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Product-Service Systems across Life Cycle

Process standardization to support service process assessment and re-engineering

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Abstract

Service Engineering (SE) discipline is currently supporting companies during the engineering and re-engineering phases of their service offering. With the support of SE methods, companies can undertake their servitization journey with the best premise to gain as well as deliver value to their customers. For this purpose, the Service Engineering Methodology (SEEM) has been proposed. The SEEM entails methods to design service concepts and processes capable of balancing value between customers and the company. Some industrial cases, carried out in collaboration with ABB, a leading provider in power and automation technology, demonstrate the effectiveness of such methodology in the re-engineering of existing services in B2B context. Despite that, the cases show that the SEEM application is time consuming, especially in the validation of the service provision process. Thus, in order to facilitate and speed up the implementation of the methodology, a standard process for service provision becomes relevant. Then, starting from the re-engineering of the existing product-oriented services offered by ABB, this paper aims at laying the foundation for the definition of a reference model and a standard process model for product-oriented service delivery. The results will support the SEEM adoption and the definition of service processes avoiding the design of customized models, that cannot be compared and adapted to different realities. In line with what has been found in literature, the definition of a possible reference model and a preliminary standard process model are presented.

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Keywords: Service Engineering; PSS Design; Process Standardization; Reference Model

1. Introduction

Business complexity can be seen as the direct consequence of the globalization phenomenon that led to continuous changes in customers' demand. In order to face this evolving market and to fulfill the different requests, companies are seeking to provide bundles of products and tailored services, the so-called Product-Service Systems (PSS). Therefore, the materialistic value is nowadays replaced by an intensification of the service contents leading to the consequent dematerialization of offers [1, 2].

In such a context, companies that in the past were mainly focused on product engineering, are now striving to develop new services and/or improve the existing ones. However, the availability of proper methods and tools to support the service design is currently limited especially due to the intangibility of services. Indeed, existing engineering methodologies are more product-oriented and cannot be adopted in the case of intangible "product" (service). Therefore, in order to support companies in the design of the service components of a solution, Service Engineering (SE) emerged as a technical discipline, proposing structured methods for service design and development. Far from being a marketing-oriented approach, as the new service development is, the SE is a more technical-methodological approach that inherits and adapts (when possible) the traditional know-how to develop innovative services [3].

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In spite of the great success of the SE as an academic discipline, only few authors have proposed methodologies and tools, which can be easily adopted in the industrial context as they are usually customer-centric during the design of a solution [4,5,6,7,8,9,10]. For this reason, [11] proposed the Service Engineering Methodology (SEEM) as a useful framework to design solutions able to technically satisfy customer needs and considering, at the same time, the operational excellence during the service delivery. Fig. 1 shows the SEEM and the two main areas: i) left hand part regarding the analysis of customer requirements and needs and its comparison with the company current offering (if any) ii) right hand part focusing on the definition of the provision process optimizing company performance fulfillment.

Although this methodology provides a detailed description of each step along with the methods to be applied, its application [12], turned out to be time consuming, especially in the process validation phase. In fact, the methodology envisages the use of discrete event simulation model to validate the service delivery process prototype and to perform what-if analysis. This means that all the needed activities have to be detailed and data related to timing, demand, and resources involved have to be gathered or assumed.

Thus, in order to facilitate and speed up the implementation of the methodology, a standard process for service provision becomes relevant. In this way, a company when (re)-engineering its service portfolio does not have to start from scratch in the designing and validating the delivery process. Obviously, different standard processes should be defined for similar service categories. Service category refers to the classification made by [13], that distinguished between i) *product-oriented* services that are performed on the product itself and primarily requires deep technical knowledge of product functioning and operation, and ii) *customer-oriented* services addressing broader customer needs beyond product functioning and operation.

This paper focuses on product-oriented services and aims at laying the foundation for the definition of a standard process. In particular, starting from the re-engineering of existing product-oriented services offered by ABB, the goal of this paper is the definition of a process reference model and a possible standard service provision process for ABB.

Hence, Section 2 describes ABB and the main requirements in terms of standard process. Then, in Section 3, a standardization procedure is proposed to address the main gap identified in the SEEM with the objective of building up a standard model suitable for the application in different ABB units. Finally, Section 4 summarizes the main insights of this work and proposes further research prospects.

2. ABB: Identify a proper balance between product complexity and standardization requirements

2.1. ABB Company

ABB is a global leader in the power and automation technologies and its product range varies from robots to low voltage breakers, household appliances and high voltage motors. Two important goals of ABB are generating value for customers and enhance company value. Indeed, if on one side ABB has to beware of the customers' requirements, on the other side internal efficiency is crucial to ensure a profitable business. As a consequence, the portfolio of offered services is extremely heterogeneous to adequately address the different needs expressed by customers. Moreover, this complexity is further increased by the fact that ABB is split in several divisions spread all over the world. As a result, the different geographical locations, the different value propositions offered, and organization settings lead to the implementation of diversified delivery processes.

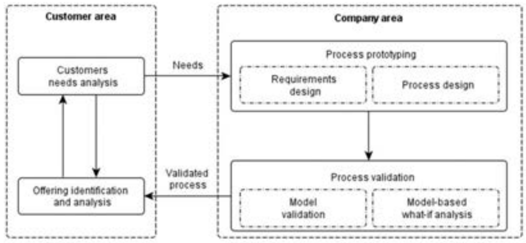

Fig. 1. SEEM framework [11]

With the aim to align the existent services to the changing customer's requirements, the SEEM has been adopted in several ABB units to re-engineer the current service offering. Among the variety of ABB services, those related to low voltage products (breakers and switches), robotics, and motors and generators have been analyzed [12,14].

The applications helped to identify the drawbacks of the current offering in satisfying customer needs and to highlight the main problems of the current service delivery processes. In particular, the process validation phase, carried out with a simulation-based approach, showed the bottlenecks of the current process and the possible issues in the future scenarios undermining the customer satisfaction and, at the same time, the company profit.

All the SEEM applications in ABB confirmed that the methodology provides valuable insights from company point of view. However it is very time consuming since every implementation requires the creation of highly customized service delivery process models. For instance, the SEEM implementation in the Motors and Generators (MG) division in Italy showed that the defined service delivery process model cannot be extended to other Motors and Generators units spread around the world or to other ABB divisions because every units has its own taxonomy and its own features. Thus, starting from this SEEM application, this paper aims at defining a standard service delivery process and a standard process model for ABB. In particular, the analyzed process is related to the delivery at worldwide level of product-oriented services (technical support, installation, commissioning, diagnosis, preventive maintenance and corrective maintenance).

The following section presents a brief review of existing works related to process standardization and reference model construction then, the procedure adopted for ABB case is presented.

3. Process Standardization

As previously highlighted, besides the effectiveness of the SEEM application to a specific reality, a challenge has emerged trying to define a standard service delivery process model that can speed up the SEEM implementation in other MG units around the world, and, in general, in other ABB divisions. As already mentioned, this is due, firstly, to the complex organization of the company which in many case manages the same process in different ways also within the same business unit. Second, the absence of a standard reference model in the PSS field, in terms of taxonomy and process steps definition, makes difficult to design, update or replicate a service offering in a standard way.

3.1. Existing works in the area of process standardization

In order to ensure content validity of the standard process, literature has been screened searching for a recognized standardization procedure. In this regards, [15] proposed a four-step-approach for the standardization of a service delivery process, suggesting to i) document all the process variants, ii) define an archetype process and then iii) enhance it to a standard process, exploited at the end to iv) homogenize the variants. Similarly, a seven-step-approach has been developed by [16], called "standard work wheel", which focuses not only on the generation of contents but also on the definition of user-friendly layout and KPIs to make the model easy to implement, control and update. Furthermore, [17] pointed out the following three main criteria for a business process-modeling standard:

- An intuitive notation;
- A meta-model and vocabulary—a group of concepts and relationships—that are strictly and consistently defined to provide a solid foundation for the various business process approaches.
- A breakdown of the meta-model and notation for each level of analysis of business processes.

Besides the identification of a standard process, literature highlighted the importance of adopting a common terminology, which is clear and reduces misunderstanding, allowing an easier application of a specific model to different realities and ensuring consistent results from process optimization.

Considering the literature findings, the following two parallel actions should be undertaken to identify a standard process and taxonomy:

- **Definition of the process archetype.** According to [15] it derives from the analysis of the process variants. In this phase, the two main objectives are the identification of common activities and the isolation of process specificities. Moreover, the effectiveness of the standardization can be enhanced by the process modularization and the use of an intuitive notation, as suggested by [16] and [17].
- **Definition of a reference model** for the taxonomy and the process structure, developed on the basis of [18], for building up a univocal documentation about process flow, structures, resources and tools, which contributes to simplify and fasten the implementation procedure, while providing a better understanding of the processes.

Table 1 Reference model literature review

Reference Model	Purpose
APICS-SCC Framework	
SCOR	SC performance measurement and comparison [20]
DCOR	Link R&D business processes, metrics and practices [21]
CCOR	Link sales operations and customer support business process, metrics and practices [22]
PLCOR	Link product lifecycle processes, metrics and practices [23]
Federal Enterprise Architecture (24)	
PRM	Link strategy, internal business component and investments
BRM	Link business function and IT investment
DRM	Facilitate the discovery of existing data
ARM	Categorize standards and technologies that support the delivery of IT service
IRM	Provide a categorization scheme for physical IT assets
SRM	Controlling security and privacy
Other Models	
VCOR	Release a unified reference model for the entire enterprise [25]
E-TOM	Provide a common language for service providers' internal process, collaborations, alliance, agreements with other providers [26]
ITIL	Provide a wide accepted guide of Best Practice for the IT Service Management [27]

If in the case of process archetype definition the standard procedure is related to process modularization, in the case of a reference model, there are many existing works that can be adopted and adapted. A reference model can be defined as an abstract framework for understanding significant relationships among the entities of some environments [19]. Its main objective is to provide a consistent breakdown of the process under analysis, while using a taxonomy suitable for different implementation across and between different industries. Table 1 reports the reference models found in literature along with their specific purpose.

It emerges from the table that there are many models referring to the IT industry and models focusing on different company departments, but only few of them refers to service processes models. In addition, only the CCOR mentions activities in direct contact with customer.

In any case, whenever one of the suggested reference model cannot be adapted to a specific case, literature provides some useful suggestion to develop a new reference model even if a wide recognized approach is still missing.

An example from the IT industry is presented by [28] that construct a reference model for product derivation process, using an evolutionary multi-method approach. An additional method, more oriented to business process, is proposed by [18] who suggest to aggregate existing reference models taking into account only the most useful and significant elements of each model. Anyway, this method requires also a careful final check in order to eliminate possible redundancies. A practical application of this approach in the mainboard industry can be found in [29].

Based on the approach suggested by [18], the following sections report how the standardization of the service delivery process has been carried out. Then, the main issues and positive implications faced in the application in ABB Motors and Generators business unit are also discussed.

3.2. ABB process standardization

In line with literature findings, the two steps needed to identify a standard process and taxonomy for the product-oriented services delivery process (technical support, installation, commissioning, diagnosis, preventive maintenance and corrective maintenance) have been carried out in parallel.

3.2.1. Definition of a process archetype

As already mentioned in the previous section, there is not a standard process replicable and applicable worldwide because of the complexity generated by ABB service variety, different customer requests and diverse organizations. Accordingly, several service delivery processes are implemented in different realities trying to match requests, resources competences, availability and cultural differences. For this reason, the process variants have been documented, comparing the main process mapped for MG with the process of other MG units. Consequently, some adjustments to the initial model have been introduced to come up with a standard map adaptable to the different realities. These modifications have not been immediate and they required several meetings with ABB managers. The focus has been on the following three main objectives:

- **Re-definition of resources**: resources have been classified in different groups and analysed, considering their role and their tasks. Specific resources who perform tasks that in other units are performed by other resources have not been considered as necessary resources in the archetype process and they have not been considered "per-se". Their tasks have been included in other more general resources task. For example, the team responsible of handling warranty requests is not present in other units and so this kind of resource has not been included in the reference model that only considers necessary resources. In case a business unit requires warranty handling activities, they are performed by other more general resources, in this case the back office. Moreover, the nomenclature used for the other resources was aligned with ABB standard role definition to avoid misunderstanding.
- **Re-definition of activities:** to provide a better understanding of the process phases, they have been organized to accomplish the reference model developed in parallel and presented in the next section. In addition, process variants have been defined and the basic process archetype has been settled. For example, warehouse activities have been identified as non-common activities and therefore have been considered as process variants.
- **Re-classification of service products:** the service products analysed in the standard model are essentially the same of in all the units. However, also in this case, the terminology has been adapted in order to be understood by everyone. They have been modified according to the reference model described in the next paragraph.

Regarding process modularization, no further modification has been introduced, since all the service delivery processes can be decomposed in sub-processes defined by the company itself.

3.2.2. Definition of ABB reference model

Although several reference models have been developed for different purposes and applications (see table 1), none of them seems to perfectly fit with ABB reality. In fact, neither they are focused on the service delivery process nor they are able to manage systems complexity. Therefore, they cannot be easily adapted to the company. Moreover, the different languages and process definitions used in the existing reference models lead to ambiguity and difficulties in the comprehension of the process mapping, so that people have to be trained to understand such notation.

For all these reasons, the development of a new reference model has been required. As highlighted before, literature lacks a wide recognized approach for building up a consistent framework.

Following the suggestions emerged from the literature [18], the development of ABB reference model has been accomplished merging two existing reference models. In particular, a custom framework for the service macro-processes defined by the German corporate research center of ABB, and the CCOR reference model have been selected. The CCOR is a wide accepted model proposed by APICS SCC [30] for organizing and analyzing customer's chain processes. The CCOR framework has been selected since, as reported in Table 1, is the only one considering customer support and, for this reason, can be a good starting point for the development of ABB reference model. The majority of the activity descriptions in the level-1 "assist" developed by APICS-SCC can be applied to the process identified in ABB context, contributing to the goal of realizing a framework as standardized as possible, with low complexity. At the same time, the integration with ABB macro-processes framework allows making the model more familiar to ABB managers and it defines a consistent breakdown of the process flow.

About this, it is important to point out that the rigorous structure defined for reference model enhances process standardization and ensures a wider applicability of the model. At the same time, it generates repetitions in some definitions. Anyway, those are essential in order to make each part self-explaining and better comprehensible. In the next paragraph, a short summary of the reference model built is reported.

3.3. ABB reference model

The final reference model developed through the merging of CCOR and ABB standard macro-processes is organized upon a hierarchical structure. So far, the reference model developed focuses on one process of the first level that refers to the "assist" activities. It has been called (Level-1) called "Field Service". It corresponds to the macro-area of interest, namely the product-oriented services and so far, it does not consider the other Level-1 processes that, in the CCOR mainly refer to the product component of a PSS solution. The identified "Field Service" Level-1 is then divided into two main Level-2process types: *Remote Support* and *Service Job on site,* that are further decomposed in Level-3 processes according to the ABB classification of macro-processes (i.e. *Handle customer's request, Assess feasibility and create the offer, Manage the* *order, Mobilize and plan, Prepare job, Perform service job at customer, Complete job.*). The first three levels of the reference model are represented in Fig. 2.

Once identified Level-3 structure, the analysis moves to a more customized level where specific company activities are identified and described (Level-4). Due to space constraints, the lower levels of the reference model are not reported. Similarly to [28], a meeting with the Global product manager of the ABB Field Service has been carried out for the definition of ABB standard service activities. Accordingly, for each Level-2 processes (i.e. Remote Support, Service Job on site), all the activities performed to deliver services to customers have been listed (Level-4), dividing them according to the macro-processes defined by ABB (Level-3). The activities reported in this last level are only those ones in common among the main MG service delivery process and the other MG units' service delivery processes.

This initial step was essential to establish a structured standard framework for the service delivery process, which offers the possibility to set up a more powerful process model expected to reflect the real features of the product-oriented service processes. In this way, managers would be able to align a service delivery process to a standard model. This archetype process has been represented in the blueprint structure as suggested by the SEEM methodology and reported in Fig.3. This blueprint is not just a map useful to visualize the different steps of the process and the resources involved, but it can be exploited as a tool for supporting the decision making process. In fact, the static model can be turned into a dynamic adding data related to activity timing, input requests, and so on. In this way, managers could measure performances and compare them with other units.

However, from the previous ABB case studies, it has been noticed that not always the data required to run the simulation (i.e. *Activities Time, Number of Resources, Resources Calendar, Number of yearly requests per type*) are available or easy to collect, especially for what concerns the number of requests processed. For this reason, further modifications have been aimed at making the model as "user-friendly" as possible considering that this tool has been designed to be applied autonomously by managers in different centers. In the map, the macro processes identified in the reference models (Level-3) have been highlighted with blocks of different colours as shown in Figure 3. In the background of figure 3 it is also possible to observe the (Level-4) specific company activities.

FIELD SERVICE	
FS1. Remote Support	The process of enabling customers to perform after-sales support for products offering remote assistance. This includes receiving and responding to customer's inquiries or claims, trying to suggest a solution for problems deployable by the customer himself. All these tasks are held directly on phone.
	• FS1.01 Handle customer's requests
FS2. Service Job on Site	The process of providing after-sales support for products provided to the customer at the customer site. This includes receiving, logging, assigning support resources and responding to customer inquiries.
	• FS2.01 Handle customer's request • FS2.02 Assess the Feasibility and Create the Offer • FS2.03 Manage the Order • FS2.04 Mobilize and Plan • FS2.05 Prepare Job • FS2.06 Perform Service Job at Customer • FS2.07 Complete Job

Fig. 2. ABB Motors and Generators Reference model upper levels

4. Conclusions

In the age of globalization, the business word is experiencing many changes. Competition is more and more aggressive in an environment in which customers' requests are growing and becoming more precise and specific. Thus, services, combined with responsiveness and quickness in meeting customer wishes, enclose the real strategy to fight rivalry and boost the profit for manufacturing companies.

On this wave, the presented work originated from the need to support companies in re-engineering its services offerings, through a practical and effective methodology. In particular, the SEEM has been developed. However, this methodology turned out to be very time consuming. In fact, the adopted SEEM framework adopted neither includes a reference model nor a standard process model for service delivery process, which could aid companies and practitioners to simplify and facilitate the comprehension of the entire process. This would avoid time-consuming meetings necessary to understand and design the process of service delivery every time a new service or an

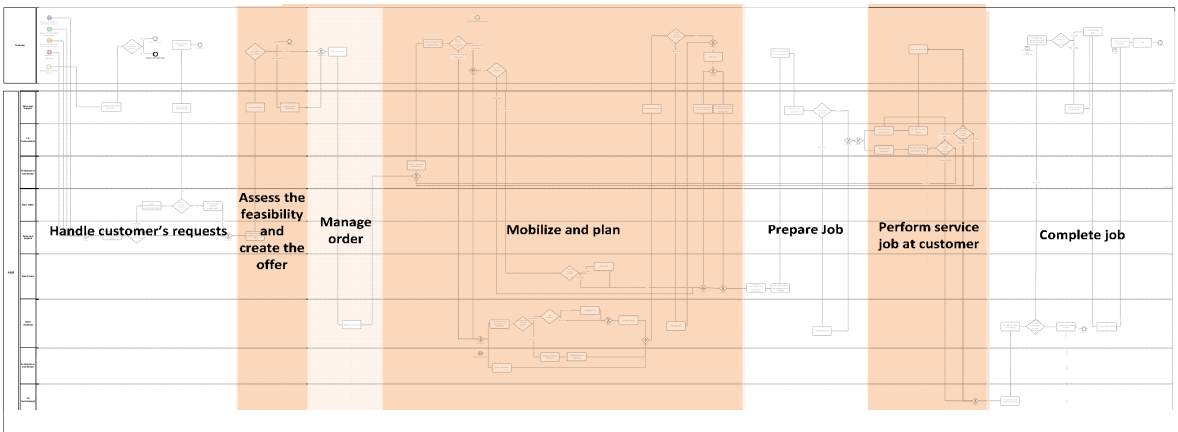

Figure 3 Blueprinting map of ABB standard process

updated version of an available service would be implemented. Therefore, with the aim to fill this gap a procedure for process standardization has been identified, adopting suggestions available in the literature related to the merging of different reference models. In particular, a process archetype has been developed and a reference model has been defined for ABB service delivery process, starting from the Motors and Generators division field service delivery processes.

As a result, ABB was able to exploit the standard framework for the service re-engineering and also benefits from a standard process model to use as a guideline for service delivery process homogenization along the motors and generators business units.

This work represents a starting point for the definition of a standard service delivery process that can be included in the SEEM. Future work regards the integration of Level-1 process “Field Service”, which was the focus of this initial reference model definition with other Level-1 related processes that refers to the product components of PSS. This would allow the definition of a complete reference model for a PSS solution.In parallel the identified framework will be integrated with a set of KPIs and robust performance indicators against which measure the results of the simulation runs. Finally, more case studies in other industrial contexts should be carried out in order to define similarities and contact points among the different product-oriented service delivery processes and finally come up with a common standard process and reference model.

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