------

Task 5.10 Project manager

Select one type of project manager that should lead the implementation of the PSS proposal:

project coordinator	supervised project coordinator	autonomous project manager	functional and supervised project coordinator	functional and supervised project manager
---------------------	--------------------------------	----------------------------	---	---

Specify the competences of the type of project manager you selected.
This business should be created and conducted by people with both functional and organizational competences. Since the business might start with a small number of people, they will have high levels of project authority and responsibility.

Task 5.11 Dependency between projects

Does not apply.

Task 5.12 Project complexity

Select one option of project complexity you might face when implementing the PSS proposal within a business model:

high demand from the project team regarding organizational tasks and interaction	low demand from the project team regarding organizational tasks and interaction	no demand from the project team regarding organizational tasks and interaction
--	---	--

Describe the organizational tasks and interaction that can be already defined.
High demand since it is a new company.
Organizational tasks still need to be defined.

Task 5.13 Uncertainties

Select one or more types of uncertainties you might face by creating or improving the PSS business model:

commercial uncertainty	uncertainty of employees capacity to sell the offer	uncertainty of employees capacity to develop the offer	uncertainty of employees capacity to supply services	project/business uncertainty
------------------------	---	--	--	------------------------------

Describe actions to reduce uncertainties selected. Project uncertainties related to great number of decisions that still need to be taken (described in the next task)
---	---

Task 5.14 Risks

- Select one or more types of risks that you might face by creating or improving the PSS business model:

technology complexity risk	risk due to environmental laws creation and changes	development risk	market risk	financial risk
-------------------------------	--	---------------------	----------------	-------------------

Describe actions to reduce risks selected. In order to reduce the risks, key decisions need to be taken concerning: <ul style="list-style-type: none"> • Number of Pedelects to be produced; • Number of dock stations; • Price to charge customers (both annually and per period of use); • Amount of money required for start the investment;
---	--

Step 6. Configure Resources

Task 6.1 Resources of the current business

Does not apply.

Task 6.2 Technology interface

Select one type of technology interface you will require for product-service integration:

technology as a direct enabler	technology as an indirect enabler	technology as a mediator (servitization mediator)
technology as a mediator (productization mediator)	technology as a facilitator (service facilitator)	technology as a facilitator (product facilitator)

Describe the role of the technology in the product and service integration.
Technology first applied on the product by means of sensors. Then, the information acquired through the sensors trigger service provision. For instance, the sensors monitor the condition of the bicycle. If the bicycle needs to be repaired (corrective or preventive), the user of the bicycle is informed about this task and can fix the bicycle himself in a nearby "do it yourself workshop".
In addition, sensors have the ability to communicate e.g. via Bluetooth and other telecommunication technologies with other sensors and they provide the possibility to locate and reserve a bicycle near the user.

Task 6.3 Technology capability

Does not apply.

Task 6.4 Acquisition of client competence

Select one or more types of acquisition on client competence:

by marketing channel (market research)	by distribution channel	by managing client business process	by communication channel (information exchange)
--	-------------------------	-------------------------------------	---

Detail how this channel should be developed or improved.
Acquisition of knowledge about customer by communication channel (information exchange through sensors).

Task 6.5 Sources of knowledge

Select one or more options of which actors should be sources of knowledge required for the implementation of the PSS business model:

services supplier	customer	competitor	consultant	OEM	technology supplier	internal departments	knowledge institution
-------------------	----------	------------	------------	-----	---------------------	----------------------	-----------------------

Specify the type of knowledge that should be obtained by the ones selected.
The institution provides access to knowledge required to implement the business, e.g. for PSS development (software, methods and techniques) and for manufacturing and assembly (workshop and tools available).

Task 6.6 Resources

Select one or more types of resources you will need to run the PSS business model:

Types of tangible resource

financial	material	human resources
infrastructure	equipment	software

Specify the resources selected.
Resources specified in the table following.

Item	Type of tangible resources	Purpose	Unit
Initial investment	Financial	To start the business	To be defined
Employees required	Human Resources	Execute manufacturing, assembly, services and support functions	4
Facility required	Infrastructure	Execute manufacturing and assembly, services and storage	500 m ²
Monthly electricity consumption	Infrastructure	For manufacturing, assembly and services activities	550 kW
Special equipment for ergonomic adaptation of material supply	Equipment	For assembly workplace	2
Control PC	Equipment	For assembly workplace	2
Industry Touch Monitor	Equipment	For assembly workplace	2
Kinect sensor	Software	For assembly workplace	2
Hand tracking system components	Material	For assembly workplace	2
Beckhoff PLC m. Cards	Material	For assembly workplace	2
Worktable	Material	For assembly workplace	2
Workplace with fixtures and shelves	Material	For frame joining workplace	2
Small stands and fixtures	Material	For frame joining workplace	2
Special purpose tools	Equipment	For frame joining workplace	2
Angle grinder	Equipment	For frame joining workplace	2
Bicycle frame fixture	Equipment	For frame joining workplace	2
Tube notcher	Equipment	For frame joining workplace	2
Belt grinder	Equipment	For frame joining workplace	2
Trucks	Equipment	To reallocate Pedelecs from full to empty dock stations	1

Sensors in the bike	Software	Monitoring of bicycles to automatically detect critical parameters. Locate and reserve a bicycle near the user.	To be defined
Interactive learning system	Software	the user is guided through the specific repair tasks by a system to use the necessary tools in order to "do it yourself"	2
Lifecycle sustainability assessment	Software	To support the selection of material utilized to develop the Pedelec	1

Next figures presents the equipment required for the frame joining workplace.

Types of intangible resource

intellectual (brand patents)	partnership	technology
skills	experience	knowledge

Specify the resources selected.
Resources specified in the table following.

Type of intangible resources	Detailing	Purpose
Partnership	With a communication company	To make advertisement of the PSS offer
Skills	Certification and training according to employees functions	To guarantee product quality
Skills	Self to help	To enable customers to repair the bike
Technology	Software required already defined in intangible resources	

Step 7. Configure Revenue Streams

Task 7.1 Revenue streams of current business

Does not apply.

Task 7.2 Types of revenue

Select one or more types of revenue you plan to have through the PSS business model:

based on fixed contracts	based on availability	based on units consumed
transfer of partnership	based on per use	based on result of the use (performance based)

Describe options selected.

- Based on availability: annual fee (to be part of the group).
 - Based on per use: additionally, customer pays according to the time utilizing the bike.
- Online payments through credit card.

Task 7.3 Sources of revenue

Select one or more sources of revenue you plan to have through the PSS business model:

selling services	product selling (ownership transfer)	selling product use (without ownership transfer)	selling result	selling spare parts
product-service customization	managing client business process	selling new technologies	selling consulting and training service	selling licenses

Specify the approximate percentage of revenue for options selected.

100% selling product use. All the services are included on the contract.

Step 8. Configure Cost Structure

Task 8.1 Cost structure of current business

Does not apply.

Task 8.2 Cost drive

Select one option of cost drive for PSS business model:

cost-driven	value-driven
-------------	--------------

Task 8.3 Cost elements

Select one or more options of cost elements (variable costs and fixed costs) for the PSS business model:

Variable costs

material costs	direct labor costs (production area)	variable manufacturing costs (direct variable costs such as energy)	variable transport costs (packaging and outbound freight)
----------------	--------------------------------------	---	---

Fixed costs

direct fix manufacturing costs (maintenance/ repair building, external services and depreciation)	indirect fix manufacturing costs (indirect personnel as well as IT costs and external services)	material overhead costs (such as raw material purchase)	fixed logistics costs (logistics and/or distribution center and logistics management)
---	---	---	---

Type of cost specified in the table following.

Item	Type of cost	Subtype of cost	Cost estimation in €
Labor cost per hour	Variable costs	Direct labor costs	21
Electricity cost per kwh	Variable costs	Variable manufacturing costs	0,25
Consumables per month	Variable costs	Material costs	1.000
Packaging and outbound freight	Variable costs	Variable transport costs	To be defined
Facility cost per m2/month	Fixed costs	Direct fix manufacturing costs	10
Maintenance/ repair	Fixed costs	Direct fix manufacturing costs	To be defined
External services and	Fixed costs	Direct fix manufacturing costs	To be defined
IT costs	Fixed costs	Direct fix manufacturing costs	To be defined
Depreciation	Fixed costs	Direct fix manufacturing costs	To be defined
Material overhead costs	Fixed costs	Indirect fix manufacturing costs	To be defined
Logistics and/or distribution center	Fixed costs	Fixed logistics costs	To be defined

Define a percentage of each cost elements (variable costs and fixed costs) in terms of percentage of sales of the PSS offer. Example: The material cost may only account for 55% of sales.

To be defined.

Additional costs of tangible resources

(i) Material required for Reconfigurable assembly workplace	Cost in €
Worktable	2 x 10.000
Control PC	2 x 3.000
Industry Touch Monitor	2 x 1.500
Kinect sensor	2x 500
Hand tracking system components	2x 10.000
Beckhoff PLC m. Cards and Software licenses	2x 5.000
Special issue equipment for ergonomic adaptation of material supply	2x 10.000
Total	80.000

(ii) Material required for Frame joining workplace	Cost in €
Workplace with fixtures and shelves	2x 5.000
Special purpose tools	2x 5.000
Angle grinder	2x 200
Small stands and fixtures	2 x 2.500
Bicycle frame fixture	2 x 6.000
Tube notcher	2 x 300
Belt grinder	2 x 1.000
Total	40.000

(iii) Standard equipment for both types of workplaces (Frame joining workplace and reconfigurable assembly workplace)	Cost estimation in €
Hand tools for assembly procedures	4 x4.000
Special purpose tools	4x 6.000
Assembly wagon	4x 3.000
Material supply wagon (kanban)	4x 4.500
Small stands and fixtures	4x 2.500
Total	75.000

Item	Cost estimation in €
(i) Reconfigurable assembly workplace	80.000
(ii) Frame joining workplace	40.000
(iii) Standard equipment	75.000
Total	195.000

Appendix 5 – Evaluation questionnaire

Evaluation questionnaire

This questionnaire aims to assess both the business proposal of the Pedelec and the method utilized to create the proposal, named “Configurator of PSS proposals”.

Name of the respondent: _____

1) How do you evaluate the Configurator as a guide for the creation of the business proposal?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

2) How do you assess the knowledge you acquired through the process of creating the business proposal (e.g. through the method and the meeting with the business case research group)?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

3) How do you evaluate the utility of the help (examples of cases, relations, methods and tools and hints) on the process of creating the business proposal?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

4) How do you evaluate the order of the steps regarding its consistence?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

5) How do you assess the division of information into business model dimensions in order to classify the attributes?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

6) How do you assess the completeness of the tasks suggested to create a business proposal?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics:_____

7) How do you evaluate the results generated through the application of the method, i.e. the business proposal?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics:_____

8) How do evaluate the applicability of the Configurator for different situation, such as different industries or size of business?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics:_____

9) How do you evaluate the description of the tasks in order to be understood by people from different functional areas and different types of businesses?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics:_____

10) How do you assess the depth of the attributes and options?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics:_____

11) How do you evaluate the description of the tasks concerning its simplicity and comprehensiveness?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics:_____

12) How do you assess the clarity of the instructions to use the Configurator?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

13) How do you assess the clarity of the description of the steps?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

14) How do you assess the clarity of the description of the attributes (available on the hyperlinks)?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

15) How do you evaluate the objectiveness of the tasks?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

16) How do you evaluate the coherence between the tasks and their help
(examples of cases, relations, methods and tools and hints)?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

17) How do you assess the Configurator regarding its assistance on improving an
already existent business?

☐ Very satisfactory

☐ Satisfactory

☐ Needs improvement

☐ Unsatisfactory

Comments, suggestions, critics: _____

18) How do you assess the Configurator regarding its assistance on creating a
new PSS business model?

☐ Very satisfactory

☐ Satisfactory

() Needs improvement

() Unsatisfactory

Comments, suggestions, critics: _____

19) Please, point out the weak and strong points of the method and the business proposal:

	Configurator of PSS proposals	Pedelec proposal
weak points		
strong points		