Smart Service Engineering: Promising Approaches for a Digitalized Economy

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Abstract. In our digitalized economy, many traditional service engineering models lack flexibility, efficiency and adaptability. As today's market differs significantly from the market of the late 20th century, service engineering models must meet different requirements today than they had to meet in the past. The present paper starts off by providing an overview of the requirements that modern service engineering models need to fulfill in order to succeed in today's economic environment. Afterwards, three promising models that meet several of these requirements will be introduced.

Keywords: Smart services, service engineering, requirements.

1 Introduction

Over the past decades, service engineering models have proven to be valuable aids for the design and implementation of new services. They guide companies through the different steps that they need to take when developing new service offerings, starting from the initial generation of ideas and concluding with the service's market entry and subsequent adjustments or improvements. A great variety of service engineering models has been developed in the past, and many of them have displayed practical benefits in different contexts and industries. However, today's service industry differs significantly from the service industry of the late 20th century when the first service engineering models were developed. One of the major factors inducing these changes has been the ongoing digitalization. While it has opened the door for numerous possibilities, it has also created multiple challenges. Among other things, the digitalization has led to an exponential rate of change in the way services are created and delivered [1, 2], and it has lowered the barriers of market entry and thus paved the way for stronger competition and an increased supply [3]. Consequently, companies must now differentiate themselves from competitors by continuously delivering innovative solutions that speak to individual customer needs.

Existing service engineering models often lack pace and are too inflexible to succeed in the face of today's ever-changing market situation. Many older models also require excessive temporal and material resources, which makes them highly inefficient. Service engineering models that want to succeed in today's market situation must be highly flexible and efficient, economic in their use of resources and align the entire development process with the needs of the customers [4, 5]. There are some promising approaches toward service engineering from recent years that may be able to succeed in the digitalized economy of the 21st century. The present paper introduces three promising service engineering models and examines how well each of them suits today's market situation. For this purpose, the requirements that service engineering models need to fulfill today will be summarized in the following section. Afterwards, three selected models, each of which meets several of these requirements, will be described and compared to one another.

2 Present-day requirements to service engineering models

As hinted at in the introduction, today's digitalized economy poses specific challenges to companies who seek to develop new service offerings. Consequently, service engineering models must meet different requirements today than they had to meet in the past. Instead of prescribing a detailed, but inflexible approach to the development of services, they must now provide a highly flexible, adaptable and efficient course of action, allowing companies to quickly develop prototypes and to rework feedback or changing customer or market requirements at any step of the development process. A comparison of recommendations from recent literature and trends in service engineering reveals three best practices for the development of new services. A further specification of these best practices results in seven requirements for modern service engineering models.

The first best practice, user centricity, pursues a **co-creative** approach in which the user is continuously integrated and their individuality considered in the design process. In a second step, a first prototype developed based on customer ideas can be introduced into a **feedback** loop until it meets user expectations. [6-8] The second best practice is using service ecosystems to enable companies to **collaborate** and thus profit from shared resources. Today's **digital** infrastructure facilitates and enhances this exchange. [4, 9, 10] The third best practice follows a resource-efficient agile mindset [11, 12] combining **adaptability**, i.e. the design process being customized to meet any changing requirements while value is constantly being measured, with a **lean** mindset and **cross-functional** development. Therefore, this approach allows for reduced waste and resources and a shorter time to market by developing minimum viable products. [13, 14] For further information, please refer to the paper "Service Engineering Models: History and Present-Day Requirements" by Senderek and Kuntz.

3 Promising new service engineering models

While many service engineering models do not meet the requirements summarized above, some recent models display multiple characteristics of innovative, modern service engineering. The following section presents three recent models and points out to what extent they meet these requirements. Each model emphasizes at least one of the three categories of best practices and can therefore be considered a promising approach to developing services in today's economic environment.

3.1 Smart Service Engineering

The first model to be presented here is Smart Service Engineering (SSE), an approach for the development of data-driven services developed by FIR at RWTH Aachen University. The model relies on speed and an early positive market impact for its success, and therefore focuses on an agile customer centric approach. It consists of three consecutive loops. The loops are not designed for a linear process, but for a flexible movement between different tasks and multiple iterations of the same loop as needed. While there is a perceived starting and finishing point, they don't need to be the first or last task to be performed. Instead, the tasks can be completed as the circumstances of each project call for.

The main goal of the first SSE loop is to develop a strategy for the company to follow throughout the service engineering process. First, the company needs to analyze its ecosystem, which includes a differentiation of competitors, an identification of key customer segments and a consideration of both the company's current and desired market position. The second task is the development of user stories, which represent typical application scenarios and provide insight into the customer's goals and actions. Following, the company can begin to formulate value hypotheses for its new smart service, which is the third task belonging to the first phase.

The second phase of SSE is the creation of a prototype. This loop allows the company to quickly test its ideas following the principles of a minimum viable product (MVP). The first task here is to define the service's core functions that are required for user testing. The second task is to develop the core functions before they can be tested with the user, which is the third task of the loop. Following these tasks, the company can ascertain the strengths and weaknesses of the new service regarding user satisfaction and rework that feedback into a new prototyping iteration.

The main goal of the third loop of the SSE model is to enter the market. The first task is to devise market entry strategies. Building upon the previously identified customer segments, the company can determine suitable sales channels and communication strategies. The second task to be performed here is to build up all resources required to deliver on a wide scale. The third task is to develop the business case for the new service, focusing on developing the cost structure and revenue streams to support the business model as well as consolidating the value proposition. [15]

3.2 Multilevel Service Design

The second service engineering model to be discussed here is Multilevel Service Design (MSD), which stresses user centricity and the integration of multiple digital interfaces in the service design process. MSD is clearly designed for the digital age as it makes direct references to digital channels at certain design activities. MSD follows an iterative process consisting of four consecutive steps. This iterative character of

MSD relates toward the individual tasks, as the model is designed to be executed in a linear fashion with a clear finish line in the form of the final task and outcome.

MSD begins the first step by a thorough examination of the customer experience. To this end, data is collected on three levels: the Value Constellation Experience (VCE), the Service Experience and the Service Encounter Experience (SEE). The ultimate goal of this step is for the company to achieve an in-depth understanding of the customer's desired experience on each level.

The second step is the design of the service concept. It begins by understanding the VCE, the collective co-created experience from all interactions between the customer and the service provider. Afterwards, the service concept is designed through the Customer Value Constellation (CVC), a construct that expands upon the VCE by putting the customer's given activity in the center and mapping all the services they rely on to fulfill said activity with their interrelations to one another. The CVC allows the company to analyze its surrounding service offerings and reflect on how it can reposition its service concept within this shared space to improve its position.

In the third step, the service system is designed. The first task here is to understand the customer's service experience, including his preferred interfaces and communication paths. Afterwards, the service system is designed with the help of the Service System Architecture (SSA) and the Service System Navigation (SSN). The company can thus easily view where it is active and add or remove elements of its service system to improve the service experience. In the design process, alternative service interfaces should be included without simply replicating service offerings on each interface. The SSN then adopts the SSA and describes how the customer may navigate through the service system, which allows the company to optimize the connections between the interfaces.

The final step is the design of the service encounter. Again, MSD begins with a comprehension task that aims at understanding the SEE. For each service encounter, the company analyzes how the customer interacts at each service interface to fulfill a specific service task. At this point, the critical experience factors, which can range from usability to interface aesthetics, need to be determined. Using this knowledge, the company designs the service encounter using the Service Experience Blueprint (SEB), a variation of the Service Blueprint by Shostack that captures each participant's actions in the service encounter, identifies service interface links and allows the company to enhance the SEE by exploring design alternatives. [16]

3.3 Design Thinking for Industrial Services

The third model to be introduced here is Design Thinking for Industrial Services (DETHIS). Apart from a service development model, DETHIS also includes a digital toolbox with practical Design Thinking methods that empowers SMEs to apply DETHIS without external help. DETHIS adopted the Design Thinking process by the HPI D-School [17] and added a phase at the beginning and at the end of the existing phase sequence. Hence, it consists of eight phases, each serving a singular purpose and including prescribed methods to complete it. Despite the seemingly linear outline, the model follows an iterative process which can be started or finished at any given phase.

Still, the process should be completed in the given order as this enables the Design Thinking mindset to be implemented successfully.

The first phase of DETHIS is the design challenge, during which the company defines what it wishes to accomplish. The design challenge forces them to obtain a more open and customer-centric perspective, which guarantees the company's chances of success as it initiates the subsequent Design Thinking process with the correct mindset. The second phase's goal is to understand the parameters of the problem at hand and to build empathy toward all stakeholders involved. This understanding is validated in the third phase, in which the company must observe and analyze the stakeholders closely.

In the fourth phase, the customer's point of view is defined. By incorporating all critical aspects of the customer's character into the persona, the company guarantees that it has a strong grasp of how the customer thinks and acts. In phase five, the company uses the previously established point of view to generate multiple ideas that address the customer's needs. The ideas are then clustered and weighed before the most promising one is selected for prototyping. In phase six, the prototype of the selected idea is created before it is tested with the customer in phase seven. All feedback is then reworked as need be. The last phase of DETHIS is an implementation phase, in which the broader implementation of the developed idea is planned out and integrated into the company. Given the iterative nature of the Design Thinking process, the steps described above may be repeated multiple times depending on customer feedback. [18, 19]

3.4 Comparison

The service engineering models described above can be examined with regards to the seven requirements for innovative service design presented in chapter 2. This comparison lays open the individual strengths and weaknesses of each model. A qualitative evaluation for each requirement reveals the degree to which each model reflects a given requirement compared to the other three models. The results can be illustrated with the help of Harvey Balls (see Fig. 1). The evaluation discussed below is thus of relative and indicative nature and aims at contrasting the three reference models only.

The first model introduced above is Smart Service Engineering. In terms of user centricity, SSE utilizes user stories to form value hypotheses. While this promotes a user centric mindset, it is limited to the functional needs of the user and does not delve deeper into the bigger picture. On the other hand, the prototyping cycle at the heart of this model allows for the speedy testing of development hypotheses and ensures the offering is constantly aligned with the user. This prototyping cycle makes SSE the most agile of the three models, as it directly adopts MVP best practices. Prioritizing the development of the MVP is also in line with lean principles. Additionally, the iterative cycles allow the model to maintain a consistent pace of development and easily adapt to changing parameters. However, SSE falls short when it comes to utilizing service ecosystems. The full potential of partnerships or new forms of resource combinations are not explored. SSE stresses the importance of cross-functional project teams, promoting the dissemination of knowledge and agile development practices. Moreover, the model was derived from case studies and collaboration with industry partners, who tested the model and validated its agile approach. Thus, SSE can be said to display a high practical relevance. [15]

	Requirement	SSE	MSD	DETHIS
User Centricity	**Cocreative** - Continuous user integration into design process - Users encouraged, empowered to innovate and add value - Offering is individualized for different users - Design of personal subjective customer experiences	◑	●	●
	Validated - Hypotheses constantly tested and aligned with user - Constructs fixed feedback channels	◕	●	●
Service Ecosystems	**Collaborative** - Utilizes internal and external resources - Offering is designed as service platform - Value is created in combination with other actors - Shares knowledge and removes company boundaries	◑	◕	◑
	Digital - Integrates complementary data for deriving user insights - Exercises multichannel service delivery - Applies modular architecture in offering's design	◔	◕	◔
Agile	**Adaptable** - Pivots to meet changing requirements - Progresses in iterative consistent development cycles - Value continuously measurable during development	◕	◔	◑
	Lean - Output oriented, adopting rapid MVP prototyping cycles - Prioritizes working prototype over thorough documentation - Prioritizes resources for creating measurable customer value	●	◔	◕
	Cross-Functional - Employs multidisciplinary self-organizing project teams - Upholds constant communication between all functions	●	◕	●

Fig. 1. Comparison of the three selected models

The second model introduced above is MSD, which particularly shines in its user centricity. The model simultaneously identifies other actors within the user's value constellation that can be partnered with to improve the offering. At the same time, this analysis provides the model with the insights into the types of interfaces that best suit the user, allowing it to adapt its forms of service delivery. MSD is cross-functional in its use of interdisciplinary methods such as the Service Experience Blueprint for the development process. However, the use of cross-functional teams is not explicitly mentioned. The main disadvantage of the MSD model lies in its limited adaptability. By basing the model on fixed interdependent methods of service design, it leaves little room for companies to improvise or adjust the design process. Its practical implementation in different industry contexts does, however, speak for its utility in practice. [16]

DETHIS builds on a Design Thinking approach and therefore excels in its user centricity. The entire process is based on understanding the user's inherent needs and emotional drives, which puts DETHIS in a strong position to create resonant personal user experiences. Furthermore, it adopts an early and iterative prototyping and testing approach in order to validate its hypotheses and create measurable customer value. The

Design Thinking technique promotes creativity and collaboration among multiple disciplines, thus, benefiting from cross-functional knowledge and expertise. DETHIS, however, does not include any references or methods for utilizing service ecosystems. Indeed, it suggests conducting a stakeholder analysis in the early stages of understanding the user, yet this is not capitalized on later by other methods. [18]

4 Outlook

While many old service engineering models are no longer suitable for today's economic environment, there are some recent approaches to service engineering that might be suitable solutions for the challenges of the digital age. These newer models focus on user centricity, make use of service ecosystems and incorporate an agile mindset. All three models presented above meet several of the requirements for modern service engineering models, and some of them have been successfully tested in practice. They can therefore be considered promising approaches toward developing new service offerings in the complex and digitalized economy of the 21st century.

5 Acknowledgment

This research and development project project Digivation constitutes the superordinate project of the funding line Service Innovation Based on Digitization and is funded by the German Federal Ministry of Education and Research within the research program Innovations for Tomorrow's Production, Services and Work under the registration number 02K14A221 and managed by the Project Management Agency Karlsruhe (PTKA). The author is responsible for the contents of this publication.

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