Consulting via Research in IMPRESS

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ABSTRACT

Manufacturing companies in mechanical and plant engineering are increasingly aiming for the change from product manufacturer to digital service provider. Digitalization is bringing data-driven digital services – so-called Smart Services – into focus. However, the resulting systems of hybrid value creation and work differ fundamentally from the systems established today.
Especially small- and medium-sized companies face major challenges concerning the transformation to a Smart Service provider. The reason for this are the historically grown corporate structures of value creation and work. Additionally, there is often a lack of sufficient expertise and resources to identify and implement necessary changes. Many small and medium-sized enterprises are aware of the potential of Smart Services. But the realization and offering of Smart Services has so far only taken place occasionally. Therefore, we cannot but deduce that a comprehensive socio-technical consulting approach is required to launch Smart Services efficiently.
The paper at hand presents an approach which addresses these challenges holistically by using research-based consulting. It is based on the Design Research Methodology according to Blessing and Chakrabarti. The adapted consulting via research approach is applied and validated by four case studies from tooling machine industry within the joint research project IMPRESS.

Keywords: Smart Service, Hybrid Value Creation and Work, Design Research Methodology, Consulting via Research, Innovation Chain, Transformation Process

1. INTRODUCTION

The manufacturing industry is currently undergoing profound change. This is particularly due to the two megatrends servitization and digitalization which change the value creation of the companies. The convergence of these trends enables companies to create and offer a new form of hybrid market offerings, so-called Smart Services. However, the high complexity of Smart Services and the often classical, traditional corporate structures of value creation and work pose challenges to the companies in implementing them successfully. It is indispensable to support companies with adequate consulting during their transformation process from product manufacturer to smart service provider. In the joint research project IMPRESS we therefore scientifically develop a set of instruments for the pattern-based planning of hybrid value creation and work for Smart Services and provide the companies with corresponding consulting measures. In the paper at hand, we will present our consulting via research approach.
First, we introduce Smart Services as a synthesis of the two megatrends digitalization and servitization. Second, we point out the challenges in providing Smart Services. We therefore analyze the effects of Smart Services on the socio-technical value creation and work of companies in the dimensions business, organization, human resources and technology. Moreover, we present a framework for the planning of Smart Services to structure the field of action for designing the transformation from manufacturer to smart service provider. This framework provides the scientific basis for consulting via research. Third, we present the specific approach we pursue in the joint research project IMPRESS. Our consulting via research approach is based on the Design Research Methodology according to Blessing and Chakrabarti [1]. Specifically, we discuss the concept of an innovation chain. We also examine the project structure of the project IMPRESS with focus on research and consulting activities. Fourth, we show how our consulting via research approach led to the first results in the joint research project and give a brief outlook on upcoming project activities.

2. SMART SERVICES

Today's manufacturing companies are confronted with the opportunity for change from a pure product manufacture to a Smart Service provider [2]. The significant triggers are described by the two trends: digitalization and servitization [3]. The increasing information and communication technology are key aspects for the digitalization [4, 5]. In this context, there are two main developments which characterize the digitalization: Internet of data and services and Internet of Things [6]. A central aspect of the development of Internet of data and services is the

change from using a central computer towards the use of big data, cloud computing or smart devices. The progress of physical objects to embedded systems towards cyber physical systems results in the internet of things [6]. The servitization is basically defined as the process of creating value by adding services to products [7]. Whilst manufacturers run their business mainly with products, manufacturing service providers name services as their core business [8]. Figure 1 presents the convergence of the trends servitization and digitalization.

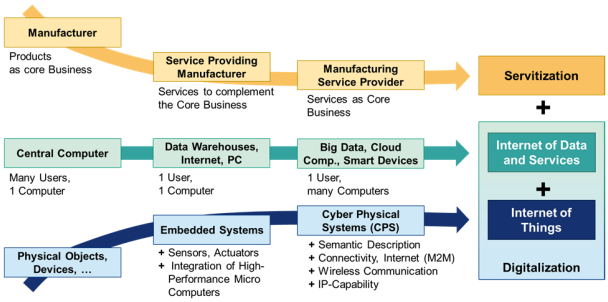

***Figure 1**: Converging two trends of servitization and digitalization inspired by Gausemeier and colleagues (2015), Schuh and colleagues (2004)*

The convergence of both trends enables new opportunities of hybrid market offerings, so-called Smart Services [9]. One of the first descriptions of Smart Services goes back to Allmendinger and Lombreglia. They defined Smart Services as a digital service which is connected to an intelligent and networked object [10]. In addition, Smart Services are digital services that create value based on the data of cyber physical systems [11]. The continuous collection and analysis of data create an added value for the costumer and provide both [12]. Another key aspect of Smart Services is the need of an own business model [13]. Moreover, there is an intelligent IT infrastructure needed to deliver Smart Services [12]. Based on the characteristics of Smart Services, manufacturing companies wide up their opportunities to generate new value creation. In today's market there are already some established Smart Services For an example. ThyssenKrupp offers predictive maintenance to reduce the downtime of their lifts. Another example for established Smart Services is the German agricultural machine manufacturer CLAAS. This company uses Smart Services to increase the efficiency of their agricultural machines [14]. However, as Smart Services are new forms of hybrid market offerings and go with a high complexity. Their implementation to successful business is challenging. The challenges in providing Smart Services are discussed in the following.

3. CHALLENGES IN PROVIDING SMART SERVICES

Since manufacturing companies aim for strong competitive positions, new market offerings like Smart Services must be provided efficiently. Therefore, a change in value creation may be inevitable. Manufacturing companies face highly complex challenges in transforming their value creation. Small and medium-sized companies in particular often lack sufficient competences and resources to implement Smart Services. Companies must regard collaborating with partners and opening their boundaries to implement and develop Smart Services. Smart Services definitely base on product data and are integrated into a complex socio-technical system of stakeholders and technologies as well. Due to the complexity of Smart Services, a multidimensional view of business functions, technologies, human resources and organizational aspects is indispensable [15, 16, 17, 18]. Koldewey and colleagues (2018) suggest a framework that includes the influencing variables on the value creation in the context of Smart Services shown in Figure 2.

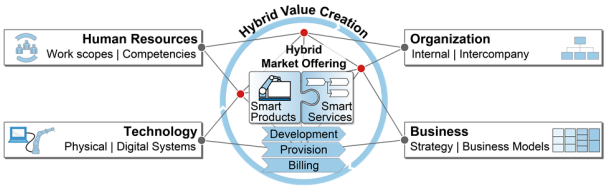

***Figure 2:** Dimensions for value creation in the context of Smart Services (Koldewey and colleagues 2018)*

The core of this approach is the hybrid market offering, divided into the elements of Smart Service and Smart Product. The main processes to generate value are the development, provision and billing of Smart Services. These are developed with the help of four dimensions: human resources, organization, technology and business. The discussed complexity of value creation in the context of Smart Services suggest a comprehensive view [14]. Taking these four dimensions for value creation in the context of Smart Services into account, Koldewey and colleagues (2019) introduce a framework for the planning of Smart Services [11]. It consists of nine elements that are arranged on the two levels of value offering and value creation (figure 3).

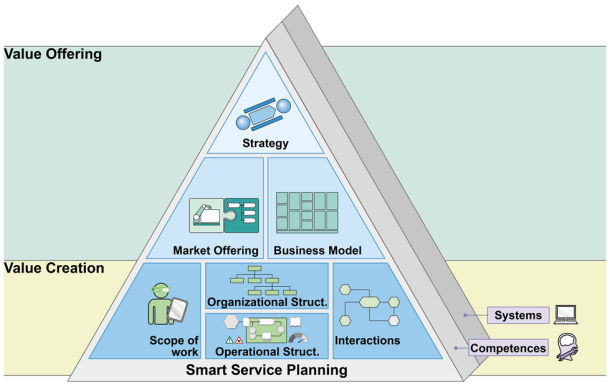

***Figure 3:** Framework for the planning of Smart Services according to Koldewey and colleagues (2019)*

Based on the future oriented business structure of the considered company, the Smart Service strategy is positioned at the value orientation level. The Smart Service strategy describes the general market offerings, which market will be focused and how the value is generally generated. In addition to that, a specific market offering as well as a corresponding business model are defined. The market offering includes the specific use case and the specific technical characteristics of the Smart Service and its required Smart Product as well. The business model describes the aggregated business logic and the way how companies create, mediate and account the market offering. The elements scope of work, organizational structure, operational structure and interactions are the content of the value creation level. The scope of work presents the necessary work content and conditions for the implementation of Smart Services. Companies' functional framework for the development, provision and billing of Smart Services is defined by the organizational structure. It consists of

concrete business processes for the development, provision and billing of Smart Services. Another important part for a successful Smart Service provider are cross-company relationships and indispensable interactions, e.g. collaborations in research and development. Within the planning process of Smart Services, the integration of data-based services into the present IT systems is a cross-sectional topic for companies. Furthermore, the new qualifications of competences are another cross-sectional topic to provision Smart Services [3, 14, 19]. The adapted framework for the planning of Smart Services is the basis for us to realize our approach for consulting via research within the conjoint project IMPRESS. This approach is explained in detail below.

4. SOLUTION: CONSULTING VIA RESEARCH IN IMPRESS

Research and industry are equally affected by the fundamental challenges mentioned above in providing Smart Services. The joint research project IMPRESS addresses these challenges holistically. The aim of the joint project IMPRESS is to develop a set of instruments for pattern-based planning of hybrid value creation and work for the provision of Smart Services. It will enable companies to shape the transformation independently and purposefully. Methods and tools based on solution patterns will be developed. These demonstrate proven partial solutions for the value creation and work in the context of Smart Services.

In order to achieve these goals, we therefore pursue a consulting via research approach within the joint research project. First, the Design Research Methodology according to Blessing and Chakrabarti is described as it is the basis of our approach [15]. Second, the specific adaption of the Design Research Methodology for IMPRESS is presented in detail.

The Design Research Methodology according to Blessing and Chakrabarti is divided into four phases: research clarification, descriptive study I, prescriptive study, descriptive study II. It should be noted that the procedure shall not be interpreted as a rigid and linear sequence of phases. Rather, it is an iterative procedure in which the various phases can be efficiently advanced in parallel and closely coordinated [1].

In the first phase a realistic and valuable research goal is formulated precisely. Based on a comprehensive analysis of the relevant literature, the theoretical foundation, the state of the art and the goal are defined. The definition of success criteria and the description of the procedure belong to the research clarification as well. The descriptive study I comprises the development of a detailed understanding and support requirements in theory and practice. In addition to in-depth research and analyses of the relevant literature, empirical data, e.g. through observations and interviews, is collected and analyzed. In this context, qualitative and quantitative research approaches can be applied. The prescriptive study deals with the systematic development of a methodological solution for the formulated research goal and the corresponding challenges. This step builds up on the expectations and experiences of the previous phase. Finally, the solution developed is evaluated in practice during descriptive study II. For this purpose, the usability and applicability of the solution is examined for concrete use cases based on empirical data and potentials for improvement are derived accordingly [1].

In the joint research project IMPRESS, we adapted the Design Research Methodology of Blessing and Chakrabarti. In order to cope with the various challenges of the transformation from product manufacturer to Smart Service provider, it is indispensable to directly involve companies from industry in the development of the set of instruments. We therefore installed a so-called innovation chain as a construct to optimally support the consulting via research approach.

Figure 4 shows the participants and their tasks within the innovation chain. The participants can be divided into four categories: research institutions, enabling companies, application companies and disseminators. In the following, the individual elements of the innovation chain will be described in general and in particular for the joint research project IMPRESS.

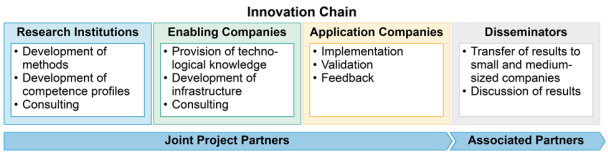

Figure 4: *Innovation chain of the joint research project IMPRESS*

In IMPRESS, the ten joint project partners cover the three main categories of the innovation chain: research institutions, enabling companies and application companies. Moreover, the broad transfer of the project results to industry is ensured by several associated partners which represent the disseminators.

On the one hand, the participating research institutions serve to scientifically the set of instruments in order to support the transformation process from product manufacturer to Smart Service provider. Specifically, they provide the application companies with business model patterns, organization patterns, competence profiles, methods etc.

On the other hand, the enabling companies contribute their technological knowledge and their practical experience to the project. This includes knowledge and experience in industrial data analytics, billing system development and (IoT) platform development. Hence, they provide the technological basis for the implementation of Smart Services.

The group of application companies includes four heterogeneous small and medium-sized companies with distinguishing use cases, company sizes and organizational forms. On their way to become Smart Service providers, they use certain elements of the set of instruments and build up on the technological basis of the enabling companies. In this way, they validate the set of instruments and provide qualified feedback for research institutions and enabling companies.

The associated partners are indirectly involved in the project. As so-called disseminators, they spread the findings gained in IMPRESS through two channels. First, associated application companies can make us of selected tools and methods of the set of instruments. Subsequently, the additional applications generate further feedback for discussing and improving the set of instruments. Second, networks are used to multiply the reach of the obtained results in the industry and to anchor them in the long term. In this way, more companies are enabled to execute the transformation from product manufacturer to Smart Service provider independently.

Based on the identified need for research, the participating research institutions formulated initial research objectives which marks the first iteration of the research clarification process. The objects were then discussed with the whole consortium. The feedback of the project partners from industry and further analysis of the relevant literature led to an improved formulation of the research objects. At the end of the research clarification process, the detailed project contents have been defined in the jointly coordinated project plan as well as an overarching realistic and valuable research objective: the development of set of

instruments for pattern-based planning of hybrid value creation and work for the provision of Smart Services.
Since our approach is based on the Design Research Methodology and takes both research and consulting into account, we organize the project in a matrix. It consists of cross-sectional projects (CP) and pilot projects (PP). Figure 5 presents the matrix organization of the joint research project IMPRESS and considers the interactions between CP and PP.

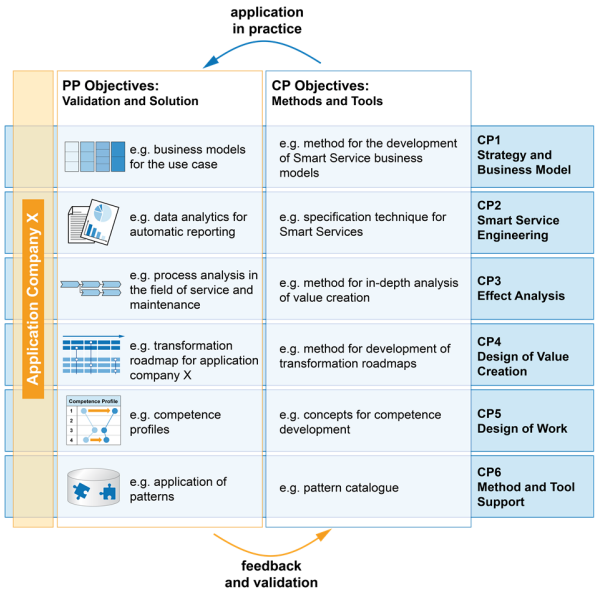

Figure 5: *Matrix organization of the joint research project IMPRESS – interactions between CP and PP*

The six cross-sectional projects serve to develop the set of instruments. They are mainly driven by the research institutions and the enabling companies. The set of instruments developed will be tested and validated for specific applications in the four corresponding pilot projects.
First, strategies and business models for Smart Services will be developed (CP1). Then technical solutions are developed taking into account the specifications of the strategy and the business model (CP2). Based on this, the effects on the value creation system and the working structure will be analyzed (CP3). Value creation and work are then designed in such a way that the previously identified need for action is taken up and implemented (CP4 and CP5). General solution patterns are derived from each CP and systematized in a pattern catalogue. Furthermore, a process model for the application of the patterns will be developed (CP6).
The development of the scientific results in the CP and the company-specific problem solutions in the PP take place interactively. Based on the problems of the companies and the scientific literature, requirements for the scientific methods are defined within the CP. The resulting methods are applied in the PP for the respective companies in joint workshops. Subsequently, the companies provide qualified feedback regarding the quality of methods and results. According to the pursued consulting via research approach, the feedback is then used in order to adapt and improve the methods and tools iteratively. The set of instruments will be made available to the general public during the project and beyond fostering further research and consulting activities in the context of Smart Services.

5. FIRST RESULTS

After one year of applying the consulting via research approach described above, we have already obtained first scientific results (see figure 6). These include a procedure for the development of Smart Services, a method for the iterative, pattern-based development of business models in the context of Smart Services and a quick check to identify relevant fields of action in value creation for the application companies. Our consulting via research approach is described in more detail below using the quick check as an example. Additionally, research and consulting challenges concerning the procedure for developing Smart Service strategies and the iterative business model development will be outlined.

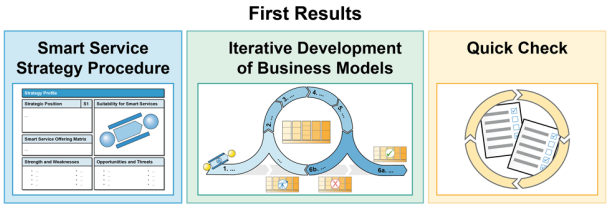

Figure 6: *First results achieved by consulting via research*

One central result of the joint research project is a so-called quick check. The aim of this instrument is to analyze the current value offering of a company in the dimensions strategy, market offering and business model using a catalogue of questions. As a result, relevant fields of action for the value creation of a company can be derived transparently together with the application companies for a further in-depth analysis.
First, the analysis of comprehensive literature regarding Smart Services and existing, thematically relevant quick checks such as the digitalization index (for small and medium-sized companies 2018) led to a large pool of smart service-specific transformation drivers. In addition, corresponding workshops with the application companies were conducted and evaluated. In this way, in accordance with our approach of the innovation chain, the application companies were actively involved in the identification of the relevant transformation drivers right from the beginning. On the one hand, important aspects from industry were considered, thus complementing the transformation drivers derived through pure research. On the other hand, the early integration of the application companies significantly increases the acceptance of the obtained results. In total, more than 120 transformation drivers were collected, which can be assigned to the three categories of strategy, market offering and business model.
Second, we developed a first version of the quick check. As a first step, the pool of transformation drivers had to be reduced in order to ensure the independent execution of the quick check by companies beyond the joint research project. For the selection of the transformation drivers, the experiences and findings from the previous scientific research and workshops with the enabling companies were used. The result was a list of about 40 central transformation drivers which affect the value creation and work of a company socio-technically. Then, we developed questions for each transformation driver in several iterations. Next, we aggregated the results to three questionnaires – one for each dimension of the value offering. In addition to the questions, the quick check allows companies to evaluate the relevance of each listed transformation driver. Together with the answers to the questions, this forms the starting point for the subsequent company-specific in-depth analyses.

Third, the resulting first version of quick check was applied at the next meeting of the whole consortium. The three questionnaires of the quick check were processed in heterogeneous small groups. Initially, the corresponding questionnaire or rather dimension (e.g. strategy) was presented. Then, the project partners completed the questionnaires individually. Subsequently, the quick check itself was intensively discussed and qualitative feedback was collected. This evaluation process enabled the enabling companies and especially the application companies to be actively involved in designing and developing this instrument alongside the research partners.
Subsequently, the feedback was used to revise the first version of the scientifically developed quick check. The previously selected transformation drivers were reviewed in detail once again and the design of the quick check was adapted according to the feedback. In further iterations questions were adapted, new transformation drivers were added, and less relevant drivers were removed. Afterwards, the quick check was conducted once again in a workshop together with each application company to analyze their respective value offering. On this occasion, we served as consultants for the application companies.
The revised quick check is a central result of the IMPRESS research project. The scientifically developed instrument, which has been tested in industry, can also be used outside the project by companies to support their transformation from manufacturer to Smart service provider. It therefore provides the basis for further consulting activities.
Moreover, the development and application of the procedure for deriving Smart Service strategies and the method for the iterative business model development posed further research and consulting challenges. In research and industry, the topic of a Smart Service strategy had not been addressed holistically or rather addressed at all. This points out the need for research to provide suitable consulting for companies [19]. In this regard, the main consulting challenge was to design the Smart Service strategy consistent to the overarching strategy of the respective application company. Therefore, we developed and documented the smart service strategies with the application companies interactively in subsequent workshops.
In fact, apart from the strategy definition, the implementation of Smart Services affects the business planning as well. It is necessary to consider several business models simultaneously and iteratively, since Smart Services are usually commercialized with specific business models [13], [14]. On the one hand, there was need for research for an iterative, Smart Service-specific business model development method. On the other hand, the heterogeneous application companies within the joint research project IMPRESS needed support in developing and evaluating business models for this new form of hybrid market offerings, although each to a different extent. In short, research need meets consulting need. Therefore, we build up on the pattern-based approach of the former research project GEMINI [20]. We adapted the existing business model patterns and complemented them with Smart Service-specific ones. According to our consulting via research approach, we used this patterns in joint workshops in order to develop initial business models for the application companies' individual Smart Service use case.
Finally, the three instruments can be compiled in an independent workshop format. First, the Smart Service strategy is discussed and documented (in a corresponding profile). Second, an initial business model for the respective Smart Service is derived. These steps form the basis for the successful execution of the quick check. The execution marks the third and last part of the workshop format we applied individually tailored for each application company in IMPRESS.

6. CONCLUSION AND OUTLOOK

The two megatrends digitalization and servitization lead to a profound change in the value creation and work in the manufacturing industry. The convergence of these trends is bringing data driven digital services, so-called Smart Services, into focus. However, the resulting systems of value creation and work differ fundamentally from the often historically grown systems established today. Together with the high complexity of Smart Services, these aspects complicate the successful implementation of Smart Services, especially for small and medium-sized enterprises. Consequently, research and consulting activities are needed in order to support the transformation of companies from product manufacturer to Smart Service provider.
With the paper at hand, we present a consulting via research approach to tackle these challenges effectively. First, we presented a framework for the planning of Smart Services which addresses the value offering and value creation. Second, we outlined our specific consulting via research approach based on the Design Research Methodology according to Blessing and Chakrabarti. In this context, we introduced the construct of an innovation chain to directly involve the industry in our research activities. Furthermore, we outlined the advantages of organizing the joint research in a matrix of cross-sectional projects and pilot projects. Third, we described how we obtained first results in IMPRESS using the quick check as an example. In conclusion, we can state that consulting via research is an effective way to cope with challenges equally affecting research and industry.
The joint research project IMPRESS will continue for another two years. The evaluation of the quick check or rather the questionnaires is the basis for the next research activities. With scientifically developed instruments in-depth analyses of the value creation and work of each application company will be carried out. Hence, we will continue to use the consulting via research in order to support the transformation process from product manufacturer to digital service provider.

7. SUPPORT

The research findings presented in this paper were conducted in the joint research project Instruments for pattern-based planning of hybrid value creation and work for the provision of Smart Services (IMPRESS). In addition to the University of Paderborn, 2 other research institutes and 7 mechanical and plant companies (enabling companies and application companies) are participating in the project. The IMPRESS project (funding code: 02L17B070) is/was funded by the Federal Ministry of Education and Research and the European Social Fund within the program "Innovations for tomorrow's production, services and work: the future of work" ("Innovationen für die Produktion, Dienstleistung und Arbeit von Morgen: Zukunft der Arbeit"). The joint research project is implemented by Project Management Agency Karlsruhe (PTKA). The author is responsible for the content of this publication.

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