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Methodical Approach For Detailed Planning Of Services To Offer Product Service Systems

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Abstract

The transformation of current business models towards offering product service systems (PSS) provides manufacturing companies numerous opportunities to consolidate or even expand their competitive position. Companies are confronted with the challenge of successfully designing this transformation process simultaneously. In order to approach the development of new business models and the transformation process, business model patterns and best practices provide a good first orientation for companies. However, these are designed to be industry-neutral and rather abstract when considering the actual processes. Thus, they do not offer any individual support to companies in the specific development of a business model and its required service delivery processes. Service delivery processes are part of a business model and describe activities that take place to provide services. Small and medium-sized enterprises (SMEs) in particular do not have the necessary time, technical and methodological resources to manage a transfer from abstract business model examples to an individual business model. This barrier often leads SME to remain with their traditional business model.

Therefore, this paper presents a methodology for the detailed planning of service delivery processes. The designed methodology supports the phases design and implementation, which are part of the business model development. The methodology describes a structured procedure, in which relevant services first have to be identified. These services are then broken down into individual process modules on a second level. The modules are elements that can get combined to services. On a third level there are explicit process models. The process models are assigned to the modules and define the respective process steps and the requirements for the implementation. The approach is designed to support companies successfully transform to new business models for PSS by applying the detailed planning for services with specific modules that contain detailed process models and requirements.

Keywords

product service systems; business model transformation; process modeling; detailed planning; SME

1. Introduction

Manufacturing companies, especially small and medium-sized enterprises (SMEs), face the challenge of consolidating or even expanding their competitive position in the increasing global market [1]. Ongoing digitalization and the development towards industry 4.0 drives and enables the transformation of current business models towards offering product service systems (PSS) and at the same time help companies to cope with the mentioned challenges [2,3]. A PSS is an integrated offer of one or more goods and services [4]. Companies are therefore increasingly concerned with the development of innovative business models

for PSS that include the actual product combined with integrated services as individual product solutions. This creates greater added value for customers through more customized products, while companies also benefit through, for example, closer customer ties and continuous contact during the service delivery phase [5]. However, regardless of the advantages PSS offer, e.g. in terms of competitive position, customer loyalty and customized product solutions, a large number of SMEs remain operating as traditional producers who sell the physical product as the main sales object and only in some cases offer individual services like repair and spare parts delivery upon request. One of the reasons for remaining with the traditional business model is the lack of time and the lack of technical and methodological resources which are required to overcome the barriers that are linked with the servitization [6,7]. Existing process models and business model patterns that can be used to develop business models for PSS provide a good framework for the development of the integrated services and offer methods for implementation. Yet, the existing process models do not provide a detailed support, especially for SMEs, as they are often designed to be industry-neutral and application neutral, thus rather abstract [8]. Therefore, this paper examines the research question "How does a methodical approach for detailed planning of service delivery processes to offer a PSS has to be designed so that SMEs can independently manage the business model transformation to offer a product solution consisting of the product and integrated services?". For this purpose, chapter two first deals with a general overview of business model development and implementation, existing models, phases and methods and a summarized evaluation with regard to suitability for SME support. The actual methodical approach for detailed planning of service processes for manufacturing companies in business model transformation and its considered development procedure are presented in chapter three. Chapter four then summarizes the methodical approach, considering the research question, and provides an outlook on how it can be expanded and used further.

2. Business model development and implementation – initial situation

A business model generally represents the framework for all entrepreneurial business processes on an abstract level and serves as a management tool with the help of which the business activities can be described, analyzed and designed holistically [9,10]. It describes in an abstract way the architecture of value creation by mapping how a company creates, provides and protects value [11,12]. This can be seen on the middle level of the pyramid, which represents the levels of business model differentiation according to Osterwalder and Pigneur (see Figure 1). The strategy at the planning level determines the direction and scope for business models. The company-specific implementation includes the design of the business processes, which is executed on the implementation level [13,14].

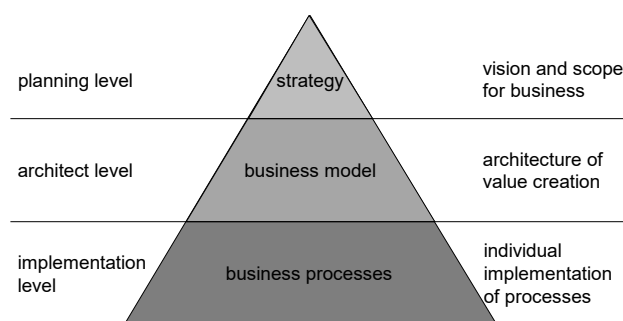


Figure 1: Business model differentiation according to levels and characteristics based on [14]

In order to achieve the strategic goals and taking into account the strategy as orientation as well as the scope for action, the business model development represents a core element for a successful transformation. More and more manufacturing companies are pursuing the goal of developing new business models, thus changing into PSS providers. This transformation requires the implementation of change management processes and innovation processes, which are initiated by means of the methods and tools specified in the process models.

In the literature and in practice, a variety of process models exists to support and guide companies through the development and innovation process. Gassmann et al. for example composed a database and procedure called the *St. Gallen business model navigator* which includes *55 innovative business concepts* [15] to help companies develop new business models. Osterwalder and Pigneur also published a widely known guideline [15]. According to Lins et al., who analyzed different process models, 25 process models were selected from a literature research according to criteria such as, among others, providing real process models and a connection to digitization and industry 4.0 [8]. Within these selected models six general phases (*preparation, idea generation, design, evaluation and selection, implementation and sustainment*) for business model development were identified [8], which are fully or at least partially addressed by the various models. The start of the transformation process begins in the preparation phase which supports the companies to become aware and prepare for the transformation. This is followed by the creative process for new business models, their design and evaluation. When a new business model is selected it gets implemented, operated and continuously monitored and improved. The whole procedure is an iterative process and needs to be regularly run through by the companies in order to remain competitive. Most of the process models for business model development suggest practical methods and tools to support a successful realization of each process step. Thus, the authors provide tools like the business model canvas from [16] or supporting guiding questions, business model patterns (e.g. [17,15]) or software programs as possible methods [8]. Guiding questions can be used as reference during the transformation process while the business model patterns serve as input for the creative and development phase giving examples on actual business models or samples with abstracted models of different business models of different branches. Software-based tools (e.g. the business model configurator by [17] or the tool for the business model engineering by [4]) support automated the execution of the steps and its methods so that the user can manage the implementation of each of the phases more quickly and easily based on the stored databases and software processes.

The evaluation of the analysis of process models for business model development by [8] shows that the detailed steps of the process models and the linked methods help the companies to understand the different and necessary steps well and to apply them more easily and correctly. It also underlines that business model patterns and best practices are a good orientation for the companies which want to renew their business model or want to develop a new one. But one occurring barrier especially for SME is the final and detailed planning of the processes for the new business model and its implementation because the existing process models are on an abstract level and industry-neutral so that the companies are not able to perform the transfer and the individualization on their own. As long as there is a lack of an individual development methodology with consideration of the existing internal processes and the strategic orientation of the respective company, the process models and its elements that are generally known in science have to be extended accordingly [18]. This can also be applied to the software-based tools, which are a good support but, like the underlying approaches, are on too abstract level to answer the research question. In addition, the approach must be easily and independently implementable by companies and contain solution-patterns that are understandable and can be individualized and transferred to the processes of the companies. In order to provide full support to companies, the solution-patterns and requirements for the chosen scope must be complete [8]. Therefore, in the following a methodical approach for detailed planning of service processes for manufacturing companies is presented, that supports the specific individual realization of service delivery processes for new business models.

3. Approach for detailed planning of service delivery processes in PSS

3.1 Research design and boundary conditions

The approach for detailed planning of services should support companies by planning their service delivery processes in detail and get necessary requirements for the implementation. Therefore, the approach provides

a service catalog, which represents the core element. The service catalog includes solution-patterns in form of process modules with stored process models. These solution-patterns are created by applying the theory of inventive problem solving (TIPS also known as TRIZ) according to [19] as the considered research design and are then listed in the catalog. After the catalog got created it can be used by the companies to plan their new service delivery processes in detail. The procedure for the detailed planning by companies is methodically supported by applying the TIPS method with the new created solution-patterns. TIPS originated in Russia and describes a method to solve (technological) problems and innovation tasks. It follows the three hypotheses that abstract problems and solutions repeat independent of their field of knowledge, that similar patterns are the basis for many technical developments and that reasons for innovation are often made from external influences [19]. The theory includes two levels, the concrete and the abstract level. First a concrete problem is abstracted before an abstract solution for the abstracted problem is sought. In a third step the abstracted solution gets transferred to the concrete level and a concrete solution for the origin problem is developed [20]. The abstract description of the problem is carried out by 39 predefined parameters while the abstract solution is generated from 40 defined principles. The TIPS principles and parameters were derived by analyzing several thousand patents and were then summarized in patterns which are represented by the principles and parameters. This means that the inventor of TIPS first sought concrete solutions (patents) for abstract problems, and then abstracted them. By collecting the many solutions and bundling them into patterns, it was then possible by following the known TIPS method to first generate abstract solutions for abstract problems and specify them in the final step.

For the present research question the single parameters and principles are not usable, because they are based on technical contradictions and are not suitable for business model development [20]. But in accordance with the systematic of Lehner, who used this procedure for the solution-pattern-based development of business models for frugal innovation [20], the hypotheses and procedure to solve a problem almost automated with standard solution-patterns that are finally individualized are of huge interest and suitable for the approach of detailed planning. Therefore, the steps of creating the principles and parameters from concrete solutions according to the TIPS inventor will be first used as research design for creating new solution-patterns. The solution-patterns of services for the manufacturing companies consist of derived standardized and generally applicable process models which are combined and linked to modules and these modules to services. The detailed services are then listed in the solution-pattern-based service catalog (see Figure 2). And secondly the actual TIPS method is used as a process model for the companies to plan their service delivery processes in detail by applying the newly created solution-patterns (see chapter 3.3).

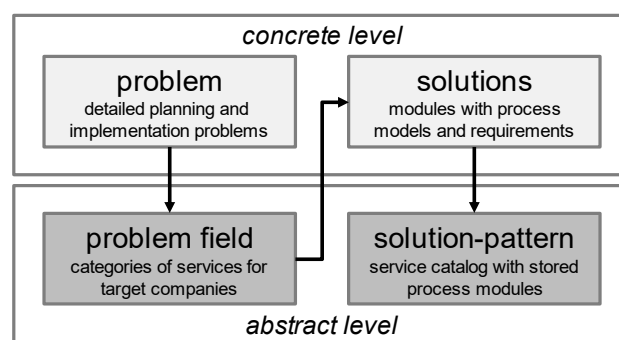


Figure 2: Research design for creating solution-patterns for service delivery processes in adaption to TIPS

To meet the requirements of specific and detailed process modules and process models, that can be used and individualized by companies especially by SME on their own, the methodology considers the following boundary conditions. By the fact that specific process models, which are designed to be realistic and detailed, are necessary as solution-patterns, which can be easily transferred to the own company, the approach defines a clear scope that is considered. In this case the scope is set for companies from the machines and plant engineering. Although, the general procedure of the approach to derive specific process models is applicable

for all branches and fields where service processes need to be developed, it is so first implemented for SME from the machines and plant engineering. This scope is set to have a clear area for analyzing which must be completely covered with detailed solution patterns. This focus is also laid of manufacturing companies because as mentioned before their need is to develop integrated services to act as a provider of PSS to stay competitive and in this branch, machines are often still seen as the actual technical products. The still predominantly classical and conservative manufacturing SME particularly need to get support in developing new business models for offering PSS to consolidate or even expand their competitive position in a globalized and digitalized market [21].

3.2 Solution-pattern-based service catalog to offer PSS

The creation of the service catalog following the presented research design considers the two phases identification and derivation of a listing of suitable services (steps “problem” and “problem field” in Figure 3) and creation of solution-patterns as process modules consisting of process models for the detailed planning (steps “solutions” and solution-pattern” in Figure 3).

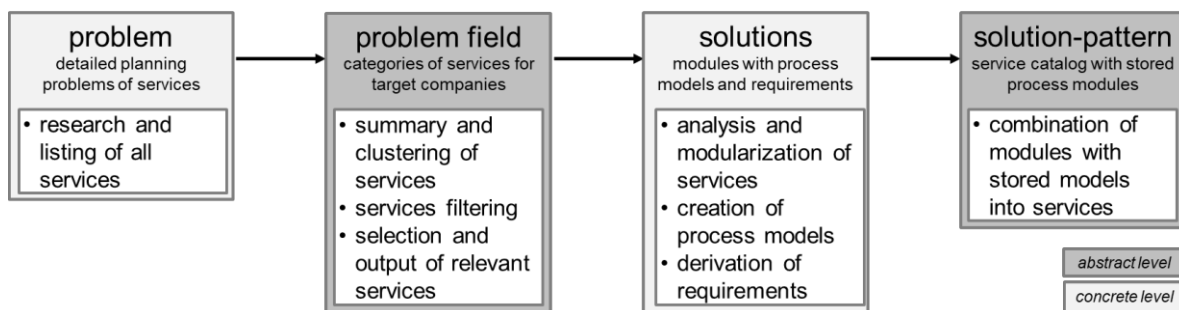


Figure 3: Process steps for creating a solution-pattern-based service catalog

Starting from the concrete problem that companies are not able to develop and implement the necessary service delivery processes for new business models to offer PSS on their own, suitable services are researched and listed. The systematic literature research was conducted in the databases “Web of Science” and “Scopus”. It was carried out with terms which contain combinations of relevant search strings from the area product-service-system, such as *product service system*, *servitization*, *industrial product service system*, *sales service* or *smart services*, and from the area production, such as *machinery*, *manufacturing* or *production*. Also, the database of “Springer” was used with german search phrases like *after sales service*, *product-service-system* or *services* in combination with the term *industry*. After removing duplicates and reviewing the titles and the abstracts, 27 works are listed and present the basis for the creation of the listing of suitable services. The researched services are reviewed and then summarized and clustered. It is checked if services have common categories or if they are the same or synonymously used. In a next step the summarized list of services that clusters the services in different categories is filtered. To meet the boundary conditions, it was filtered by the following underlying criteria:

- Is the viewed service a real performance (process) in the sense of a value proposition?
- Is it a performance for which a customer might be willing to pay?
- Is the service standardizable and transferable or only individually for a single company?
- Does the service show a relation to production and manufacturing as well as a relevance for manufacturing companies?

All services were evaluated according to these criteria. Finally, an overview in the form of a listing with the different selected categories and their subordinated services is derived and visualized. Categories corresponding to the criteria are, among others, monitoring, maintenance, operations, spare part management, installation, remote services, and trainings.

In the following the categorized and listed services get analyzed and broken down into individual process modules on a second level and these modules then into process models on a third level with concrete solutions (see Figure 4).

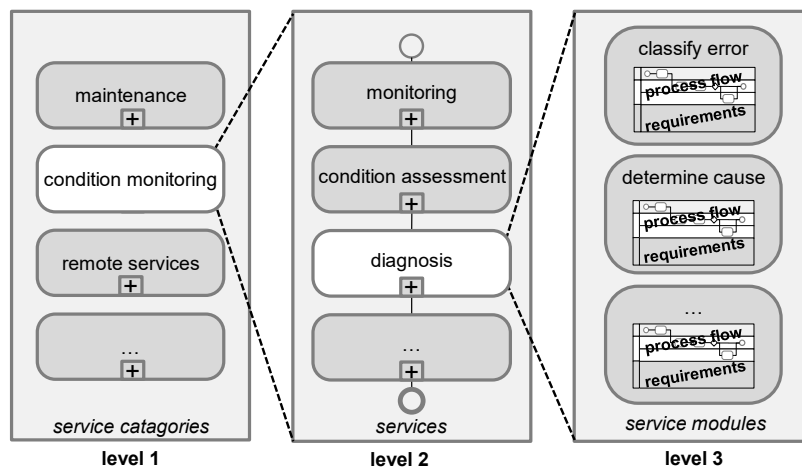


Figure 4: Structure of the service catalog with examples

Each service is reviewed in which modules it can be divided by using standardized descriptions of the services. For this purpose, norms, standards and technical literature (e.g., German Norm DIN, European Norm EN, VDI or VDMA norms) that describe the service or parts of the service processes in a standardized way are used as references. For example the service category *maintenance* can be divided, among others, into the services servicing, inspection, repair and improvement which can be divided into other modules on a more specific level on the basis of the DIN norm 31051 [22]. The subcategory servicing includes the process modules cleaning, readjustment, refilling, replacing and lubrication [22] (exemplary see Figure 5). In addition, more subdivisions according to the planning ahead and the used database are derived for these services and are compatible with the other modules. Following this general procedure, process modules for all services are derived. On a third level there are explicit process models which are assigned to the process modules. As with the subdivision of the listed services, the process models are created by further breaking down the process modules by using standardized descriptions. Each process module can be created by using one or combining more than one process model.

The process models are the core element for the detailed planning. They provide all information about the processes step by step. The sequences are modeled and visualized which is done with the help of the method business service blueprint modeling (BSBM). The BSBM represents an approach for modelling service processes with customer interaction. For this purpose, it combines the standardized and well known notation of the business process modeling notation (BPMN) with the structure and layout of the method service blueprint (SB) [23]. Based on BSBM an uniform and customized template for describing and visualizing the process models is created. Accordingly, all process models are created with a starting point, defined process steps with specified order and necessary branching points, level of customer interaction and end point. Adapted from the SB and in consideration of services for offering PSS the possible forms of customer interaction vary from customer activity over provider activities with customer contact to provider activities in the background without customer contact. The process steps are arranged in the respective lanes by their level of interaction and are linked with arrows in the correct order. Additionally, special requirements for each process step are defined to support the implementation of new service delivery processes for new business models in the companies. The focus of the requirements is on the one hand on the competencies required to perform the process step and on the other hand on the necessary (technical) data and their properties for steps of data-based services. The requirements are noted for each step and are connected to it.

For the required competencies for the technicians who need to execute the process steps a literature research is carried out. As basis for the overview of possible required competencies the CDIO Syllabus v2.0 by [24] is used that defines in detail skills and goals for the engineering education by comparing the first version of the Syllabus with the UNESCO four pillars of learning and with national accreditation and evaluation standards of several nations [24]. These results are then aligned with the other approaches to competence management. The aligned competencies are evaluated against the last criteria that is defined for the evaluation of the services. It is checked if they show a relation to technical processes, production, manufacturing and (technical) data processing. Competencies for the common interaction with customers like e.g., kindness and language, are highly important for a service technician but they are taken for granted and are not part of the present approach. The other matching competencies are summarized in a checklist that facilitates the assignment of competencies to the process steps. Also, a checklist is given for the second group of requirements. Data as well as its correct capture and use are gaining in relevance for all services especially for smart services [25]. Therefore, the checklist mentions possible and exemplary data requirements. Among others, it should propose the type, origin and intake, the quantity and classification, as well as the evaluation of the data as points to be considered for each process step. The checklists for both groups of requirements serve as a help that for all steps the requirements are standardized assigned and that none are forgotten. Finally, a process model defines in detail the necessary process steps, their level of customer interaction and special requirements.

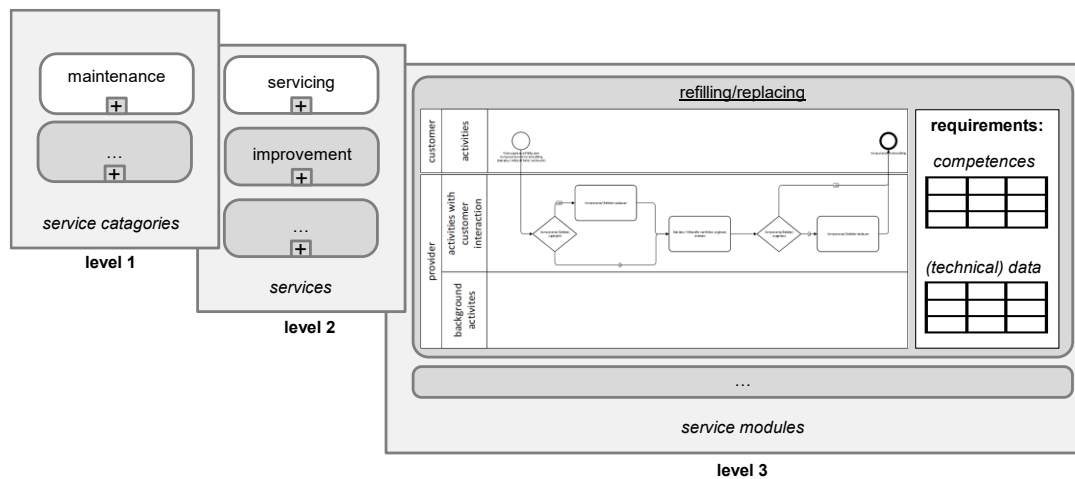


Figure 5: Extract from the modularization of the example "maintenance"

The solution-patterns of services for the manufacturing companies are created by combining the derived process models to modules and these modules to services. With this procedure the detailed and subdivided process models can get linked to one or more modules and services, because many of the generalist process models are part of different service delivery processes. The services and modules are listed in the service catalog as solution-patterns. By the fact that the process models, which contain all information of the required process steps and requirements, get combined to services and are linked to these, there are all information noted and visualized for each service. In this way the solution-pattern-based service catalog for the detailed planning of services to offer PSS includes the model of the ideal-typical process flow composed of the different process models and the requirements related to necessary competencies and data. It represents the input for the actual detailed planning of the service delivery processes by the companies. The catalog can be extended for another scope or other branches by following the steps of the methodology.

3.3 Procedure for implementing service delivery processes by companies

Manufacturing companies which want to plan a new business model in detail and implement it, often get through the business model development phases until they have to develop their individual processes und

structures in the companies. That means they create and evaluate ideas for new business models within the scope of the intern strategy and select one or more models for further processing. At that point in many cases they miss time, technical and methodological resources to transfer the ideas into real implementation projects and remain with their traditional business model. Therefore, the second part of the methodical approach is designed to support companies successfully implementing integrated service delivery processes to transform to a provider of PSS using the solution-pattern-based service catalog. The approach foresees to apply the TIPS method with the newly created solution-patterns to get the individual processes for the companies for the chosen service as individual solution (see Figure 6).

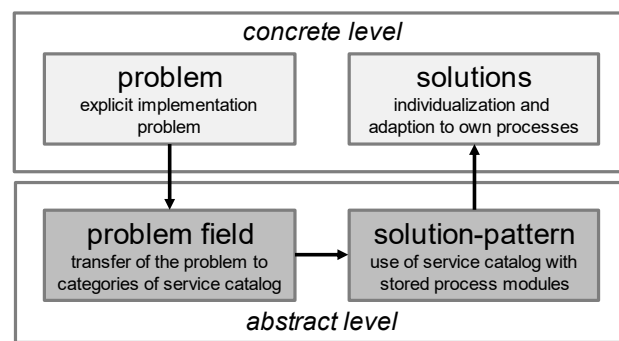


Figure 6: TIPS-based procedure for applying solution-patterns for the detailed planning by companies

Companies which already got through the creative phase of the business model development or already know their desired business model can check out the service catalog for their target service category and target services. By choosing the target service they get the deposited information including the ideal-typical process flow and the requirements related to necessary competencies and data as results which can be used for the next actions by the companies. In a next step they have to individualize and adapt the processes according to the own and individual conditions and situation. Simultaneously a matching and an analysis of the required competencies and data with those available in the company are carried out. At that point the companies do have all information about the required processes with individual process steps that can get implemented and it can be decided whether all requirements are met. If a deviation occurs during the matching and the analysis of the actual and the target situation the approach with its detailed information serves as a decision support e.g., whether to build up missing skills through training or buy them in, whether to outsource the entire process or revise the idea of the selected business model again. This approach enables companies to independently plan in detail and develop the existing or generated ideas for a new business model and thus successfully move from the idea of a business model to its real implementation.

4. Summary and outlook

The transformation and the development of new or adapted business models is a current topic in practice and research supported in particular by the ongoing digitization and industry 4.0. Manufacturing companies are increasingly trying to transform their business model in terms of offering PSS by combining their physical product with integrated services. The business model in general serves at an abstract level as a management tool for visualizing, analyzing and developing all business processes required for value creation. Therefore, there is a variety of process models that aim at the development of business models and offer methods and tools for the transformation process. Although many methods and tools are mentioned there is a lack of support for the competence-based detailed planning and individual implementation of the new business models developed in the creative phases. This concerns especially SMEs, some of which do not have the necessary resources to perform that transfer on their own. This gap is addressed with the present methodical approach which is based on the solution-pattern-structure of the theory of inventive problem solving. The methodology foresees two procedures. The first describes the creating of the service catalog with process

modules and linked process models. The catalog provides information about the ideal-typical process flow and requirements for the process steps because each service delivery process is formed by a combination of different process modules, which in turn are composed of the derived elementary process models. The second procedure addresses the application of the service catalog by the companies to plan their business models in detail and implement the corresponding service delivery processes on their own. The approach provides relevant services with ideal-typical, detailed process models and required competencies, so that companies from the mechanical and plant engineering sector can directly test and independently implement the delivery processes of the new PSS. The procedure for creating the solution-pattern-based service catalog is generally valid and transparent, so that it can also be transferred and elaborated in further work to areas and service processes outside the set boundary conditions. Also, the requirements elaborated here, which are based on the boundary conditions, can be extended according to the needs of the target group in terms of the present procedure. In this way, the service catalog can be extended and can be used in fields and branches other than its original narrow focus. In future work a proof of concept must be further carried out with manufacturing companies for the application of the methodical approach for detailed planning of services to offer PSS with the specific focus set by the boundary conditions. For user-friendly use, the contents of the service catalog, such as categories, modules, process models and requirements as well as dependencies, will be transferred into a software-based tool.

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Biography

Dominik Lins (*1991) has been working as a research assistant at the Chair of Production Systems (LPS) at the Ruhr-University Bochum since 2016 in the field of production management. He earned a bachelor's and master's degree in mechanical engineering at the Ruhr-University Bochum. His primary research topics are the digitalization of production systems and product service systems.

Until 2009 **Bernd Kuhlenkötter** (*1971) was responsible for product management and technology at ABB Robotics Germany. In 2009 Bernd Kuhlenkötter took over the Professorship for "Industrial Robotics and Production Automation" at the Technical University of Dortmund. Since 2015 he holds the professorship of the Chair of Production Systems (LPS) at the Ruhr-University Bochum and is managing director of the Institute for the Engineering of Smart-Product Service Systems.