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Balancing Product-Service Provider's Performance and Customer's Value: the SErvice Engineering Methodology (*SEEM*)

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Abstract

Manufacturing companies are currently competing for the identification of innovative value propositions to position themselves in the market. This led to a shift from providing traditional transaction-based and product-centric offerings towards the provision of integrated solutions to their customers. In this context, Service Engineering, the discipline concerned with the systematic development and design of service and product-services, is gaining particular interest. This paper provides a contribution in this field proposing a *SErvice Engineering Methodology* (*SEEM*) which aims to support servitizing companies in: (i) (re)engineering of service and product-services offering, (ii) defining the most suitable and complete service and/or solution for customers, and (iii) balancing the excellence in the customer satisfaction and the efficiency and productivity in the service provision process.

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1. Introduction

The recent economic crisis has contributed to increasing the awareness of the strategic relevance of the provision of product-related services, as an anti-cyclical remedy for tackling the dramatic contraction experienced in some business-to-business (B2B) and business-to-consumer (B2C) markets. This strategic evolutionary path towards servitization, undertaken by many manufacturing companies nowadays, is mainly motivated by the necessity to continuously quest for new sources of value, either reactively fulfilling explicit customers' requirements [1], or proactively providing them with new integrated product-service solutions [2].

A major managerial challenge during the servitization journey is for product-service providers to re-think and re-design their organizational principles, structures, processes [3], capabilities [4], relationships with customers [5], and supplier relationships [6].

Under such a pressure, the design and development of a product-service solution, along with the management of its whole lifecycle, raise new issues. In particular, the cultural shift from a transaction-based approach to a long-term relationship with a customer needs to be thoroughly understood by product-service providers, throughout the acquisition of suitable models, methods and tools for collecting, engineering and embedding in a solution all the knowledge that meets or exceeds people's emotional needs and expectations [7] [8]. Indeed, the service component of the product-service solution introduces further requirements when compared to product-based solutions. In this context, Service Engineering (SE) has emerged as a discipline calling for the design and the development of an integrated product-service offering adding value to the customers.

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In spite of the great success of the SE as a discipline in the academic context, only few authors have proposed methodologies and tools, which can be easily adopted by industrial companies as they are usually product-centric during the design of a solution. In addition, the existing models ([10] [9] [11] [12] [13] [14] [15]) in SE are mainly focused on designing solutions able to technically satisfy customer needs, while omitting the balance with operational excellence during the delivery of the service solution.

This paper proposes to address those challenges and gaps by introducing the *SEEM* (*SErvice Engineering Methodology*). In particular, *SEEM* aims at supporting companies embarking in the servitization journey during either the engineering of a new product-related service, or the reengineering of already available offerings. The *SEEM* allows for the definition of the most suitable and complete service and/or solution for a customer in terms of service content and service provision processes. A particular emphasis is also given to balancing the excellence in the customer satisfaction and the efficiency and productivity of the service-related processes.

It is worth mentioning at this stage that the *SEEM*. The methodology benefited from extensive industrial feedbacks. SEEM has been developed starting from the theoretical background on SE, addressing the related gaps; then, it has been continuously refined considering the input and the feedback obtained from several industrial test cases. In particular, thanks to several meetings carried out with service managers, it has been possible to refine the theoretical aspects and terminology, making the methodology more intelligible and suited for practical use.

The reminder of the paper is structured as follows: Section 2 presents a literature review on Product-Service and Service Engineering with a focus on the models and methods currently available. Section 3 describes the main constructs of the methodology, providing a full overview of its deployment, while Section 4 concludes the paper and proposes further research prospects.

2. PRODUCT-SERVICE SYSTEM ENGINEERING

The first definition of product-service appears in the literature in the ‘70s by Rathmell [16]: “Services may be an accompanying sale of a product”. Although a sharp distinction between the two concepts of product and service was still present, due to the intangibility of the service compared to the corporeality of the product, it portrayed a new perspective for their mutual integration to improve customer satisfaction. Later, the idea of integrating physical products and additional services grew a step further and became crucial for many companies [17]. Today, this concept has a new meaning, and the basic idea behind the Product-Service System (PSS) concept ensues from an innovation strategy, shifting the business focus from designing and selling physical products to designing and selling systems consisting of products, services, supporting networks and infrastructures, which are jointly capable of fulfilling specific customer demands [18] [9].

The profit generation and the commercial success of the PSS offering critically depend on its conceptualization, design and development, although this notion has been largely ignored [19]. Designing and developing a PSS is a complex task due to the long and unpredictable lifecycle of the solution and the number of interactions existing between the different actors involved and the components constituting it [20] [21]. Issues related to service design and development are increasingly being recognized by designers, engineers and managers as relevant to the success of their business, even-though the knowledge on how to develop a PSS and who should design it is still marginal [22]. According to Baines et al. [9], the plethora of models and methods available for designing PSS are typically a rearrangement of conventional processes, and lack of a critical and in-depth evaluation of their performance in practice. In fact, service when compared to physical products are generally under-designed and inefficiently developed [23].

This is the main motivation behind the rise of Service Engineering (SE) as an emerging technical discipline since the ‘90s and of its today’s relevance. Based on the definitions provided by Bullinger et al. [19] and Shimomura and Tomiyama [15], SE can be termed as a technical discipline concerned with the systematic development and design of services, aiming at increasing the value of artefacts. It is a rational and heuristic approach based upon the discussion of alternatives, goals, constraints and procedures, through the adoption of modelling and prototyping methods. Accordingly, the aim of SE is to increase the value of service offering by improving the service conception, service delivery and service consumption. This can be achieved through the evaluation of existing services and the design of new services by visualizing the relationship between customer’s requirement and the service delivery process.

Among the several available models and methods, few have been developed specifically for service and PSS design, development and engineering. Most of the available Service Engineering models, methods and tools derive, however, from the adaptation of traditional engineering, business and computer science approaches to the Service System or PSS fields [1] [24] [25].

The development of a Service Engineering methodology implies the definition of process *models* describing the steps needed to engineer a service, and concrete *methods* defining how to perform the model phases [9]. A detailed analysis of a literature on Service Engineering Models demonstrates that there is a plethora of proprietary process models, each providing a different nomenclature and a specific relevance to the engineering phases. Summarizing the most widespread models ([10] [9] [11] [12] [13] [14] [15]), four main common phases can be highlighted: 1) customer analysis, 2) requirements analysis, 3) PSS design, and 4) PSS test and implementation. Table 1 provides a further detailed view on how these phases are carried out as well as an analysis of the main methods currently available. Each method is then linked to the phases where it has been implemented [1][26][27].

The common thread between these models and methods is the central role covered by the customer, where customization, customer satisfaction, and long-term relationships are the leading elements. This is due to the fact that the main focus in the service paradigm is the customer with its preferences and its desires [28].

Table 1: Analysis of available SE methods

Phase	Method
Customer analysis	• Benchmarking • Delphi • Persona Model • Cost-benefit analysis • Value-benefit analysis • Gap analysis
Requirements analysis	• Quality Function Deployment (QFD) • TRIZ • Functional Analysis • FAST - Function Analysis System Technique
PSS design	• Functional Analysis • Function Analysis System Technique (FAST) • Service Blueprinting
PSS test and implementation	• Simulation • 3D visualization • Failure Mode and Effects Analysis (FMEA) • AHP/ANP

However, even though the customer plays an important role, and he/she should be considered in co-designing and co-creating the service offering, companies need to focus also on the standardization and optimization of their processes, to increase their revenues and remain competitive. For this purpose, we propose in the next section a service engineering methodology that takes into consideration both company internal performance and customer satisfaction.

3. *SErvice Engineering Methodology* Overview

One of the main gaps in the SE models and methods previously described in the literature is their focus on the customer perspective, with practically no consideration of the company's internal performance. This exclusively customer-centered perspective can lead to the development of services fulfilling customer needs completely, but that can potentially undermine the company economical sustainability in the long term, since a suitable optimization of the service delivering process is not provided.

Considering this gap, the SErvice Engineering Methodology (*SEEM*) has been developed in order to support servitizing company during the engineering of their service offering taking into consideration both customer and company perspective. The *SEEM* is therefore divided into two main areas: the customer area and the company area. The former addresses customer analysis, whereas the latter aims at defining the service delivering process that allows for the best trade-off between customer satisfaction and company performance optimization.

As concluded in the SE literature, the *SEEM* encompasses the four most common phases in the SE models, namely in the SEEM as: i) Customer needs analysis, ii) Process prototyping, iii) Process validation, and iv) Offering identification and analysis. As shown in Figure 1, the first and the fourth phases belong to the customer area, while the remaining two belong to the company area. In addition, some of these phases are further decomposed into tasks, and for each of them, one or more methods have been adopted.

In order to ensure an effective industrial applicability, the methodology has been developed based on leading academic contributions. It has been subsequently tested, validated and revised through discussions with service managers and researchers, as well as with the application in real contexts.

In the remainder of this section, a brief overview of the four phases is provided considering the case of a new service and PSS engineering. Since this methodology can also be applied to the case of service reengineering, the differences in the application are reported at the end of the section.

3.1. *Customer needs analysis*

The first phase in engineering a new service solution is the analysis of the customers' needs and what do they value most. This step can be implemented in several ways, such as market research, customers' interview, focus groups or expert panels.

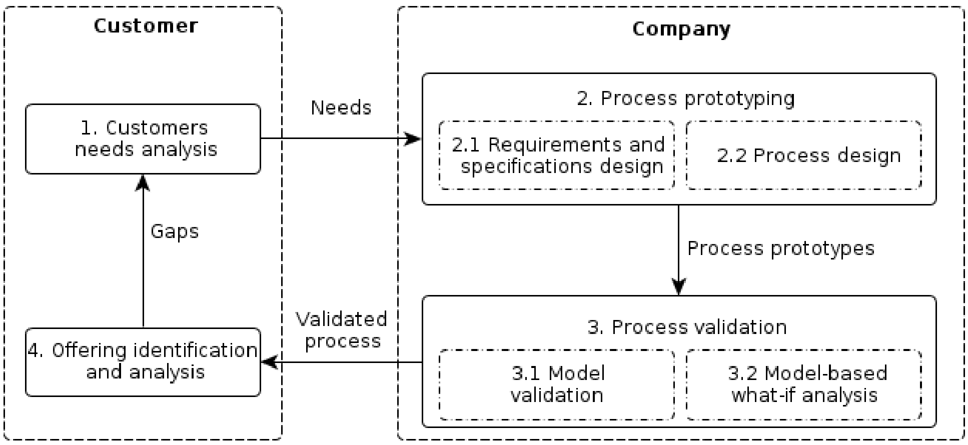

Figure 1: SErvice Engineering Methodology

Regardless the actual implementation, the purpose is to obtain a clear understanding of the customers' needs and requirements in terms of products, service, and expected performance. This analysis can also lead to the segmentation of customers in several, homogeneous classes in terms of main requirements and needs.

3.2. Process prototyping

The customers' needs identified in the first phase are used as input for the development of the second phase of the *SEEM*, which decomposed of two core tasks. The output of this phase is a prototype of the process, that is a sample of the process which has to be tested in the third phase.

Task 1. Requirement and specification design: the aim of this task is to identify the main relationships between the customers' needs and the product-service provider's resources. For this purpose, we define the *Service Requirement Tree* (*SRT*) as a suitable conceptual construct able to support the analysis and consequential decomposition of customers' needs as well as the connections between the needs and the provider's resources. The SRT represents one of the core elements of the *SEEM*; it is based on the functional design domain knowledge, and it is mainly drawn on the "Customer - Oriented FAST model" [29] and the "View Model" [30]. Figure 2 illustrates the SRT concepts and uses the following glossary:

a. *Needs* (N): needs express the customer necessity, in terms of the results of the expected service and/or performance. The needs are identified through the customer analysis performed in the first *SEEM* phase. In general, different customer segments display different needs or emphasize the same needs in different ways. For example, considering a manufacturing company, a need can be to maximize the plant availability.

b. *Wishes* (W): wishes express how the customer wants to satisfy his needs. For example, with regard to the need of maximizing the plant availability, the wishes can be "reduce breakdown time" and "reduce downtime". Wishes can be further decomposed in sub-wishes, if required to clarify better their content.

c. *Design Requirement* (DR): design requirements represent how the company can satisfy the customer's wishes. More specifically, design requirements specify or constrain the options available to satisfy a wish(es). For example, to fulfill the customer wish of reducing breakdown time, a design requirement can be represented by "preventive maintenance".

d. *Design Specifications* (DS): a design specification represents what a not-yet-designed service process is intended to do to deliver the design requirement. Its aim is to provide explicit information to the subsequent process design and development in terms of main activities (A) and technical and human resources (R).

These four elements are hierarchically connected to each other as depicted in Figure 2. As it could be seen, the product-service provider's internal resources are connected to the fulfillment of customers' needs through the activities they have to execute to implement the design requirements in the process they are involved in, which in turn are meant to fulfill customer's wishes descending from customer's needs. Given the hierarchical link between resources and needs in the SRT, it is necessary to define the impact of each resource on each design requirement. This way, it would be possible to identify the most important area to act on in order to succeed in

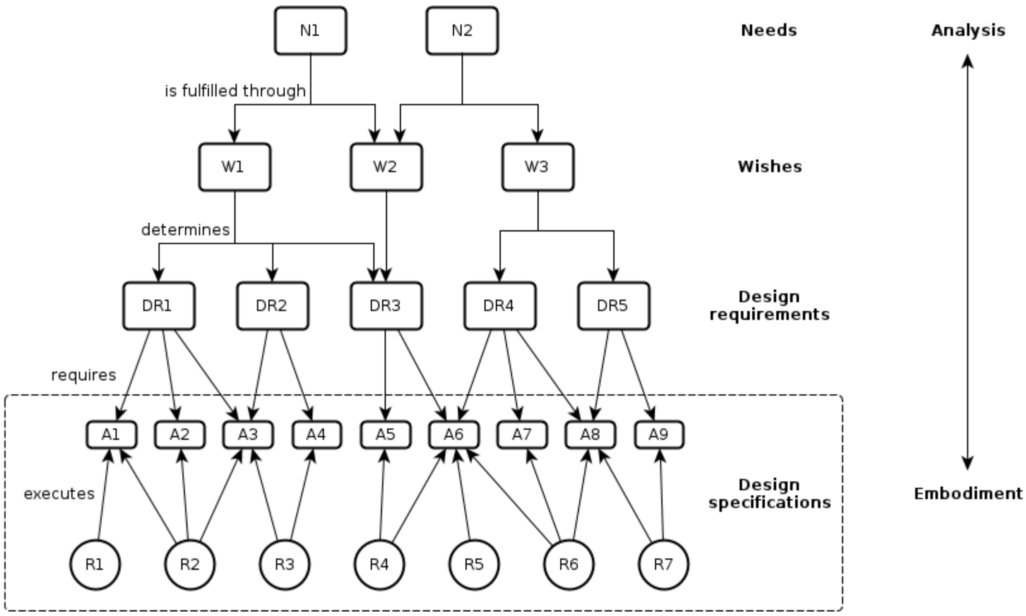

Figure 2: *Service Requirement Tree* (*SRT*)

fulfilling customer wishes and needs. Among the available approaches suitable for assessing the impact of resources, we opted for the Quality Function Deployment (QFD) approach.

Task 2. Process design: this task involves the representation of the service provision processes. In the *SEEM*, the Service Blueprinting [31] [32] technique is used for simultaneously depicting the service process, the points of customer contact, and the evidence of the service delivery from the customer's point of view. In particular, the activities composing the process are classified into four categories: i) customer's activities (performed by the customer), ii) front-end activities (performed by the company interacting with the customer), iii) back-end activities (performed by the company, but hidden from customer view), and iv) support activities (general management activities performed by the company to support several processes).

In addition, to provide a unified view of all the elements discussed so far, the activities in the blueprinting model are connected to service design specifications in the SRT; in this way, each design requirement will be connected, through the design specifications, to one or more activities in the blueprinting, effectively representing how the design requirement will be fulfilled. After this association, each activity in the blueprinting may or may not be assigned to one or more design requirements. This allows for a triple-check of the activities, the design specifications, and the design requirements included in the process as follows:

- activities that are not connected to any design specification are not contributing to the customer value creation, and should be analyzed to understand whether they must be kept, changed, or removed from the process;
- design specifications that are not modelled in the blueprinting reduce the fulfillment of the DR and, therefore, the customer value could not be optimized;
- a completely disconnected DR means that there are no activities in the service blueprinting that are able to address the design requirement and, therefore, to fully satisfy the customer wish(es),

In case of disconnected DR or DS, the service designer can decide whether to change the process in order to address the missing specifications and requirements, or to omit them if it is deemed as not relevant. In this way, it is possible to formulate alternative processes able to cope with customers' requirements and needs. Furthermore, the link between the SRT and the activities composing the process allows for the identification of the performance to be monitored. In fact, in each element of the tree, one or more performance indicators are identified. In this way, it is possible to measure the modeled design requirements and the related wishes. Consequently, by the adoption of the SRT, designers can clarify and measure the relationship between the service process and the customer expected value.

3.3. Process validation

The results of the previous stage allow for assessing whether all the requirements are addressed by the activities composing the service provision process. Nonetheless, this is a rather static result: nothing can be inferred about the performance of the process in relation to the assigned resources, both for the *as-is* processes and the *to-be* proposals. Therefore, the aim of this third phase is to validate and assess the performance of the process, as well as to identify the most suitable configuration of the process resources. To this end, the *SEEM* adopts a process simulation approach, since it allows for the dynamic analysis of a system (the service process, in our case) under different conditions and scenarios.

The purpose of the simulation is to: i) assess the performance of a service system under different conditions (what-if analysis), ii) evaluate the effectiveness of possible changes in the service system organization, iii) support the selection of the process configuration with the best trade-off between internal performance and value for customer, and iv) provide insights about the service system's dynamics and bottlenecks.

Simulation can thus be used as a decision making tool to test different, alternative scenarios and process configurations, as well as to identify the best one according to the pre-specified key performance measures. The identification of possible scenarios can be done in a "qualitative way", considering the company and the market condition and perspective, and in a "quantitative way", thanks to the analysis of the process weaknesses highlighted by the simulation (e.g. bottlenecks, resources utilization, costs and so on). Alternatively, Design of Experiments (DOE) techniques can also be used in order to design simulation scenarios, analyze the results through statistical methods and draw significant and objective conclusions.

Through the analysis of the simulation process output (in terms of the impact on internal and customer KPIs) and the strategic direction of the company, the best scenario is identified.

3.4. Offering identification and analysis

The last phase of the *SEEM* refers to the definition of new or re-arrangement of the service offering. The service prototyped and validated through the simulation is in this stage added to the company offer.

3.5. The service reengineering case

A good PSS must be continually improved and constantly adjusted in order to be able to answer to the variable customer demands and needs. In this sense, if a service offering already exists (i.e. the company is interested in re-engineering the existing service offering), it is relevant to start the reengineering process from a deep analysis of the current offering. Thus, in the case of a re-engineering project, the fourth *SEEM* phase will be the starting point of a new project. The result of such an analysis is then compared to the identified customers' needs and requirements (phase one), with the aim at identifying existing or potential gaps, which can influence the customers' (or, more in general, market) needs.

4. Conclusion and further development

The methodology presented in this paper aims at supporting the (re)engineering of the most suitable and complete PSS solution to increase company's competitiveness and profitability. For these reasons, the methodology focuses on two main areas: the customer and the product-service provider. The strong industrial emphasis reached by the deep involvement of service managers allowed to develop the methodology in such a way it can be easily understood and implemented in an industrial context. Many are the advantages achievable through the adoption of this methodology to (re)engineer a PSS: i) the adoption of a systematic procedure to analyze the existing services, ii) an improvement of the process performance by the identification of the elements affecting customer needs, iii) the adoption of an economic and risk assessment tool (such as simulation) to monitor the expenditure related to the risk of the introduction of an ineffective (customer perspective) and poor performing (profitability) service, and iv) a better definition of the process changes in order to properly manage an increase of demand and revenues.

The methodology developed is now being adopted in different contexts with the theoretical aim to understand better its appropriateness and robustness and, on the other hand, with the practical aim to better (re)engineer the PSS offering of the product-service provider analyzed. Further research is to investigate the case of a network of organizations designing and delivering a service offering, as it add complexity to the performance management of such a network.

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