Enabling companies to make use of industrial clouds - Foundations for Evidence-Based Engineering of Service Systems (Dissertation Proposal)

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Abstract

Cyber-physical systems (CPS) and their underlying technological manifestations have a deep impact on various industry sectors, e.g. manufacturing or logistics. The conjunction of machine intelligence with human intelligence together with the ubiquitous availability of data and vast opportunities for automation allow for new forms of service provision. To date, however, the lack of design knowledge on such architectures limits the opportunities for taking advantage of recent technological developments to engineer innovative service. Gaining this design-knowledge represents a challenge since value creation in the field of services strongly relies on their conceptualization as being contextual and collaborative. The complex socio-technical context of service systems and the central role of interactions among the participating actors are limiting the opportunities for meaningful research in laboratory settings. Hence, in order to generate design knowledge with strong validity, research has to be embedded within existing service systems or within the engineering of respective novel socio-technical entities. By this, evidence-based knowledge can be aggregated and instrumentalized for the design, implementation and evaluation of real-world service systems in the course of service systems engineering (SSE).

1 Introduction

Service engineering with its tools and methods primarily addresses the service economy. Over time, this economic sector is facing a set of changes in terms of content and structure (Hartmann, 2002). Services in the context of B2B or B2C relationships are in a state of flux and new forms of service provision are arising. A phenomenon contributing to these changing market environment deals with the rise of cyber-physical systems. Their technical architecture can be identified as one of the biggest factors influencing the service ecosystem (Zolnowski, Schmitt, & Böhmann, 2011). This specifically applies to their impact on industrial product manufacturers. By equipping industrial products with sensors and connectivity, manufacturers might still collect data from the equipment that is already sold which enables them to provide additional service (Herterich, Uebernickel, & Brenner, 2015b). In this sense, remote services, teleservices, or remote maintenance services facilitate monitoring and maintenance of industrial machines and whole plants by utilizing ICT (Holtbrügge, Holzmüller, & von Wangenheim, 2007). Moreover, the substitution of reactive services by proactive or even predictive approaches is fostered by data pooling and data analysis methods in order to calculate maintenance intervals and failure probability in the forefront of a potential breakdown (Muller, Crespo Marquez, & Iung, 2008). In the context of recent developments, open cloud platforms, so called industrial clouds, are utilized which provide smart data tools for data analytics, data visualization or business intelligence to multiple stakeholders. By contextualizing big data, which is per se non-descriptive, with additional domain information, smart data is generated (Siemens, 2014, 2015). These data sets bear high potential for innovating new services since they are based on evidence from real-world settings. Arising from this perspective, industrial clouds enable the aggregation of evidence for engineering new service systems.

Concomitant with these technologically connoted developments, also a shift regarding the underlying mechanisms of value creation becomes apparent. Due to increased interdisciplinary and complexity, more players are involved in product and service offerings, and the market and the ecosystem are getting more complex (Zolnowski et al., 2011). Service provision is increasingly manifested by cooperative service networks (Klostermann, 2008) where value is not only created in a dichotomy of provider and customer. In fact, in a multi-sided value logic, value creation takes place in the course of collaboration among multiple stakeholders (Benkler, 2006). This increased complexity in service provision constitutes a need for expanding its conceptual understanding. Thus, not merely concrete services, but rather complex service systems are the object of observation (K. Meyer & Böttcher, 2011).

The incorporation of industrial clouds in conjunction with the thereby precipitated increased complexity in service systems and networks requires input from disciplines and expertise outside the traditional service research arena. Here, the potential of theories from design science and engineering can be leveraged. An example in this context is systems engineering, which can be regarded as a promising approach for integrating IS expertise with other aspects of service design (Ostrom, Parasuraman, Bowen, Patricio, & Voss, 2015). Arising from this perspective, service systems engineering seeks to advance knowledge on models, methods, and artifacts that enable or support the engineering of service systems (Böhmann, Leimeister, & Möslein, 2014).

There is already a solid knowledge base on traditional service engineering which provides simple and easy to handle models, methods and tools (Bullinger, Fähnrich, & Meiren, 2003; Bullinger & Scheer, 2006; Fähnrich, Meiren, & Barth, 1999; Luczak, 2004) for engineering new services in a systematic way. However, these approaches do not take full advantage of the opportunities for systemic, interactive, and collaborative service innovation arising from the advances in ICT (Böhmann et al., 2014). Novel approaches face this challenge by setting up complex toolkits for engineering new services systems (Hermann, Ganz, & Westner, 2013; L.-P. Meyer & Meyer, 2013; Westner & Hermann, 2015). These approaches address industrial application contexts where services are developed professionally. Large firms can manage these processes by creating structurally separate business units whereas SMEs and traditionally oriented companies that want to make a shift towards providing services commonly suffer from limited slack resources so that only limited competence in this field can be maintained (McDermott & Prajogo, 2012). Therefore, companies with limited design knowledge in the field of service engineering are mostly not capable of making use of the value creation potential (Herterich, Uebernickel, & Brenner, 2015a) fostered by the rise of CPS, i.e. open cloud platforms.

Against this backdrop, novel work should seek to strike a balance between the two manifestations described above. Thus, there is a need for new models, methods and tools in the field of service systems engineering which are simple and easy to handle on the hand, but also make use of the recent developments in connection with CPS, i.e. industrial clouds. Guided by this, the following research question can be identified: Which models, methods and tools are suitable for making use of the incorporation of industrial clouds among companies with limited design knowledge in the field of evidence-based engineering of service systems?

2 Theoretical framework

In the course of contributions from Vargo and Lusch, a rethinking in service research is postulated and the idea of a systemic approach is propagated (Vargo & Lusch, 2004; Vargo, 2009). From a systems perspective (Kast & Rosenzweig, 1972), service systems enable value co-creation through the configuration of actors and resources (Vargo & Lusch, 2004).

In the context of industrial clouds, the underlying technological system predetermines the role of actors and resources. Based on that, a distinction in between data providers, cloud provider, and data receiver can be made. The roles of actors and resources, respectively the roles of service provider and user are changing according to the different value creation constellations. Based on this assumption, potential service providers shall be identified and enabled for engineering their service systems as a subsystem of the whole system. A framework will be developed as an initial foundation for further research and will be adjusted accordingly by applying the research methods mentioned in the further course.

3 Research Design

By applying action design research as a research method, design knowledge for engineering new services systems on the fundament of industrial data clouds will be aggregated. In order to aggregate this knowledge, three studies with respective focuses will be conducted.

The first study will consist of setting the stage for the use of industrial data clouds among various companies from various industry sectors and various degrees of knowledge in service engineering. Therefore, a state of the art review of industrial data clouds will be conducted with the aim of identifying various value creation constellations and according requirements concerning the use of the cloud infrastructure on behalf of the respective service provider. In a first step, a framework is created which incorporates all actors and relevant resources in the service ecosystem constituted by the cloud infrastructure. This framework is applied to various use cases of the industrial data cloud among companies which could potentially engineer new services in this environment. In the course of action design research, interviews with corresponding companies and workshops will be held. By this, a holistic and widely applicable model representing the whole service system shall be created iteratively. Furtheron, the framework will be used to determine emerging value creation potentials from the perspective of different actors in the whole service system. In order to ensure a broad transferability of the evidence generated, a widely applicable theoretical foundation, such as the work systems framework by (Alter, 2008, 2012) will be instrumentalized. By this, resulting partial service systems can be conceptualized as subsystems of the overall service systems derived from the cloud infrastructure and all of its incorporated actors and resources. Based, on that, inherent requirements for the use of industrial clouds will be aggregated from the respective value creation perspectives identified beforehand.

In the course of the second study, existing methods in service engineering will be identified, analyzed and evaluated in terms of their potential for engineering new service systems in the context of industrial clouds. Against this backdrop, a literature review will be conducted where methods are contrasted with the value creation constellations and according requirements identified beforehand. Based on that, a model for engineering service systems is set up. This model incorporates stages in which cloud-based tools can be applied in the course of evidence-based engineering. The approach determined in the course of action design research in the first study will be incorporated as an initial phase.

The core of the third study is to apply the service system engineering process developed beforehand in different value creation constellations. As mentioned above, the first study also depicts a phase in this process which determines the service system to be engineered by the respective service provider within the whole system constituted by the cloud infrastructure. Arising from various perspectives of value creation among the different companies involved, different requirements for the engineering process and according cloud-based tools are relevant. The resulting scenario-dependent service engineering processes are evaluated in a multiple case study setting in order to determine their applicability and to adjust them by means of action design research.

4 Research Contribution & Managerial Implications

The dissertation to be conducted will provide valuable contributions in this context. By applying a systemic perspective, services can be regarded as complex socio-technical systems, i.e. service systems. In the course of applying this perspective, crucial factors in terms of service provision, i.e. the integration of industrial clouds with the thereby induced increased complexity in the underpinning ecosystem, can be challenged. In this sense, besides generating evidence-based knowledge on real world service systems by recognizing the connectedness and complementarity of their elements, the aim of this work is to provide simple and lightweight models, methods, and tools for service systems engineering which are fully making use of recent developments in ICT, but also facing the challenges of multi-sided value co-creation. In the course of piloting service innovation within real-world environments, these models, methods, and tools can be created on the foundation of evidence-based design knowledge which promises a broad applicability. By formalizing the research findings, a valuable contribution to the approach of service systems engineering as a whole is accomplished.
In a managerial context, a valuable contribution is made in terms of enabling companies with only limited knowledge in engineering services in complex environments to extend their business opportunities. By providing an end-to-end guideline which helps to sensitize respective companies for the potential of making use of industrial clouds on the one hand and providing an easy to handle and scenario-dependent service system engineering process on the other hand, especially SMEs, which can be regarded as the backbone of the German economy, are capable of getting their share out of recent technological developments.

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